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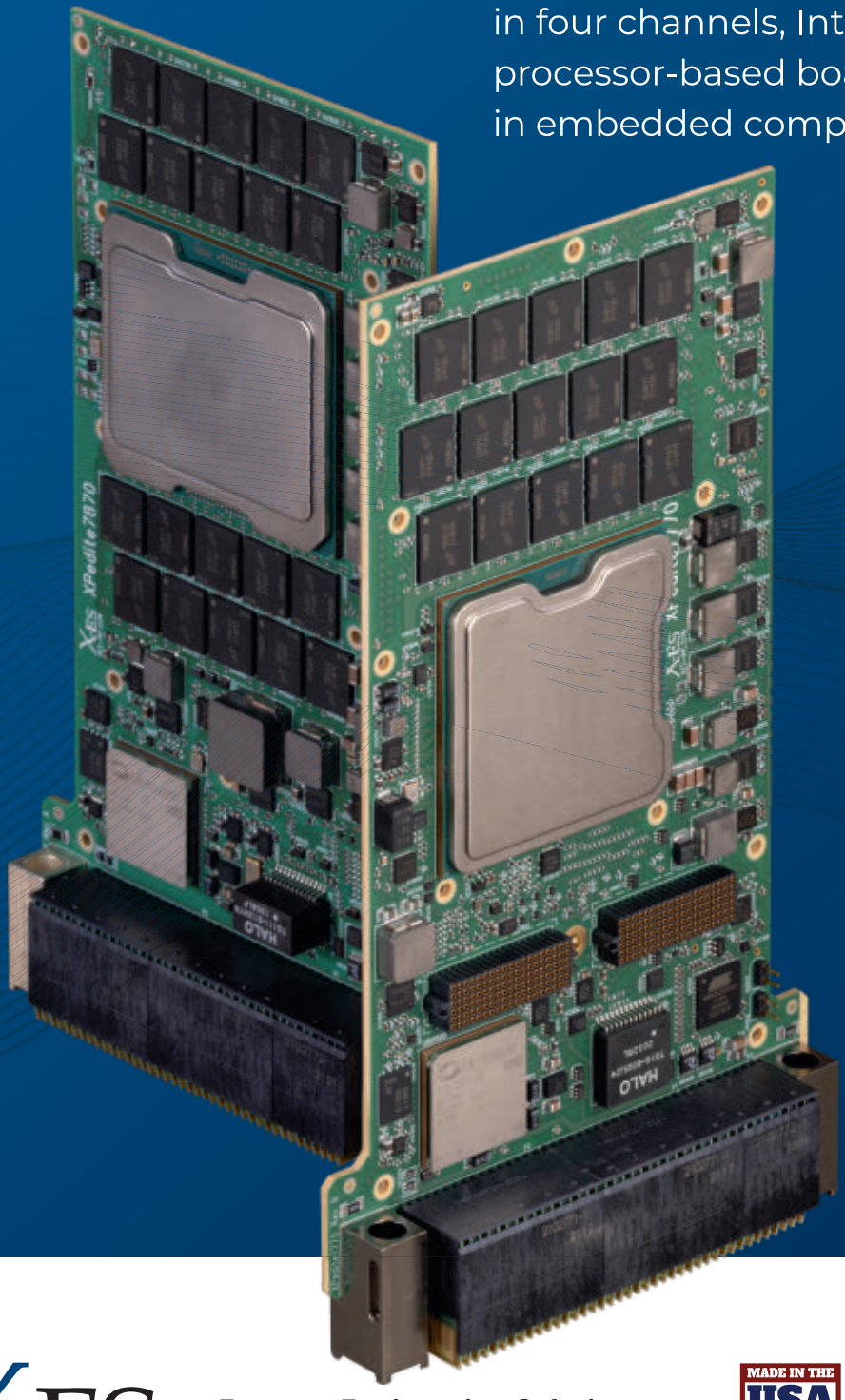

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Foundational research work is in progress to make next-generation electromagnetic weapons a reality

BY **John Keller**
EDITOR IN CHIEF

One of the next frontiers of U.S. military weapons development involves electromagnetic warfare — or the ability to destroy or disable enemy computers, guidance systems, communications, sensors, and other electronics using high-power microwaves.

This type of weapon could enable military commanders disable the enemy's ability to fight effectively, while limiting collateral damage from conventional bombs and missiles that kill civilians and disrupt civil infrastructure like transportation, water supplies, and medical care.

A group of experts impaneled by the Air Force last year reported that by 2060 — within the next four decades — that given the right technology investments, directed energy weapons will be placed on manned and unmanned aircraft, as well as on satellites, that can track a target and then fire an energy pulse to damage or destroy it.

Just last month, the U.S. Air Force Research Laboratory at Kirtland Air Force Base, N.M., issued a broad agency announcement for the High Power Electromagnetics (HPEM) Empirical Effects project, which seeks to perform vulnerability testing on several electronic systems to determine the effectiveness of potential high-power electromagnetic weapons.

This work will include capturing effects and waveform data, identifying new targets, developing surrogate electronic systems for testing, purchasing representative electronic subsystems, developing fault trees, building probability of effect curves for the electronic subsystems, and planning outdoor effects tests to characterize electromagnetic weapon effectiveness.

Earlier this year the Air Force Research Lab kicked off the High Power Electromagnetics (HPEM) Modeling and Effects project to model and simulate the effects of electromagnetic warfare in destroying or disabling enemy electronics, improvised explosive devices, unmanned aircraft, and similar systems. This project seeks to characterize the effectiveness of potential HPEM weapons by developing tools and generating vulnerability data to feed those tools. Last July the research lab at Kirtland Air Force Base began the Advanced Electromagnetic Technology (AET) project to develop new HPEM weapons concepts, materials, components, and compact power topologies for future military programs, and to evaluate advances in prime power technologies to optimize size, weight, and power (SWaP) requirements for future HPEM weapon systems.

The five-year AET project revolves around six enabling technologies: repetitive pulsed power; charged particle beam interactions; compact low-duty-factor prime power HPEM material and plasma technology; HPEM fundamental research; and solid-state-HPEM.

Repetitive pulsed power seeks to advance compact pulsed-power technologies that enable compact, pulsed power systems suitable to drive high-power electromagnetic sources.

These enabling technologies include Marx banks, pulsed forming networks, pulse forming lines, linear transformer drivers, hybrid pulsed power topologies, nonlinear transmission lines, solid state switches, gas switches, capacitors, transformers, insulating dielectrics, varactors, resistors, magnetic and dielectric conducting and structural materials.

So it's clear that deployable electromagnetic weapons aren't here yet, but much of the foundational work necessary to bring these weapons to fruition already is being done in research projects that are in progress.

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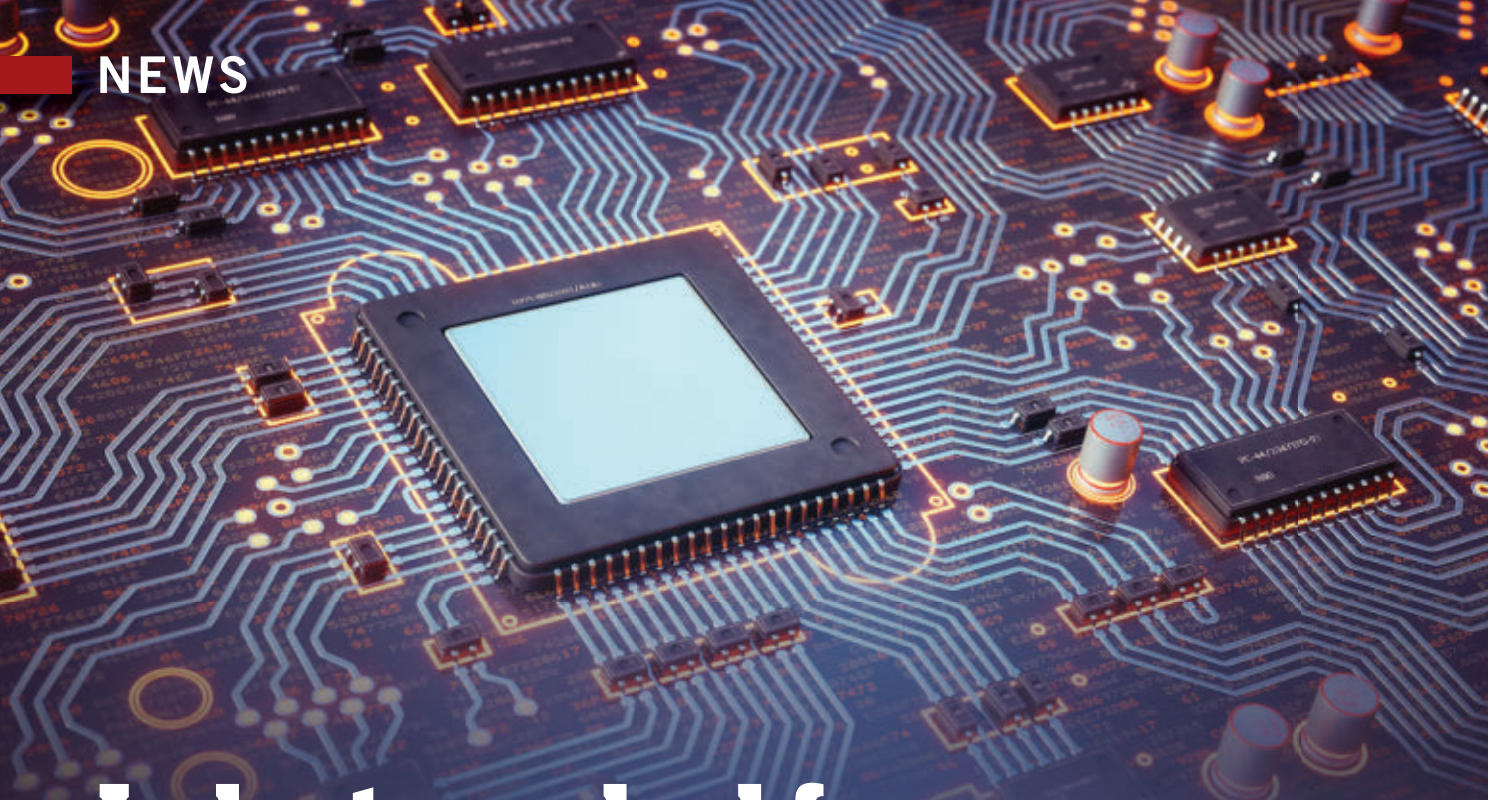

Industry asked for advanced microelectronics for machine autonomy and sensor processing

BY John Keller

ARLINGTON, Va. – U.S. military microelectronics experts are reaching out to industry for enabling technologies in four areas: embedded microsystem intelligence and localized processing; next-generation front-end component technologies for electromagnetic spectrum dominance; microsystem integration for increased functional density and security; and disruptive defense microsystem applications.

DARPA wants alternatives to large, costly optical and RF systems such as new fabrication technologies and next-generation positioning, navigation, and timing (PNT) technologies.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) Microsystems Technology Office (MTO) have released a broad-agency announcement (HR001122S0030) for revolutionary research ideas for these topics, which sometimes are not addressed by MTO programs or solicitations.

Since its inception in 1991, MTO has helped create and prevent strategic surprise through investments in compact microelectronics components such as microprocessors, microelectromechanical systems (MEMS), and photonic devices.

These technologies have led to applications in wide-band-gap materials, phased array radars, high-energy laser weapons, and infrared imaging.

MTO seeks to develop high-risk, high-reward technologies that help prevent strategic surprise, secure U.S. military technological superiority, and address complex national security threats.

Embedded microsystem intelligence and localized processing seeks to develop self-tuning, self-optimizing, and mission reconfigurable systems with low size, weight, power, and cost (SWaP-C).

This includes advances in artificial intelligence (AI) and machine learning processors, graphic processing units (GPUs),

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machine autonomy, and other special-purpose computer technologies for sensors for the tactical edge and microsystems capable of learning. One area of particular interest is improved cognitive electronic warfare (EW).

Next-generation front-end component technologies for electromagnetic spectrum dominance involves military command, control, communications, computing, intelligence, surveillance, and reconnaissance (C4ISR) and EW systems. This involves material, device, and circuit approaches that provide leap-ahead performance in sensing and modulation for RF, active and passive photonic, electro-optical and infrared (EO/IR), and magnetic-field applications.

MTO experts also are pursuing alternatives to large, costly optical and RF systems such as new fabrication technologies and next-generation positioning, navigation, and timing (PNT) technologies.

Microsystem integration for increased functional density and security involves 3D heterogeneous integration at multiple length scales. Fine-scale integration will bridge the technical gap between traditional assembly technology and the lithography-defined back-end-of-the-line dense interconnects, and complex circuits and systems-on-chip (SoC).

Potential applications include next-generation electronic design automation (EDA) tools, new approaches ensure secure and trusted microsystems, and microsystem thermal management technologies.

Disruptive defense microsystem applications seeks to identify and demonstrate innovative microsystems component technologies, and hasten the adoption of advanced microsystem technologies and enable future military C4ISR, EW, and directed energy systems for electromagnetic warfare.

Topics of interest include advanced RF and EO/IR filters and related front-end components; imaging systems; photonic and electronic interconnects; atomic physics; chip-scale sensors; cold-atom microsystem component technologies; cognitive and advanced EW; compound semiconductor-based electronics; architectures and algorithms for next-generation artificial intelligence; directed energy component technologies; electro-optical/infrared (EO/IR) technologies; and electronics and micro sensors for harsh environments

Also of interest are hardware assurance, reliability, and validation; heterogeneous integration technologies; high-energy laser and microwave technologies; low power electronics; low temperature electronics; low-volume microsystems manufacturing and assembly; materials for next-generation microelectronics; metrology and manufacturing tools for multi-chip packaging; microelectromechanical system technology; microsystem design; microsystems for PNT and RF and optical transceivers; mixed-signal electronics; tools for virtual prototyping; photonic devices; processing for imaging and spectral recognition; signal processing algorithms to reduce hardware requirements; and thermal management of microsystems. ←

Companies interested should upload abstracts no later than 6 Jan. 2024, and proposals no later than 16 March 2024 to the DARPA BAA website at https://baa.darpa.mil. Email questions or concerns to DARPA's Mark Rosker at HR001122S0030@darpa.mil. More information is online at https://sam.gov/opp/744ab14c6e0448fd82c6b5730740610c/view.

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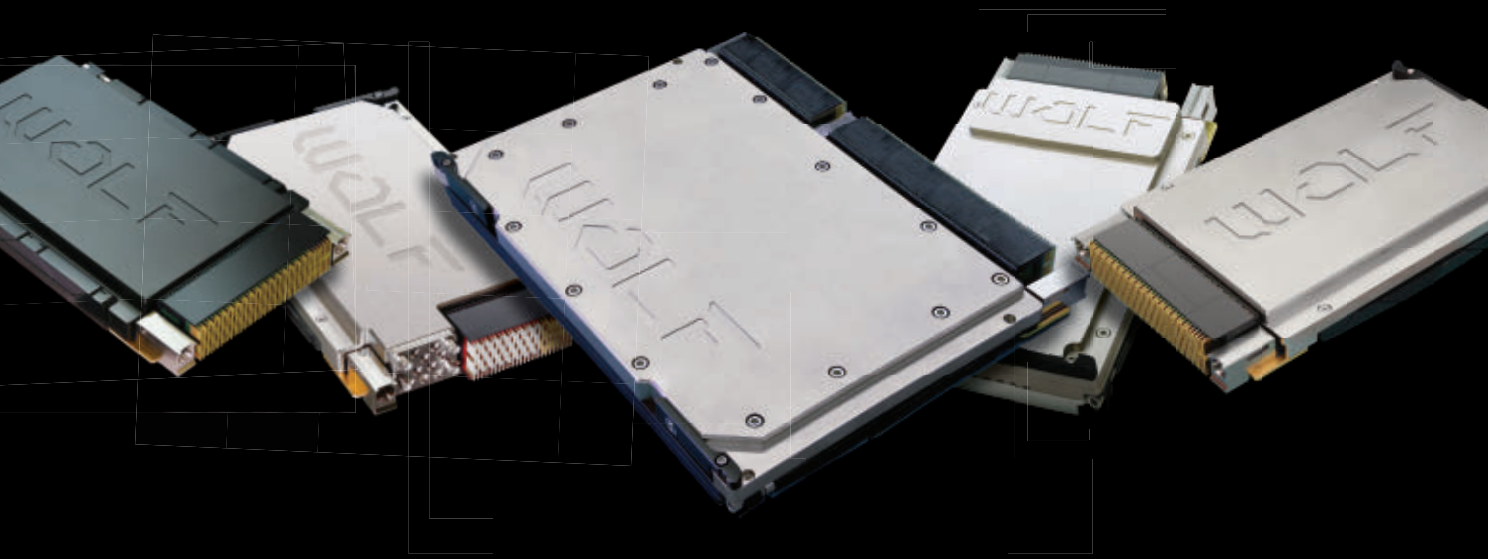

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FAA seeks to replace older analog communications equipment

The U.S. Federal Aviation Administration (FAA) has announced its intention to acquire new analog Very High Frequency (VHF) Maintenance Communications Transceivers (MCT) through a Blanket Purchase Agreement (BPA). Through the BPA, the FAA will acquire both handheld and mobile MCT configurations. Included in this acquisition will also be transceiver accessories such as microphones, speakers, antennas, battery chargers, spare replacement parts, and other related accessories. The primary objective of the MCT is to provide FAA Technical Operations System Support Specialists the ability to communicate via analog voice communications with Air Traffic Controllers, Flight Check Aircraft and other personnel. The MCT will replace an older generation of MCT operated Double Side Band Amplitude Modulation (DSB-AM) mode transceivers that only operate in the 25 kHz DSB-AM mode. The FAA is stressing that this BPA is not a contract. A BPA is an agreement between FAA and the contractor that allows the FAA to place future orders more quickly by identifying terms and conditions applying to those orders. This acquisition is limited to the acquisition of MCT radios manufactured by Icom Inc. - specifically the Icom A25N (handheld radio) and the Icom A120 (mobile radio) along with accessories and repair services. For more information, please contact Jorge R. Martell of the FAA at Jorge.R.Martell@faa.gov.

