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On the cover – November 2019

Keep a fresh eye on CEM innovations

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Buyers' Guide

All the facts and figures to help you buy

Editor's Word



Efficiency: a battle of attrition

As the climate change debate surges around me, I would like to thank one group of people for their contribution to a more sustainable world. These are the employees of the global electronics industry who work tirelessly, some across their entire careers, to steadily improve the efficiency of electronic components and then deliver them to the market.

Over the past 30-years I've never attended a press conference for a new electronic component where the presenter is pleased to announce they had reduced the efficiency of the new device. The opposite is always true.

However, the reason these people don't get more praise is that this is a battle of attrition. Every improvement it typically tiny and thus gains little attention. However, when you add all the efficiency gains, across all the new components, from all corners of the world, across decades of effort, the net results mount up.

Essentially, there is no end in sight for efficiency enhancement. Just as one technology appears to have reached its zenith, a new material or manufacturing process pushes it on again. Nano technology is a classic example of this evolution.

So thank you, continue the good work and keep press releasing your new, ever more efficient, components.

As a closing note I doubt the human race can take sole ownership of the earth's climate using the single lever of carbon dioxide. I fear its more complicated than that and wonder who gets to pull the lever, how far and how fast. All I can do is place my faith in people much cleverer than me.

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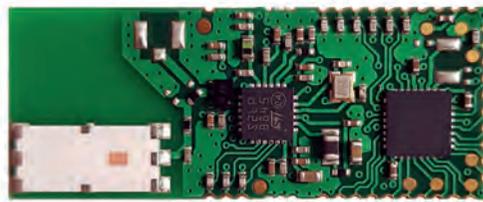
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Are you ready for rapid IoT rollout?

Arrow Electronics is now shipping certified Sigfox modules created by XoverIoT. The modules, which can help accelerate internet of things development, offer low-energy Sigfox wireless connectivity to create connected solutions in applications such as industrial monitoring, asset tracking, supply chain, and smart infrastructure.

Two versions are available, including the Sigfox-Mod1-C with integrated chip antenna and the Sigfox-Mod1-E with a U.FL socket for an external antenna. The modules offer the flexibility to dynamically reconfigure for short-range FSK operation or long-range communication.

Based on the STMicroelectronics Sigfox chipset, these compact modules are said to support long battery life, with an operating current of 29mA in transmit mode, running off a 3.3V supply. The underlying ST chipset is certified for all Sigfox geographical zones.

In conjunction with Arrow, XoverIoT offers additional engineering services to support design-in, antenna design, product approval, and firmware customisation.

www.arrow.com

New source for terminal blocks

Aerco has signed a UK distribution agreement with Taiwan-based Dinkle International, providing purchasers with access to Dinkle's PCB terminal blocks for industrial and connectivity applications.

General manager of Aerco, Harry Laughton, commented on the agreement: "Dinkle enables us to offer an increased range of components to our customers, who will benefit from Aerco's local support and stock holding. We are delighted to offer availability on all Dinkle PCB terminal block product ranges."

Regional sales manager for Dinkle International, Sam Lei, added: "Aerco is recognised in the industry for its excellence in customer service and technical support, backed by a long history of successfully supplying electrical components to the UK market. In setting up this new partnership, we have been impressed with the positive attitude, professional approach and market knowledge of the entire Aerco team. It is clear that Aerco will soon become an important part our European distribution family."

www.aerco.co.uk

Buy into defence expertise

UK engineering and design consultancy, Plextek, is launching a new defence business unit to help government agencies, defence suppliers and military stakeholders find new ways to support UK forces.

Called Plextek Defence Technology Solutions, the unit will develop trusted technology partnerships through specialist R&D support, technology exploitation and design partner services, including system supply and manufacture.

It will draw on Plextek's existing track record of developing solutions to meet the needs of the modern infantry soldier. For example, in collaboration with DSTL and MOD, Plextek developed a low size, weight and power armour integrity monitoring sensor. Plextek DTS is extending this capability to provide impact monitoring to tactical helmets.

Director of defence, Gareth Williams, summarises how customers will benefit from Plextek DTS's expertise in sensing, communication and data exploitation technologies. He said: "Plextek DTS understands the need for leveraging capabilities in R&D, exploiting existing technology and delivering deployable system solutions to ensure product differentiation."

www.plextek-dts.com



Finger on the pulse

Digi-Key Electronics has signed an exclusive distribution deal with Directed Energy giving purchasers access to a range of ready-to-use electrical pulse modules. Products in the range are suitable for driving laser diodes and providing high current and high voltage pulses for scientific, industrial and commercial applications.

President and owner of Directed Energy, Stephen Krause, said: "As a Digi-Key partner, we are excited to know that our pulsed laser diode driver and high voltage pulse modules will offer problem-solving value to a wide array of industries."

Vice president of global supplier management for Digi-Key, David Stein, added: "Directed Energy has an impressive line-up of off-the-shelf modules that provide high-quality pulses of high current and/or high voltage for a variety of applications, from LiDAR to ADAS, laser diode characterisation, precision measurement, and scientific experimentation."

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In Brief

Ready to ship RoHS 3

Anglia is now entirely compliant with the expanded RoHS 3 (EU 2015/863) standard. All inventory shipped is RoHS 3 compliant and declarations for all parts can be downloaded directly from Anglia Live so customers can complete their documentation. Non-RoHS parts are clearly identified and remain available to customers with appropriate exemptions.

www.anglia.com

IoT survey now open

Farnell has launched its second, annual IoT survey, which will be open until the 4 December 2019. It provides an opportunity for those working on IoT and IIoT projects to give insight on the market to help shape Farnell's product range and technical resources. All participants can enter a prize draw to win various prizes including an iPad pro, £250 Amazon gift card and £50 Farnell voucher.

www.farnell.com

Amplifiers sound unbeatable

Farnell announces availability of Infineon's Merus range of Class D audio amplifiers, which use multilevel switching to increase audio performance and reduce power loss. Ideal for applications such as battery-operated speakers, soundbars, and home theatre systems, the new range boasts improved power efficiency, decreased size, weight, and lower overall cost than traditional solutions.

www.farnell.com

Buy broadcast quality

Foremost Electronics has been appointed UK distributor for Neutrik Industrial Connectors and is launching two new series designed to meet demand for complete data signal integrity. etherCON is a ruggedised and lockable RJ45 connector in an XLR body optimised for professional audio, video and lighting networks. opticalCON connectors offer single up to 24 optical fibre capacity for applications such as professional digital mixing desks.

www.4most.co.uk



A perfect fit for MRO

RS Components has introduced a low-cost non-contact voltage-output temperature sensor designed for factory maintenance, repair and operations in smart manufacturing environments.

The RS PRO infrared temperature sensor is designed to meet demand from maintenance engineers that require a small, low-cost temperature sensor that can fit into tight spaces, and that shows the measured temperature in situ, so they don't have to return to the control room to check it.

Measuring 30mm deep by 31mm in diameter, the new sensor features a side-entry cable making it easy to mount in small spaces. It shows the temperature on a built-in backlit OLED display, without the need for contact with the target surface. This makes it ideal for situations where contact probes cannot be used, such as when the target is moving or inaccessible.

Able to measure surface temperatures from zero to 1000°C, the RS PRO infrared temperature sensor boasts a response time of just 250ms.

uk.rs-online.com/web

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Agreement extends IoT RAM line-up

Rutronik has entered into a global distribution agreement with AP Memory Technology, a supplier of IoT RAM, speciality DRAM and AI memory solutions. The agreement, which encompasses all of AP Memory's products, positions Rutronik as the sole distributor of AP Memory IoT RAM products in Europe.



