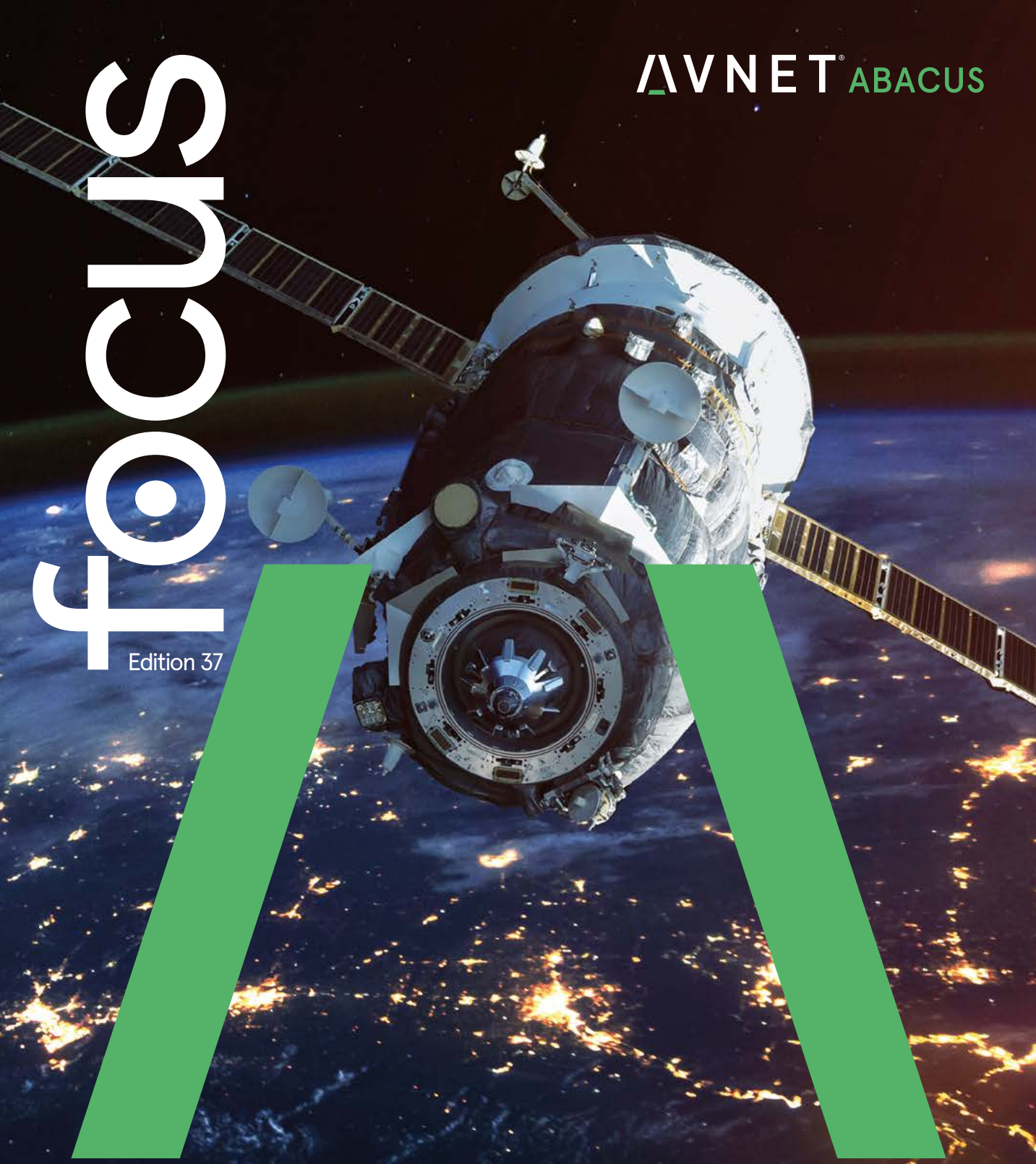
AVNET ABACUS

focus

Edition 37



Aerospace and Defence: New frontiers in innovation

focus

Focus is the quarterly magazine from Avnet Abacus, featuring in-depth trend and technology reviews, new product spotlights, Avnet community news and interviews with market leaders.

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Features

Supplier technologies

Connectors

Electromechanical

RF and wireless

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Editor Anais Dupont
Design Chiltern Graphics
Print Image Evolution

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Welcome to this latest edition of Focus magazine, dedicated to the aerospace and defence markets, which have long been at the forefront of technological advance and innovation. Industry players in these sectors are pushing technology to its limits, enabling breakthroughs that proliferate into other industries, and follow a similar pattern to developments such as the Internet, GPS and computing in previous decades.

In this edition, we investigate the new challenges and opportunities faced by engineers in aerospace and defence applications, looking at what is common across the sector and what is unique to each sub-segment.

Whilst Covid-19 has created one of the biggest challenges in recent times for the manufacturing industry, aerospace has undeniably been one of the most affected. Yet even before the arrival of Covid-19, the industry was facing significant change, with key innovations such as urban air mobility and electric propulsion aircraft shaping the future of commercial aerospace. Our first article investigates **advances in avionics**, a market at the heart of the aerospace industry and a key enabler of the innovations that are likely to follow from the current restructuring of the industry.

Demand for defence equipment is on the rise as governments across the globe focus on national security modernisation. The uncertainty and sustained complexity of the international security environment worldwide is likely to boost global defence spending over the next five years, with an estimated CAGR of 3% to US$2.1 trillion by 2023. In our article **how a multipolar world is boosting defence innovation**, we examine today's rapidly changing national security landscape and the wide variety of innovation opportunities that could emerge. Addressing these opportunities will involve solving both traditional and emerging defence engineering challenges.

Space 2.0 is predicted to yield significant returns, in both scientific and engineering advances — each of which hold tangible benefits for all of us — but will increasingly be about direct and indirect economic benefits from space. Our third article, **the space race takes off**, looks at our involvement in the world beyond this planet's surface. As the twenties take off, this has never been stronger, and the opportunity to benefit from enabling that involvement has never been greater.

From an engineering perspective, these industries represent some of the most challenging and competitive industries out there, with reliability, cost and technological sophistication as the key drivers and challenges for both manufacturers and engineers.