Lockheed Martin to build AN/TPQ-53 counter-fire radar

Radar experts at Lockheed Martin Corp. are moving to full-scale production of the company's AN/TPQ-53 counter-fire radar to detect, classify, track, and pinpoint enemy drones and incoming artillery shells without posing a risk to nearby aircraft and military forces. Officials of the U.S. Army Contracting Command at Aberdeen Proving Ground, Md., announced a $3.3 billion five-year contract to the Lockheed Martin Rotary and Mission Systems segment in Liverpool, N.Y., for AN/TPQ-53 radar systems for U.S. allies. The so-called Q-53 is a solid-state phased array radar that detects, classifies, tracks, and determines the location of enemy indirect fire weapons like rockets, artillery shells, and mortars in either 360- or 90-degree modes. This system is replacing the aging U.S. Army AN/TPQ-36 and AN/TPQ-37 medium-range radars. The contract

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includes spare parts and services. Lockheed Martin builds the Q-53 radar in Liverpool and Owego, N.Y.; Moorestown, N.J.; and Clearwater, Fla.

TSA debuts state-of-the-art checked baggage inspection system at Long Beach Airport

The U.S. Transportation Security Administration (TSA) has completed certification on an upgraded and automated checked baggage inspection system to screen the checked luggage of travelers departing Long Beach Airport (LGB) in Long Beach, Calif. The new system was installed at the same time as a new ticketing lobby, which opened to passengers on May 4. The checked baggage inspection system features a network of conveyor belts that sorts and tracks checked luggage, and moves it from the airline ticket counter, through security screening, and to the aircraft for loading. By law, TSA must screen all checked luggage for explosives and other security threats.

Lockheed Martin to provide Trident nuclear submarine-launched ballistic missiles

Strategic weapons experts at Lockheed Martin Corp. will build additional UGM-133A Trident II D5 submarine-launched nuclear ballistic missiles and support deployed D5 nuclear weapons under terms of a $396.7 million order. Officials of the U.S. Navy Strategic Systems Programs (SSP) office in Washington are asking the Lockheed Martin Space Systems segment in Titusville, Fla., to provide for Trident II (D5) missile production and deployed systems support. The Trident II D5 is one of the most advanced long-range submarine-launched nuclear missiles in the world. It is the primary U.S. sea-based nuclear ballistic missile, and is deployed aboard U.S. Navy Ohio-class ballistic missile submarines. The U.S. Navy operates 14 of these ballistic missile submarines, each of which can carry as many as 24 Trident II missiles. Although the Trident II is designed to carry as many as 12 multiple independently targetable reentry vehicle (MIRV) warheads, current treaties reduce this number to four or five. The Navy started the D5 Life Extension Program in 2002 to replace obsolete components using as many commercial off-the-shelf (COTS) parts as possible to keep costs down and to enhance the missile's capability. Draper Lab is in charge of upgrading the Trident II's guidance system.

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U.S. military moving forward on Hyper Weap

Sensors, navigation and guidance, ruggedization, thermal management, sensors, and other enabling technologies hypersonic flight are coming into line for future weapons test and deployment.

BY Megan Crouse

Hypersonic missile development continues around the world as militaries jockey to be the fastest threat. Hypersonic — typically considered faster than Mach 5, or 3,836 miles per hour — remains a hotly contested area. Fast enough to offer an adversary only a matter of seconds of reaction time, these are the subject of intense competition and counter-competition, albeit still in early stages. These missiles have the ability to maneuver under their own power on approach, and come in generally two categories: hypersonic glide vehicles, which launch from a rocket and glide from there, or hypersonic cruise missiles, which activate a scramjet after reaching supersonic speeds.

They've also kicked off some speculation as to whether American efforts should shift away from large expensive aircraft carriers that would be the weapons' likely targets. However, some of the projects are themselves intended to fit on vehicles aboard aircraft carriers. The degree to which hypersonic weapons are adopted in the future depends on a variety of technological limitations today.

sonic ons

Photo: The October SRM test was part of the Navy's Conventional Prompt Strike (CPS) offensive hypersonic strike capability and the Army's Long Range Hypersonic Weapon (LRHW).

Regardless of opinion and limitations, industry is mobilizing to make super-fast missiles work. What is being worked on today, and what is coming next? In 2021, the U.S. Department of Defense (DOD) named hypersonic weapons and counter-hypersonic capabilities as the highest technical priorities for the nation's security, say Raytheon Missiles & Defense personnel involved in one of the DOD projects. The Biden administration requested $7.2 billion for long range fires, including hypersonic missiles, in the 2023 defense budget. According to a 2021 report from the Government Accountability Office, the country's 70 efforts related to hypersonic weapons are expected to cost nearly $15 billion between 2015 and 2024.

A selection of current projects

Of those 70 efforts, we'll highlight a few of the more high-profile projects. In the Navy, the Conventional Prompt Strike project is based on the ability to deploy a missile around the world in less than an hour. The Navy is working with the Lockheed Martin Space Systems segment in Littleton, Colo. on a $22.8 million contract to integrate hypersonic weapons on board three stealthy Zumwalt-class (DDG 1000) destroyers.

As well as wanting to have the infrastructure in place for weapons that can handle high-value or fleeting targets quickly, the project also has as a stated goal to "increase today's industrial base capability for Navy and Army long-range hypersonic weapons [and] build ready-to-fire hypersonic weapons with diameters larger than 30 inches." Integrating the weapons system with the ships will require building an advanced payload module with weapons in a three-pack configuration, interfaces between the ship and the weapons, support structure, protection, compressed-air ejectors and environmental control. This follows up on a sources-sought notice from 2021.

The Conventional Prompt Strike project shares a hypersonic glide vehicle with the Army's Long-Range Hypersonic Weapon project, while the Air Force is working on the AGM-183 Air-Launched Rapid Response Weapon (ARRW) and the Hypersonic Attack Cruise Missile.

At the same time, Raytheon Missiles & Defense, Northrop Grumman Corporation, the U.S. Air Force and DARPA continue to work together on the scramjet-powered Hypersonic Air-breathing Weapon Concept (HAWC). Raytheon declared the first test flight a "history-making moment," with the missile dropping from the wing of an aircraft before activating a solid rocket motor and then the scramjet to push it to hypersonic speeds.

"Decades of learning advanced manufacturing techniques and industry partnerships helped us define what is now possible," said Dan Olson, vice president and general manager of the Weapon Systems Division for Northrop Grumman, in a press release.

The ARRW project has missed a few deadlines so far. It was supposed to reach early operational capability in October 2021, according to CNN. Instead, it was postponed for up to a year due to "recent flight test anomalies," said an official Air Force statement.

Last year we covered the intriguing but short-lived Screaming Arrow Innovative Naval Prototype program from the Navy. Cancelled in April 2021, it was since quietly revived in August 2021, but remains a subject of some confusion. This program calls for an anti-ship hypersonic weapon small enough to fit on a Super Hornet multirole fighter plane.

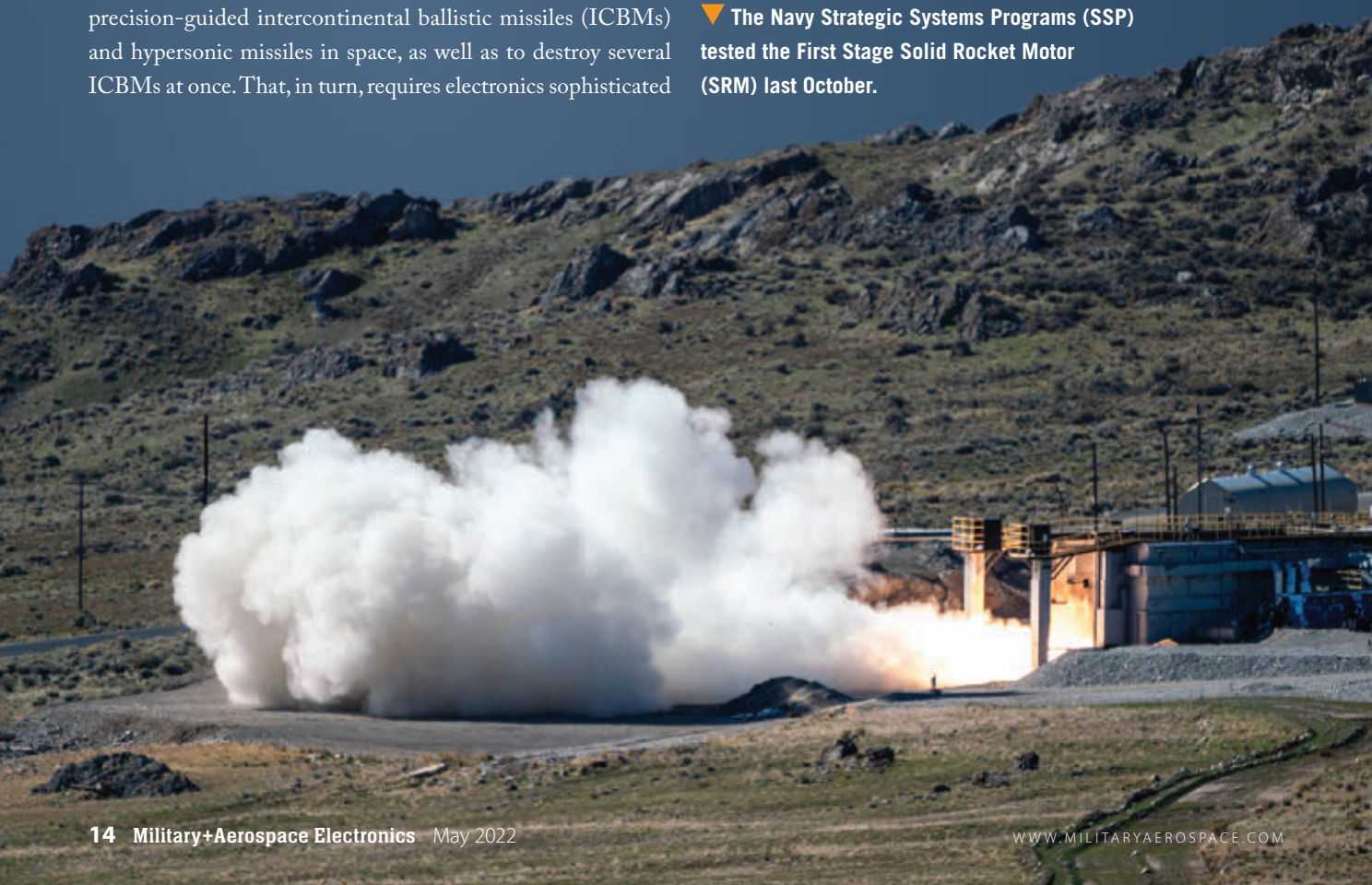
At the same time, the U.S. is working on anti-hypersonic missile defenses such as the U.S. Next-Generation Interceptor (NGI) and others. The NGI's goal is to defend against high-speed, precision-guided intercontinental ballistic missiles (ICBMs) and hypersonic missiles in space, as well as to destroy several ICBMs at once. That, in turn, requires electronics sophisticated enough to determine threats from decoys, or to track multiple threats. The DOD has invested in a variety of proposed defenses, all still in progress.

Another forward-looking effort is the U.S. Air Force's Mayhem project. While details are under strict lock and key, public information states that it seeks developers for a large air-breathing missile with a standard payload interface. We do know it focuses on extendable multi-mission intelligence, surveillance, and reconnaissance (ISR) and strike capabilities. Proposals were due by May 24.

"We don't expect hypersonic standardized payload interfaces to be substantially different from those that have come before, except for the addition of the hypersonic-unique environments, such as thermal loading," says Michael Gay, Engineering Fellow, Raytheon Missiles & Defense. "A key element of such interfaces would be implementation of Open System Architecture elements to ensure that the interfaces are well defined and extensible as both platform and payload capabilities evolve."

An important distinction in this field is that the U.S. is not focusing on designing hypersonic missiles to be used with a nuclear warhead, although Russia and China potentially could arm theirs with such, notes a 2022 Congressional Research Service report.

▼ The Navy Strategic Systems Programs (SSP) tested the First Stage Solid Rocket Motor (SRM) last October.



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Technical limitations around extreme heat

Engineering and manufacturing for hypersonic vehicles is still a relatively new niche. Randy Brodsky of Primus Aerospace in Lakewood, Colo., notes in a blog post that hypersonic vehicle manufacturing only has kicked into high gear in 2018, and still faces some infrastructure challenges. On the other hand, ground work has been laid by efforts like the Conventional Prompt Global Strike (CPGS) program in the early 2000s.

Development in this area is challenging because of the ultra-high-precision and complex machining required for manufacturing, Brodsky wrote. Linear, positional and circular dimensions require tolerances in the thousandths and millionths of an inch for many hypersonic components.

"At hypersonic speeds, friction and air resistance create an incredible amount of heat, which needs to be managed through tough but lightweight heat shields and thermal protection systems," wrote Scott Greene, executive vice president of Lockheed Martin Missiles and Fire Control, and Richard F. Ambrose, executive vice president of Lockheed Martin Space, in a blog post. "Instruments, like sensors and electronics, must also be equipped and protected to stand up to these extreme conditions."

Exotic materials often are required for the heat and other performance conditions experienced at hypersonic speeds, leading the military to seek new supply chains for component makers, such as carbon composite producers. Overall, supply chains still need to be solidified in this area, according to the 2020 Institute for Defense and Government Advancement white paper Hypersonic Weapons: Technical Challenges and Emerging Opportunities.

"Managing extreme heat and speed requires inventing and deploying new solutions, advanced materials and composites that can withstand extreme environments," Greene and Ambrose say.

When it comes to electronics in hypersonic missiles, the vehicle faces the most extreme heat at the leading edge in the final descent. The military and contractors have been trying to solve the problem of cooling this area for decades. Common ways to solve this problem include conduction cooling and heat pipes, often at the same time. Naturally, it's a little more complicated than installing a fan in a home computer. This is true whether you're working with a missile or a passenger plane.

"In hypersonic flight the challenge comes from both directions: thermal protection systems are implemented to limit the high surface temperatures of the airframe structure from entering into the cabin space, and passive thermal management schemes to capture the self-generated heat produced by the electronics," Gay says.

At Mach 6, that temperature can reach up to 1,200 degrees Fahrenheit. "The two sources of heat results in a challenging equation to keep electronic systems operating within their capabilities," says Gay.

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Studying flight turbulence

This March, NASA launched a hypersonic stress test that has been more than a decade in the making. The Air Force's Office of Scientific Research (AFOSR) Boundary Layer Transition and Turbulence (BOLT II) was the successor to a 2008 project which never got off the ground. However, the March 2022 flight provided important new information about the behavior of a hypersonic vehicle at the 'boundary layer transition location,' a state observable in the study of fluid dynamics. Most of the heating on the vehicle will concentrate here. Put simply, this layer also marks the path where airflow changes from calm and laminar to turbulent.

"When turbulent, more of the frictional energy of the particles gets pulled down to the vehicle surface. This added energy to the wall can lead to excessive surface heating that make or break a vehicle design," says Scott Berry, NASA principal investigator for the roughness experiment for BOLT II, in a NASA news announcement.

"The desire is to be able to tailor the boundary layer to be laminar everywhere, but turbulent just ahead of the engine as flow separations within an engine are likely and more catastrophic if laminar," says Berry.

The challenges of sensor design

What about sensors, navigation and guidance for hypersonic flight specifically? Gay expressed interest in new approaches to electrical power generation which could make the vehicle somewhat 'regenerative' in the same sense as an electric or hybrid commercial car.

Specifically, he says, people are working on how to "capture the by-products of hypersonic flight in order to provide the power needs of an electrical system."

"Missiles have multiple consumers of on-board power, and these needs are only increasing over time," Gay says. "A simple analogy would be an electric vehicle: a basic factor in how far one can drive is the amount of energy stored in the batteries before you start. Regenerative braking is a method to capture a by-product of driving to create energy that can extend the range. In hypersonics people are starting to consider how the high heat generated by flight can be used as a power source to augment or even replace conventional batteries."

Some of the basic subsystems likely always will be the same as those on a ballistic missile, although the propulsion is very different. The subsystems that need to be integrated include:

- a power source;
- a computer;
- sensors (including ones which can

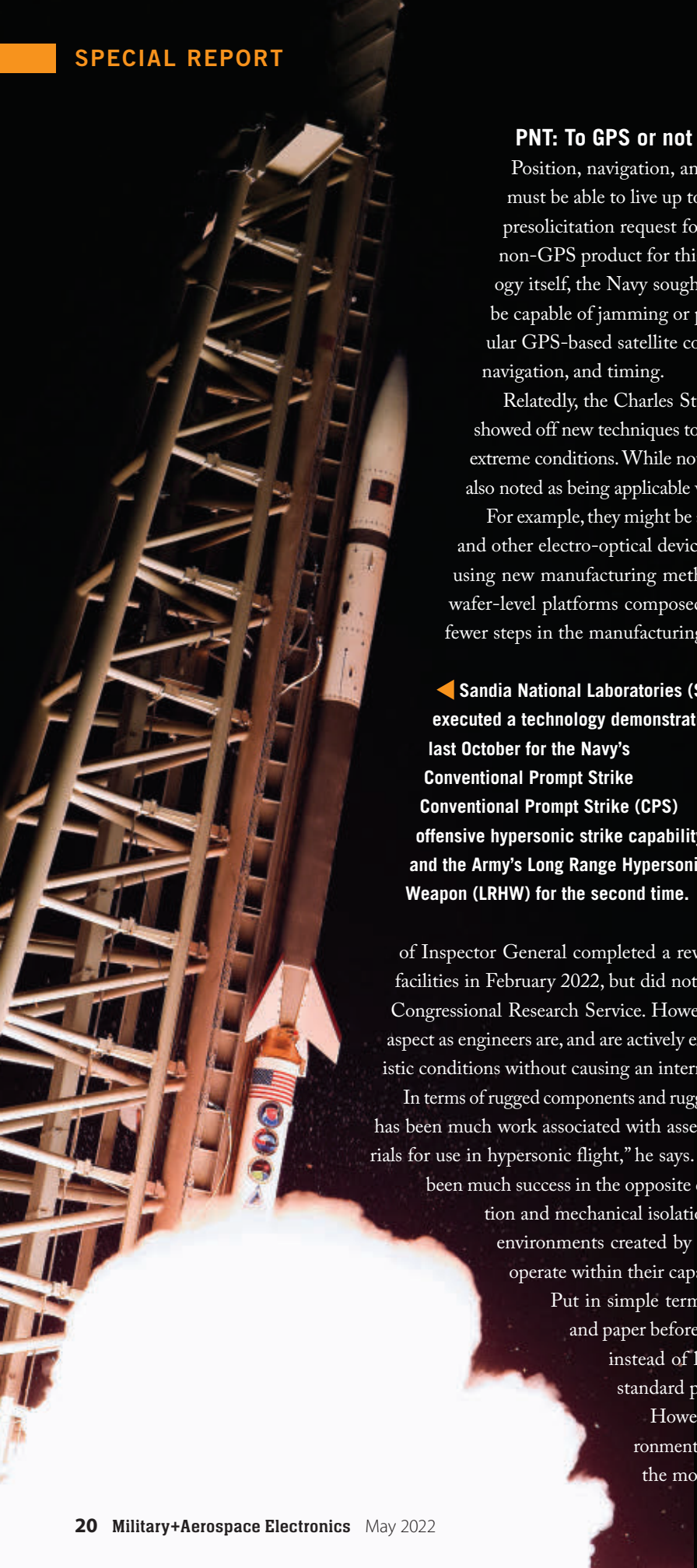
operate independently of ground stations for the reasons listed elsewhere);
- actuators such as aerodynamic control surfaces or small cold gas thrusters; and
- elements for affixing components, such as cables, bolts, screws, and nuts.