The new product range encompasses a variety of memory solutions, with a focus on low pin count ultra low power IoT RAM and long-life support of standard DRAM. In the IoT and edge AI markets, memory is an essential part of system performance and cost. Increased memory in IoT supports richer use cases, such as frame buffering, audio buffering or operating memory for industrial and consumer smart applications. AP Memory's optimised memory solutions help enable these IoT applications.

Business development director at AP Memory, Alex de la Bastie, explained: "Thanks to Rutronik's highly qualified team of field sales managers and field application engineers as well as its global logistics network, we have created a win-win situation for both companies."

Senior marketing manager at Rutronik, Adrian Elms, said: "With AP's PSRAM and IoT RAM memory chips, we can now offer customers combined memory and microprocessor solutions."

www.rutronik.com

Looking for automotive lighting?

Mouser Electronics can now offer a range of automotive lighting solutions having announced a new global distribution partnership with Stanley Electric. Under the agreement, Mouser will stock a broad assortment of Stanley Electric lighting devices, including surface mount LEDs, infrared LEDs and low-current, high-brightness bi-colour and tri-colour LEDs.

Vice president of supplier management at Mouser, Keith Privett, said: "Stanley Electric is on the leading edge of lighting technology, providing high-quality lighting equipment that fits perfectly with Mouser's focus on delivering the newest products and advanced technologies."

Director of sales at Stanley Electric, Bill Roth, stated: "Mouser's global reach and logistics expertise bring our LEDs to an even larger array of purchasing professionals."

www.mouser.com

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Choosing connectors for tough environments

With the internet of things spreading across all industries, practically everything will be connected soon. As global head of technical marketing at Farnell, Cliff Ortmeier, suggests, this could well impact connector specification

Connectivity is the lifeblood of today's technology driven world. From the data network to home appliances, automotive components to industrial equipment, connectors enable diverse systems to operate and stay connected.

And while much of the electronics surrounding us operates indoors in moderate and controlled conditions, many of the electrical and electronic systems that make our lives run smoothly are exposed to the elements. These systems have to function under extremes of temperature, weather, dust, water and changing pressures.

Connectors must provide a secure barrier even in unpredictable conditions. Choosing connectors designed to withstand the rigours of dirt, vibration, extreme temperatures, or potentially explosive environments can make all the difference in how well a system holds up over time.

Review connector technologies

When selecting connectors for systems that will operate in tough and challenging environments, there are

several criteria to consider. First assess the connector's ingress protection rating. This indicates the degree of protection provided against harsh elements like dust and water. The first digit of the IP rating ranges from 0 to 6 to indicate protection against solids and moving parts, including dust. The second digit ranges from 0 to 8 and indicates the level of protection against liquids and moisture.

Locking and coupling mechanisms may also be important. There are several different mechanisms including push-pull, quick-disconnect, twist locking, bayonet and more. For tough environments, it will probably be more important to select a mechanism designed to withstand vibration than one meant for ease of use.

Finally, the material used for housing and insulation must be examined to ensure that it is also resistant to temperature fluctuations, dust and moisture.

Assess environmental challenges

Systems used in industrial, infrastructure, construction, drilling and marine

environments often combine mechanical systems with sophisticated electronic components. These systems undergo heavy use under inhospitable conditions and are expected to operate safely. To meet these criteria, it's wise to select rugged, sealed connectors in plastic or metal with ratings aligned to the specific expected conditions.

In manufacturing environments automation is paving the way for 'lights out' production, which will see the demands on connectors continue to increase. Automation relies heavily on sensors and signals, which leads to a noisy and high-EMI environment. This can reduce the performance of high-speed data connections, so choosing connectors with 360deg EMI shielding may be a priority.

Marine applications require connectors that withstand saline water. Both moisture and salts are highly corrosive, so connectors must be tightly sealed and highly waterproof. They should have minimum IP68 and have high salt spray resistance, preferably over 500 hours.

The oil and gas industry is another sector where

equipment must withstand harsh conditions. Underwater remote operated vehicles are widely used and equipment may also be exposed to explosive environments with a mixture of volatile gases and liquids. Once again, connectors must be chosen with appropriate ruggedness such as a minimum IP68 rating, high salt spray resistance and EX Zone 1 and 2 rating.

An IoT future

These are just some of the examples where harsh conditions are the norm, however, as the internet of things makes its presence felt across all industries, many more connected devices and sensors will be outdoors. Connectors will naturally play an important role in their reliable and safe functioning.

To help purchasers review and select relevant interconnect products, Farnell's Connector e-Guide allows users to search for products by sight or by part number. This online reference tool showcases connectors from more than 30 brands including Molex, TE Connectivity and Samtec.

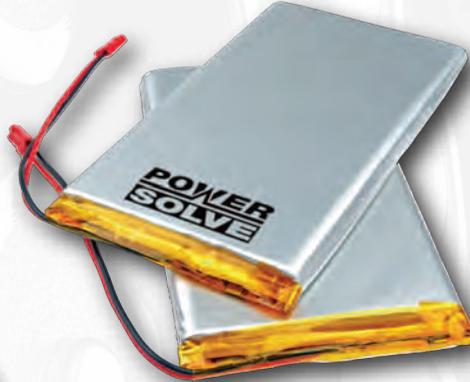
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Smart sourcing for drone lift-off

Unmanned drones are constantly finding new uses, but as purchasers will be aware, their future success depends on sourcing smaller, lighter, more robust components. TTI explores some of the options

Drones often operate in demanding environments—having to deal with difficult weather conditions, high degrees of vibration and potentially heavy shocks. There are also size and weight considerations that need to be factored in. Ensuring the successful operation of drones means that while miniaturisation is important, the constituent electronic components also need to be exceedingly robust.

Reductions in component size and weight are obvious beneficial for drones that are themselves constrained by these parameters. Their small and lightweight construction naturally limits the payload that they can carry. By designing in smaller, lighter components, such drones can use these savings on more payload, as well as covering greater range before needing to be recharged.

Tiny but tough

Harwin's high reliability connectors and cabling solutions offer these advantages, combining compactness with a rugged

but lightweight construction. This is designed to enable the necessary power and data to be totally assured, without adding any unwanted bulk.

The Datamate J-Tek range provides a secure and robust connection under extreme conditions, including vibration, shock and high operating temperatures. Products feature a jackscrew design, which provides maximum strain relief and enables the connector to perform in the demanding environments affecting drones and other aerospace applications. The four-finger beryllium copper contact is gold plated and capable of achieving 3A per contact.

To address the need for improved size, weight and power parameters in aerospace applications, Harwin has also introduced a new female T-Contact to the Datamate range utilising a proprietary six-finger design machined from a single piece of beryllium copper. Suitable for use with the existing Datamate J-Tek housings, the T-Contact raises current capacity on the 2mm pitch connector range to up to

8.5A per contact. An increased number of contact points also enhances Datamate's vibration resistance to 40g for six hours, while heavier gold plating improves overall durability to 1000 mating operations.

Improved EMI resistance

In order to keep the weight of wire harnessing down, the Datamate Mix-Tek family can accommodate power, signal and RF contacts inside the same compact housing. The Mix-Tek range offers 3A, 20A or 40A contact options as well as multipoint 50 ohm coax contacts capable of frequencies up to 6GHz. Since drones and their supporting infrastructure require proper shielding of connectors and cables to ensure resistance against electromagnetic interference, Harwin's Datamate range offers rugged aluminium alloy backshells with electroless plating, compatible with both J-Tek and Mix-Tek configurations.