Rudy Van Parijs
President, Avnet Abacus

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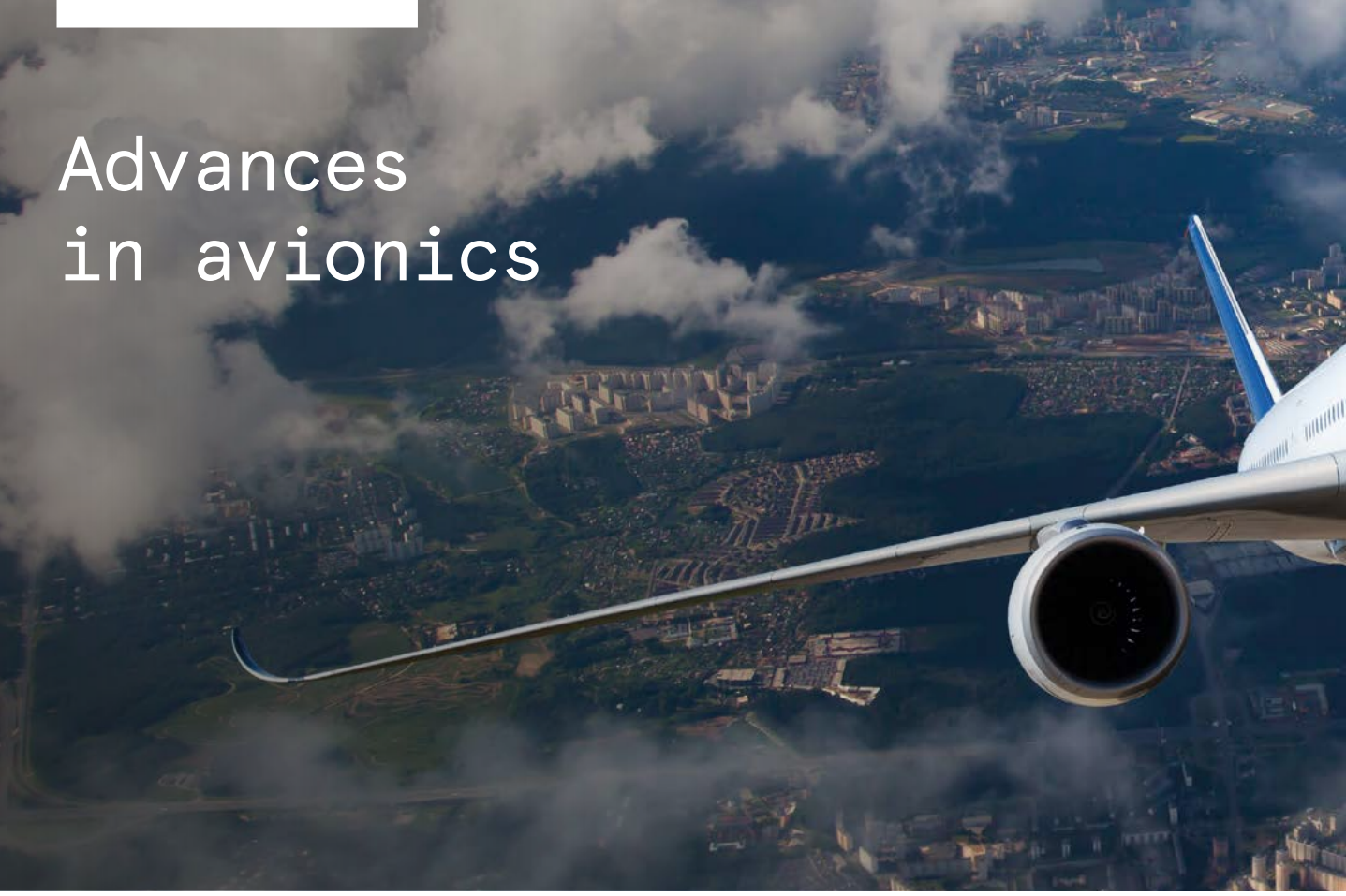
Advances in avionics



The global pandemic of 2020 has upended expectations about growth in the aerospace industry and therefore demand for the avionics equipment that enables it.

What was, according to a report from consultants Deloitte, already a down year for commercial aircraft deliveries in 2019, has been exacerbated by general uncertainty about travel caused by the 2020 pandemic. It is not clear whether old travel patterns will resume once the crisis is over, or whether our habits and expectations will have been so completely remade that it demands a rethink of the whole aerospace sector.

What does seem likely, though, is that the current uncertainty will accelerate the pace of change and create mid-term opportunities to innovate in support of a renewed aerospace industry. Electronics engineers will be at the heart of such innovation, building the avionics systems that will enable the reconfigured industry to survive and thrive.

Mid-term opportunities

Electric vehicles are just reaching the point at which they are regarded as a credible alternative to petrol or diesel cars. While this evolution has been underway, some aerospace propulsion companies, including Rolls-Royce, have been developing electric powertrains for aircraft, to reduce the carbon footprint, noise and cost of air travel. The Rolls-Royce 'Spirit of Innovation' demonstrator, pictured opposite, has been built to challenge for the title of the world's fastest electric aircraft. The company claims it could fly from London to Paris on the charge held in its 6000-cell battery pack.

The uptake of electric propulsion in aircraft will create demand for sophisticated new control systems, which use the learning that emerged from the rise of electric vehicles to create advanced control systems and powertrains focused on efficiency.

For example, the avionics of the Rolls-Royce plane include the engine control unit, power distribution unit, and flight sensors. The company says it will collect in-flight information, such as battery voltage, temperature and other performance metrics, at more than 20,000 points a second on the powertrain.

Experience with electric cars may have taught us that, at first, electric propulsion systems will work best for short journeys, given the energy storage challenges of today's battery technology. However, this apparent limitation could dovetail well with emerging plans for 'urban air mobility ecosystems', which might be better thought of as flying taxis for use in cities.

Martin Keenan

Technical Director
Avnet Abacus

Source: https://www.rolls-royce.com/innovation/accel.aspx

As the Deloitte report argues, it's going to take a lot of work to create the infrastructure and ecosystem necessary to enable urban air mobility. There will be the challenges of regulating pilotless vehicles, certifying their airworthiness and controlling the way they use airspace. There will be substantial avionics challenges as well. The vehicles will need to be extremely energy efficient, and have multiple sensors and rich data fusion capabilities to enable effective collision avoidance systems. There will also be a lot of work to be done to create the supporting infrastructure, such as upgraded air traffic control management systems that work flawlessly all the time, which will encourage and sustain consumer demand.

Source: https://lilium.com/newsroom-detail/lilium-partners-with-tavistock-and-orlando

Advances in avionics

Although this may sound like science fiction, in November 2020 the city of Orlando, Florida, and Lilium, a German aviation company, announced plans to build a 'vertiport' in the city by 2025. The vertiport will be home to a fleet of vertical-take-off, electrically powered aircraft that will be used as air taxis to help the city's wealthiest passengers avoid the pain of ground-based gridlock. Lilium's development aircraft uses 36 electric motors, mounted in the wings, to provide directed thrust. The company argues that this allows its design to do away with many of the control surfaces, and the associated gearboxes and lubrication circuits, of conventional aircraft. This should increase the vehicle's reliability while reducing its weight and the maintenance overhead.

Lilium isn't alone in its ambition to build an electric vertical take-off and landing craft. Japanese company SkyDrive said in August 2020 that it had completed a four-minute test flight in its SD-03 test vehicle, which uses eight propellers, two at each corner of the roughly rectangular vehicle, to provide lift. The company also said it had received Yen3.9bn (€31.5 million) in funding from the Development Bank of Japan and other investors to continue its work.

Other avionics opportunities may emerge from moves to increase the amount of automation used on flight decks, which will demand more computing power. In the cabin, too, rising passenger expectations will prompt the installation of much more complex seatback entertainment and communication systems, creating demand for more computing power, better graphics, seat to seat networking, onboard Wi-Fi and air to ground connectivity. The challenge here is to create such powerful systems, and the wiring infrastructure to power, connect and manage them, while minimising their mass and power consumption.

The avionics of unmanned aerial vehicles, such as inspection drones or unmanned cargo aircraft, will undergo almost continuous updates. You can see this trend at work in the consumer and semi-professional drones offered by companies such as DJI. The control software for its drones is constantly being updated to improve features such as the stability of the platform in flight for photography, or its ability to track a moving subject, such as a skier, in order to film them in motion. Interestingly, the intense development pressure brought to bear by competing in a consumer market such as drones is likely to prompt innovations that will, in turn, be

"Avionics engineers will need to think about how to provide the computing power necessary to capture, fuse and interpret this data, which may lead to an exploration of alternate computing architectures such as machine-learning coprocessors, to handle pattern recognition tasks efficiently and at low energy cost."

Lilium and Tavistock have together created a breakthrough vertiport architecture for its hub location that is both functional and aesthetically unique and resembles the iconic art within Lake Nona.

fed back into the company's professional ranges. After all, nothing will test a piece of equipment quite as harshly as handing it over to a YouTuber for the weekend. It may also provide the insight necessary to make informed decisions about whether avionics equipment always needs to use the most highly rated componentry, or whether Commercial Off-The-Shelf (COTS) parts will be good enough in many use cases.