Early experiments in this area were so packed with the components they needed to work that there was no room for a payload, according to a report from the Stockholm International Peace Research Institute.

Communications also can be difficult at hypersonic speeds. Sensor systems need to be built for high-stress environments, while communications channels need global coverage. Telemetry dropout is a concern, as is the severe shock, vibration and temperatures expected at such a high speed and altitude. Of course the United States, Russia, and China have decades of experience in protecting electronics from conditions like these because of their space programs, as well as military rocketry.

The delivery of the first prototype hypersonic hardware to the Army was completed on Oct. 7, 2021. The Army is prototyping the land-based, ground launched Long Range Hypersonic Weapon (LRHW).

But for communications in particular, ground-based stations often aren't able to see hypersonic weapons at the speed at which they move. Those stations will need to be able no only to warn of incoming missiles, but to keep up with commanding missiles already under way, adjusting them, if needed, in a matter of seconds.



PNT: To GPS or not to GPS?

Position, navigation, and timing (PNT) systems for hypersonic vehicle must be able to live up to all that pressure, too. According to Janes, a 2021 presolicitation request for solutions from the Navy expressed interest in a non-GPS product for this use case. Rather than a response to the technology itself, the Navy sought this in response to adversary tactics that might be capable of jamming or physically compromising GPS systems, in particular GPS-based satellite communication (SATCOM) and assured position, navigation, and timing.

Relatedly, the Charles Stark Draper Laboratory Inc. in Cambridge, Mass., showed off new techniques to ruggedize electro-optical components for PNT in extreme conditions. While not specifically for hypersonic vehicles, the solution is also noted as being applicable where GPS satellites are not.

For example, they might be able to build interferometric fiber-optic gyroscopes and other electro-optical devices to support applications in harsh environments using new manufacturing methods. Draper's silicon optical benches, which are wafer-level platforms composed of precision-etched surface features, allows for fewer steps in the manufacturing process. In this method, they can assemble several microscale optical components closely together in one device.

Sandia National Laboratories (SNL) executed a technology demonstration last October for the Navy's Conventional Prompt Strike Conventional Prompt Strike (CPS) offensive hypersonic strike capability and the Army's Long Range Hypersonic Weapon (LRHW) for the second time.

Updates for 2022

Last year, we heard about some predictions for major changes coming in the future. These included challenges in testing in international airspace, data security and the perpetually important field of rugged or ruggedized sensors. The DOD's Office of Inspector General completed a review of the country's ground test and evaluation facilities in February 2022, but did not release the results to the public, according to the Congressional Research Service. However, this does show the DOD is as aware of this aspect as engineers are, and are actively examining possibilities for testing in relatively realistic conditions without causing an international incident.

In terms of rugged components and ruggedization, shielding is another focus for Gay. "There has been much work associated with assessing and implementing high-temperature materials for use in hypersonic flight," he says. "However when it comes to electronics there has been much success in the opposite direction, meaning implementing thermal protection and mechanical isolation schemes that shield electronics from the harsh environments created by hypersonic flight, allowing electronic systems to operate within their capabilities."

Put in simple terms, it's like packing a glass statue in bubble wrap and paper before trying to ship it. Protecting electronics from heat instead of leaving them out in the elements may seem like standard procedure for any aerospace project.

However, Gay says, "the analysis tools, modelling of environments to create predictions, and ground testing to anchor the models have been new engineering developments."

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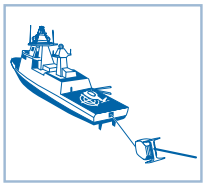

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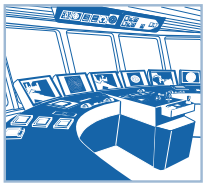
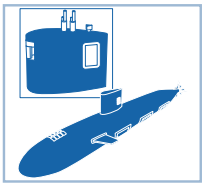
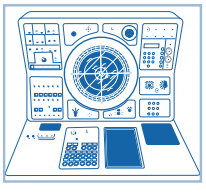


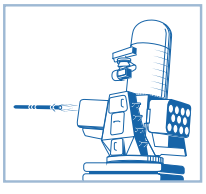
Navigation



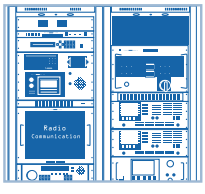
Periscope



Radar



Targeting



Comms

WHO'S WHO IN ENABLING TECHNOLOGIES FOR HYPERSONIC MUNITIONS

Charles Stark Draper Laboratory Inc.
Cambridge, Mass.
https://www.draper

Lockheed Martin Space Systems
Denver, Colo.
https://www.lockheedmartin.com/en-us/capabilities/space.html

Northrop Grumman Corp.
Falls Church, Va.
https://www.northropgrumman

Primus Aerospace
Lakewood, Colo.
https://primusaero

Raytheon Missiles & Defense
Tucson, Ariz.
https:/www.raytheonmissilesanddefense.com

Data security

In regards to the increasingly important realm of data and cyber security, hypersonic missile component suppliers are subject to the Cybersecurity Maturity Model Certification (CMMC) framework. Following up on this brings us to a larger shift within how the U.S. government is looking at and managing cyber security. It's becoming more and more of a priority in any piece of hardware that needs to connect to a network. In this case, the CMMC will now be overseen by the Department of Defense's chief information officer, not the undersecretary of defense for acquisition and sustainment. With concerns about hacking rising in the international community, the switch seeks to better streamline the process by which CMMC facilitates the creation of new standards and controls for defense contractors. In particular, CMMC was created to prevent threat actors from being able to exploit contractor information.

"By establishing a more collaborative relationship with industry, these updates will support businesses in adopting the practices they need to thwart cyber threats while minimizing barriers to compliance with DOD requirements," says Jesse Salazar, Deputy Assistant Secretary of Defense for Industrial Policy, in a DOD press release in November 2021.

After all, both digital and physical speed are hot topics in the industry in 2022.

Hypersonic missiles conjure up images of global war. They're part of the rapidly-changing network of defense technology today, a field which has had to respond to changing capabilities (speed, power) developments in cyber warfare, and the shifting needs of military customers. From the long history of the intercontinental arms race to possible technology crossover with the futuristic-sounding possibility of commercial hypersonic flight, they're a niche but remarkable part of the industry.

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RF and microwave designers grapple with crowded spectrum

Enabling technologies for 5G and other leading-edge RF and microwave applications continue to rely on commercially developed components that are refined for the rugged military environment.

BY **Jamie Whitney**

Even in an increasingly digital world, radio frequency (RF) and microwave technology confronts military and aerospace experts with working within an increasingly crowded RF spectrum to transmit data and voice communications.

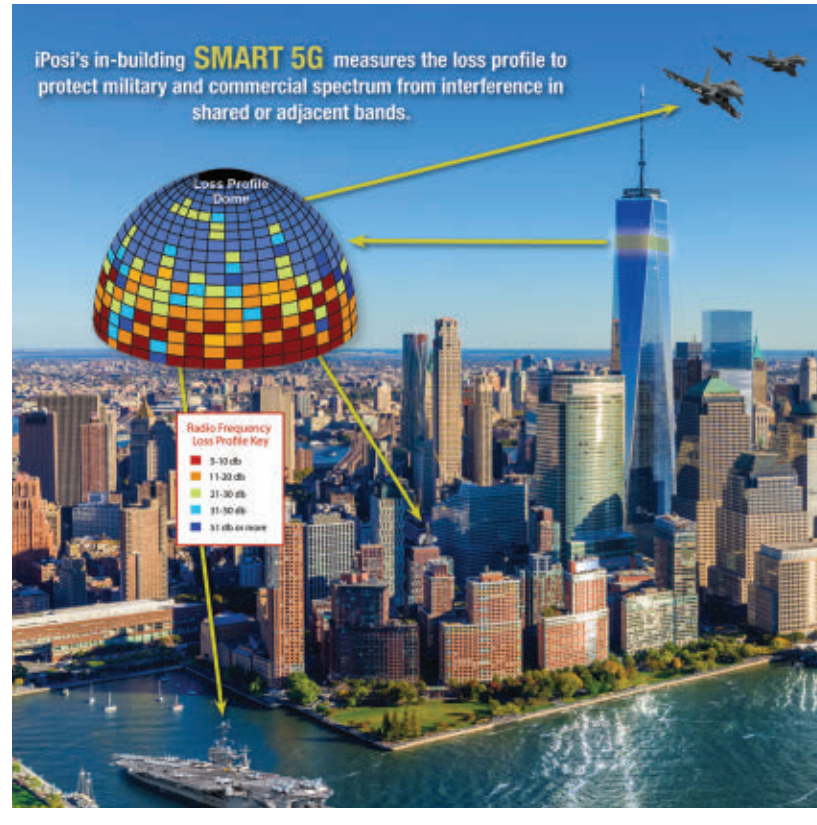
Thankfully, those technology experts can ensure the security of sensitive information in a market that often sees a blurring of what constitutes civilian and commercial markets and what is being developed for military use.

One driver of the dual-use technology foundation on which many military systems are built is the U.S. Department of Defense (DOD) commercial off-the-shelf (COTS) mandates. The COTS philosophy sees military branches using rugged mission equipment with a technological backbone built of easily replicated, non-proprietary parts so that critical items can repaired quickly, affordably, and nearer to where the tech utilized.

"To take advantage of all these great technologies from the commercial realm, issues such as security and interference have to be addressed," says David Keisling, director of commercial sales and marketing for Times Microwave Systems in Wallingford, Conn. "5G is different from previous wireless technologies because it enables the radio to be programmed with software, independent of the hardware. For example, if a 5G-enabled military drone is being designed, commercial off-the-shelf radios can be used with military hardened software."

Another trend in the military and commercial aerospace RF/microwave world is the use of fifth generation (5G) technology, which is able to increase speed, reduce latency, and more reliably transfer data than previous generations across the low, medium, and high band spectra.

For passengers aboard a commercial aircraft, 5G means a more reliable internet connection and in-flight entertainment options. 5G also means warfighters at the tip of the spear may have access to crucial data faster.



iPosi's in-building SMART 5G measures the loss profile to protect military and commercial spectrum from interference in shared or adjacent bands.

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5G roll-out

While 5G technology may be a boon to end users, industry experts need to contend with issues that arise from a crowded field attempting to utilize the RF spectrum, plus literal impediments that crop up when signals hit buildings and even rain.

▲ Times Microwave Systems new contact works at frequencies to 40 GHz to meet the needs of high-frequency applications.

Knowles Precision Devices, a producer of capacitors and microwave to millimeter wave components in Cazenovia, N.Y., has customers across the military and civilian markets. Peter Matthews, a senior technical marketing manager at the company notes work is being done to alleviate crowding issues that have cropped up.

"While there are always some initial border skirmishes when a new technology shows up in a piece of spectrum where an older technology is operating, over time, these issues tend to get smoothed out," Matthews says. "For example, at the beginning or 2022, there was a lot of concern over new C band 5G transmissions in the U.S. interfering with some aircraft radio altimeters. At the time of the initial launch of the new 5G operations, airline carriers around the world canceled flights into many major US airports as there were fears that landing equipment would not properly deploy. However, as more testing was done on the aircraft altimeters, and buffer zones around airports were created, this concern was quickly alleviated.

Times Microwave's Keisling notes that 5G's earliest adopters were commercial airlines.

"This brought together IoT (internet of things) technologies and sensors to help make the aircraft more efficient by providing real-time monitoring of fuel levels, support at the gate, etc. This ultimately enabled better coordination of resources and greater capital utilization. The same concepts can be applied to military aircraft," Keisling says, and continues, "As a result of this convergence, RF is everywhere now and is integrated. This creates the need for a lot more RF connections. RF reliability and performance depend on a perfect fit between the system design and specific application needs. One size does not fit all; the performance of any RF system is heavily determined by each of its hardware components and, especially, how they fit together. Some RF installations demand relatively standard products, while others need custom solutions to meet unique requirements."

The military faces even stronger technological challenges because of the need to deploy 5G capabilities on the leading edge of the battlefield, where little 5G infrastructure exists, and where intentional RF jamming or other kinds of interference from enemies is likely.

Air Force Chief of Staff Gen. Charles Q. Brown, Jr. is briefed on 5G capabilities by members of the U.S. Air Force Warfare Center at Nellis Air Force Base, Nev., 4 March 2021.

Sharing the spectrum

With 5G devices gaining market share and the RF spectrum getting more crowded, military — alongside competing commercial interests — can create headaches as everyone settles into their relative niches.

Knowles Precision Devices' Matthews says, "Since the Ka radar band for military applications overlaps with the 5G FR2 band, it is only a matter of time before 5G operations proliferate at these frequencies and we see similar concerns like what we recently saw in the C band. However, RF

engineers can proactively address these concerns by incorporating highly efficient filters into these systems. To do this, we can bring some lessons and innovations from the commercial world into the military and aerospace world. Since commercial 5G innovations have traditionally been driven by the need to reduce costs and size for years, there has been a push to develop surface mount components. Thus, there has been a lot of innovation on the development of surface mount packaged monolithic microwave integrated circuits (MMICs) to achieve predictable performance at higher frequencies. This MMIC technology developed for commercial applications can also be used to build all surface mount integrated microwave assemblies that would be ideal for higher frequency military and aerospace applications."

Rotors President Neil Malhotra instructs Lt. Col. Brandon Newell of Marine Corps Installations West on drone flight during a 5G Demo Day test event at Norco College in 2021.

Last month, the DOD's Defense Spectrum Office contracted global positioning (GPS) and global navigation satellite systems (GNSS) firm iPosi Inc. in Boulder, Colo. and the Virginia Tech Applied Research Corporation in Blacksburg, Va., to develop a system to measure RF path-loss that substantially increases shared spectrum without interference. This solicitation occurred because of the need for increased shared spectrum between the DOD and wireless providers who require expanded access because of demand for 5G services.

The academic and industry partnership between VTARC and iPosi are one of several the DOD has undertaken in an effort to enable sharing between the agency and commercial 5G efforts in the 1-10 GHz mid-band spectrum blocks.

Making the bands

Knowles Precision Device's Matthews says that one key trend the industry is military and aerospace operations are being switched to higher frequencies. "For example, high-throughput satellite applications now operate in the Ka and V bands while missile seeker systems are using higher frequencies to increase their hit-to-kill accuracy," Matthews says. "Another trend we are seeing is the drive to fully digital, or every element, beamforming. When you couple this trend with the increase in operational frequency mentioned above, we are also seeing an overall size reduction in the analog RF chain."

Matthews continues, "A big driver for fully digital beamforming arrays is the need for multi-function, multi-mission arrays, since, for example, it is increasingly common to see the radar array in the nose cone of a fighter plane double as a component in the aircraft's communications and electronics warfare suite. A fully digital, or active array, also performs better when it comes to metrics like dynamic range, clutter attenuation, and the ability to scan a volume rapidly. Additionally, since each element in a fully digital array is software defined, you can quickly change the 'job' each element needs to do."

Power plays

Power density is also a concern, says Baljit Chandhoke, a product manager of RF products at Microchip Technology in Chandler, Ariz. Chandhoke cites the increased adoption of power density in gallium nitride (GaN), silicon carbide high electron mobility transistors (SiC HEMTs), and monolithic microwave integrated

circuits (MMICs). Specifically, Chandhoke refers to mil-aero applications in the Ku, Ka, L, S, and C bands for radar, electronic warfare, aviation, and satellite communications (SATCOM) applications.

"The trend is being driven with the need for higher output powers for these applications to drive longer distances as well as new applications such as LEO (low-Earth orbit) satellite communication for broad band internet access," Chandhoke says.

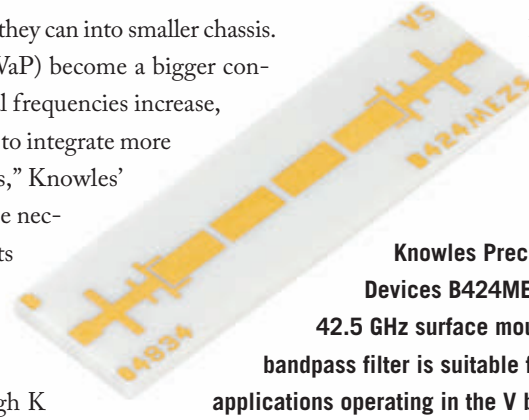
Microwave Technology's Chandhoke also spoke of the "5G revolution" as civilian and military entities adopt and rollout capabilities enabled by fifth-generation technology. Chandhoke remarks, "5G is bringing about a new revolution with new applications with its ultra-wide bandwidth for broadband communication, low latency, and reliability for mission critical applications such as remote medical procedures, ADAS and broad connectivity with applications for the IoT. One of the critical figures of merit for 5G applications is the linear output power of the power amplifier.

AT&T technicians and civilian contractors assemble a Cell on Wings drone to provide 5G connectivity to individuals participating in the Advanced Battle Management Systems Onramp 2 at White Sands Missile Range, N.M., 27 Aug. 2020.

This is where GaN on SiC with its highest power density across a broad frequency range plays a pivotal role and provides the best figure of merit for the power amplifier in terms of linear output power."

The RF and microwave sector — like just about any device utilizing electricity in the military-aerospace world — have to contend with packing as much technology as they can into smaller chassis.

"As size, weight, and power (SWaP) become a bigger concern for RF engineers as operational frequencies increase, we are seeing more customers ask us to integrate more functionality in small form factors," Knowles' Matthews says. "We can produce the necessary small form factor components to meet these needs because of the custom materials we use in our substrates. We have material scientists on staff and make our own high K ceramics, which allows us to produce very small high-performance filters that are perfect for these applications.



Knowles Precision Devices B424MEZS 42.5 GHz surface mount bandpass filter is suitable for applications operating in the V band.

Microwave's Chandhoke notes his company's customers also bring up power concerns.