Sourcing compact, lightweight and rugged connectors that allow for optimum flexibility will help push the boundaries of drone capabilities. Drones

are finding new applications all over the world in a variety of sectors and will continue to do so for a long time to come. In whichever way related legislature and regulations develop, it seems likely that this technology will play an increasingly important role in the development of both commercial and industrial landscapes. Their adoption is therefore limited only by the confines of humans' imagination.

www.ttieurope.com





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Mil/aero helps drive distributor sales

With increased defense spending, distributors that sell to the defense industry report robust component demand



James Carbone

While sales of semiconductors, passives and connectors have slowed this year compared to 2018, distributors that service defense and aerospace OEMs and their subcontractors say component demand from the mil/aero segment remains strong because of the increase in defense spending in the United States and foreign countries.

"Sales to the defense and aerospace market have increased significantly over the past two years," said Roger Raley, vice president for TTI's military/aerospace segment. TTI's sales to companies that build military aerospace systems and equipment increased 23 per cent in 2018 and were projected to rise more than 20 per cent in 2019.

"Defense spending both to domestic and foreign militaries has increased significantly over the past two years," he said. The Trump administration has increased spending and "our allies overseas also are allocating more of their budgets to defense spending, so it's a great time to be involved in the defense segment," said Raley.

To serve the military/aerospace segment, TTI continues "to invest in resources and expertise to allow us to stay focused on our core markets" including the military/aerospace market. The focused strategy is paying off and TTI is "building stronger, more focused partnerships that allow us to address the critical needs this market requires," said Raley.

TTI, which sells passives, connectors, electromechanical devices and specialised semiconductors, was founded 50 years ago to service military and aerospace manufacturers, Raley noted. "While our customers now include manufacturers involved in all areas of transportation, communication devices and industrial applications, a large percentage of our business continues to be in support of our mil/aero partners," he said.

TTI sells components into a wide range of military equipment including avionics, ground vehicles, aircraft, satellites, missiles, connected warrior applications and unmanned vehicles. "In fact, it would be hard to find a defense application where we don't provide component content," said Raley.

Expanded focus

He added that TTI has always had the broadest and deepest passive inventory in the industry to support the mil/aero segment. "However, over the past few years we really expanded our product focus and supplier relationships to include the broadest and deepest interconnect and electromechanical inventory profile in the industry. Because we're not focused on inventory turns like our larger competitors are, we invest well ahead of our customers' needs to ensure we have product on the shelf when they need it," Raley said.

Doing business with mil/aero customers is different than with commercial customers. "One



Roger Raley, vice president for TTI's military/aerospace segment

"Sales to the defense and aerospace market have increased significantly over the past two years"

reason is the products we sell may be required to operate only once but must operate without fail because lives are very literally on the line," said Raley. "Quality is paramount in all areas, whether it's documentation, counterfeit mitigation or additional inspection." TTI has the proper certifications, processes and expertise in place to ensure the highest reliability for our products, he said.

John Hunter, director of Avnet's defense and aerospace segment, said the defense business is also different than the commercial business because defense requirements are more stringent and there are more enhanced testing requirements, component preparation for

severe environments, and strict documentation control requirements. "In general, the stakes are higher, as battlefields and space deployments are higher risk, which means the technology has to work every time. Lives depend on it," said Hunter.

Avnet has been supplying to the defense and aerospace segment over the past 20 years and has seen growth, especially in recent years because of Department of Defense budget increases, overseas sales, strong commercial avionics, space and satellite markets, and overall increased electronic capability and content.

He said while business to the mil/aero segment has always been



strong, in recent years there has been growth in specific defense initiatives including smart munitions, unarmed air vehicles and satellite communications.

Distributors say there are challenges in supporting the defense market, including the high-mix, low-volume nature of many of many military programs. "This creates a challenge in our customers' ability to forecast," said Raley. TTI offsets this by having the "broadest and deepest IP&E inventory in the industry. We also work with our customers to pipeline inventory well ahead of when they need it," he said.

Another challenge is long lifecycles of defense systems. TTI needs to support defense programs that have lifecycles of 20, 30, 40 years or more, he said. "We work closely with our OEM partners to ensure product availability over the life of a program." When products do become obsolete TTI can offer alternative solutions because of its comprehensive line card.

The counterfeit risk

Hunter added counterfeit parts pose a greater risk in the defense sector than with commercial customers. "By the critical nature of the defense and aerospace customer applications, there is absolutely a greater risk for the segment. This risk is exacerbated

by the longevity of defense and aerospace programs and the costly reluctance to redesign," he said.

To combat the risk, Avnet only sells product from a franchised manufacturer or an authorised distributor, with traceability to the franchised manufacturer, Hunter said.

"Avnet has a robust returned material verification process, which ensures the product being returned is the exact material shipped," he said. The verification process includes, but is not limited to, customer information, quantity, date code, and packing integrity. "This helps ensure the authenticity of the parts and their manufacturer," said Hunter.

Another challenge is managing the use of more commercial off-the-shelf (COTS) components. Hunter said the trend to use more commercial off-the-shelf components in the defense industry has not made it easier for distributors to support the defense and aerospace sectors. "The reality is that the move to COTS has increased the support challenge for distribution as the defense and aerospace customers design in COTS components, then flow down the additional requirements," he said. These customers are not immune from cost down challenges, which

forces them to look for price and efficiency opportunities. As a result, distributors are being pulled into additional support functions such as low dollar procurement activities, quality support, and various value add support functions, he said.

Because of long life cycles and component obsolescence, many defense OEMs purchase components from independent distributors. For instance, independent distributor Smith, based in Houston, Texas, supplies components to customers "across all sectors of the aerospace and defense industry," said Tim McQuade, trading manager, aerospace & defense for Smith. "Our team specialises in sourcing critical, obsolete, and hard-to-find components."

He noted that as defense spending has increased over the past two years Smith has increased its sales to defense contractors and their subcontractors. "Our team sells all types of electronic components to aerospace and defense customers. Memory, LCD panels, and processors are especially popular commodity groups within the industry.

To meet the needs of its defense customers Smith has invested in aerospace-and-defense-specific certifications such as AS6081 and AS9120 at its distribution centers in Houston and Hong Kong, said McQuade. "Offering nitrogen storage capabilities for long-term requirements has also helped us earn more customers," he said. Value-added services, such as specialised testing, offer key supply chain support for EOL parts.

He said that aerospace and defense customers have even greater quality and testing requirements than customers in other industries. Most A&D

customers require certification to the AS6081 and AS9120 standards to ensure the proper mitigation of nonconforming product. These key certifications also outline the sourcing and traceability requirements and processes for distributors, which aerospace and defense customers rely on strongly to help keep their supply chains active."

"Strict date codes and lead times are a few of the aspects that can be challenging to navigate when working with defense customers. Sourcing obsolete components for A&D applications can pose a particularly acute challenge, which makes adherence to the AS6081 and AS9120 standards critical," said McQuade. Maintaining a strict supplier rating and management system is one of Smith's top priorities to ensure the highest-quality parts.

Doing business with defense contractors has become more challenging for independent distributors over the last 10 years because the aerospace and defense industry has tightened its procedures and sourcing policies for distributors to enter its supply chain. "The investment Smith has made in obtaining ISO certifications that are A&D specific, coupled with 35 years of experience and all of the peripheral value-add services we offer, has certainly opened doors for us," said McQuade.

He added overcoming barriers to entry can be quite steep in the A&D industry, but once those are satisfied, "opportunities to partner on a variety of supply chain services exist, and the customers tend to be very loyal."



"By the critical nature of the defense and aerospace customer applications, there is absolutely a greater risk for the segment"

John Hunter, director of Avnet's defense and aerospace segment



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The voice of experience

Choosing an electronics manufacturing service provider with first-hand experience of designing and manufacturing its own products could offer a crucial competitive edge, suggests FermionX

It's been three years since contract electronics manufacturer C-Tech joined forces with laboratory manufacturer Seward to form FermionX, a CEM with a portfolio of own brand products. Despite major challenges in the UK manufacturing sector over that period, from trade wars and Brexit to supply chain and economic uncertainty, FermionX has maintained its focus on growth and investment.