Technical challenges and responses

As in the space and defence sectors, future avionics systems will be making much greater use of sensor data to increase their situational awareness and ability to make accurate decisions quickly. This will mean that developers will have to think more carefully about how they connect to these sensors, the bandwidth of the interconnect schemes they specify, and the physical ruggedness of their implementation. This could see a shift to the use of two-wire Ethernet implementations, fibre-optic systems, and denser/lighter traditional interconnect strategies.

Avionics developers will also need to think about how to provide the computing power necessary to capture, fuse and interpret this data, which may lead to an exploration of alternate computing architectures such as machine-learning coprocessors, to handle pattern recognition tasks efficiently and at low energy cost.

In the powertrain, especially for electric flight vehicles, the emphasis will be on making the absolute most of the energy stored in the battery pack. This will lead to an emphasis on maximising the efficiency with which power can be converted and distributed to the motors and other systems that use it. Rolls-Royce is exploring these issues with its Magnus eFusion two-seater training aircraft, a testbed for sub-100kW electric propulsion systems. The first iteration of the powertrain had a 45kW electric motor, but after a series of upgrades it has a continuous power output of 70kW. The motor and its associated inverter have now been registered by Rolls-Royce for certification.

There will also be a strong focus on minimising the mass of everything in the aircraft, to compensate for the relatively low energy/mass ratio of batteries when compared to fossil fuels. Some of this will be achieved by taking learnings from the development of e-vehicle powertrains, which are evolving very rapidly at the moment, and then carrying across the relevant architectural and component choices for use in avionics.

Advances in avionics

"There will be a strong focus on minimising the weight of everything in the aircraft, to compensate for the relatively low energy/mass ratio of batteries when compared to fossil fuels."

Molex OTS MultiCat discrete cable assemblies.

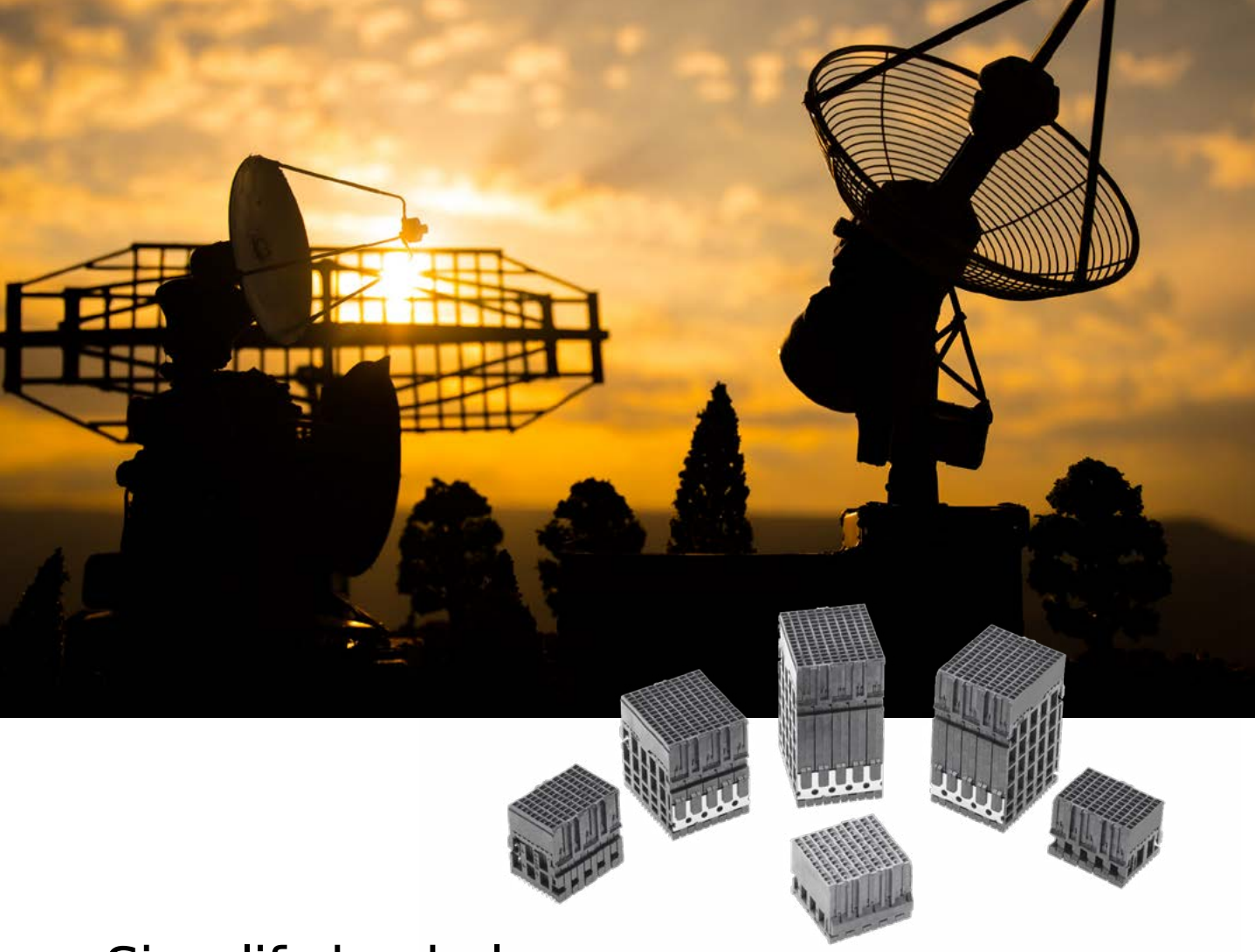
Bourns PDF241 series long-life potentiometer.

For example, Molex makes cable assemblies, such as the OTS Multicat, that can provide dense power distribution with high reliability.

And, as in almost all other avionics designs, there will be continuing pressure to minimise factors such as equipment size, energy consumption, and cooling requirements, within the envelope of traditional avionics design concerns such as reliability, operating lifetimes, and robustness.

Even the specifications of a humble potentiometer have to be carefully considered if it is going to be used as part of a human machine interface for an avionics system, like the PDF241 long-life part from Bourns. It is specified to last for one million rotations and also meets standards that enable it to be used in medical lab equipment and medical diagnostics systems.

Avionics is at the heart of the aerospace industry and is the key enabler of the innovations that are likely to follow from the current restructuring of the industry. It will be down to electronics engineers to make the complex design trade-offs necessary to create these innovative avionics systems which, in turn, will help provide a route back to a thriving aerospace industry.



Simplify backplane connections and achieve superior electrical performance ›

With one of the most versatile offerings in the market, the Impact Backplane Connector and Cable Assembly System is pushing the envelope to meet next-generation high-speed demands.

Featuring data rates up to and beyond 25Gbps, Impact Backplane Connectors offer superior signal integrity and electrical performance in a modular design. This fast, electrically clean, and flexible solution is ideal for use in high-performance applications such as aerospace and defence, as well as data networking, telecommunication, and medical equipment.

Visit avnet-abacus.eu/molex

molex

Samtec Sudden Service® solutions for standard and application-specific military and aerospace designs

The military and aerospace world utilises products that must be able to properly perform in harsh conditions. Because of this, many Mil/Aero manufacturers typically use full Mil-Spec products.

Samtec's Sudden Service® solutions for standard and application-specific military and aerospace are designed to meet the stringent quality, production and compliance requirements of its customers. The combined efforts of Samtec's ongoing Severe Environment Testing initiative with its extremely flexible high-speed interconnects provides a quick turn and cost-effective solution for military and aerospace applications that require reliable performance and durability.

Severe Environment Testing (SET) is a Samtec initiative to test products beyond typical industry standards and specifications, many set forth by common requirements for rugged/harsh environment industries. These products undergo additional testing to ensure they are more than suitable for military, space, automotive, industrial and other extreme applications. Samtec's SET products are approved for NASA Class D missions that require high-reliability, quick-turn and cost-effective solutions for LEO and GEO satellites, SmallSats, CubeSats and other space exploration applications. And while these tests might not be the exact same as a Mil-Spec qualification test, they afford the user the confidence that a COTS product will perform as needed in their application.