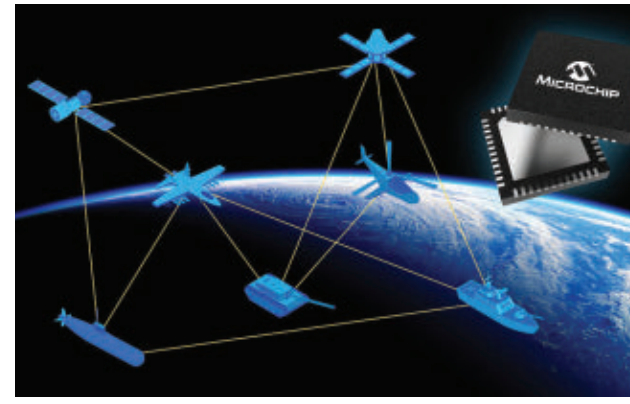
"The requests for customers have been focused on linear output power. We are designing MMICs with best-in-class linear output power meeting the requirements of 5G, satellite communications, and aerospace and defense customers."

Air and space

Baljit Chandhoke says that Microchip Technology's flagship product for SATCOM and 5G communications is the ICP2840 MIMC power amplifier, which Chandhoke says achieves 22 percent power-added efficiency (PFE) at a 10-Watt output, when viased at 24V and 22 dB small-signal gain. In addition, the Ka Band MMIC power amplifier is fabricated using 0.15µm GaN SiC technology. It achieves 39 dBm saturated output power from 27.5-31GHz

The balanced topology provides broadband input and output match to 50O and DC blocking capacitors ensure simple integration, and the die are 100 percent DC and RF tested on wafer ensuring compliance to the electrical specifications.

For Times Microwave Systems, Keisling says that the company "has created numerous solutions to address the complexities of 5G, including bundled cable solutions, locking miniature connectors, multiport, and mini-multiport connectors. Our latest introduction is the M8M contact, excellent for use in the high vibration, harsh environments typically found in military avionics and electronic warfare applications. The new contact works up to 40 GHz to meet the needs of high-frequency applications and is compatible with all Times Microwave Systems' M8 multiport shells to maximize existing infrastructure investments."



Microchip Technology's ICP2840 achieves 22 percent power-added efficiency (PFE) at a 10-Watt output.

Finally, while Knowles Precision Devices specializes in custom work for RF/microwave customers, Matthews explains that the company is able to provide ready-made catalog products plus Knowles can use those parts as a starting point for development.

"For X band, one of our popular filters is the B095MB1S 9.5 GHz surface mount bandpass filter," Matthews says. "This part is just under 1/7 of a wavelength wide at 10GHz and is built with low-loss, temperature stable materials."

Matthews continues, "For applications operating in the V band, the B424MEZS 42.5 GHz surface mount bandpass filter is popular. This filter still manages to hit the target at 45 GHz and measures under 1/3 of a wavelength wide."

WHO'S WHO IN RF AND MICROWAVE TECHNOLOGIES

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Ashburn, Va.
www.curtisswrightds

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Elma Electronic
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Fairview Microwave Inc.
Lewisville, Texas
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Knowles Precision Devices
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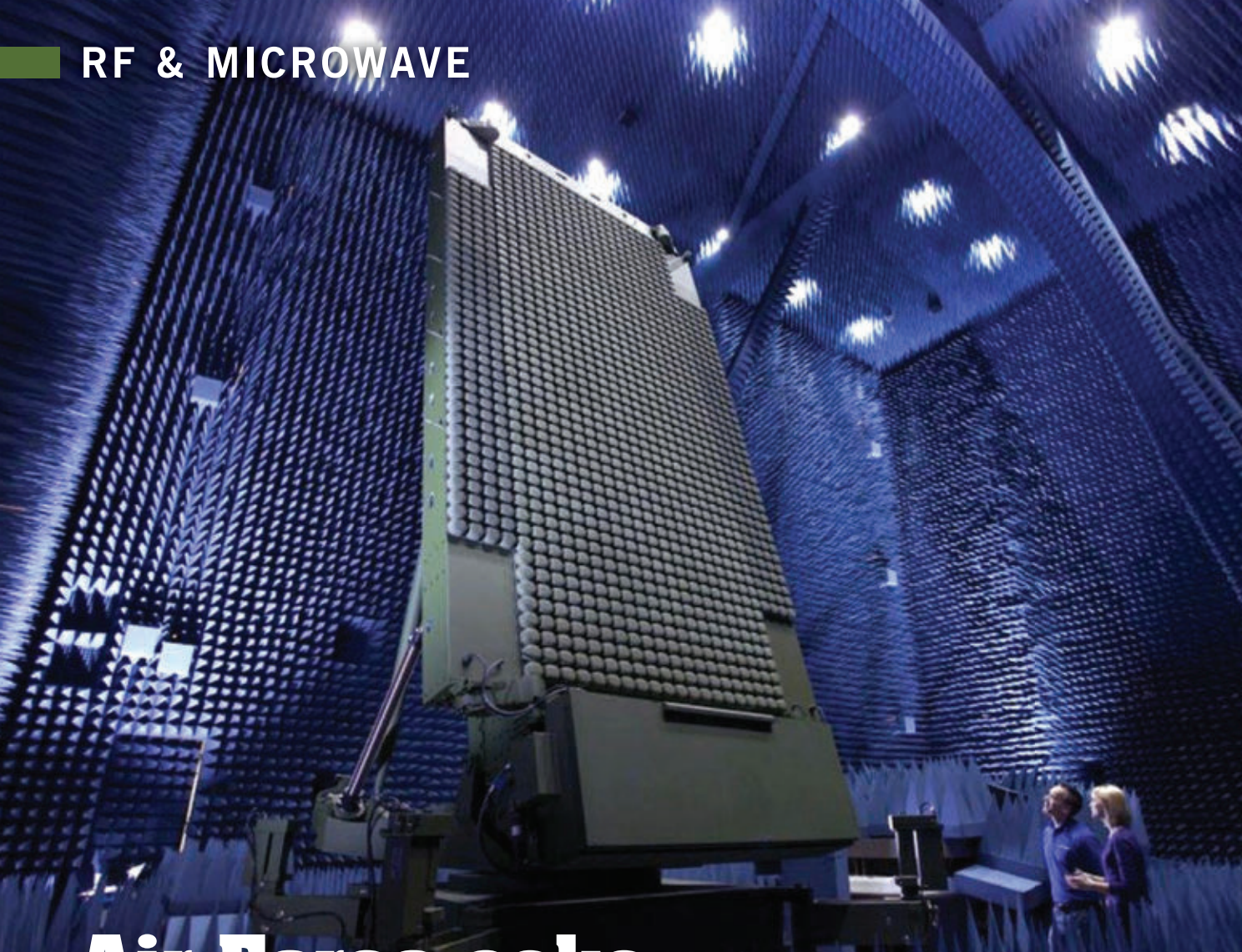


Air Force asks Lockheed Martin for 3DELRR expeditionary radar systems

BY John Keller

HANSCOM AIR FORCE BASE, Mass. – U.S. Air Force tactical radar experts needed an air-defense radar system intended to detect, identify and track enemy missiles as well as manned and unmanned aircraft. They found their solution from the Lockheed Martin Corp. Rotary and Mission Systems segment in Liverpool, N.Y.

Officials of the Air Force Life Cycle Management Center at Hanscom Air Force Base, Mass., announced a $75 million order to Lockheed Martin for the Three-Dimensional Expeditionary Long-Range Radar (3DELRR) system.

Lockheed Martin will build and deliver the initial two 3DELRR radars, as well as production management and supporting tasks. The 3DELRR radar is to replace the Air Force's Northrop Grumman AN/TPS-75 transportable 3-D passive electronically scanned array air search radar for

Photo: 3DELRR is to be the principal Air Force long-range, ground-based sensor for detecting, identifying, tracking, and reporting aerial targets.

enabling U.S. and allied invasion forces to protect themselves from airborne threats after establishing beachheads.

3DELRR is to be the principal Air Force long-range, ground-based sensor for detecting, identifying, tracking, and reporting aerial targets for the Joint Force Air Component Commander through the Theater Air Control System, Air Force officials say.

The 3DELRR system is designed to deal with regional and near-peer conflicts of the future that could involve large numbers of enemy advanced unmanned aerial vehicles (UAVs), fixed-wing aircraft, helicopters, and ballistic and cruise missiles, Raytheon officials say.

3DELRR is designed to detect, identify, and track a wide variety of objects accurately at great distances. C-band is a relatively uncongested portion of the electromagnetic spectrum. The radar is interoperable with coalition systems and meet the requirements of many foreign militaries.

The 3DELRR system is similar to the Ground/Air Task-Oriented Radar (G/ATOR) that Northrop Grumman is building the for U.S. Marine Corps. G/ATOR is being developed to protect Marine Corps expeditionary forces from rockets, artillery, mortars, cruise missiles, UAVs, and other low observables. It is a deployable short-to-medium-range multi-role radar system. 3DELRR, on the other hand, is designed to detect and track threats at longer ranges.

Like 3DELRR, the G/ATOR is based on GaN technology, yet the G/ATOR system is designed to handle air surveillance, weapon cueing, counter-fire target acquisition, and air traffic control for Marine Corps warfighters operating in invasion beaches.

The 3DELRR will provide the Air Force control and reporting center with real-time data to display air activity, and will provide warning and target information.

The system also will provide operators with a precise, real-time air picture to provide air traffic control services to individual aircraft across a wide range of environmental and operational conditions.

Raytheon Technologies Corp. initially won the 3DELRR contract in 2014, but industry protests held up its initial development. Even before its initial award to Raytheon, the 3DELRR program was in hot contention among three of the nation's most prominent radar houses: Raytheon, Northrop Grumman, and Lockheed Martin.

Air Force leaders opted to recompete the 3DELRR radar program in 2020 because of technical and supplier challenges. Raytheon and Northrop Grumman still may share in some 3DELRR development. ←

On this contract modification Lockheed Martin will do the work in Liverpool, N.Y., and should be finished by January 2024. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

Raytheon continues support for shipboard DBR radar

Shipboard radar experts at Raytheon Technologies Corp. will continue supporting an expensive surface-search radar system for large U.S. Navy warships until a suitable replacement comes online, under terms of a $19.1 million order. Officials of the Naval Sea Systems Command in Washington are asking the Raytheon Missiles & Defense segment in Tewksbury, Mass., for design agent engineering efforts in support of the Dual Band Radar (DBR) program. The Navy's DBR dual-band radar combines the benefits of S-band and X-band radar capabilities for a range of environments, while its open architecture software design enables automatic operation with minimal human intervention. The S-band VSR radar arrays, built by Lockheed Martin, are integrated with Raytheon's SPY-3 X-band Multi-Function Radar to form the advanced DBR, which was tested in 2009 at the Navy's Engineering Test Center at Wallops Island, Va. Initial installations of the DBR were aboard the Navy's Zumwalt-class land-attack destroyer and Ford-class aircraft carriers. By 2016 Navy officials decided to replace the DBR aboard aircraft carriers and other large surface warships with the more-economical Raytheon Enterprise Air Surveillance Radar (EASR). In the meantime, however, Navy officials still must maintain the few DBR systems that are operational, hence this order to Raytheon for engineering services. For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or Naval Sea Systems Command at www.navsea.navy.mil.

Inline splicing connector for tool-free wiring introduced by WAGO

WAGO Corp. in Germantown, Wis., is introducing the 221 inline splicing connector that allows a universal conductor connection — a visibly secure conductor contact. The 221 power connector comes with intuitive orange levers for tool-free wiring for solid, stranded, and fine-stranded conductors from 12 to 20 American Wire Gauge (AWG). Equipped with WAGO's spring pressure and maintenance-free CAGE CLAMP connection technology, the inline connectors offer the option of using additional adapters where several poles are required. Whether with or without strain relief, the freedom of a modular and flexible connector is possible. A snap-in mounting foot, screw, adhesive, tie-on, or suspended mounting and can be placed on a 1- or 35-millimeter DIN rail. For more information contact WAGO Corp. online at www.wago.com.

Sentient Vision to develop machine autonomy for unmanned reconnaissance

BY John Keller

WASHINGTON – U.S. military researchers needed an artificial intelligence (AI) system to detect and classify targets for future U.S. Marine Corps applications. They found their solution from Sentient Vision Systems in Port Melbourne, Australia.

▲ Sentient Vision Systems will develop visual detection and ranging (ViDAR) technologies for Marine Corps evaluation for future unmanned reconnaissance applications.

Officials of the U.S. Department of Defense's Directorate of Defense Research and Engineering for Advanced Capabilities at the Pentagon have chosen Sentient Vision to provide ViDAR Maritime systems for integration and evaluation for future Marine Corps applications.

ViDAR, which stands for visual detection and ranging, is an artificial intelligence (AI) system that uses an infrared sensor to detect and classify targets in the imagery stream that would be invisible to a human operator or to a conventional radar -- such as a human head-size object in the water or a stealthy watercraft.

The ViDAR systems handle intelligence surveillance and reconnaissance (ISR) missions aboard a Marine Corps medium-altitude long range unmanned aerial vehicle (UAV) to gather intelligence and enhance situational awareness during amphibious operations.

ViDAR uses Sentient AI, a combination of machine autonomy and deep learning to detect, geo-locate, track, and classify objects autonomously in its field of view. It has a greater than 96 percent accuracy on first pass for small targets to sea state six.

A ViDAR-equipped crewed or uncrewed aircraft can cover a search area about 300 times larger than one without ViDAR, Sentient Vision officials say. The company will demonstrate the system at sea, which could lead to wider deployment within the Marine Corps. ←

For more information contact Sentient Vision Systems online at www.sentientvision.com, or the Directorate of Defense Research and Engineering for Advanced Capabilities at https://ac.cto.mil.

Senseeker eyes longwave infrared sensor technologies for aerial search and track

BY John Keller

WRIGHT-PATTERSON AFB, Ohio – U.S. Air Force researchers needed a large-format longwave infrared digital pixel readout integrated circuit for future infrared search-and-track (IRST) sensors for combat aircraft. They found their solution from Senseeker Engineering Inc. in Santa Barbara, Calif.

Senseeker is developing a large-format long wave infrared (LWIR) digital pixel readout integrated circuit for airborne IRST applications.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, announced a $1.4 million contract to Senseeker last month for the Large Format High Dynamic Range LWIR Solution for Airborne IRST project.

The company will develop an advanced large-format high-dynamic-range long wave infrared (LWIR) digital pixel readout integrated circuit (DPROIC) for airborne IRST applications.

This project is part of the Air Force Research Lab's Multi-Spectral Sensing Technologies Research and Development (MUSTER) program to develop radio frequency and electro-optical sensors for offensive, defensive, and integrated offensive and defensive systems.

Senseeker will develop enabling technologies for Air Force Researchers that provide everything necessary for a 20-micron pixel pitch 2k-by-2k format digital pixel demonstration sensor system. Except for the LWIR detectors, these technologies will make the final IRST sensor focal plane array.

Senseeker will supply top-graded DPROIC dies, specialized test electronics, advanced imaging software, leadless chip carrier packages, and cryogenic test to accommodate the large-format infrared focal plane arrays.

Company engineers will create one demonstration system, and two finished systems for the Air Force. The company also will provide 20 top-grade dies; several lower-grade dies in wafer form; and wafer maps of die yield that are ready for a vendor to create focal plane arrays.

Leading the MUSTER program are experts in the Sensors Directorate of the Air Force Research Lab's Multispectral Sensing and Detection Division.

MUSTER is sponsoring research not only in IRST enabling technologies, but also in antenna technologies and electromagnetic scattering; RF sensor systems; waveform phenomenology, design and applications; ultra-sensitive receivers for signals intelligence; standoff high resolution imaging; passive infrared space-based sensing; laser radar (ladar) imaging, systems, components, and applications; sensor information processing and integration; adaptive radar; and advanced digital multifunction arrays. ←

For more information contact Senseeker Engineering online at https://senseeker.com; or the Air Force Research Laboratory at www.afrl.af.mil.

ELECTRONIC WARFARE

Boeing to enhance EW capabilities for Japan Super Interceptor jet

Jet fighter designers at the Boeing Co. are enhancing electronic warfare (EW) capability to a major upgrade of Japan's F-15 combat aircraft under terms of a $24.6 million order.

Officials of the U.S. Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, are asking the Boeing Defense, Space & Security segment in St. Louis to add EW capability to upgrades involved in the Japan Super Interceptor (JSI) program.

The JSI program is helping Japan to upgrade the nation's F-15 combat aircraft with new enabling technologies to enable Japanese F-15s to fight effectively alongside Japan's growing fleet of F-35 joint strike fighters.

The contract modification provides for the foreign military sales requirement to add EW system initial non-recurring engineering for the Japan Air Self Defense Force.

Boeing won a $471.3 million Air Force foreign military sales contract in late 2021 to develop an integrated suite of aircraft systems to support modification of the Japan Air Self Defense Force F-15MJ aircraft as part of a potential $4.5 billion program approved by the U.S. State Department in 2019 to upgrade 98 Boeing F-15J jet fighters to Japan Super Interceptor aircraft.

These updated aircraft are expected to fly alongside Japan's fleet of Lockheed Martin F-35 fighter-bombers and take advantage of the strongest capabilities of each aircraft. The F-35 is stealthy with advanced airborne networking, while the F-15 is fast, long range, and carries a large weapons payload.

The JSI upgrade includes new systems like the Raytheon's AN/APG-82(V)1 active electronically scanned array (AESA) radar and the BAE Systems AN/ALQ-239 digital EW system. The JSI also could carry new missiles.

The Japan Super Interceptor program is expected to be similar to the U.S. F-15EX aircraft, which will augment the new F-35 with plenty of fire power on an affordable budget. In 2020 the U.S. Air Force announced a potential $22.9 billion contract to Boeing to design and build the F-15EX jet fighter.

The F-15EX is based on the F-15 Advanced Eagle that Boeing is building for the air forces of Qatar and Saudi Arabia, which has a fly-by-wire flight control system, digital EW suite, an infrared search and track (IRST) system, and the Raytheon APG-63(v)3 AESA radar.

The F-15EX carries more weapons than similar fighter aircraft, and will be able to launch hypersonic weapons that are as large as 22 feet long weight as much as 7,000 pounds. The F-15EX also is following the U.S. Department of Defense (DOD) DevSecOps initiative to develop secure, flexible, and agile software and an open-systems avionics architecture.

The F-15EX will be a large, powerful, non-stealthy, twin-engine jet fighter able to carry a large air-superiority weapons payload. The plane will be able to carry as many as 22 AIM-9X Sidewinder and AMRAAM medium range air-to-air missiles.

It also will have a substantially more powerful mission computer than all existing versions of the F-15, new cockpit displays, a digital backbone, infrared search and track (IRST) system, the Raytheon APG-63(v)3 active electronically scanned array (AESA) radar, and the Eagle Passive Active Warning Survivability System (EPAWSS) — an EW and threat identification system.