Manning director, Dan Crothers, explained: "This is part of our ongoing-plan to increase CEM services to our customer base. It's not just about building new components and one-off jobs; it's about working with our customers long term and offering a total package of services and expertise. Long term relationships are the way forward for us, with customers knowing they can come back for product reviews, supply chain support and quality product builds."

Extended capabilities

The introduction of two new iPulse M20 and one new iPulse M10 surface mount placement machines has increased capacity to over 100,000 component placements an hour. A Nordson automated optical inspection system increases quality checking capacity and the company has also invested in automated BGA rework with a station suitable for normal surface mount device and micro-SMD component repair.

Dan continued: "Often the term rework is a false economy in manufacturing, but as production automation continues to increase in speed and complexity, the decision to replace BGAs with new rather than rebuild the entire board, can be far more cost effective."

To increase support and customer service, which is vital in the development of strong customer relationships, FermionX has

also expanded its sales team. The new sales manager, technical sales manager and product sales manager all bring expertise to their roles from the FermionX brands of Seward and Airbox Sampling Pumps.

Own brand expertise

FermionX brands continue to realise strong market growth. Seward laboratory sampling blenders remain popular, while Airbox Asbestos Sampling Pumps continue to gain foothold as asbestos management becomes increasingly high profile and regulated.

This growth has key benefits for CEM customers. An ability to develop its own products from design innovation and product re-fresh, to build and distribution, enables FermionX to understand the issues faced by customers in their own product development and production. The team believes that this offers a unique service to customers — the ability to

comprehend and react to issues within a design and build project, along with the standard quality and on-time delivery expectations.

Dan concluded: "We will continue to deliver total solutions for our customers, whether they require part or full CEM support and our brands will continue their focus on gaining market share through quality build and innovative product development. 2020 and beyond is all about continuing to do what we do best and looking at where we can innovate and lead."

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Building a better BoM

Contract electronics manufacturer, Circuit Solutions (Cambridge) Ltd, explains how its purchasing and supply chain services work to support customers — from day one

When a potential client first contacts Circuit Solutions, initially the enquiry will be handled through the sales team. Normally a request for quotation is supplied in the form of a bill of materials or parts list and Gerber data. The Circuit Solutions purchasing team will then liaise with the sales team or directly with the client regarding component lead times and life cycle status, offering alternatives for obsolete parts and then locating the best fully franchised prices on the market.

The purchasing team works closely with the design engineering team. An open office environment between the two departments helps with efficient communication between engineering and purchasing teams. Buyers will discuss with engineers the components available and the suitability for SMT placement, as well as checking that there is no sign of end of life. Although Circuit Solutions does not undertake circuit design, it can discuss with clients any feedback in relation to rationalising components, component availability and suggested alternatives, as well as working closely on cost reduction.

Overcoming supply challenges

If a component previously purchased is scheduled to go EOL, Circuit Solutions is made aware by suppliers. If the customer has placed orders for assemblies containing this part in the last 18 months, purchasing will advise the sales team. For obsolete components, customers can then either agree for CSL to source from a non-franchise supplier from CSL's trusted source list, agree an acceptable alternative, or carry out a last time buy.

With the components selected, it's time to put together a quotation, which involves costing various elements. These include planning, SMT assembly, hand assembly, inspection, test, kitting, price of components, programming and tooling. These are all incorporated onto an internal quote sheet, with both SMT and hand assembly calculated on placement rate. The surface mount placement rate is calculated on a scale depending on the number of components placed for the total build.

Extended lead times can be an issue and may have a knock-on effect on the production line. The

CSL buying team have experienced extended lead times on power magnetics, power discretes and tantalum polymer devices, although MLCCs are still affected most of all, with longer than usual lead times. Fortunately, CSL has highlighted many lines, especially within the hi-cap area, that are common components and has purchased stock to ensure it can offer customers an alternative part to ensure that production is not impacted.

Over the last 24-months, Circuit Solutions has reduced its preferred supplier portfolio. The company maintains strong relationships with the well-known franchised distributors and with a handful of trusted non-franchise suppliers. Having fortified relationships with its current supply base, CSL can get improved responses and optimum pricing due to the closeness of these relationships. New suppliers are approved only if they offer bespoke componentry or if CSL has opted to go to the manufacturer direct.

Evolving buyer support

In recent years, CSL has also modified the role of its buying team. Previously, the purchaser's role was to focus



CSL has purchased stock to ensure it can offer alternative parts so production is not impacted



With the components selected, it's time to put together a quotation, which involves costing various elements



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on sourcing all parts required for a customer build and securing the most competitive price available, as well as getting parts to site in time and in a format suitable for SMT production.

Although these points are still a focus, over the last five years, it has improved its strategy. The company now provides a dedicated buyer for a set of customers, which allows them to develop knowledge of the customer and products, in order to provide the best service possible. Also, when quoting, the BoM is checked and cleaned up, advising of any parts that are obsolete or scheduled for obsolescence along with last time buy information. Any part numbers that have typos or have changed over time are updated and alternatives are offered if a part cannot be sourced.

Each member of the team has a specific area of expertise with a sound technical knowledge, providing greater support on a wider range of materials. These changes have meant more direct

contact with customers, fewer queries at point of order and a higher 'right first time' rate.

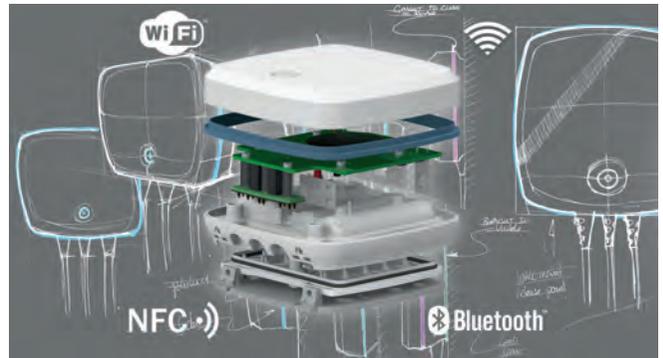
Meanwhile, there have also been changes in the way Circuit Solutions is supported by principal component manufacturers and distributors. Many CSL suppliers now hold a no liability stock level to ensure that CSL has a constant supply of high running or high-ticket items. All non-franchised suppliers share the sources they purchase from, provide any certificates of conformity available and include decap testing on parts as standard.

Looking ahead to 2020, the company's goal, it says, is to broaden the lines within its supplier stock holdings as well as working closely with suppliers to identify and manage any risks, including addressing any potential outcome of Brexit.

circuitsolutions.co.uk

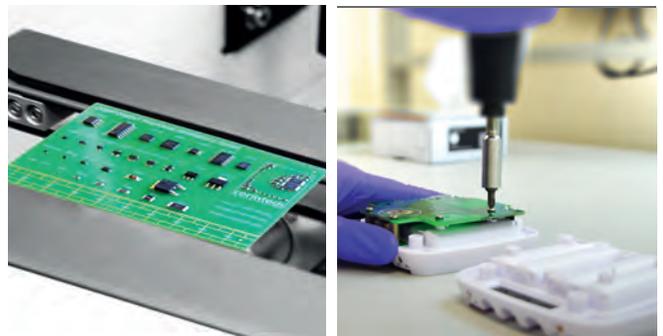


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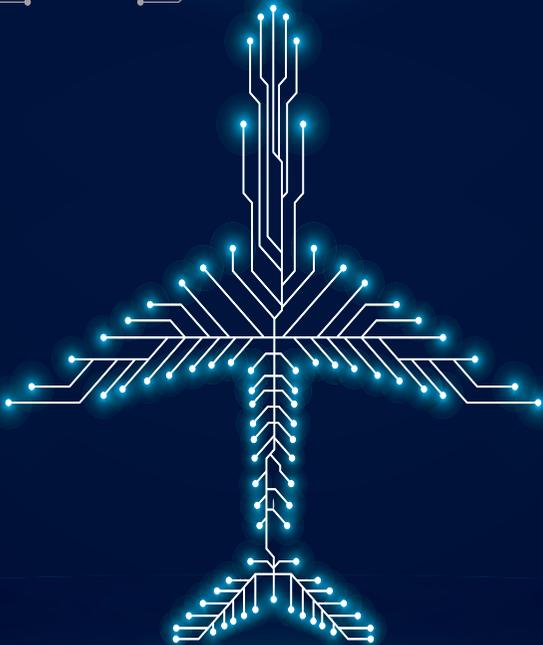
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Is outsourcing still the answer?