SEVERE ENVIRONMENT TESTING (SET)

Developed to bridge the gap from standard qualification testing offered on COTS products and a full Mil-Spec product, SET takes the standard qualification test and builds on top of it to prove to the customer that Samtec products can withstand the rugged environments and conditions of the Mil/Aero world. Current available test results can be viewed at **samtec.com/SET**.

ADDITIONAL TESTING INCLUDES:

- Mating/unmating/ durability
- Mechanical shock/ random vibration/LLCR and nanosecond event detection
- Temperature cycling
- Non-operating class temperature
- DWV at altitude
- Electrostatic Discharge (ESD)

Samtec can also perform Salt Fog Testing and conformal coating for its FireFly™ series.

Severe Environment Tested badge.

SAMTEC MIL/AERO PRODUCT RANGE

Each application has different levels of service requirements, budgets, testing requirements, and lead-times. Because of the unique requirements of Mil/Aero applications, Samtec offers three different styles of products to meet the wide range of needs:

- Commercial Off-The-Shelf (COTS)
- Application Specific Product (ASP)
- Military/Aerospace Product (MAP)

RUGGEDISING OPTIONS

JACK SCREWS
Ideal for high normal force, zippering and other rugged applications

POSITIVE LATCHING
Manually activated latches increase unmating force by up to 200%

FRICTION LOCKS
Metal or plastic friction locks increase retention/ withdrawal force

RETENTION PINS
Increase unmating force by up to 50%

BOARD LOCKS
Boards are mechanically locked together

WELD TABS
Significantly increase shear resistance of connector to PCB

GUIDE POSTS
Easy and secure mating

SHIELDING
360° shielding reduces EMI

SCREW DOWNS
Secure mechanical attachments to the board

BOARD STANDOFFS
Precision machined standoffs for 5mm to 25mm board spacing

Each style of product offering affords the customer different options. Product modification such as non-standard plating options up to 50µ" gold can be ordered with ASP or MAP offerings. Rugged situations require rugged solutions, and a majority of the time they still need to offer high-speed performance as well. Samtec offers rugged signal integrity solutions with speeds up to 112Gbps PAM4 and extreme design flexibility to ensure performance reliability. Some of these rugged solutions include jack screws, positive latching, friction locks, retention pins, board locks, weld tabs, guide posts, and shielding.

For more information visit avnet-abacus.eu/samtec

SAMTEC MIL/AERO PRODUCT SOLUTIONS

COMMERCIAL OFF-THE-SHELF (COTS)

- Certified ISO-9001
- Cost effective
- Short lead times
- No minimum order quantity
- Full qualification testing online

APPLICATION SPECIFIC PRODUCT (ASP)

- Modified COTS built to Samtec's print
- AS9102 FAI available
- Non-standard options available
- Similar part qualification testing online

MILITARY/AEROSPACE PRODUCT (MAP)

- Modified COTS built to Samtec's print
- Manufacturing location control available
- Product specification control available
- Non-standard options available
- AS9102 FAI available
- ITAR control available

ADDITIONAL CAPABILITIES

- Up to 30µ" gold
- Tin lead
- -55°C to +125°C operating temperature on most connectors; -40°C to +125°C on THV/FEP cables

ADDITIONAL CAPABILITIES

- Customer specified plating (up to 50µ" gold, tin lead)
- Non-standard product options

ADDITIONAL CAPABILITIES

- Customer specified plating (up to 50µ" gold, tin lead)
- Non-standard product options
- ITAR control available

Hirose FX27 high-speed transmission floating card edge connectors

Hirose

Hirose Electric Co. Ltd, a world-class manufacturer in connectors, has introduced the FX27 series of floating card edge connector, to support applications requiring PCI express Gen. 1 (2.5Gbps) high-speed transmissions.

The structure of the FX27 series features a flexible stacking height, dependent on the interposer PCB length. By using an interposer, a stacking height of 22mm (minimum) can be achieved. In addition, a wide self-alignment guide range of ±0.7mm allows for easy mating in X and Y directions.

The FX27 provides the ultimate design flexibility with the option for designers to customise their original interposer printed circuit board with chip components.

A highlight of the FX27 series is that it can be used as a power connector, by using the entire surface of the interposer as a conductor for applications with good heat dissipation efficiency.

Connectors contribute to the device design by absorbing assembly errors which help to reduce the need for corrective re-work operations, and the spring portion of the terminal absorbs stress imparted by alignment errors. This reduces the stress applied to the mounted parts, which enhances reliability and prevents solder cracking.

The FX27 series provides ±1.2mm floating with double floating in XY directions, with the option of having multiple floating connectors on the same PCB.

The FX27 series is part of the FunctionMAX product family. FunctionMAX consists of board-to-board connectors designed to meet the requirements of the industrial market with maximum functionality. FunctionMAX is designed based on a differential transmisson system and offers excellent noise resistance of high-speed signals.

FEATURES

- Contact positions: 40, 60, 80, 100, 120
- Pitch: 0.8mm
- Rated current: 0.5A/contact
- Rated voltage: AC 100V, DC 141V

- Stacking height: 22mm min.
- Operating temperature: -55°C to +105°C
- Floating rating: 0.6mm max. in X and Y directions
- High-speed transmission: 2.5Gbps (PCIe-Gen. 1)
- Customisable interposer PCB
- Pick and place mounting (suction tape attached as standard)
- RoHS compliant

Suitable applications are FA control devices, broadcasting camera/ projector, base transition station, car navigation and smart meters.

For more information visit avnet-abacus.eu/hirose

HIROSE ELECTRIC EUROPE B.V.

How a multipolar world is boosting defence innovation

The UK's armed forces could include up to 30,000 robots by the middle of the next decade, if General Sir Nick Carter, Chief of the Defence Staff, is right. Discussing the evolution of the UK's armed forces on Sky News in November 2020, Carter speculated that the army could have 120,000 soldiers, of which 30,000 might be robots, by the 2030s.

Carter's vision may or may not come to pass – it's hard for governments to make the spending commitments necessary to enable such a vision at the moment – but it does suggest that today's rapidly changing global defence landscape will throw up a wide variety of innovation opportunities. Addressing these opportunities will involve solving both traditional and emerging defence engineering challenges.

'Major European nations are trying to increase their defence spending so it is closer to 2% of gross domestic product.'