The F-15EX also will have terrain-following radar to enable the pilot to fly at a very low altitude following cues displayed on a heads up display. The targeting pod contains a laser designator and a tracking system with a 10-mile range. The plane also will have as many as 11 underwing weapons stations and digital Joint Helmet-Mounted Cueing Systems. The original F-15 jet fighter began development in 1967, and entered service with the U.S. Air Force in 1976.

On this order Boeing will do the work in St. Louis and should be finished by December 2028. For more information contact Boeing Defense, Space & Security online at www.boeing.com/company/about-bds, the Air Force Life Cycle Management Center at www.aflcmc.af.mil, or the Japan Air Self Defense Force at www.mod.go.jp/asdf/English_page.

COMMUNICATIONS AND NETWORKING

Northrop goes full-rate production of Link 16 data link on Marine helicopters

The U.S. Navy has awarded Northrop Grumman Corp. a $65 million contract to carry-out full-rate production of the Link-16 tactical datalink for the U.S. Marine Corps AH-1Z attack UH-1Y utility helicopters.

The contract from Naval Air Systems Command at Patuxent River Naval Air Station, Md., calls for the Northrop Grumman Mission Systems segment in Woodland Hills, Calif., to integrate the Link 16 data link hardware across the Marine Corps AH-1Z and UH-1Y helicopter fleets.

Link 16 is a military tactical data link network used by the U.S. military and its NATO allies that enables military aircraft, ships, and ground forces to exchange their tactical picture in near-real time. Link 16 also supports the exchange of text, imagery, and digital voice messages.

Link-16 will enable the AH-1Z and UH-1Y to carry out sensor networking, and share data and communications securely with other aircraft and other users of secure military networks.

The AH-1Z Viper is a twin-engine attack helicopter based on the AH-1W SuperCobra that features a four-blade rotor system, uprated transmission, and a new target sighting system. It has upgraded avionics, weapons, and electro-optical sensors designed to find targets at long ranges and attack them with precision weapons.

The UH-1Y Venom helicopter — also called the Super Huey — is a twin-engined, medium-sized utility helicopter designed to replace the U.S. Marine Corps UH-1N Twin Huey light utility helicopters, first introduced in the early 1970s.

Link 16 is based on time-division multiple access (TDMA) communications technology, and is a secure, jam-resistant, high-speed digital data link that operates at RF and microwave frequencies from 960 to 1,215 MHz.

This frequency range limits information exchange directly to line-of-sight distances, although satellite communications (SATCOM) and ad-hoc protocols can pass Link 16 data over long-haul protocols such as TCP/IP using MIL-STD 3011 (JREAP) or STANAG 5602 (SIMPLE). Information typically passes at rates of 31.6, 57.6, or 115.2 kilobits per second.

The AH-1Z and UH-1Y are part of the Marine Corps H-1 upgrades program to build new helicopters, as well as rebuilding legacy AH-1W SuperCobra attack helicopters and UH-1N Twin Huey utility helicopters with state of the art designs. The program seeks to upgrade AH-1Ws to AH-1Zs, and UH-1Ns to UH-1Ys.

The AH-1Z can carry a payload of 5,764 pounds, can fly as fast as 222 knots, has a range of 370 nautical miles, and can fly as high as 20,000 feet. It has a crew of two, and carries a 20-millimeter Gatling gun, and can fire 70-millimeter Hydra rockets, AIM-9 Sidewinder air-to-air missiles, and AGM-114 Hellfire air-to-ground missiles.

The UH-1Y can carry a payload of 6,660 pounds — including as many as 10 crashworthy passenger seats and six litters or equivalent cargo. It has a range of 260 nautical miles, and can fly as high as 20,000 feet. It can fly with one or two pilots, has two external stations for 70-millimeter Hydra 70 or APKWS II rockets, and has two pintle mounts for M240D machine guns or Gatling guns.

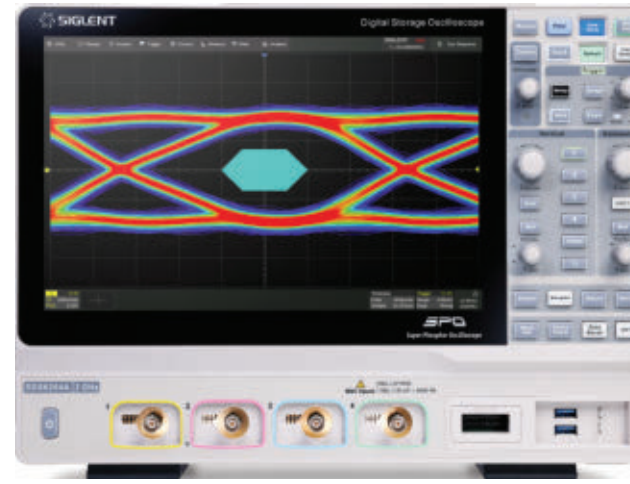
"As lead technology integrator for H-1 avionics, we are modernizing electronic systems across the fleet through an open-systems architecture approach," says Lindsay McEwen, vice president of navigation, targeting, and survivability at Northrop Grumman. "Link-16 full rate production is the starting point."

Northrop Grumman's mission systems solution for the H-1 fleet is trusted and combat-proven, with more than 450,000 total flight hours, Northrop Grumman officials say. For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com, or U.S. Naval Air Systems Command at www.navair.navy.mil.

TEST AND MEASUREMENT

▶ Oscilloscopes for high-performance test and measurement introduced by SIGLENT Technologies

SIGLENT Technologies America Inc. in Solon, Ohio, is introducing the SDS6000A series of oscilloscopes for high-performance test and measurement applications. The SDS6000A oscilloscopes are available with a maximum bandwidth of two GHz. In addition to the higher bandwidth, the device offers five gigasamples per second per channel and an interpolation technique enhanced sample rate (ESR) for equivalent sample rates to 10 gigasamples per second per channel. This also is the first SIGLENT oscilloscope with an A/D converter per channel to enable the scope to maintain a high sample rate, regardless of the number of channels activated. The input stage delivers spurious-free dynamic range (SFDR) of more than 45 dBc, channel-to-channel isolation to 70 dBc, and DC amplifier accuracy plus-or-minus 1.5 percent to capture small signals at 500 microvolts per division. Furthermore, the high resolution of these high-performance oscilloscopes improves the vertical resolution from 8 to 16 bits and enhances the signal acquisition accuracy. The SDS6000A oscilloscopes are available in 500 MHz, 1 GHz and 2 GHz bandwidths. The acquisition memory has a maximum size of 500 Mpts and is distributed over 1, 2, or 4 channels. The waveform capture rate can reach up to 750,000 waveforms per second in sequence mode. For more information contact SIGLENT online at https://siglentna.com.



CONNECTORS

▼ Rugged connector that balances power and signal introduced by TE Connectivity

TE Connectivity in Harrisburg, Pa., is introducing the Unmanned Power (UMP) connector as a reliable and durable interconnect device that can balance signal and power capabilities for unmanned aerial vehicles (UAVs). The UMP connector offers as much as 80 amps per contact and is available as a power or mixed-signal and power connector. Today's UAV connectors have experienced challenges with amp rating, connector size, and mixed signal variations, which can force designers to sacrifice one benefit for the other. TE's UMP connector is designed to provide a reliable contact interface that safely delivers power or power and signal to control rotors, battery systems, and power-distribution systems of unmanned vehicles. TE's UMP connectors withstand harsh environments using high-temperature materials; crimp pigtail assembly with flexible silicone wire; integrated power with two or three position power options; mixed-signal options; and a small bulkhead mount. For more information contact TE Connectivity online at www.te.com.

EMBEDDED COMPUTING

▼ SOSA-aligned embedded computing development platform offered by Mercury

Mercury Systems Inc. in Andover, Mass., is introducing the model 8257A development platform aligned to the Sensor Open Systems Architecture (SOSA) technical standard. Featuring a single-slot 3U VPX backplane and integrated power supply, the 8257A enables engineers to accelerate sensor processing applications development in a SOSA aligned desktop environment. The model 8257A accepts 3U VPX conduction-cooled boards and uses integral fans for air cooling, enabling development

on a rugged and conduction-cooled board in a desktop or benchtop environment. It is designed to accommodate Mercury's Quartz model 5550 or 5553, eight-channel A/D and D/A converter 3U OpenVPX embedded computing modules based on the Xilinx Zynq UltraScale+ RF system-on-chip (RFSoC), both aligned with the recently released technical standard for SOSA Reference Architecture 1.0. Developers can connect a notebook or desktop PC running Xilinx's Vivado design suite and Mercury's Navigator design suite to develop, run, and debug their applications. For more information contact Mercury Systems online at www.mrcy.com.

BOARD PRODUCTS

▼ XMC module for sensor fusion and signal processing offered by Acromag

Acromag in Wixom, Mich., is introducing the XMC-7AWP and XMC-7KWP embedded computing modules for signals intelligence, image processing, communications, adaptive filtering, and hardware simulation. The switched mezzanine card (XMC) embedded computing modules come with high-speed interfaces for PCI Express, 10-gigabit Ethernet, LVDS, serial, and other I/O signals. These COTS modules are for algorithmic acceleration, protocol conversion, simulation, HIL test, motor control, image analysis, and

PRODUCT & LITERATURE SHOWCASE

sensor fusion. These modules come with a user-programmable Xilinx Artix-7 or Kintex field-programmable gate array (FPGA), and feature write-protected flash memory to secure the configuration files. The XMC-7KWP models offer a choice of Kintex-7 FPGAs for 325k or 410k logic cells. Dual SFP+ ports offer support for 10-gigabit Ethernet with fiber or copper transceivers. A 36-pin VHDCR connector provides JTAG, USB, global differential clock pairs, and LVDS signals to the FPGA. The rear I/O XMC port offers a four-lane high-speed serial interface and supports SelectIO channels for single-ended or differential I/O. A PMC-style port supports additional SelectIO channels. The XMC-7AWP models feature a user-configurable Artix-7 FPGA with 200k logic cells. The rear I/O provides an 8-lane high-speed serial interface on the P16 XMC port, with support for 34 single-ended SelectIO or 17 LVDS channels. The P4 port adds another 60 SelectIO or 30 LVDS and global clock lines. For more information contact Acromag online at www.acromag.com. ←

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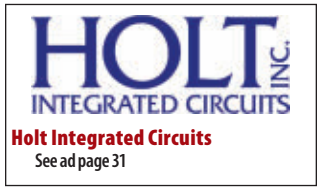

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See ad page 11
Interface Concept
See ad page 6
Marvin Test Solutions Inc
Mercury Systems
Mercury, formerly Pentek
See ad back cover
North Atlantic Industries Inc
Smiths Interconnect
Trenton Systems Inc
VersaLogic Corp
WOLF Advanced Technology
See ad page 7
Z3 Technology
See ad page 22

COMMUNICATIONS AND PERIPHERALS

AUDIO EQUIPMENT

Minoru Co Ltd
RGB Spectrum
See ad page 40

COMMUNICATIONS EQUIPMENT - LASER COMMUNICATIONS

Bodkin Design & Engineering LLC
DLS Electronic Systems Inc
Fiber Optic Center Inc
H&L Instruments LLC
Lfiber Optic Ltd

COMMUNICATIONS EQUIPMENT - MICROWAVE COMMUNICATIONS

Anritsu
Carolina Microwave Associates Inc
Coherent Logix Inc
CTT Inc
Electromagnetic Technologies Industries Inc
Evans Capacitor Co
Fiber Optic Center Inc
HUBER+SUHNER Inc
Mercury, formerly Pentek
See ad back cover
Minoru Co Ltd
NuWaves Engineering
PIC Wire & Cable
Pro-Comm Inc
Times Microwave Systems

COMMUNICATIONS EQUIPMENT - MILITARY TELECOMMUNICATIONS

Anritsu
API Technologies Corp
Carolina Microwave Associates Inc
Coherent Logix Inc
Crystal Group

CTT Inc
Dawn VME Products
See ad page 10
Dayton T Brown Inc
DLS Electronic Systems Inc
Electromagnetic Technologies Industries Inc
Evans Capacitor Co
Fiber Optic Center Inc
Gemstar Custom Hard Cases
GiDEL
HD Barcode
Henkel Corp
Holt Integrated Circuits
See ad page 31
HUBER+SUHNER Inc
Interface Concept
See ad page 6
Mer-Mar Electronics
Mercury, formerly Pentek
See ad back cover
Milpower Source
See ad page 29
New Wave Design and Verification
See ad page 28
NextGen Adhesives
North Atlantic Industries Inc
NuWaves Engineering
Per Vices Corp
PIC Wire & Cable
Rohde & Schwarz USA Inc
SynQor Inc
See ad page 21
Technotronix Inc
TopFlite Components
Trenton Systems Inc
United Electronic Industries Inc
Z3 Technology
See ad page 22

COMMUNICATIONS EQUIPMENT - RADIO

Anritsu
Carolina Microwave Associates Inc
Coherent Logix Inc
Computer2100 LLC
DLS Electronic Systems Inc
Henkel Corp
HUBER+SUHNER Inc
Interface Concept
See ad page 6
Mercury, formerly Pentek
See ad back cover
Minoru Co Ltd
NuWaves Engineering
Per Vices Corp
Rohde & Schwarz USA Inc
Sealevel Systems

COMMUNICATIONS EQUIPMENT - SATELLITE EQUIPMENT AND TELEMETRY

Acroamatics Telemetry Systems
Aitech
Carolina Microwave Associates Inc
Coherent Logix Inc
Computer2100 LLC
Crane Aerospace & Electronics
Dayton T Brown Inc
Diamond USA Inc
Electromagnetic Technologies Industries Inc
Gemstar Custom Hard Cases
Henkel Corp
HUBER+SUHNER Inc
L3Harris Technologies
Mer-Mar Electronics
Mercury, formerly Pentek
See ad back cover
Per Vices Corp
PIC Wire & Cable
SynQor Inc
See ad page 21
Technotronix Inc

DATA BUSES AND NETWORKING - HIGH-SPEED SWITCHED FABRICS

Abaco Systems
Acromag Inc
See ad page 16
Aitech
CAEN Spa
Crystal Group
Curtiss-Wright Defense Solutions
Dawn VME Products
See ad page 10
Dynatem
Elma Electronic Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Interface Concept
See ad page 6
Mercury Systems
Mercury, formerly Pentek
See ad back cover
New Wave Design and Verification
See ad page 28
Trenton Systems Inc

DATA BUSES AND NETWORKING - NETWORK INTERFACE CONTROLLERS

Abaco Systems
Acromag Inc
See ad page 16
Aitech
Alta Data Technologies
Dawn VME Products
See ad page 10
Dynatem
Elma Electronic Inc
esd electronics Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover

Interface Concept
See ad page 6
Mercury, formerly Pentek
See ad back cover
New Wave Design and Verification
See ad page 28
United Electronic Industries Inc

DATA BUSES AND NETWORKING - TACTICAL NETWORKS

Abaco Systems
Crystal Group
Dynatem
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
HD Barcode
Interface Concept
See ad page 6
Mercury, formerly Pentek
See ad back cover
New Wave Design and Verification
See ad page 28
Sealevel Systems

DATA BUSES AND NETWORKING - WIRED NETWORKS

Alta Data Technologies
AstroNova Aerospace
Aukua Systems Inc
Dynatem
esd electronics Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Mercury, formerly Pentek
See ad back cover
MilesTek
New Wave Design and Verification
See ad page 28
PIC Wire & Cable
Powell Electronics

DATA BUSES AND NETWORKING - WIRELESS NETWORKS

Dynatem
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Gemstar Custom Hard Cases
Mercury, formerly Pentek
See ad back cover
Minoru Co Ltd
Per Vices Corp
PIC Wire & Cable
Silvus Technologies Inc

DATA STORAGE - DATA RECORDERS

Acromag Inc
See ad page 16
Aitech
Ampex Data Systems
Annapolis Micro Systems Inc
See ad page 34
Curtiss-Wright Defense Solutions
dSPACE Inc
EIZO Rugged Solutions
Falcon Electronics
GiDEL

HOLT INC. INTEGRATED CIRCUITS
Holt Integrated Circuits
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Mercury, formerly Pentek
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New Wave Design and Verification
See ad page 28
Phoenix International
See ad page 41
RGB Spectrum
See ad page 40
United Electronic Industries Inc

DATA STORAGE - OPTICAL MEMORY

Mercury, formerly Pentek
See ad back cover

DATA STORAGE - RAID/COMPUTER FARMS

Crystal Group
Curtiss-Wright Defense Solutions
Elma Electronic Inc
GiDEL
Mercury, formerly Pentek
See ad back cover
Phoenix International
See ad page 41

DATA STORAGE - SOLID-STATE MEMORY

Aitech
Ampex Data Systems
Curtiss-Wright Defense Solutions
Elma Electronic Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Falcon Electronics
Greenliant
Intel Corp
Interface Concept
See ad page 6
Mercury, formerly Pentek
See ad back cover
Phoenix International
See ad page 41
SMART Modular Technologies
Viking Technology

DATA STORAGE - TAPE MEMORY

Mercury, formerly Pentek
See ad back cover
Phoenix International
See ad page 41

FREQUENCY MANAGEMENT SYSTEMS

Computer2100 LLC
HUBER+SUHNER Inc
Mercury, formerly Pentek
See ad back cover
Per Vices Corp

COMPONENTS/POWER ELECTRONICS/SENSORS

ADHESIVES, ENCAPSULANTS AND BONDINGS

Alfa International
Arkema Inc
Bakelite Synthetics
Ellsworth Adhesives
See ad page 30
Henkel Corp
Hexion Inc

Master Bond

NextGen Adhesives
Rudolph Bros & Co
Specialty Coating Systems

COMPONENTS - ALTIMETERS

Dayton T Brown Inc
Lintech Components

COMPONENTS - BACKPLANES

Aitech
Atrenne Integrated Solutions
See ad page 27

Dawn VME Products
See ad page 10

Elma Electronic Inc

Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
General Micro Systems Inc
See ad page 11
Interstate Connecting Components
See ad page 18
LCR Embedded Systems
See ad page 1
Pixus Technologies
See ad page 33
Smiths Interconnect
TopFlite Components
Trenton Systems Inc
TTI Inc

COMPONENTS - CIRCUIT BREAKERS

Dayton T Brown Inc
Interstate Connecting Components
See ad page 18
Lintech Components
P&A Components Inc
Ross Engineering Corp
TTI Inc