Strong demand for smart phones and 5G wireless has prompted an increase in contract electronics manufacturing. Although the shift to low cost regions may be over, it seems appetite for outsourcing continues to grow

With the release of its latest annual electronics manufacturing services report, the 'Worldwide Electronics Manufacturing Services Market – 2019 Edition', New Venture Research is highlighting healthy growth in the electronics industry. Notably, the preceding year saw significant expansion for the contract manufacturing market, with a total revenue increase of 15 per cent.

The results are particularly encouraging coming as they do on the back of flat revenue growth from 2013 to 2016. Dramatic expansion in 2017 and 2018, however, has prompted the welcome news of a combined EMS and ODM revenue of nearly \$542 billion; an expansion of \$70.7 billion.

Connectivity drives growth

Strong demand for smart phones has sustained the contract manufacturing market, along with even more powerful demand for the infrastructure networking equipment required to build out the 5G wireless architecture. This has seen a boost in products like enterprise storage systems, enterprise local area networks and servers. Furthermore, the need for cloud computing, social media, and real-time data and video streaming has also been a strong driving factor in demand for advanced switching, routing, and wireless communication hardware.

So how does the industry building all this equipment break down? Overall, the report looks at 42 electronics manufacturing service providers and 17 original

design manufacturers, recording that the industry was once again profitable for the ninth year in a row.

Foxconn accounted for nearly half of all the money made by the EMS industry in 2018, and EMS companies accounted for approximately 80 per cent of the total. Reassuringly, only five EMS companies and one ODM lost money in 2018. Pegatron ranked second in net income for EMS firms, meanwhile Delta Electronics, Quanta Computer and Lite-On ranked highest in earnings for the ODMs.

Plant closures and openings were rare in 2018 as most companies appear to have right-sized their operations or closed facilities due to consolidation. New openings clearly related to new business opportunities, while closures are being driven by economic decisions about company structure.

Outsourcing tomorrow

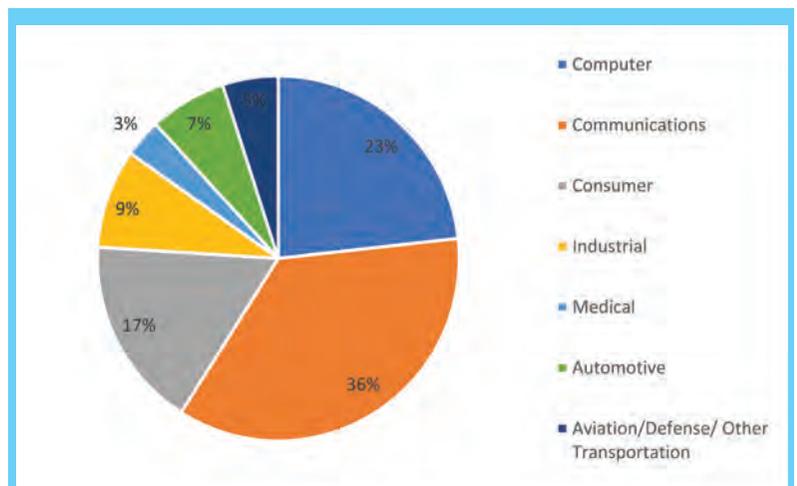
Looking ahead, communications and computer products will continue to be the segments driving the largest growth in the electronics industry. Fueled by demand for EMS services, the research indicates that the contract manufacturing industry will grow from \$542 billion in 2018 to \$777 billion in 2023; around 7.5 per cent per year.

As the report highlights, outsourcing has clearly become a critical element in keeping the electronics assembly industry expanding and in driving costs down each year, making it a leading factor in stimulating continuous consumer demand and technology deployment. Despite the

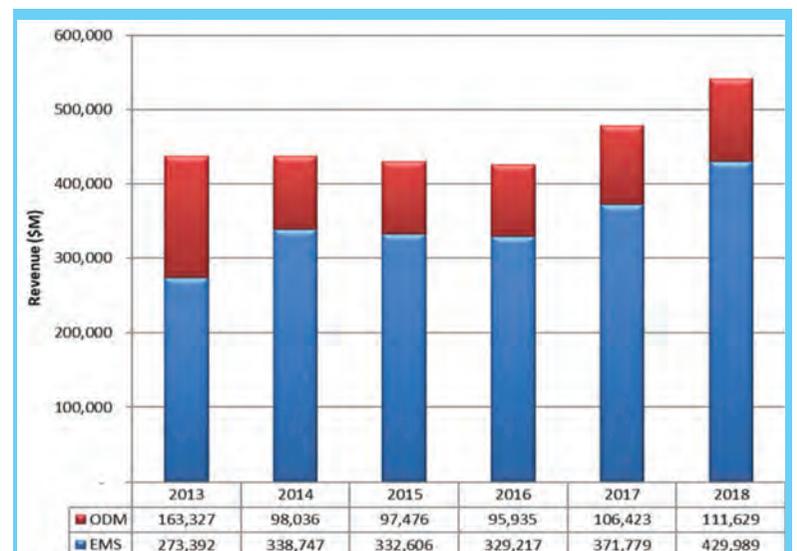
trend to move price-sensitive manufacturing to low-cost regions having come to an end, it seems its impact will continue to shape the industry for all suppliers, at least in the foreseeable future.

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Communications and computer products drive the greatest growth in the electronics industry – a trend that looks set to continue



The electronics industry continues to increase its reliance on contract manufacturers





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No two customers are alike

Every clients' products, supply chains and markets will be different, which is why contract electronics manufacturer, Key-tech Electronic Systems, aims to provide a tailored assembly service, from prototype to final test

As a UK contract electronics manufacturer committed to providing the highest quality electronics manufacturing services, Key-tech Electronic Systems emphasises customer service and satisfaction at the forefront of its offering. Its aim is to tailor a service model to meet original equipment manufacturers' technical and commercial business requirements.

Customised services

Key-tech understands that no two customers are the same; their products, their supply chains and their markets all differ. This is why Key-tech offers a tailor-made, customised electronics manufacturing service to customers with a complex, highly diversified business. From design to distribution world-wide, it enables customers to be more competitive by bringing innovative solutions to market faster, with a commitment to quality in everything it achieves.

Operating across various markets, the company's 25-plus years of experience and investment in manufacturing technology enables Key-tech to support all kinds of PCB assembly and product build through the complete production lifecycle, from prototypes, to volume production and test. Throughout, it remains

committed to delivering 'best in class' contract electronics manufacturing services.

Based in Kirkcaldy, Scotland, Key-tech is located some 90 minutes' drive south of Aberdeen and 30 minutes from Edinburgh. Being just outside the immediate Aberdeen and Edinburgh area means it has access to a vast skilled labour pool from the central belt of Scotland.

Quality is key

Expertise is vitally important to Key-tech and the company is now working toward achieving BS EN ISO 13485:2016 accreditation as part of its continuous improvement programme and growth aspirations. This certification will enable Key-tech to enter the manufacturing market for medical devices.