Adam Chidley

Marketing Manager
European Product Marketing
Avnet Abacus

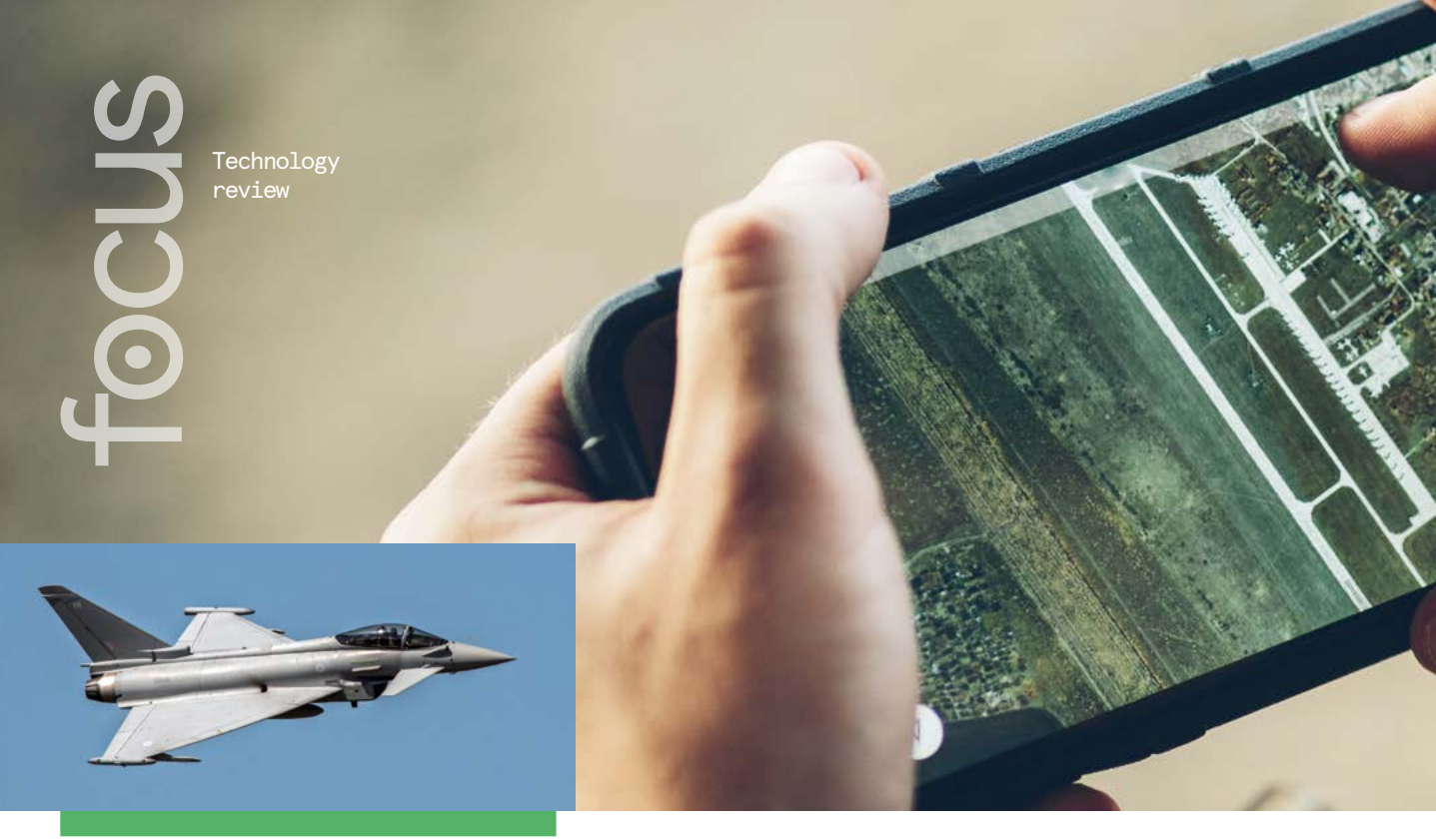
Military power is becoming more widely distributed, international alliances are shifting, and the threat to national security is becoming more complex and diverse. The well-defined challenge of the Cold War – to carefully balance two competing ideologies – gave way in the early 21st century to the reality of America as a solitary hyper power. As the last decade has shown, however, America's supremacy did not go unchallenged for long. China and Russia are taking an increasingly confident role in shaping the world and backing their ambitions with growing military capacity.

At the same time, the nature of the threat to national security is becoming much more complex. Defence chiefs are trying to both sustain their responses to traditional conflicts and deal with unconventional threats, ranging from terrorism and disinformation campaigns to cyber warfare.

Europe has woken up to this more challenging environment by spending more on defence and creating coordinating bodies, such as the European Defence Agency, to align member countries' strategies. Major European nations are trying to increase their defence spending so it is closer to 2% of gross domestic product, which is what their commitment to NATO requires. For example, Germany's defence spending in 2019 was 10% more than in 2018, at €47.3bn, the largest increase since the Cold War. Before the pandemic hit, Germany was also planning to increase spending in 2020. However, this would still leave it falling short of its NATO commitments, with defence spending only reaching 1.5% of GDP by 2024 and the 2% target by 2031.

France boosted its 2019 defence budget by 4.7% compared to 2018, to €40.8bn, or 1.8% of GDP. Again, before the pandemic, it was planning to increase its defence spending by 40% by 2025, to meet its NATO commitment. The UK's defence budget of €41.6bn is already above 2% of GDP, and the government's defence committee has recommended that it should reach 3% of GDP to strengthen the armed forces.

China's defence spending accounts for 14% of the global total, second only to the United States. This is due to years of double-digit annual spending increases. Although the trend is now slowing, China still spent 7.5% more on defence in 2019 than 2018, at €151bn. Japan will spend €42.7bn on defence in 2019/2020, up 1.2% and its eighth consecutive increase, but still less than 1% of GDP.



How a multipolar world is boosting defence innovation

On the other hand, Russia's defence spending was down 3.5% in 2018 to €52.1bn, due to economic challenges.

The short-term opportunity

The general increase in defence spending, the widening customer base and the changing nature of security threats will create plenty of opportunities for companies to replace and upgrade existing equipment, and to deliver innovative solutions to evolving challenges. For example, Germany has just signed a deal with the NATO Eurofighter and Typhoon Management Agency to modernise its Eurofighter Typhoon fleet by acquiring 38 new Typhoon Quadriga aircraft to replace the versions currently in service. The Quadriga aircraft will have upgraded radar systems, future-proof hardware and software, and will be able to engage with air and ground targets in more ways.

To give a sense of the longevity of programmes like this, production of the first Eurofighter prototypes began in 1989. Germany's Quadriga fleet is expected to be in service until at least 2060. Such programmes also come with multiple subprograms to evolve and update subsystems such as the radar, and to add capabilities to counter emerging threats. Here, the engineering challenge is to design equipment that is compatible with what has gone before, upgrades the aircraft's capabilities to meet today's threats, but keeps its architecture open enough to enable future developments without burdening every aircraft with facilities that may never be used.

And then there are emerging defence concepts, such as "the connected soldier", a plan to give service-people body-worn electronics with which they can become part of a battlefield Internet of Things, sharing and receiving data to increase situational awareness and their ability to command and control events. Service-people could end up wearing head-mounted cameras, displays, radios and headsets; GPS systems for positioning; body diagnostic sensors and wrist-mounted displays; as well as portable computers with personal area networks to drive and control this equipment and integrate with any weapons systems they are carrying. The graphic on page 15, by connector makers TE Connectivity, illustrates the concept and outlines some of the connectivity choices that need to be made to enable the connected soldier concept to become reality.

For such complex systems, the engineering challenge is to implement them in ways that are robust enough to go to war, and yet to still meet the fast-evolving expectations of service-people who have been raised on sophisticated consumer electronics, software, networks and cloud services. Consumer technology has been used to cover for military supply chain issues before: in the first Gulf War, some service-people bought consumer satnav units when military versions

'The general increase in defence spending, the widening customer base and the changing nature of security threats will create plenty of opportunities for companies to replace and upgrade existing equipment, and to deliver innovative solutions to evolving challenges.'

became scarce. What's new is the challenge of replicating consumer ecosystems in a military context.

The mid-term opportunity

In the mid-term, both individual nations such as the UK and regional alliances such as the European Union will have to rethink their approach to defence to deal with evolving and multiplying threats.

The UK's Ministry of Defence has set out its thinking in its Integrated Operating Concept 2025 report, released in September 2020. It lays out a new approach to the use of armed force in an era of persistent competition and rapidly changing threats.