COMPONENTS - CONNECTORS

Advanced Interconnections Corp
Aiconics
AirBorn Inc
See ad page 9
API Technologies Corp
Applied Avionics
Cinch Connectivity Solutions
Diamond USA Inc
Eaton
Fairview Microwave Inc
See ad page 15
Hermetic Solutions Group
HUBER+SUHNER Inc
Hybrid Electronics
Interstate Connecting Components
See ad page 18
LEMO USA Inc
Lintech Components
MilesTek
Minoru Co Ltd
NextGen Adhesives
OFS
Omnetics Connector Corp
P&A Components Inc
Pasternack
See ad pages 5, 25
PAVE Technology Co Inc
See ad page 19
PIC Wire & Cable
Pickering Interfaces
Powell Electronics
Radiall USA
Samtec
Smiths Interconnect
Southwest Microwave
Times Microwave Systems
TopFlite Components
Trendsetter Electronics
TTI Inc
Wiselink

COMPONENTS - ENCLOSURES AND CHASSIS

AdTech Ceramics
Atrenne Integrated Solutions
See ad page 27
Crystal Group

Dawn VME Products
See ad page 10

Dayton T Brown Inc

Elma Electronic Inc

Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Gemstar Custom Hard Cases
General Micro Systems Inc
See ad page 11
Hermetic Solutions Group
HUBER+SUHNER Inc
Interstate Connecting Components
See ad page 18
LCR Embedded Systems
See ad page 1

Mercury, formerly Pentek
See ad back cover

Pickering Interfaces
Pixus Technologies
See ad page 33
United Electronic Industries Inc
Verotec Inc

COMPONENTS - FASTENERS

Lintech Components

COMPONENTS - FIBER OPTICS

AirBorn Inc
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API Technologies Corp
Bodkin Design & Engineering LLC
Diamond USA Inc
H&L Instruments LLC
HUBER+SUHNER Inc
Interstate Connecting Components
See ad page 18
LaserOptec
Lfiber Optic Ltd
LLC VTC BASPIK Ltd
MilesTek
OFS
P&A Components Inc
PAVE Technology Co Inc
See ad page 19
Photonchina Co Ltd
Powell Electronics
Ross Engineering Corp
West Coast Tech Ltd

COMPONENTS - FILTERS/GASKETING

API Technologies Corp
TopFlite Components
TTE Filters
Vicor Corp

COMPONENTS - FLIGHT INSTRUMENTS

Applied Avionics
DLS Electronic Systems Inc
Momentum FPD Services Corp

COMPONENTS - GYROSCOPES

Analog Devices Inc
Dexter Magnetic Technologies Inc
Gooch & Housego Plc
KVH Industries Inc
VectorNav Technologies

COMPONENTS - HUMAN-MACHINE INTERFACES

Allied International
Applied Avionics
Dynatem

COMPONENTS - LATCHES AND HINGES

Pixus Technologies
See ad page 33

COMPONENTS - MEMS AND NANOTECHNOLOGY

AdTech Ceramics
Crane Aerospace & Electronics
Embassy Global
LLC VTC BASPIK Ltd
Minoru Co Ltd
Powell Electronics
Silicon Designs Inc
VectorNav Technologies

COMPONENTS - RADIATION-HARDENED COMPONENTS

API Technologies Corp
Coherent Logix Inc
Crane Aerospace & Electronics
Falcon Electronics
IR HiRel - An Infineon Technologies Co
Linear Integrated Systems
Silicon Designs Inc
Teledyne e2v
Trendsetter Electronics

VPT Inc
See ad page 8

COMPONENTS - RELAYS

Applied Avionics
Falcon Electronics
Interstate Connecting Components
See ad page 18
IR HiRel - An Infineon Technologies Co
Lintech Components
Minoru Co Ltd
P&A Components Inc
Pickering Interfaces
Powell Electronics
Ross Engineering Corp
TTI Inc
Wiselink

COMPONENTS - SWITCHES

Abaco Systems
AMETEK Haydon Kerk Pittman
Analog Devices Inc
Applied Avionics
AstroNova Aerospace
Crystal Group
Dynatem
Embassy Global
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Fairview Microwave Inc
See ad page 15
Interstate Connecting Components
See ad page 18
IR HiRel - An Infineon Technologies Co
Lfiber Optic Ltd
Linear Integrated Systems
Lintech Components
MilesTek
OTTO
P&A Components Inc
Pasternack
See ad pages 5, 25
Pickering Interfaces
Powell Electronics
RGB Spectrum
See ad page 40
Ross Engineering Corp
Standex Electronics
See ad page 34
TTI Inc

COMPONENTS - WIRE AND CABLE

Abaco Systems
AirBorn Inc
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Eaton
ESAM Inc
Fairview Microwave Inc
See ad page 15
HUBER+SUHNER Inc
Interstate Connecting Components
See ad page 18
LEMO USA Inc
MilesTek
P&A Components Inc
Pasternack
See ad pages 5, 25
PIC Wire & Cable
Pickering Interfaces
Powell Electronics
Saelig Co Inc
Southwest Microwave
Times Microwave Systems
TTI Inc
Wiselink

DISPLAYS - COCKPIT DISPLAYS

Applied Avionics
Curtiss-Wright Defense Solutions
Lintech Components
Momentum FPD Services Corp
Rogerson Kratos
Vicor Corp

DISPLAYS - ENHANCED/ SYNTHETIC VISION SYSTEMS

Coherent Logix Inc
Z3 Technology
See ad page 22

DISPLAYS - HEADS-UP DISPLAYS

Coherent Logix Inc
Minoru Co Ltd
Reynard Corp
SwissOptic AG

DISPLAYS - HELMET-MOUNTED DISPLAYS (HMD)

Coherent Logix Inc
PNY

DISPLAYS - IN-FLIGHT ENTERTAINMENT SYSTEM DISPLAYS

DLS Electronic Systems Inc
HUBER+SUHNER Inc
Momentum FPD Services Corp
Vicor Corp
Z3 Technology
See ad page 22

DISPLAYS - LIQUID CRYSTAL DISPLAYS

Crystal Group
EIZO Rugged Solutions
Minoru Co Ltd
Momentum FPD Services Corp

INTEGRATED CIRCUITS, ANALOG - BIPOLAR TRANSISTORS

Falcon Electronics
Hybrid Electronics
IR HiRel - An Infineon Technologies Co
Linear Integrated Systems
P&A Components Inc
TTI Inc

INTEGRATED CIRCUITS, ANALOG - IGBTS

Falcon Electronics
Hybrid Electronics
IR HiRel - An Infineon Technologies Co
P&A Components Inc
TTI Inc

INTEGRATED CIRCUITS, ANALOG - MOSFETS

Falcon Electronics
Holt Integrated Circuits
See ad page 31
Hybrid Electronics
IR HiRel - An Infineon Technologies Co
Linear Integrated Systems
Microchip Technology Inc
P&A Components Inc
Trendsetter Electronics
TTI Inc

INTEGRATED CIRCUITS, ANALOG - PASSIVE COMPONENTS

API Technologies Corp
Crane Aerospace & Electronics
Dexter Magnetic Technologies Inc

Evans Capacitor Co
Falcon Electronics
Gowanda Electronics
Hermetic Solutions Group
Holt Integrated Circuits
See ad page 31
HUBER+SUHNER Inc
Lintech Components
P&A Components Inc
PICO Electronics Inc
See ad page 23
Smiths Interconnect
Trendsetter Electronics
TTE Filters
TTI Inc

INTEGRATED CIRCUITS, ANALOG - POWER DISCRETE DEVICES

API Technologies Corp
Falcon Electronics
Hybrid Electronics
IR HiRel - An Infineon Technologies Co
Linear Integrated Systems
Lintech Components
P&A Components Inc
Trendsetter Electronics
TTI Inc
Vicor Corp

INTEGRATED CIRCUITS, ANALOG - POWER INTEGRATED CIRCUITS

API Technologies Corp
Falcon Electronics
Holt Integrated Circuits
See ad page 31
Hybrid Electronics
IR HiRel - An Infineon Technologies Co
P&A Components Inc
PICO Electronics Inc
See ad page 23

SynQor Inc
See ad page 21

Teledyne e2v
Trendsetter Electronics
TTI Inc
Vicor Corp

VPT Inc
See ad page 8

INTEGRATED CIRCUITS, ANALOG - RECTIFIERS

Crane Aerospace & Electronics
Falcon Electronics
Hybrid Electronics
IR HiRel - An Infineon Technologies Co
P&A Components Inc
Trendsetter Electronics
TTI Inc

INTEGRATED CIRCUITS, ANALOG - THYRISTORS

Falcon Electronics
Hybrid Electronics
P&A Components Inc
Trendsetter Electronics
TTI Inc

INTEGRATED CIRCUITS, DIGITAL - A-D CONVERTERS

Analog Devices Inc
Falcon Electronics
General Micro Systems Inc
See ad page 11
Hybrid Electronics

Mercury, formerly Pentek
See ad back cover

Microchip Technology Inc
North Atlantic Industries Inc
Teledyne e2v
Trenton Systems Inc
United Electronic Industries Inc

INTEGRATED CIRCUITS, DIGITAL - ASICS

API Technologies Corp
Intel Corp
Mercury, formerly Pentek
See ad back cover

INTEGRATED CIRCUITS, DIGITAL - COMMUNICATIONS/ NETWORKING ICS

Falcon Electronics
Holt Integrated Circuits
See ad page 31
Intel Corp
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
New Wave Design and Verification
See ad page 28

INTEGRATED CIRCUITS, DIGITAL - D-A CONVERTERS

Analog Devices Inc
Applied Avionics
Falcon Electronics
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
North Atlantic Industries Inc
Teledyne e2v
Trenton Systems Inc
United Electronic Industries Inc

INTEGRATED CIRCUITS, DIGITAL - DIGITAL SIGNAL PROCESSORS

Coherent Logix Inc
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
Z3 Technology
See ad page 22

INTEGRATED CIRCUITS, DIGITAL - FPGAS

Falcon Electronics
Hybrid Electronics
Intel Corp
Lintech Components
Mercury, formerly Pentek
See ad back cover
New Wave Design and Verification
See ad page 28
Teledyne e2v
Z3 Technology
See ad page 22

INTEGRATED CIRCUITS, DIGITAL - GENERAL-PURPOSE ICS

Falcon Electronics
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
Teledyne e2v

INTEGRATED CIRCUITS, DIGITAL - GRAPHICS ICS

Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
PNY
Trenton Systems Inc

INTEGRATED CIRCUITS, DIGITAL - IP CORES

Mercury, formerly Pentek
See ad back cover
New Wave Design and Verification
See ad page 28
Z3 Technology
See ad page 22

INTEGRATED CIRCUITS, DIGITAL - MEMORY ICS

Coherent Logix Inc
Falcon Electronics
Greenliant
Hybrid Electronics
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
P&A Components Inc
Teledyne e2v
Trenton Systems Inc
Viking Technology

INTEGRATED CIRCUITS, DIGITAL - MICROPROCESSORS/ MICROCONTROLLERS

Coherent Logix Inc
Falcon Electronics
Intel Corp
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
Teledyne e2v
Trendsetter Electronics
Trenton Systems Inc
Viking Technology

INTEGRATED CIRCUITS, DIGITAL - MIXED-SIGNAL ICS

Analog Devices Inc
Falcon Electronics
Holt Integrated Circuits
See ad page 31
Lintech Components
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
Teledyne e2v

INTEGRATED CIRCUITS, DIGITAL - NETWORK INTERFACE ICS

Holt Integrated Circuits
See ad page 31
Hybrid Electronics
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
New Wave Design and Verification
See ad page 28
North Atlantic Industries Inc

INTEGRATED CIRCUITS, DIGITAL - PERIPHERAL/ SUPPORT ICS

Holt Integrated Circuits
See ad page 31

Mercury, formerly Pentek
See ad back cover

Microchip Technology Inc

INTEGRATED CIRCUITS, DIGITAL - SOLID-STATE MEMORY

Falcon Electronics
Greenliant
Lintech Components
Mercury, formerly Pentek
See ad back cover
Microchip Technology Inc
Viking Technology

POWER ELECTRONICS - ACTUATORS

AMETEK Haydon Kerk Pittman
Dexter Magnetic Technologies Inc
DLS Electronic Systems Inc
Marotta Controls
Powell Electronics
Ross Engineering Corp
Velmex Inc

POWER ELECTRONICS - AUXILIARY POWER UNITS (APUS)

Nova Electric
SynQor Inc
See ad page 21
Vicor Corp

POWER ELECTRONICS - BATTERIES

Ametek IntelliPower Inc
Nova Electric
SynQor Inc
See ad page 21

POWER ELECTRONICS - CIRCUIT BREAKERS

Interstate Connecting Components
See ad page 18
Lintech Components
Ross Engineering Corp

POWER ELECTRONICS - EMERGENCY POWER UNITS

Allied International
Ametek IntelliPower Inc
Marotta Controls
Nova Electric
SynQor Inc
See ad page 21
Trendsetter Electronics

POWER ELECTRONICS - GENERATORS

Highland Technology

POWER ELECTRONICS - INVERTERS/CONVERTERS

Allied International
Ametek IntelliPower Inc
API Technologies Corp
Crane Aerospace & Electronics
Custom Manufacturing & Engineering Inc
General Micro Systems Inc
See ad page 11
Highland Technology
LEMO USA Inc
Nova Electric
PICO Electronics Inc
See ad page 23

SynQor Inc
See ad page 21

Unitron LP
Viable Power Conversion Technologies
Vicor Corp

VPT Inc
See ad page 8

POWER ELECTRONICS - MOTOR CONTROLLERS

AMETEK Haydon Kerk Pittman
Crane Aerospace & Electronics
IR HiRel - An Infineon Technologies Co
Marotta Controls
North Atlantic Industries Inc
Ross Engineering Corp
SynQor Inc
See ad page 21
United Electronic Industries Inc
Velmex Inc
Vicor Corp

POWER ELECTRONICS - MOTORS

AMETEK Haydon Kerk Pittman
Velmex Inc

POWER ELECTRONICS - POWER DISTRIBUTION SYSTEMS AND EQUIPMENT

AirBorn Inc
See ad page 9
Allied International
Ametek IntelliPower Inc
API Technologies Corp
Crane Aerospace & Electronics
Custom Manufacturing & Engineering Inc
IR HiRel - An Infineon Technologies Co
Marotta Controls
Mech-Tronics
Milpower Source
See ad page 29
Nova Electric
PICO Electronics Inc
See ad page 23
Ross Engineering Corp

SynQor Inc
See ad page 21

Trendsetter Electronics
Unitron LP
Versatile Power
Viable Power Conversion Technologies
Vicor Corp

VPT Inc
See ad page 8

POWER ELECTRONICS - POWER SUPPLIES

AirBorn Inc
See ad page 9
Allied International
Ametek IntelliPower Inc
Analog Modules Inc
API Technologies Corp
Beta Dyne
CAEN Spa
Crane Aerospace & Electronics
Custom Manufacturing & Engineering Inc

Dawn VME Products
See ad page 10

Diversified Technologies Inc
Elma Electronic Inc
Evans Capacitor Co
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Falcon Electronics
Henkel Corp
IR HiRel - An Infineon Technologies Co
Leonardo DRS
Lintech Components
Marotta Controls
Mech-Tronics
Milpower Source
See ad page 29
North Atlantic Industries Inc
Nova Electric
PICO Electronics Inc
See ad page 23
Ross Engineering Corp

SynQor Inc
See ad page 21

Technology Dynamics Inc
Tektronix Inc
Trendsetter Electronics
United Electronic Industries Inc
Unitron LP
VersaLogic Corp
Versatile Power
Viable Power Conversion Technologies
Vicor Corp

VPT Inc
See ad page 8

Wavelength Electronics Inc

POWER ELECTRONICS - TRANSDUCERS

Embassy Global
Interstate Connecting Components
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Palmer Wahl Instruments Inc
PICO Electronics Inc
See ad page 23
Powell Electronics
Trendsetter Electronics

POWER ELECTRONICS - TRANSIENT VOLTAGE SUPPRESSORS

Falcon Electronics
High Energy Devices LLC
PICO Electronics Inc
See ad page 23
Ross Engineering Corp
SynQor Inc
See ad page 21
Technology Dynamics Inc
VPT Inc
See ad page 8

SENSORS - INERTIAL

Allied International
Embassy Global
Interstate Connecting Components
See ad page 18
KVH Industries Inc
Silicon Designs Inc
VectorNav Technologies

SENSORS - INFRARED/ULTRAVIOLET

Bodkin Design & Engineering LLC
CAEN Spa
Falcon Electronics
Interstate Connecting Components
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Iscan Inc
Logos Technologies LLC
MoviTHERM
Opto Diode Corp
Palmer Wahl Instruments Inc
Powell Electronics
StingRay Optics LLC
SwissOptic AG
Thermoteknix Systems Ltd
UTC Aerospace Systems (Sensors Unlimited Products)
West Coast Tech Ltd
Z3 Technology
See ad page 22

SENSORS - LADAR/LIDAR

Analog Modules Inc
Areté
Coherent Logix Inc
Dexter Magnetic Technologies Inc
Diamond USA Inc
Interstate Connecting Components
See ad page 18
RPMC Lasers Inc
StingRay Optics LLC
Vicor Corp
Wavelength Electronics Inc
West Coast Tech Ltd

SENSORS - RADAR

Advanced Energy Industries Inc
CAEN Spa
Cambridge Pixel
Coherent Logix Inc
Dexter Magnetic Technologies Inc
Diamond USA Inc
Dspnor AS
Henkel Corp
HUBER+SUHNER Inc
Interstate Connecting Components
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Lockheed Martin
Mercury, formerly Pentek
See ad back cover
Milpower Source
See ad page 29
Per Vices Corp
Systems & Technology Research
United Electronic Industries Inc
West Coast Tech Ltd

SENSORS - SONAR

Coherent Logix Inc
Henkel Corp
Interstate Connecting Components
See ad page 18
Kraken Robotic Systems
Mercury, formerly Pentek
See ad back cover

SENSORS - TACTILE

Diamond USA Inc
Interstate Connecting Components
See ad page 18
Mercury, formerly Pentek
See ad back cover
Powell Electronics
TTI Inc

SENSORS - VISIBLE-LIGHT CAMERAS

Bodkin Design & Engineering LLC
Canon Medical Systems, USA, Video Sensing Division
Critical Link LLC
Iscan Inc
Logos Technologies LLC
MoviTHERM
Radiant Vision Systems
UTC Aerospace Systems (Sensors Unlimited Products)
West Coast Tech Ltd
XIMEA
Z3 Technology
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COMPUTERS

AIR DATA COMPUTERS

Mercury, formerly Pentek
See ad back cover
Systel Rugged Computers
See ad page 17
Wind River

DESKTOP COMPUTERS

HD Barcode
Mercury, formerly Pentek
See ad back cover
PNY

EMBEDDED COMPUTERS

Abaco Systems

Acromag Inc
See ad page 16

ADL Embedded Solutions Inc
Alta Data Technologies
Annapolis Micro Systems Inc
See ad page 34
Atrenne Integrated Solutions
See ad page 27
Crystal Group
Dawn VME Products
See ad page 10
Dspnor AS
Dynatem