Key-tech also maintains a fully accredited quality management system that ensures approved processes and procedures are employed in every area of the business. More specifically, the company's quality management system is BS EN ISO 9001:2015 certified, ensuring workmanship is of the highest quality. Whether working with high-temperature solders or hand-soldering surface mount, the company has maintained high standards for over a

decade. All staff training is now based around IPC610, J-STD-001 and IPC 620.

With these strict guidelines in place, the company works to various standards including IPC 610 for the acceptability of electronic assemblies, J-STD-001 operator proficiency certification and IPC 620 acceptability of cables and wire harness assemblies. The company also adheres to IPC 7711 for rework of printed circuit board assemblies, as well as following stringent inspection and control regimes.

Thanks to this level of diligence, Key-tech has built its business by earning a reputation for delivering quality products and systems on time for clients and it maintains a small number of key long-term clients as the backbone to the business. Key-tech understands the significant implications for clients of equipment downtime in the field, and the paramount importance of safety in all products. This helps maintain Key-tech's focus of being clients' clients' premier supplier, a focus which is key to the company's success.

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Key-tech understands that no two customers are the same; their products, their supply chains and their markets all differ



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Facing fake ICs head on

Counterfeit integrated circuits are a huge headache for purchasers and distributors alike. Chief executive of Saelig, Alan Lowne, presents a solution capable of checking component validity in seconds

In October 2015, a Massachusetts man was sentenced to 37 months in prison for importing thousands of counterfeit integrated circuits from China and Hong Kong which were resold to US Navy contractors for use in nuclear submarines. He also sold components to hundreds of other independent distributors and brokers in the US and Europe. The counterfeit ICs were marked as originating from thirty-one different IC suppliers, including Motorola, Xilinx and National Semiconductor. This case, and untold similar ones, show that counterfeit components in the supply chain are a significant and growing issue.

Creating fake “lookalike” parts is not difficult. It simply requires finding cheap parts in the same package and painting new marks on them. Unfortunately, the whole manufacturing and supply chain, from assembly house

to end-user, is vulnerable and the number of companies that have been duped by fake devices is incalculable.

The impact has been felt by a variety of electronics systems used by consumers, businesses, and military customers. The detection of counterfeit components has therefore become an increasingly important priority, especially for electronics manufacturers and component suppliers.

Common counterfeit techniques

There are several ways counterfeiters produce fake goods: empty packages can be marked to resemble actual ICs; cheap ICs are remarked to resemble more expensive ICs; ICs with similar characteristics are remarked to resemble more expensive ICs; and ICs can be salvaged from circuit boards.

The most prevalent counterfeiting technique is re-

badged product. It is a simple matter to remove the existing mark from a chip package and put on a new logo and part number. Sometimes the chip is only an empty package with no die inside. Sure, the finished system would fail before it left the factory—but this still requires expensive investigation and rework, and with no part available to replace the bad one, could stop production. Worse still, the failure of borderline ICs may not occur until the system is in the field where repairs can cost ten times as much as those caught before they leave the factory.

Counterfeiting can also involve chips gleaned from discarded scrap boards. After remarking, parts are sold to innocent buyers who who assume that the products are genuine.

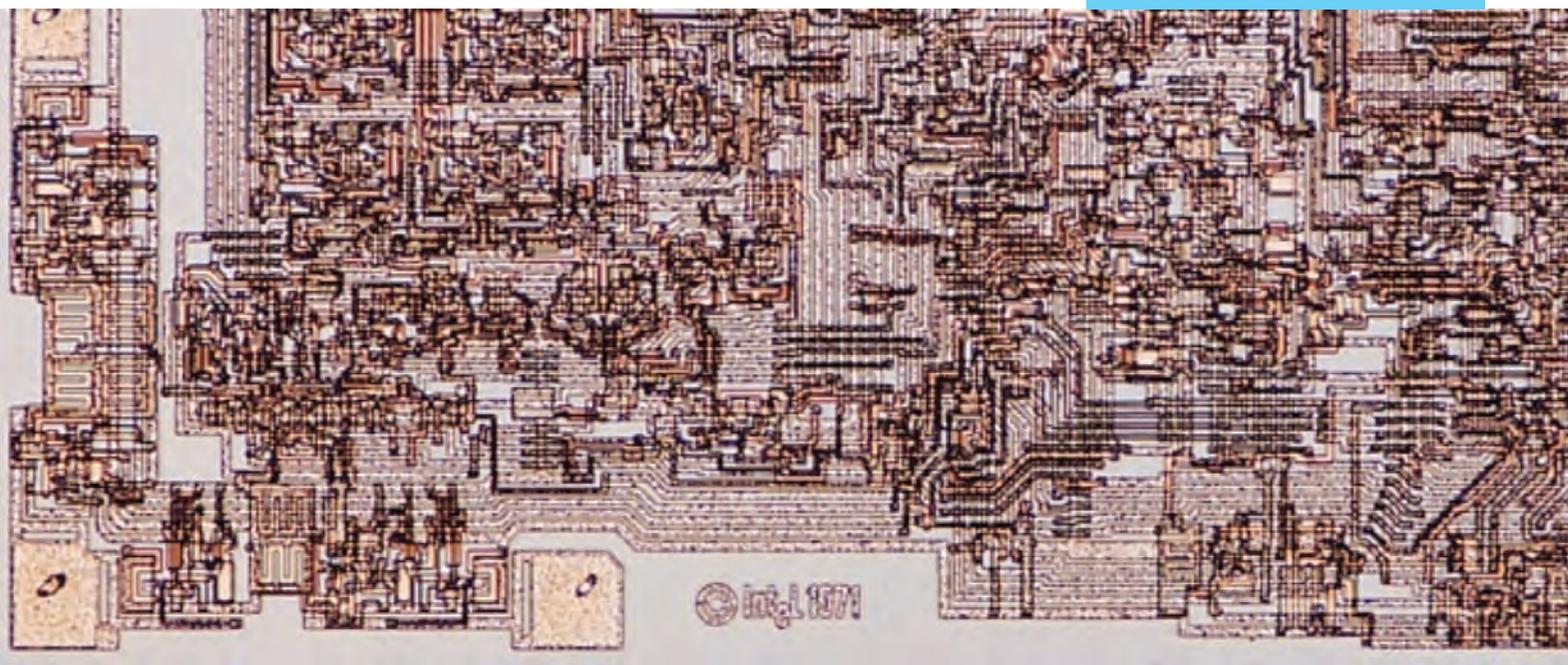
Finding the fakes

Usually, it is impossible to identify counterfeit



The detection of counterfeit components has become an increasingly important priority, especially for electronics manufacturers and component suppliers

The ABI Sentry uses an advanced form of VI testing to determine an IC's electrical characteristics or 'signature'