There are several key ideas in the report:

- Modernisation to move from an industrial age of platforms to an information age of systems
- Constant adaptation, because change is an opportunity
- Greater integration with allies, across government, with society and the private sector, and across operational domains
- Making a distinction between readiness to 'operate' and to 'war-fight', recognising that modern deterrence has to become much more competitive than it is currently
- Recognition that the nature of war does not change
- Ensuring that the people involved in defence are drawn from a much wider base than is now the case

The report also lays out some markers for the way these principles would be reflected in equipment and systems. These should:

- Include a mix of crewed, un-crewed and autonomous platforms – the 'robots' of Carter's earlier comments
- Be integrated into ever more sophisticated networks of systems through a combat cloud that makes best use of data
- Have an open-systems architecture that enables the rapid incorporation of new capabilities

Solutions for Soldier Systems

Source: TE Connectivity

How a multipolar world is boosting defence innovation

- Depend increasingly on electronic warfare and passive deception measures to maintain the information advantage
- Rely more heavily on less observable and stealth technologies
- Emphasise the non-lethal disabling of enemy capabilities, thereby increasing the range of political and strategic options
- Have smaller and faster capabilities to avoid detection
- Trade reduced physical protection for increased mobility
- Be markedly less dependent on fossil fuels
- Employ non-line-of-sight fires to exploit the advantages that can be gained from having an information advantage

The European Union has its own defence analyses and the instruments to implement them, including the €500m European defence industrial development programme. This calls for bids from industry to develop a range of technologies to service its vision of the future of warfare, including:

- Multipurpose unmanned ground systems
- Permanent air or space capabilities for intelligence, surveillance and reconnaissance and communication; tactical remotely piloted air systems; and sensor suites for integration into air-traffic management
- Cyber-situational awareness and defence capabilities
- Positioning, navigation and timing upgrades
- European command and control systems
- Ground-based precision strike capabilities
- Airborne combat capabilities
- New naval platforms
- SME-driven innovation

The response

These two visions of the future of defence suggest many opportunities to address an ever-widening range of requirements through innovative design and novel system integrations. There will be common engineering challenges. For example, the increased use of sensors to gain intelligence advantages will lead to more data flow within equipment, and therefore interconnect strategies, bus architectures, and connector choices all become critical. Increased use of sensors will also create demand for more computing power to capture, condition, analyse and integrate their outputs into useful information. This, in turn, will demand more efficient computation, and imply complex trade-offs between equipment size and weight, operating time, cooling, reliability and ruggedness.

There may even be a role for an imaginative repurposing of consumer technology. As bitter experience with terrorism has shown us, and the MoD report makes explicit: "The pace of technological change and proliferation is rapidly broadening and deepening the threat spectrum. As evidenced in Syria and Iraq, commercial technologies have disrupted the economics and character of warfare. They are – increasingly – cheaper, faster, lighter, smaller and stealthier. They offer a persistent and pervasive presence in the battle space. They are readily available in large numbers and at low cost."

The implication here is that, in some cases, the armed forces will have to meet such ad hoc threats by using ad hoc technologies. For example, it may be important to flood an area with sensors in order to gain an intelligence advantage. Do these sensors have to be accurate to one part per million and have ten-year shelf lives, or could they be cheap cellphone modules deployed in such volume that redundancy makes up for any failures in the field?

Responding to these challenges will demand a different kind of thinking about the threats that we face and the defensive responses we must make to them. This, in turn, will demand a different approach to enabling those responses. Electronics engineers will be at the forefront of implementing these changes, in a multipolar world in which the only constant is rapid change.

INTRODUCING

KILOVAC K250 HIGH VOLTAGE DC CONTACTOR

- **Sets a new industry standard performance for current carry and isolation voltage relative to package size and weight**
- **Hermetically sealed**

TE Connectivity (TE)'s K250 high voltage DC contactor is hermetically sealed and designed for harsh environments. It is rated at 250A continuous, with an isolation voltage of 1000VDC, offering bi-directional power switching capability. Additional key features include an electronic coil economiser for low power holding capability, as well as auxiliary contacts in a smaller size, lighter weight package.

KEY BENEFITS

RUGGED
- Hermetically sealed
- Designed for harsh environments

SMALL SIZE, LIGHTWEIGHT
- Small and lightweight for its service ratings compared to other contactors on the market

VERSATILE
- Bi-directional power switching
- Auxiliary contacts

RELIABLE
- Continuous current carry 250A
- Isolation voltage 1000VDC

KEY MARKETS
- Charging systems
- Military and commercial ground vehicle power systems
- Test equipment

APPLICATIONS
- Power distribution
- Alternative energy
- Circuit protection
- Energy and battery storage
- Motor control circuit isolation

MATERIALS
- Contact arrangement: main contacts SPST-NO (form x)
- Auxiliary contacts (.1A/6VDC) - 100 milliohm max.) SPDT
- Weight, nominal: 180g

MECHANICAL
- Shock, 11ms 1/2 sine (operating): 20G peak
- Sine vibration, $15G_{pk}$: 55Hz to 2000Hz
- Operating temperature range: -40°C to +85°C
- Noise emission (at 100mm distance): 70dB (a)

ELECTRICAL
- Voltage rating, main contacts (max.): 1000VDC
- Mechanical life: 100,000 cycles

For more information visit
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TE connectivity

The space race takes off

'Over the next five years, eight space agencies plan more than 15 missions to the Moon.'

Hagen Götze

Director
Supplier and Product Management,
Avnet Abacus

Humankind has been fascinated by space for millennia and has been actively exploring it for decades. But as we enter the 2020s, our involvement in the world beyond this planet has never been stronger and the opportunity to benefit from enabling that involvement has never been greater.

Public spending on space reached an estimated $75bn in 2017, the most it has been since the Apollo era of the 1960s according to the Organisation for Economic Cooperation and Development (OECD). A record number of countries and commercial firms are investing in space programmes, with more than 80 countries already having satellites in orbit. In 2018, there were 114 orbital launches, the most since 2000. Almost 900 very small satellites have been launched over the five years to the end of 2018. Over the next five years, eight space agencies plan more than 15 missions to the Moon.

Why this interest in space? Well, it turns out that putting satellites in orbit is incredibly useful for life here on the ground. More than half of the most important climate variables needed for weather forecasting rely on satellite data, and the resultant forecasts help us manage many critical activities on land and at sea.

'Space design is challenging because the operating environment is so unforgiving.'

The utility of earth observation satellites is so high that access to their facilities is increasingly becoming a part of official aid packages for developing countries, where the data they gather can have a positive impact on issues such as land management, climate change mitigation and agriculture.

Positioning and navigation services are another major benefit of space. Many smartphones can now access at least two of the four global navigation satellite systems (GNSS), operated by the US, Russia, Europe, and China. Given their strategic importance, regional satellite navigation services are also being introduced in India, Japan, and South Korea. And although we're used to thinking of these services as delivering positioning and navigation services, they're equally important as a source of the globally coordinated, accurate timing information needed to run critical infrastructure such as telecoms networks.

Satellite broadband subscriptions are growing, and there are plans to develop very large satellite constellations to provide broadband access anywhere on the planet by 2024. In August 2020, the US Federal Communications Commission approved Amazon's Project Kuiper plan to invest $10bn to launch up to 3,236 satellites to provide global broadband.

There are many other domains, such as government services, defence, transport, weather, environmental management and climate-change monitoring, where space technology is providing benefits such as greater efficiency, cost savings, and the opportunity to avoid costs (think of the value of being able to predict and act against the threat of flooding, for example).