EIZO Rugged Solutions

Elma Electronic Inc

esd electronics Inc

Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover

LCR Embedded Systems
See ad page 1
Mercury Systems
Mercury, formerly Pentek
See ad back cover
Neousys Technology Inc
North Atlantic Industries Inc
Pixus Technologies
See ad page 33
PNY
Sealevel Systems
Secord Solutions
Systel Rugged Computers
See ad page 17
Trenton Systems Inc
United Electronic Industries Inc
VersaLogic Corp
WIN Enterprises
Z3 Technology
See ad page 22

FLIGHT DIRECTORS

Mercury, formerly Pentek
See ad back cover
Wind River

LAPTOPS/NOTEBOOKS/ HANDHELD COMPUTERS

GRiD Defence Systems
Handheld US
HD Barcode
Mercury, formerly Pentek
See ad back cover
Systel Rugged Computers
See ad page 17

MULTICOMPUTER SYSTEMS

Crystal Group
Elma Electronic Inc
esd electronics Inc
Forefronts Defense Systems
Mercury Systems
Mercury, formerly Pentek
See ad back cover
Pixus Technologies
See ad page 33
PNY
Systel Rugged Computers
See ad page 17
Trenton Systems Inc

RACK-MOUNT COMPUTERS

ADL Embedded Solutions Inc
Ampex Data Systems
AnD Cable Products Inc
Annapolis Micro Systems Inc
See ad page 34
Atrenne Integrated Solutions
See ad page 27
Crystal Group
Dawn VME Products
See ad page 10
Dynatem

Elma Electronic Inc

esd electronics Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
LCR Embedded Systems
See ad page 1
Mercury Systems

Mercury, formerly Pentek
See ad back cover

Pixus Technologies
See ad page 33
PNY
Sealevel Systems
Systel Rugged Computers
See ad page 17
Trenton Systems Inc
Vicor Corp

SERVERS

Ampex Data Systems
Atrenne Integrated Solutions
See ad page 27
Crystal Group
Dynatem
Elma Electronic Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
GRiD Defence Systems
Mercury Systems
Mercury, formerly Pentek
See ad back cover
PNY
Systel Rugged Computers
See ad page 17
Trenton Systems Inc
Vicor Corp

SPECIALIZED COMPUTERS - TEMPEST

Atrenne Integrated Solutions
See ad page 27
Elma Electronic Inc
Forefronts Defense Systems
GRiD Defence Systems
Mercury, formerly Pentek
See ad back cover
Systel Rugged Computers
See ad page 17

WEARABLE COMPUTERS

Elma Electronic Inc
HD Barcode
Minoru Co Ltd
VersaLogic Corp
Wearin' SA
Z3 Technology
See ad page 22

DIAGNOSTICS AND CONTROL

AVIONICS HEALTH MANAGEMENT

Applied Avionics
Dawn VME Products
See ad page 10
GRiD Defence Systems
Mercury, formerly Pentek
See ad back cover
MilesTek
New Wave Design and Verification
See ad page 28
United Electronic Industries Inc

CLOCKS/TIMERS

Applied Avionics
Concurrent Technologies
HUBER+SUHNER Inc
Mercury, formerly Pentek
See ad back cover
RWC Testing & Lab Supplies
Trendsetter Electronics

ENGINE CONTROLS

Mercury, formerly Pentek
See ad back cover

ENGINE MONITORING

Crane Aerospace & Electronics
Mercury, formerly Pentek
See ad back cover
United Electronic Industries Inc

FUEL MANAGEMENT SYSTEMS

Crane Aerospace & Electronics
Mercury, formerly Pentek
See ad back cover

HEALTH AND USAGE MONITORING (HUMS)

Dawn VME Products
See ad page 10
Mercury, formerly Pentek
See ad back cover
United Electronic Industries Inc
Versatile Power

ICE DETECTION

Mercury, formerly Pentek
See ad back cover

OVERHEAT DETECTION

Dawn VME Products
See ad page 10
Mercury, formerly Pentek
See ad back cover
MoviTHERM
Palmer Wahl Instruments Inc

ELECTRO-OPTICS

BONDING AND ADHESIVES

Alfa International
Bakelite Synthetics
Ellsworth Adhesives
See ad page 30
Henkel Corp

Master Bond

NextGen Adhesives
Rudolph Bros & Co

CAMERAS

Bodkin Design & Engineering LLC
Canon Medical Systems, USA, Video Sensing Division
e-con Systems India Pvt Ltd
Gemstar Custom Hard Cases
Guernsey Coating Laboratories Inc
IO Industries Inc
MoviTHERM
NextGen Adhesives
Photonchina Co Ltd
Princeton Infrared Technologies Inc (PIRT)
Sierra Pacific Innovations
Teledyne DALSA
UTC Aerospace Systems (Sensors Unlimited Products)
West Coast Tech Ltd
XIMEA
Z3 Technology
See ad page 22

ELECTRO-OPTIC MATERIALS AND SUBSTRATES

AdTech Ceramics
Bodkin Design & Engineering LLC
Embassy Global
Gooch & Housego Plc
LLC VTC BASPIK Ltd
MOK Optics Co Ltd
NextGen Adhesives
PG&O - Precision Glass & Optics

West Coast Tech Ltd

EQUIPMENT MANUFACTURING

Bodkin Design & Engineering LLC
Diamond USA Inc
Mercury, formerly Pentek
See ad back cover
Princeton Infrared Technologies Inc (PIRT)

FORWARD-LOOKING INFRARED SYSTEMS

Bodkin Design & Engineering LLC
Mercury, formerly Pentek
See ad back cover
Princeton Infrared Technologies Inc (PIRT)
Reynard Corp
UTC Aerospace Systems (Sensors Unlimited Products)
West Coast Tech Ltd
Z3 Technology
See ad page 22

LASER COMPONENTS

AdTech Ceramics
Analog Modules Inc
Avo Photonics
Diamond USA Inc
Evans Capacitor Co
Gooch & Housego Plc
LaserOptec
MOK Optics Co Ltd
NextGen Adhesives
OFS
Photonchina Co Ltd
PICO Electronics Inc
See ad page 23
Reynard Corp
RPMC Lasers Inc
Wavelength Electronics Inc

West Coast Tech Ltd

LASERS

3 micron Laser Technology
Avo Photonics
Gooch & Housego Plc
Guernsey Coating Laboratories Inc
NextGen Adhesives
OFS
RPMC Lasers Inc
TTI Inc
West Coast Tech Ltd

LEDS

Applied Avionics
CAEN Spa
Embassy Global
GS PLASTIC OPTICS
Lambda Research Corp
Opto Diode Corp
OSI OptoElectronics Inc
TTI Inc
Wiselink

LIGHTING

Guernsey Coating Laboratories Inc
Reynard Corp
Versatile Power
West Coast Tech Ltd

NIGHT VISION

Applied Avionics
Archer OpTx
Coherent Logix Inc
GS PLASTIC OPTICS
Guernsey Coating Laboratories Inc
JML Optical Industries LLC
LLC VTC BASPIK Ltd
MOK Optics Co Ltd
MoviTHERM
Princeton Infrared Technologies Inc (PIRT)
Reynard Corp
Sierra Pacific Innovations
SwissOptic AG
Thermoteknix Systems Ltd
UTC Aerospace Systems (Sensors Unlimited Products)
West Coast Tech Ltd

OPTICAL AMPLIFIERS

Analog Devices Inc
OFS
Opto Diode Corp
OSI OptoElectronics Inc
Reynard Corp
RPMC Lasers Inc
West Coast Tech Ltd

OPTICAL COATINGS/ TREATMENTS

Archer OpTx
Bakelite Synthetics
Deposition Sciences Inc (DSI)
Gooch & Housego Plc
GS PLASTIC OPTICS
Guernsey Coating Laboratories Inc
JML Optical Industries LLC
LaserOptec

Master Bond

MOK Optics Co Ltd
NextGen Adhesives
OSI OptoElectronics Inc
PG&O - Precision Glass & Optics
Reynard Corp
Rudolph Bros & Co
Specialty Coating Systems
SwissOptic AG

West Coast Tech Ltd

OPTICAL DETECTORS

Analog Modules Inc
Canon Medical Systems, USA, Video Sensing Division
Falcon Electronics
GS PLASTIC OPTICS
Guernsey Coating Laboratories Inc
JML Optical Industries LLC
NextGen Adhesives
Opto Diode Corp
OSI OptoElectronics Inc
Princeton Infrared Technologies Inc (PIRT)
Radiant Vision Systems
Reynard Corp
TTI Inc
UTC Aerospace Systems (Sensors Unlimited Products)

OPTICAL FIBER

Alfa International
Archer OpTx
Diamond USA Inc
Guernsey Coating Laboratories Inc
Interstate Connecting Components
See ad page 18
KVH Industries Inc
MilesTek
NextGen Adhesives
OFS

OPTICAL FILTERS

Archer OpTx
Deposition Sciences Inc (DSI)
Embassy Global
Guernsey Coating Laboratories Inc
LaserOptec
MOK Optics Co Ltd
PG&O - Precision Glass & Optics
Reynard Corp

West Coast Tech Ltd

OPTICAL IMAGING

Archer OpTx
Bodkin Design & Engineering LLC
CAD/CAM Services Inc
Canon Medical Systems, USA, Video Sensing Division
GS PLASTIC OPTICS
Guernsey Coating Laboratories Inc
H&L Instruments LLC
Iscan Inc
JML Optical Industries LLC
Lambda Research Corp
LaserOptec
Logos Technologies LLC
Mercury, formerly Pentek
See ad back cover
NextGen Adhesives
Princeton Infrared Technologies Inc (PIRT)
Radiant Vision Systems
Reynard Corp
StingRay Optics LLC
UTC Aerospace Systems (Sensors Unlimited Products)
West Coast Tech Ltd

OPTICAL SWITCHES

Applied Avionics
Elma Electronic Inc
Embassy Global
Falcon Electronics
Gooch & Housego Plc
HUBER+SUHNER Inc
Lfiber Optic Ltd
Mercury, formerly Pentek
See ad back cover
OSI OptoElectronics Inc
Pickering Interfaces
TTI Inc
West Coast Tech Ltd

OPTICAL TRANSCEIVERS

Elma Electronic Inc
H&L Instruments LLC
HUBER+SUHNER Inc
Interstate Connecting Components
See ad page 18

Mercury, formerly Pentek
See ad back cover

NextGen Adhesives
West Coast Tech Ltd

OPTICS

Archer OpTx
Avo Photonics
Deposition Sciences Inc (DSI)
Diamond USA Inc
Embassy Global
Gooch & Housego Plc
GS PLASTIC OPTICS
Guernsey Coating Laboratories Inc
JML Optical Industries LLC
Lambda Research Corp
LaserOptec
Lfiber Optic Ltd
LLC VTC BASPIK Ltd
Mercury, formerly Pentek
See ad back cover
MOK Optics Co Ltd
PG&O - Precision Glass & Optics
Photonchina Co Ltd
Radiant Vision Systems
Reynard Corp
StingRay Optics LLC
SwissOptic AG
UTC Aerospace Systems (Sensors Unlimited Products)

West Coast Tech Ltd

THERMAL IMAGING

Archer OpTx
Bodkin Design & Engineering LLC
Guernsey Coating Laboratories Inc
LaserOptec
Mercury, formerly Pentek
See ad back cover
MoviTHERM
Princeton Infrared Technologies Inc (PIRT)
Reynard Corp
Sierra Pacific Innovations
StingRay Optics LLC
Thermoteknix Systems Ltd
UTC Aerospace Systems (Sensors Unlimited Products)
Wavelength Electronics Inc
West Coast Tech Ltd
Z3 Technology
See ad page 22

ULTRAVIOLET LIGHT SOURCES

Opto Diode Corp
Reynard Corp
RPMC Lasers Inc

NAVIGATION

AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B) EQUIPMENT

Applied Avionics
Dexter Magnetic Technologies Inc
Mercury, formerly Pentek
See ad back cover

GPS SYSTEMS

Applied Avionics
Carolina Microwave Associates Inc
Concurrent Technologies
Dexter Magnetic Technologies Inc
Gemstar Custom Hard Cases
HUBER+SUHNER Inc
KVH Industries Inc
Mercury, formerly Pentek
See ad back cover
PIC Wire & Cable
Rohde & Schwarz USA Inc
VectorNav Technologies

TERRAIN

Applied Avionics
Applied Physical Sciences Corp (APS)
KVH Industries Inc
Mercury, formerly Pentek
See ad back cover

PLATFORM SYSTEMS/ SUBSYSTEMS

AUTOPILOTS

Mercury, formerly Pentek
See ad back cover

AVIONICS

Abaco Systems
ADL Embedded Solutions Inc
Annapolis Micro Systems Inc
See ad page 34
Applied Avionics
AstroNova Aerospace
Atrenne Integrated Solutions
See ad page 27
Crane Aerospace & Electronics
Crystal Group
Dayton T Brown Inc
Diamond USA Inc
DLS Electronic Systems Inc
EIZO Rugged Solutions
Elma Electronic Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Holt Integrated Circuits
See ad page 31
Marotta Controls
Mercury, formerly Pentek
See ad back cover
MilesTek
Momentum FPD Services Corp
New Wave Design and Verification
See ad page 28
North Atlantic Industries Inc
PIC Wire & Cable
Pixus Technologies
See ad page 33
Rogerson Kratos
SynQor Inc
See ad page 21
United Electronic Industries Inc
VectorNav Technologies
Viable Power Conversion Technologies
Vicor Corp

CABIN MANAGEMENT SYSTEMS

Crane Aerospace & Electronics
DLS Electronic Systems Inc
Mercury, formerly Pentek
See ad back cover
SynQor Inc
See ad page 21

COUNTERMEASURES

Annapolis Micro Systems Inc
See ad page 34
Concurrent Technologies
Crystal Group
CTT Inc
HUBER+SUHNER Inc
Logos Technologies LLC
Mercury Systems
Mercury, formerly Pentek
See ad back cover
SynQor Inc
See ad page 21
Viable Power Conversion Technologies

ELECTRONIC FLIGHT INSTRUMENT SYSTEMS (EFIS)

Mercury, formerly Pentek
See ad back cover
Pixus Technologies
See ad page 33
Rogerson Kratos
SynQor Inc
See ad page 21
Wind River

LANDING SYSTEMS

Crane Aerospace & Electronics
Marotta Controls
Mercury, formerly Pentek
See ad back cover
SynQor Inc
See ad page 21
Z3 Technology
See ad page 22

LIGHT MANAGEMENT SYSTEMS

LaserOptec
Mercury, formerly Pentek
See ad back cover
MoviTHERM
Radiant Vision Systems
SynQor Inc
See ad page 21

LIGHTING

DLS Electronic Systems Inc
SynQor Inc
See ad page 21
Vicor Corp

NAVIGATION EQUIPMENT

Atrenne Integrated Solutions
See ad page 27
Crystal Group
CTT Inc
Dawn VME Products
See ad page 10
Diamond USA Inc
Elma Electronic Inc
Henkel Corp
KVH Industries Inc
Mercury, formerly Pentek
See ad back cover
Milpower Source
See ad page 29
SynQor Inc
See ad page 21
VectorNav Technologies
Z3 Technology
See ad page 22

SATELLITE SYSTEMS

Acroamatics Telemetry Systems
ADL Embedded Solutions Inc
Annapolis Micro Systems Inc
See ad page 34
Carolina Microwave Associates Inc
Coherent Logix Inc
Concurrent Technologies
Crane Aerospace & Electronics
Diamond USA Inc
Elma Electronic Inc
Gemstar Custom Hard Cases
Henkel Corp

HUBER+SUHNER Inc
Marotta Controls
Mercury, formerly Pentek
See ad back cover
StingRay Optics LLC
SynQor Inc
See ad page 21

SECURITY SYSTEMS

ADL Embedded Solutions Inc
Concurrent Technologies
Dspnor AS
Elma Electronic Inc
GiDEL
Logos Technologies LLC
Mercury, formerly Pentek
See ad back cover
MoviTHERM
RGB Spectrum
See ad page 40
Southwest Microwave
StingRay Optics LLC
SynQor Inc
See ad page 21
Z3 Technology
See ad page 22

SHIPBOARD/MARITIME ELECTRONICS

Ampex Data Systems
Annapolis Micro Systems Inc
See ad page 34
Applied Avionics
Atrenne Integrated Solutions
See ad page 27
Carolina Microwave Associates Inc
Coherent Logix Inc
Concurrent Technologies
Dawn VME Products
See ad page 10
Dayton T Brown Inc
Diamond USA Inc
Dspnor AS
EIZO Rugged Solutions
Elma Electronic Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Gemstar Custom Hard Cases
Henkel Corp
HUBER+SUHNER Inc
Marotta Controls
Mercury, formerly Pentek
See ad back cover
Milpower Source
See ad page 29
New Wave Design and Verification
See ad page 28
North Atlantic Industries Inc
PIC Wire & Cable
PICO Electronics Inc
See ad page 23
Pixus Technologies
See ad page 33
Smiths Interconnect
SynQor Inc
See ad page 21
VersaLogic Corp
Viable Power Conversion Technologies
Z3 Technology
See ad page 22

TRAINING AND SIMULATION

Ampex Data Systems
dSPACE Inc
Dspnor AS
Elma Electronic Inc
Mercury Systems
Mercury, formerly Pentek
See ad back cover
New Wave Design and Verification
See ad page 28
North Atlantic Industries Inc
Pixus Technologies
See ad page 33
PNY
RGB Spectrum
See ad page 40
SynQor Inc
See ad page 21
United Electronic Industries Inc
Viable Power Conversion Technologies

UNMANNED VEHICLES

ADL Embedded Solutions Inc
Ampex Data Systems
Annapolis Micro Systems Inc
See ad page 34
Archer OpTx
Atrenne Integrated Solutions
See ad page 27
Bell
Carolina Microwave Associates Inc
CTT Inc
Dawn VME Products
See ad page 10
EIZO Rugged Solutions
Elma Electronic Inc
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
GiDEL
Henkel Corp
Holt Integrated Circuits
See ad page 31
HUBER+SUHNER Inc
KVH Industries Inc
Logos Technologies LLC
Marotta Controls
Mercury, formerly Pentek
See ad back cover
New Wave Design and Verification
See ad page 28
Pelorus Naval Systems Inc
Pixus Technologies
See ad page 33
RGB Spectrum
See ad page 40
StingRay Optics LLC
SynQor Inc
See ad page 21
United Electronic Industries Inc
VectorNav Technologies
Viable Power Conversion Technologies
Wind River
Z3 Technology
See ad page 22