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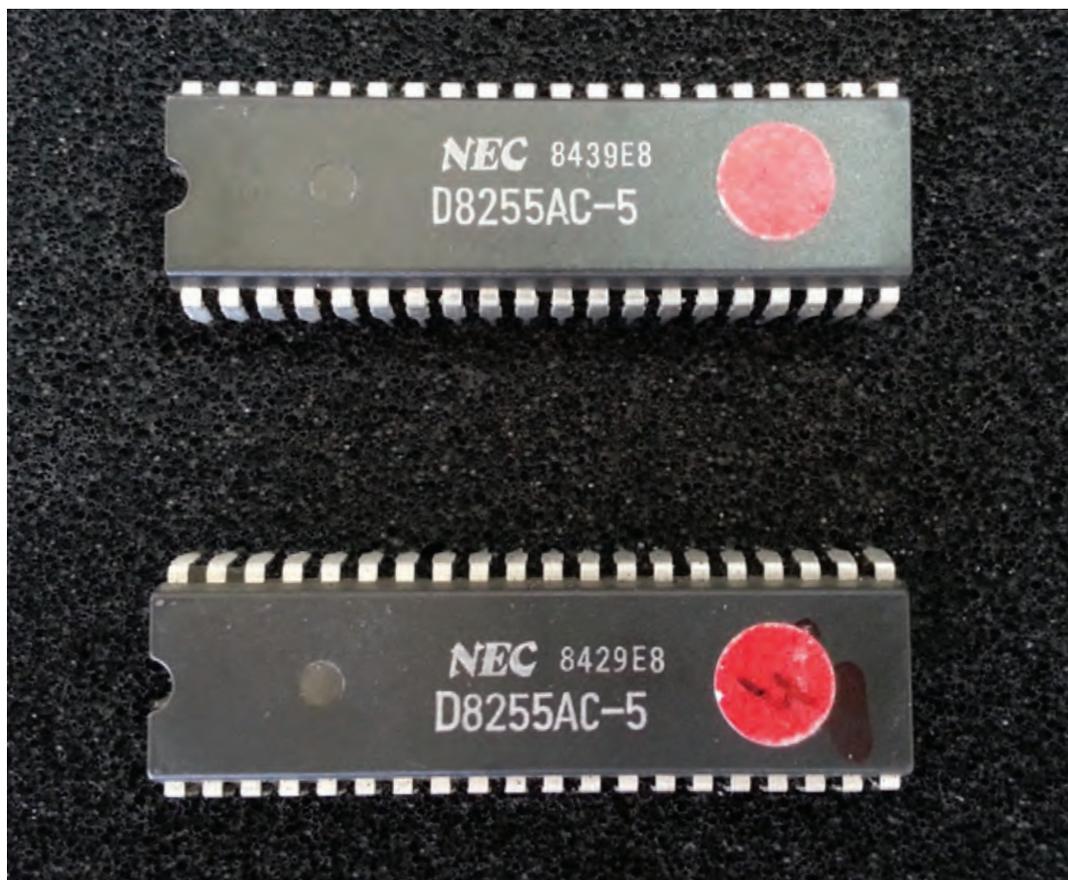


components until they are fitted on a PCB when the first tests are made on the final product. Failure requires the costly identification of counterfeit components and removal from all boards in the production line. Complete batches of finished products may need to be recalled—directly hurting a company's bottom line.

Technical measures to solve this problem have previously included visual inspection of devices for marking errors and electronically testing or x-raying every incoming batch. Another, more destructive, method is to use a decapsulation system in order to visually inspect IC die samples, immediately losing revenue due to the component's destruction. Not only is this expensive and time consuming, it requires complex training, skilled operators, and expensive equipment.

Some distributors advertise screening services to verify components, sometimes with a two-day turnaround, although, in many cases that is still unacceptable. These companies offer techniques such as: x-ray, x-ray fluorescence analysis, decapsulation, heated solvent testing, visual inspection, and solderability testing, resulting in detailed reports. In reality, however, this approach is only viable for military or large volume production runs.

Another approach is to perform a functional test on a sample of the ICs; logic I/O conforming to a truth table is an example. This will detect gross problems, such as an incorrect logical function, or no function at all, but will miss subtle 'out of tolerance' issues, which can be tell-tale signs that a component is counterfeit. With older-technology IC families, different speed variants are available. Conventional testing equipment with this level of speed test capability is extremely expensive.



Chip package markings can be almost identical to the untrained eye

Simple screening

What the electronics industry really needs is a tool that can verify the identity of received ICs quickly and economically using a statistically significant procedure. Component purchasers require a tool that is suitable for all devices and packages, simple to use by any operator, and capable of producing a fast 'good/suspect/fail' result.

In fact, there is such a commercially available device: the ABI Sentry Counterfeit IC Detector. This PC-driven product uses a complex PinPrint test algorithm to check the validity of parts in seconds. It is designed to be simple to use with minimal training as analysis takes place in the background and the operator only sees a simple 'Good Device', 'Blank Device' or 'Fail Device' message, with the option to produce a detailed report to send to the supplier.

According to its manufacturer, the ABI Sentry benchtop device uses an advanced form of VI testing to determine an IC's electrical characteristics or 'signature'.

VI testing applies a voltage waveform between two IC pins and measures how the current drawn changes as the applied voltage varies. This response is directly related to the device characteristic, its internal structure and manufacturing processes.

A vital benefit of the Sentry device's VI Matrix Test is that it exercises every possible pin combination on the IC under investigation. This provides great insight; more than simple systems that are restricted to testing between pins and ground. The Matrix VI Test can reveal differences between devices with different functionality but similar technology and a relabeled chip with the same input/output pinout would be detected by this test.

Testing against a known device

Sentry is also thought to be the first system capable of using a known good device to obtain a 'gold standard' signature. A known good component is locked into the Sentry's zero insertion force socket, and a test pattern is then applied across all



Sentry can quickly detect missing or incorrect dies, lack of bond wires, inaccurate pin outs and pin impedance variations

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pins. The component's response to this test pattern, or PinPrint, is automatically measured and stored as a benchmark.

Subsequent signatures of incoming, unknown chips are compared with this known good version to check for discrepancies. Sentry uses a combination of electronic parameter settings including voltage, frequency, source resistance and waveform to generate the 'signature' for each pin of the IC being checked. It then compares the unique electrical characteristics of known components and with suspect components.

Small variations are likely to indicate that the chips are from different manufacturers, or possibly different batches from the same manufacturer. Larger differences, however, suggest that the chips are faulty or counterfeit. Sentry can quickly detect missing or incorrect dies, lack of bond wires, inaccurate pin outs and pin impedance variations. It can also be customized for each IC type by setting tolerances that define the

point at which a tested device is deemed 'bad'.

If no reference devices are available there are two alternatives. Reference data can be exported from other users' machines or libraries and imported into the Sentry's database. Alternatively, though not quite as good, testing can be done across the batch. If there is any variance then the whole batch becomes suspect and should be rejected. A package with no internal die is easily detected with all pins showing the 'null response' of an open circuit.

Supporting traceability

Controlled via USB using PC software, Sentry's device library can be built up by adding specific known good devices. Each device can have documents associated with it, such as photos of device markings, data sheets, and other documents to help confirm the integrity of a device.

To build this database, Sentry can analyze the electrical characteristics of ICs with up to 256 pins. Devices with over 256 pins can also be tested by rotating

the BGA or QFP to allow all pins to be learned and compared. The equipment is supplied with four 48-pin dual in line zero insertion force sockets; these can be used directly for older DIP components but can also be used to accommodate a variety of additional socket adapters for different package types including DIP, SOIC, BGA, SSOP or discrete components. The socket adapter can contain multiple IC sockets if required, to allow testing several ICs at the same time or comparing one IC with another. An expansion connector allows custom socket adapters with up to 256 pins to be attached.

Designed in Europe by ABI Electronics, Sentry is ideal for component distributors and suppliers or manufacturer receiving departments that want to conduct sample testing. Detailed reports can be saved to provide quality control traceability. When used effectively, Sentry helps guard against the infiltration of counterfeit devices, identifying bad parts before they are mounted on PCBs, thereby saving time, money and frustration.

Practical counterfeit testing

As parts become increasingly complex, 100 per cent testing becomes burdensome, but testing one or two pieces in every 200 is manageable. Variations arising from a suspect shipment will reveal themselves well before such a test is complete. Nevertheless, if non-destructive testing is required, using a Sentry Counterfeit IC Detector can be the ideal solution.