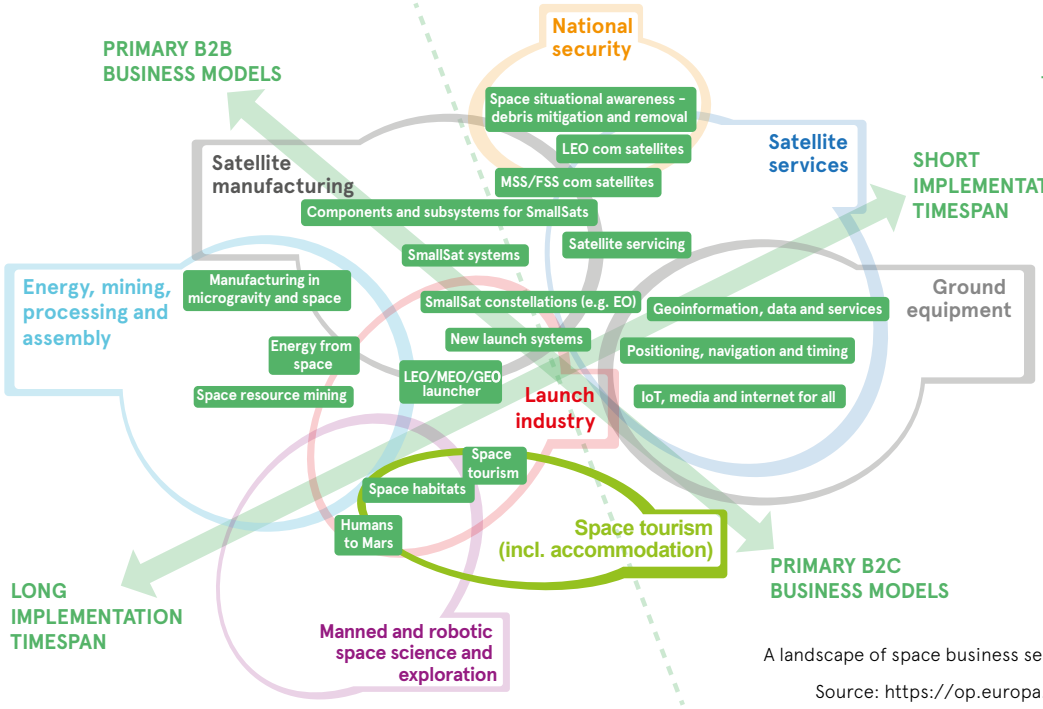
The innovation opportunity

There will always be innovation in space technology, but we are currently in a phase of rapid change, with the uptake of techniques such as small and micro satellites, the implementation of very large constellations, and the development of lower-cost launch options. We are also seeing the emergence of a new crop of space technology start-ups. The OECD estimates that more than 500 small companies, in the US, Europe, Japan, China and India, have been started over the past four years, some providing new space technologies, and other new services such as better ways to analyse data.

Some of the drivers for space innovation include the disruption caused by the general shift to more digital ways of undertaking science, R&D, and manufacturing. This has created opportunities to introduce strategies such as lean development and production processes and enabled greater end-to-end integration of products and services. Satellite manufacture, formerly a fairly bespoke activity, is now also introducing mass-production strategies.

All this transformation is likely to bring other changes to the space industry, such as the restructuring of current value chains, greater competition, and, eventually, consolidation at all levels through mergers and acquisitions.

The OECD recommends that governments should increase their use of commercial space services, through co-funding projects and targeted procurement strategies, to foster space innovation.



A landscape of space business services, models and segments.

Source: https://op.europa.eu/en/publication-detail/-/publication/5c715804-3011-11e9-8d04-01aa75ed71a1

Much like putting prestige brands in a prominent position in a shopping centre to entice other companies to move in, governments can act as 'anchor tenants' for new space services.

Europe's response

Europe has long been involved in space technology. In 2016 the Commission introduced its Space Strategy for Europe, which lays out how it sees the bloc benefiting from increased space activity. Part of the strategy is to strengthen employment and industrial growth in Europe: the Commission estimated that the space sector provides more than 230,000 EU jobs and is worth between €46bn and €54bn to the EU economy. The Commission also wants to see space helping the bloc to address socio-economic issues, accelerate innovation, and increase its autonomy.

It points to three flagship space programmes: the Copernicus earth observation data satellites; the Galileo GNSS service, whose enhanced accuracy and reliability will make it an enabler for autonomous vehicles; and the European Geostationary Navigation Overlay Service, which provides critical navigation services to air, sea and land-based users across Europe.

Having built this infrastructure, the Commission wants to ensure Europe gets the most out of it by encouraging both the public and private sectors to use it. The Space Strategy for Europe therefore calls for greater uptake of Galileo services, easier access to space-based datasets, support for the creation of more European space start-ups, greater autonomy through the development of European launch vehicles, and more international cooperation.

'New Space'

Europe's thinking about space has evolved since the Commission's 2016 Strategy report. In 2019 the European Investment Bank (EIB) published a report and recommendations about the future of the European space sector. It described the concept of New Space – "a global trend encompassing an emerging investment philosophy and a series of technological advancements leading to the development of a private space industry largely driven by commercial motivations."

Europe's ability to join this trend is limited by a couple of factors: it is not as strong as the US in the 'upstream' activities of developing satellite technology and launching it; and it has limited access to investors who will risk their money on developing or scaling up very new technology. The report estimates that around two-thirds of the 400+ global investors in space companies are from the US.

The EIB report also maps out the relationship between investment risk and space-sector business models and found that business-to-consumer models that can be implemented quickly are less risky and therefore more likely to be funded than longer-term business-to-business approaches.

'We are seeing the emergence of a new crop of space technology start-ups. The OECD estimates more than 500 small companies.'

The report makes a number of recommendations to boost private investment in European space technology, but the risk mapping shown in the EIB figure above suggests that the best place to invest is in satellite services and ground equipment developments, especially if they can be quickly implemented.

The engineering challenges

While policymakers sort out how they are going to support European space innovation, engineers will have to do their design and development in an increasingly competitive environment driven by declining costs for launches, pressure to reduce development cycles, and a focus on lower-risk business models. They will have to absorb the impact of broad technological trends such as digitalisation, which will involve deploying more sensors and the management of the resultant data streams. There will also be pressure to reduce complexity, especially in small satellites, to cut costs and boost reliability.

Space design is challenging because the operating environment is so unforgiving. Developers will have to respond to the implications of New Space strategies while continuing to manage traditional space design issues such as reliability, resistance to mechanical shock, extreme thermal environments, the criticality of materials choices, and the effects of radiation on the operating lifetime of sophisticated electronics.

However, there may be opportunities to achieve the required systemic performance through innovative thinking. For example, it may be possible to relax radiation-hardening requirements in some components if they are destined for satellites that will only remain in low-earth orbits for relatively short operating lifetimes. It may also be possible to take a hybrid approach to component choices, so that critical devices such as analogue to digital converters are specified as rad-hard devices, but the onward digital data processing is done by lower-spec parts. And architectural changes, such as implementing triple redundancy and voting schemes, may make it possible to substitute lower-cost commercial processors for more costly space-grade parts.

Some component makers are already responding to this trend by launching uprated versions of Commercial Off-The-Shelf (COTS) parts for use in space. AVX, for example, offers a range of COTS parts plus conductive polymer capacitors. They are made in a facility qualified by the European Space Agency and have gone through statistical screening and accelerated ageing processes to bring them up to spec for use in space. Similarly, Harwin is offering RFI-shielding board-level clips and cans for use in everything from home energy meters to space applications.

In other application areas, only true space-qualified components will do. For example, Harwin's high-reliability 10A connectors are designed to meet NASA's standard for limiting the amount that component materials outgas when they're used in a vacuum.

Vishay's low-profile, high-current IHLP inductors come in a rugged package, are magnetically shielded and will operate at temperatures of up to +180°C. The inductors meet the space reliability requirements of MIL-STD-981 class S. Perhaps this is one of the most challenging things about working on space electronics: designers may need to spend as much time understanding the standards and the ways in which their component choices implement that standard (for example, MIL-STD-981 has multiple sub-categories with different requirements for specific applications) as they do on designing the circuits that use them.

As the space sector continues to grow and diversify, engineers will play a key role in developing the technology that will enable new insights into our planet, as well as the development of new products and services. Looking outward to space may also turn out to be one of the most important ways in which we can look inward, towards our planet and the existential challenges that it, and we, face.

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From electronics phenomena such as equivalent series resistance in electrolytic capacitors, to discussions on the best approaches to new wireless technologies, to in-depth design guides for power solutions, this is a blog written for engineers, by engineers.