VETRONICS

Applied Avionics
Atrenne Integrated Solutions
See ad page 27
Dawn VME Products
See ad page 10
EIZO Rugged Solutions
Elma Electronic Inc
Holt Integrated Circuits
See ad page 31
Mercury, formerly Pentek
See ad back cover
SynQor Inc
See ad page 21

WEATHER SYSTEMS

Columbia Weather Systems Inc
Mercury, formerly Pentek
See ad back cover
Pixus Technologies
See ad page 33
SynQor Inc
See ad page 21

WEIGHT AND BALANCE SYSTEMS

SynQor Inc
See ad page 21

RF AND MICROWAVE

AMPLIFIERS

Analog Devices Inc
Analog Modules Inc
API Technologies Corp
CTT Inc
Dexter Magnetic Technologies Inc
Fairview Microwave Inc
See ad page 15
Falcon Electronics
Hybrid Electronics
I2R Electronics
Interstate Connecting Components
See ad page 18
Mercury Systems
NuWaves Engineering
Pasternack
See ad pages 5, 25
Pickering Interfaces
Powell Electronics
Pro-Comm Inc
RFMW
WDS Radar
Wiselink

ANTENNAS

API Technologies Corp
Carolina Microwave Associates Inc
Cubic Corp
Dexter Magnetic Technologies Inc
Electromagnetic Technologies Industries Inc
Fairview Microwave Inc
See ad page 15
Henkel Corp
HUBER+SUHNER Inc
I2R Electronics
Infinite Electronics Inc
Interstate Connecting Components
See ad page 18
Mercury, formerly Pentek
See ad back cover
Pasternack
See ad pages 5, 25
PIC Wire & Cable
Powell Electronics
Radiall USA
RFMW
Rohde & Schwarz USA Inc
Southwest Microwave
TTI Inc

BONDING AND ADHESIVES

Alfa International
Bakelite Synthetics
Ellsworth Adhesives
See ad page 30
Henkel Corp

NextGen Adhesives
Rudolph Bros & Co

DIPLEXERS/MULTIPLEXERS

Apex Waves
API Technologies Corp
Carolina Microwave Associates Inc

Electromagnetic Technologies Industries Inc
Fairview Microwave Inc
See ad page 15
Mercury, formerly Pentek
See ad back cover
NuWaves Engineering
Pasternack
See ad pages 5, 25
Pickering Interfaces
RFMW
TTE Filters

DISCRETE COMPONENTS

Fairview Microwave Inc
See ad page 15
Falcon Electronics
Gooch & Housego Plc
Gowanda Electronics
HUBER+SUHNER Inc
IR HiRel - An Infineon Technologies Co
Mercury, formerly Pentek
See ad back cover
Pasternack
See ad pages 5, 25
Powell Electronics
RFMW
Trendsetter Electronics
Wavelength Electronics Inc
Wiselink

FILTERS

API Technologies Corp
Carolina Microwave Associates Inc
Dexter Magnetic Technologies Inc
Electromagnetic Technologies Industries Inc
Fairview Microwave Inc
See ad page 15
Gooch & Housego Plc
Hybrid Electronics
Interstate Connecting Components
See ad page 18
Mercury, formerly Pentek
See ad back cover
NuWaves Engineering
Pasternack
See ad pages 5, 25
Powell Electronics
RFMW

SynQor Inc
See ad page 21

TopFlite Components
TTE Filters

FREQUENCY SYNTHESIZERS

Anritsu
Fairview Microwave Inc
See ad page 15
I2R Electronics
Mercury, formerly Pentek
See ad back cover
NuWaves Engineering
Pasternack
See ad pages 5, 25
RFMW
Saelig Co Inc

HYBRIDS

API Technologies Corp
Electromagnetic Technologies Industries Inc
Fairview Microwave Inc
See ad page 15
Falcon Electronics
I2R Electronics
Mercury, formerly Pentek
See ad back cover
Pasternack
See ad pages 5, 25
RFMW
Wiselink

MICROWAVE SUBASSEMBLIES

API Technologies Corp
Carolina Microwave Associates Inc
CTT Inc
Diamond USA Inc
Fairview Microwave Inc
See ad page 15
Gowanda Electronics
Hermetic Solutions Group
HUBER+SUHNER Inc
I2R Electronics
Mercury Systems
Mercury, formerly Pentek
See ad back cover
NuWaves Engineering
Pickering Interfaces
Pro-Comm Inc
Technotronix Inc
TTE Filters
Wiselink

MIXED-SIGNAL DEVICES

Anritsu
Apex Waves
API Technologies Corp
Fairview Microwave Inc
See ad page 15
Falcon Electronics
Mercury Systems
Mercury, formerly Pentek
See ad back cover
Per Vices Corp
RFMW

MMICS

AdTech Ceramics
API Technologies Corp
Fairview Microwave Inc
See ad page 15
HRL Laboratories LLC
I2R Electronics
Mercury, formerly Pentek
See ad back cover
RFMW
Tomahawk Robotics

OSCILLATORS/SYNTHESIZERS

API Technologies Corp
Electromagnetic Technologies Industries Inc
Fairview Microwave Inc
See ad page 15
Falcon Electronics
I2R Electronics
Mercury, formerly Pentek
See ad back cover
NuWaves Engineering
Pasternack
See ad pages 5, 25
Pro-Comm Inc
RFMW
Tektronix Inc

RF ATTENUATORS

Anritsu
API Technologies Corp
Carolina Microwave Associates Inc
Fairview Microwave Inc
See ad page 15
Gooch & Housego Plc
Mercury, formerly Pentek
See ad back cover
Pasternack
See ad pages 5, 25
Pickering Interfaces
Powell Electronics
Radiall USA
RFMW
Smiths Interconnect
Wiselink

RF PACKAGING

AdTech Ceramics
API Technologies Corp
Fairview Microwave Inc
See ad page 15
Gemstar Custom Hard Cases
Hermetic Solutions Group
Mercury, formerly Pentek
See ad back cover
Pasternack
See ad pages 5, 25
Pixus Technologies
See ad page 33
Ross Engineering Corp
Smiths Interconnect
Tektronix Inc

RF SWITCHES

Analog Devices Inc
API Technologies Corp
Elma Electronic Inc
Fairview Microwave Inc
See ad page 15
Gooch & Housego Plc
Hybrid Electronics
Interstate Connecting Components
See ad page 18
Mercury Systems
Mercury, formerly Pentek
See ad back cover
MilesTek
NuWaves Engineering
Pasternack
See ad pages 5, 25
Pickering Interfaces
Powell Electronics
Radiall USA
RFMW
Technotronix Inc
ViaLite Communications

SIGNAL GENERATORS

Anritsu
Apex Waves
API Technologies Corp
Computer2100 LLC
Fairview Microwave Inc
See ad page 15
Mercury, formerly Pentek
See ad back cover
Pasternack
See ad pages 5, 25
Per Vices Corp
Pickering Interfaces
Pro-Comm Inc
Rohde & Schwarz USA Inc
Saelig Co Inc

TRANSMIT/RECEIVE MODULES

Acroamatics Telemetry Systems
API Technologies Corp
CTT Inc
Discovery Semiconductors Inc
See ad page 3
Elma Electronic Inc
Fairview Microwave Inc
See ad page 15
Henkel Corp
HUBER+SUHNER Inc

I2R Electronics
Mercury, formerly Pentek
See ad back cover
NuWaves Engineering
Pasternack
See ad pages 5, 25
Per Vices Corp
Powell Electronics
RFMW

UP/DOWN CONVERTERS

Apex Waves
API Technologies Corp
CTT Inc
Fairview Microwave Inc
See ad page 15
I2R Electronics
Mercury, formerly Pentek
See ad back cover
NuWaves Engineering
Pasternack
See ad pages 5, 25
Per Vices Corp
PICO Electronics Inc
See ad page 23
RFMW
Tektronix Inc

SAFETY EQUIPMENT AND COMPONENTS

ALARM SYSTEMS

Applied Avionics
Graphic Products
Mercury, formerly Pentek
See ad back cover
MoviTHERM

ALTITUDE ALERTS

Applied Avionics
Dayton T Brown Inc

ANTI-ICING EQUIPMENT

Dayton T Brown Inc

ANTI-STATIC EQUIPMENT

Dayton T Brown Inc
Minoru Co Ltd

COLLISION AVOIDANCE SYSTEMS

Applied Avionics
Mercury, formerly Pentek
See ad back cover

EMERGENCY LOCATOR TRANSMITTERS (EFTS)

Mercury, formerly Pentek
See ad back cover

EMI/RFI

API Technologies Corp
Dayton T Brown Inc
Elma Electronic Inc
Fairview Microwave Inc
See ad page 15
Gemstar Custom Hard Cases
Mercury, formerly Pentek
See ad back cover
Minoru Co Ltd
SynQor Inc
See ad page 21

FIRE DETECTION

Applied Avionics
Mercury, formerly Pentek
See ad back cover
MoviTHERM
Stat-X Fire Suppression

STALL WARNING

Applied Avionics
Mercury, formerly Pentek
See ad back cover

TERRAIN AWARENESS WARNING SYSTEMS (TAWS)

Applied Avionics
Mercury, formerly Pentek
See ad back cover

WINDSHEAR WARNING SYSTEMS

Applied Avionics
Mercury, formerly Pentek
See ad back cover

SERVICES

ASSEMBLY/SUBCONTRACT SERVICES

ADCO Circuits
Advanced Component Testing
Alfa International
Atrenne Integrated Solutions
See ad page 27
Avo Photonics
CAD/CAM Services Inc
Carolina Microwave Associates Inc
Concurrent Technologies
CTT Inc
Custom Manufacturing & Engineering Inc
ESAM Inc
Gemstar Custom Hard Cases
GS PLASTIC OPTICS
HUBER+SUHNER Inc
Interstate Connecting Components
See ad page 18
John Evans' Sons

Mercury, formerly Pentek
See ad back cover
Nelson Design Services Inc
Nova Electric
NuWaves Engineering
Photonchina Co Ltd
PIC Wire & Cable
Powell Electronics
Pro-Comm Inc
Secord Solutions
Specialty Coating Systems
SwissOptic AG
Teledyne e2v
Titan Circuits
United Electronic Industries Inc
Viable Power Conversion Technologies

CALIBRATION SERVICES

Anritsu
CAD/CAM Services Inc
Custom Manufacturing & Engineering Inc
Eastern Applied Research Inc
Mahr Inc
Mensor
Mercury, formerly Pentek
See ad back cover
Monocle Industries
Radiant Vision Systems
Rohde & Schwarz USA Inc
Ross Engineering Corp
Tektronix Inc

CONSULTANTS

AEi Systems
Alfa International
AnD Cable Products Inc
Annapolis Micro Systems Inc
See ad page 34
Archer OpTx
Bodkin Design & Engineering LLC
CAD/CAM Services Inc
Dayton T Brown Inc
Deloitte
DLS Electronic Systems Inc
Embassy Global
Forefronts Defense Systems
GL Communications Inc
Graphic Products
Logos Technologies LLC
Mercury, formerly Pentek
See ad back cover
Nelson Design Services Inc
NuWaves Engineering
Pelorus Naval Systems Inc
Secord Solutions
Viking Equipment Finance

DESIGN ENGINEERING

ADL Embedded Solutions Inc
Advanced Cooling Technologies Inc (ACT)
Advanced Micro Peripherals
AEi Systems
Alfa International
Annapolis Micro Systems Inc
See ad page 34
API Technologies Corp
Archer OpTx
Avo Photonics
CAD/CAM Services Inc
Carolina Microwave Associates Inc
Critical Link LLC
Custom Manufacturing & Engineering Inc
Dawn VME Products
See ad page 10
Dayton T Brown Inc
DLS Electronic Systems Inc
Dynatem
Extreme Engineering Solutions (X-ES)
See ad inside front cover & inside back cover
Gemstar Custom Hard Cases
Hermetic Solutions Group
John Evans' Sons
Leidos
Logos Technologies LLC
Mercury, formerly Pentek
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New Wave Design and Verification
See ad page 28
Northrop Grumman Corp
NuWaves Engineering
Pelorus Naval Systems Inc
Per Vices Corp
PIC Wire & Cable
Pixus Technologies
See ad page 33
Raytheon Technologies Corp
Reynard Corp
Rogerson Kratos
Secord Solutions
Southwest Microwave
StingRay Optics LLC
Teledyne e2v

Viable Power Conversion Technologies
VPT Inc
See ad page 8
WOLF Advanced Technology
See ad page 7

DISTRIBUTORS

Acromag Inc
See ad page 16
Allied International
Falcon Electronics
Interstate Connecting Components
See ad page 18
LaserOptec
Lintech Components
Mahr Inc
Mercury, formerly Pentek
See ad back cover
Powell Electronics
Saelig Co Inc

SOFTWARE

APPLICATIONS

Annapolis Micro Systems Inc
See ad page 34
C3.ai
CAD/CAM Services Inc
Complete Inspection Systems Inc
Computer2100 LLC
Concurrent Technologies
Dspnor AS
esd electronics Inc
GiDEL
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iBASEt
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Science Applications International Corp (SAIC)
Secord Solutions
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Wind River

COMMUNICATIONS/ NETWORKING

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Concurrent Technologies
Critical Link LLC
dSPACE Inc
Dynatem
esd electronics Inc
GL Communications Inc
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iBASEt
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New Wave Design and Verification
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Wind River

DATA SECURITY

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Annapolis Micro Systems Inc
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Concurrent Technologies
Dynatem
Kitware Inc
Mercury, formerly Pentek
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Wind River

DATABASE MANAGEMENT

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DATABASES

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dSPACE Inc
Dynatem
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Lambda Research Corp
Marvin Test Solutions Inc
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CAD/CAM Services Inc
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Mass Virtual
Mercury, formerly Pentek
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RGB Spectrum
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Computer2100 LLC
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Perspecta Enterprise Solutions
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MOVING MAPS

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Custom Manufacturing & Engineering Inc
Fairview Microwave Inc
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Gemstar Custom Hard Cases
Gooch & Housego Plc
Marvin Test Solutions Inc
Mensor
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Gooch & Housego Plc
Hoffer Flow Controls Inc
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Palmer Wahl Instruments Inc
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Aukua Systems Inc
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PCE Instruments
Rohde & Schwarz USA Inc
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GRiD Defence Systems
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Mercury, formerly Pentek
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Saelig Co Inc
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Archer OpTx
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Bodkin Design & Engineering LLC
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Momentum FPD Services Corp
Monocle Industries
MoviTHERM
PCE Instruments
Radiant Vision Systems
Reynard Corp
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GL Communications Inc
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Mahr Inc
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Monocle Industries
MoviTHERM
New Wave Design and Verification
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PCE Instruments
Pixus Technologies
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Radiant Vision Systems
Ross Engineering Corp
RWC Testing & Lab Supplies
Saelig Co Inc
Silicon Designs Inc
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United Electronic Industries Inc
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Marvin Test Solutions Inc
Mensor
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Radiant Vision Systems
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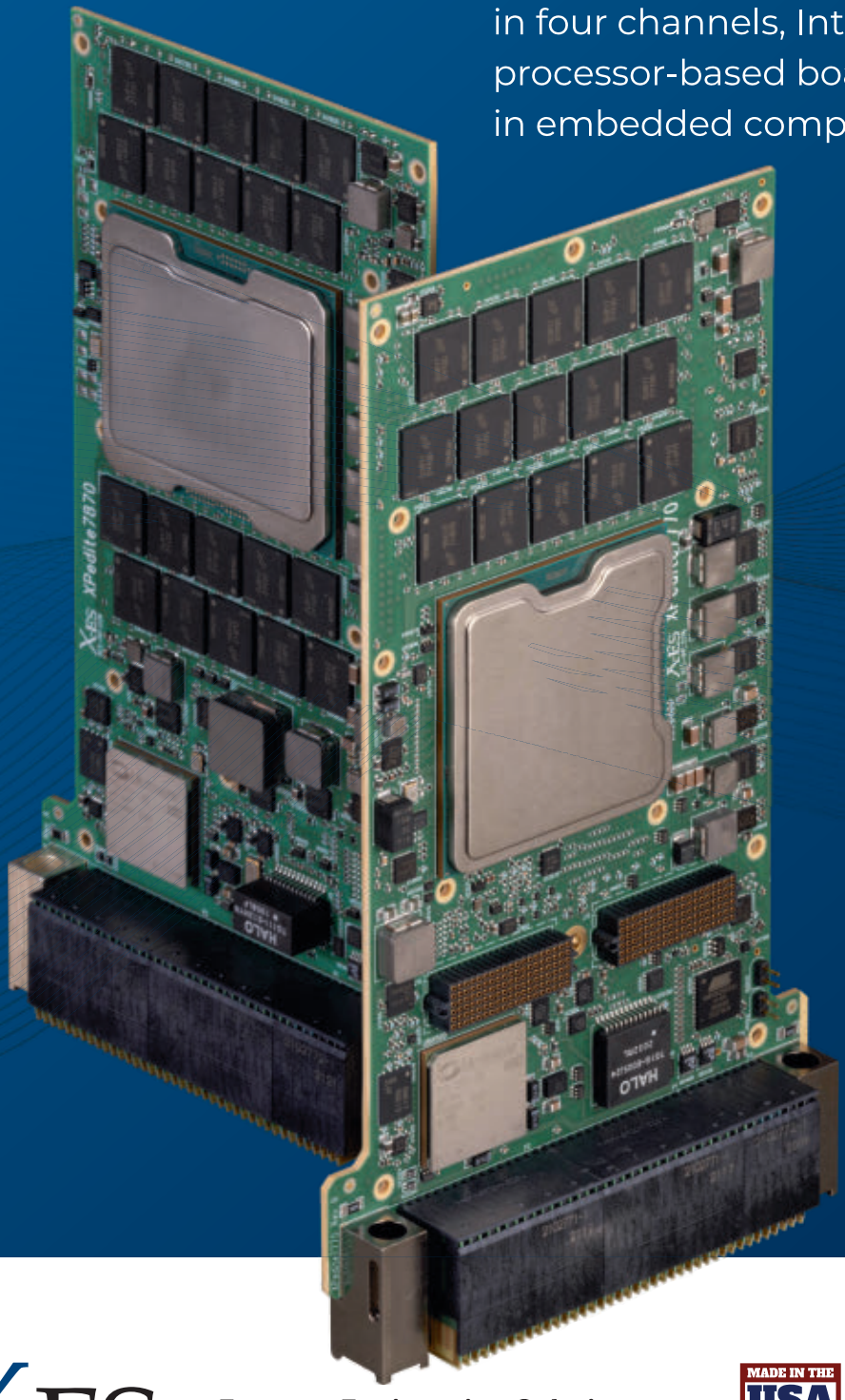

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