Where to read?
avnet-abacus.eu/engineers-insight

AVNET ABACUS

Choosing connectors for space applications

Harwin

Within the space industry, 'high-reliability' means mission-critical and involving risk to human life. For the connector industry, any vibration or temperature concerns require 'high-reliability' connectors. With many demanding applications on earth, high-reliability connectors perform well in those environments. But space brings added problems influencing connector choice.

Space approved connectors
Space qualification takes several years and qualified components are often old technology. Components can also be over-specified or even larger and heavier than COTS alternatives. If space-approved components are not compulsory, it's advisable to pursue the best and latest technologies, choosing on specification instead of regulation.

DESIGN CONSIDERATIONS

Vacuum/partial vacuum
Flashover from a conductor to the nearest metal happens above the connector's maximum voltage rating. This can cause loss of system voltage or even component damage. Air density changes the voltage at which flashover occurs – look out for voltage ratings at altitude.

Outgassing/offgassing is the release (from any material) of gas dissolved, trapped, frozen, or absorbed. Causes include sublimation, evaporation, desorption, seepage, and gas from slow chemical reactions. These contaminants can get into equipment, posing a risk to systems when in space. NASA and ESA specify recommended volume levels of outgassing – check with manufacturer information for outgassing levels.

Cosmic and thermal radiation
As the atmosphere thins, cosmic radiation is an increasing issue, interfering with electronic signals and devices. The solution is shielding, like solving EMI issues. The vehicle's metal exterior provides some protection but add shielding to vulnerable PCBs and cables.

Without atmospheric protection, space vehicles encounter wide temperature variations from direct sunlight to dark shadow. CubeSats measure just 10cm across – thermal cycling of all components is more likely than electronics buried deep in a manned vehicle. Check the operating temperature range (not just soldering heat resistance). Also, investigate thermal soak (high temperature/long term or temperature life) and thermal cycling specifications for a better understanding of the full impact.

Cost of weight/volume
Every gram saved on a connector is a gram that can be spent on the payload, more functions, or on fuel saving. Specify the smallest, lightest connector that meets your specifications, but avoid over-specifying.

Vibration
Launch brings high vibration, high acceleration – your connections need to survive this period intact and mated, ready to perform in orbit. Select jackscrews or latching rated for vibration, shock and acceleration.

Cost of failure/repair
If a failure of your CubeSat is not going to cause loss of human life or a million-dollar setback, avoid over-specification and budget wisely. Base your connector requirements on performance needs, rather than 'what-if' scenarios.

HARWIN CONNECTORS FOR SPACE APPLICATIONS

Harwin's high-reliability connectors are small and light, whilst still delivering impressive current (power) levels for their size. Every feature on the product has a purpose, and the final design is cost-effective compared to industry standard alternatives. Gecko-SL and Gecko-MT combine excellent performance with minimal size and weight – on average just 1 gram per connector for SL versions. Robust screw-loks overcome vibration issues, and outgassing meets NASA and ESA expectations. Horizontal connectors and mating cable assemblies are popular with the CubeSat industry, in dense stacks with limited height above each PCB. The horizontal connectors are fitted to the PCB edge, and cables routed sideways round the stack edge. Cables are ready-made and in stock, reducing upfront cost.

For more information visit avnet-abacus.eu/harwin

HARWiN

THE RIGHT ANTENNA MAKES ALL THE DIFFERENCE IN SYSTEM-LEVEL DESIGN

Abracon's antenna solutions span across the top protocols, such as cellular 5G/4G/LTE, Wi-Fi/Bluetooth/BLE/ISM, LPWA/LoRa/SigFox/NB-IoT, GNSS/GPS/GLONASS/BeiDou, RFID and satellite communications.

The collection includes compact chip, high-gain patch, low-profile flexible PCB, and various external antenna types with different form factors and mounts for easy installation, in a broad range of wireless high-data and military-grade applications.

The selection features antennas with multi-band capability and IP67-rated weather resistance. High-performing, energy-efficient MIMO antennas with different mounting options are available for enhanced data rate and Quality of Service (QoS).

Abracon can offer you a solution that meets your protocol, form factor and performance needs. Fully customisable solutions are also available upon request.

Protocols

- 5G/4G/LTE
- GNSS (GLONASS/Galileo/GPS/BeiDou)
- Wi-Fi/Bluetooth/BLE
- LPWA
- Combination (2-in-1, 3-in-1, and 5-in-1)

Applications

- Remote monitoring & surveillance
- Navigation & tracking
- Satellite radios
- Telematics & fleet management
- Network devices
- Wearables

Features and benefits

COMBINATIONAL SOLUTIONS

- Multiple Protocol Coverage
- Focused on Wi-Fi Bands
- Compact & low profile chip
- MIMO & IP67-rated external solutions
- High gain flexible PCB antennas
- Integrated LNA & filters to boost signal strength & eliminate noise

NAVIGATIONAL (GNSS/GPS/GLONASS/BEIDOU)

- Active & passive solutions: chip, patch, & external
- Multi-band choices
- L2, L5: Improved Positioning Accuracy (IRNSS)
- Improved signal and higher transmission power in the L5 frequency band
- IP67, rating, low profile, high gain, Low VSWR options
- Linear & circular polarisation available

SHORT RANGE (Wi-Fi/BLUETOOTH/BLE/ZIGBEE/ISM)

- Solutions without orientation sensitivity for movement-prone devices
- Compact chip & low profile flexible PCB trace antennas
- High-performance external solutions: 2x MIMO dual-band Wi-Fi coverage & low profile whip antennas
- Broad passive patch range, including integrated ground plane patch solutions

CELLULAR (5G/4G/LTE & 3G/2G/GSM)

- Active solutions: external, chip & flexible PCB
- Multi-band coverage (full)
- Compact, low profile & high gain choices
- 2x MIMO, IP67-rated options
- 5G antennas for advanced, reliable connections
- Customisable connectors, cable lengths & mountings

LPWAN (LPWA/LoRa/SigFox/NB-IoT)

- Ideal external solutions for rural environments with lower cellular reception
- Low VSWR & low profile whip antennas
- Compact chip options
- Cost-effective antennas with lower data rates and longer battery life
- All regional & multi-band ISM band coverage
- Chips with LTCC for maintaining performance integrity at high frequencies in compact solutions

For more information visit avnet-abacus.eu/abracon/

ABRACON

Avnet Names Company Veteran Phil Gallagher as new CEO

Avnet has appointed 37-year Avnet veteran Phil Gallagher as its Chief Executive Officer. Mr. Gallagher, who has been in the role of interim CEO of Avnet since August 2020, has also been appointed to the Company's Board of Directors.

"Phil's steady hand and his consistent commitment to the technology industry will benefit all of our stakeholders," said Rodney C. Adkins, Chairman of the Board, Avnet. "In today's dynamic global market, we are confident that his back to basics approach, as well as his experience and vision for the future, will enable Avnet to continue delivering value to our customers, supplier partners, employees and shareholders."

Gallagher has held executive leadership positions in sales, marketing, and operations during his tenure at the company. Prior to his interim CEO position, he was the Global President of Avnet's Electronics Components business. Gallagher was formerly the President of the National Electronic Distributors Association and currently serves on the advisory board of Women in Electronics.

"It is an honour to be named Avnet's CEO," said Gallagher. "We sit firmly in the centre of the technology value chain and therefore have a tremendous opportunity to build our leadership and market position as we help our customers and suppliers meet their evolving needs. As the company enters its centennial year in 2021, our strategy will build on Avnet's core distribution business by leveraging our talented people and strong relationships to deliver profitable growth. I am extremely excited about our future."

Industrial IoT and Industry 4.0 in manufacturing: The applications driving real business value

Download the full guide at
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