This practical solution addresses the counterfeit IC issue using a rapidly built dedicated library of component data to cross-check each part tested. With lead-time issues making ICs harder to acquire to meet aggressive manufacturing schedules, identifying any parts that are not 'real' before they enter production can potentially save every manufacturer a great deal of time and money—as well as that intangible but irreplaceable quality—brand reputation.

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Sentry is ideal for component distributors and suppliers or manufacturer receiving departments that want to conduct sample testing

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Why custom isn't always costly

Resolving component shortage issues can involve custom test solutions, innovative design adaptations and serious troubleshooting. With the right skills it can also be cost-effective says general manager of Winslow Adaptics, Josh Mancey

Q What purchasing trends are you seeing in the test and development markets?

Demand for machined test sockets is increasing. The desire for smaller, fine-pitch, high-speed devices has significantly increased the choice in package types available to system designers. Due to high front-end tooling costs, it's becoming less viable for test socket manufacturers to provide a commercial, off the shelf test socket solution to meet demand and as a result the trend is towards machined test sockets.

Manufacturer consolidation and the inevitable obsolescence caused by newer technologies has created a surge in the requirement for legacy lines. Often these devices have been stored for some time and are not sourced from manufacturers' stock. When a COTS solution for test, emulation or prototyping isn't available a machined socket is often the only answer.

Q Doesn't custom mean expensive?

Cost will always be relative to the environment and the application, but custom doesn't always speak expensive. Very often it's the cost of not engaging with a specialist manufacturer that becomes prohibitive. It's crucial that your test socket is robust and reliable, and that the results you see are from the device under test, not the test socket.

Q Is it possible to reduce test costs?

You may want to consider

whether it's necessary to access all signals in a single test procedure. In practise it's feasible to reduce the pin count of a high density test socket for a high count BGA package to 25 or 50 per cent of the I/Os. This requires the user to write their test programme accordingly and to rotate the package in the socket to complete the test. Whilst slowing the test process, this can introduce a significant hardware cost saving that could be beneficial during counterfeit or post storage testing.

Custom machining will also facilitate the addition of multiple test cavities in a single clamshell design to increase test throughput. As an example, the Gate Driver LMG1205YFXR for Texas Instruments is a DSBGA12 measuring just 1.9 by 1.75mm. A single test socket can include 25 test cavities for this type of package providing cost benefits of up to 80 per cent. Sockets can be manufactured with both surface mount and through board interconnect.

Q How about leadtimes?

Often when a test socket is required, it's required urgently. Manufacturers who specialise in machined test sockets operate with design and piece part

standardisation. This facilitates typical leadtimes of 20 working days, however this can be significantly improved when required. COTS production test sockets often have a five to eight week leadtime from the manufacturer.

Q Does size and form matter?

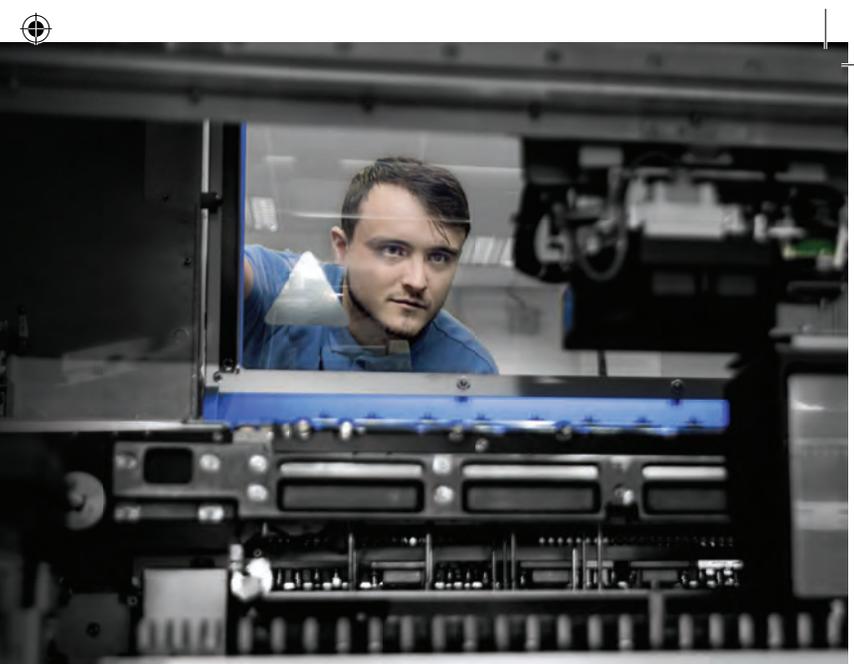
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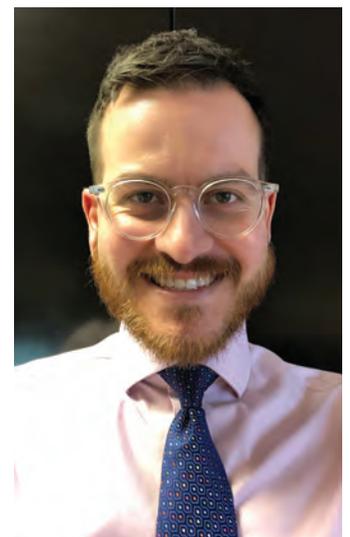
When a COTS solution for test, emulation or prototyping isn't available a machined socket is often the only answer

FPGAs that had been in storage for future use. The devices required full functional testing at -55 to 125°C prior to release for production. The package still had tie bars attached to the package leads which were therefore unformed. Machining a socket meant this could be accommodated with ease.

Q What information is needed from the customer?

The device part number or datasheet, test environment and test quantity. If the device is attached to a circuit board so, for example, an in-circuit test is required, then some detail of the position of neighbouring components is required.

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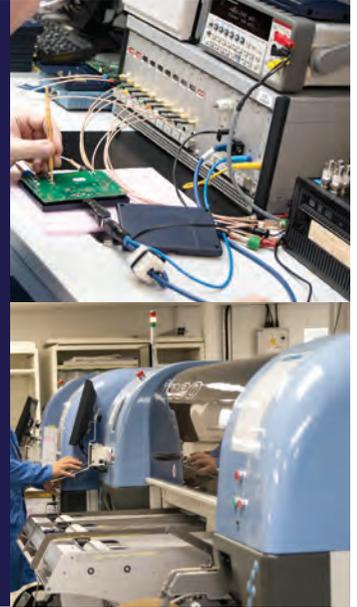


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Move dynamically from design to development

Contract electronics manufacturer, Dynamic EMS, explains how it brought one client's idea to life, utilising its supply chain connections to facilitate swift product realisation

When Chongsu Lee, founder and chief executive officer of Pacla Robo Physio, was looking to manufacture his concept for a new physiotherapy aid, he realised he needed strategic electronics assembly and supply chain support. Utilising an effective collaborative approach, UK electronics manufacturing service provider, Dynamic EMS, was able to help bring his idea to life.

Managing director and owner of Dynamic EMS, John Dignan, explained how the relationship began: "We got involved in the Pacla Robo Physio project from the outset when Chongsu Lee literally had an idea but didn't have the supply chain network connections in place to enable product realisation."

Having trained both as an engineer and physiotherapist, Chongsu Lee, conceived the idea for a robotic physiotherapy aid designed to reduce pain, help with walking, increase energy

levels and promote general well-being. He wanted to create an aesthetically pleasing back massager for home use, to ensure that patients could receive the treatment they required, as they needed it.

To this end, he designed the Robo Physio automated spine massage machine, which uses robotic fingers to move the spine while the user lies on their back. The idea was to mechanise the spinal manipulation technique Chongsu had perfected, ensuring consistency, increasing effectiveness and making the technique more affordable and accessible to those that need it.

So began Pacla Robo Physio's journey of looking for an ISO 13485 certified manufacturing partner. This certification ensures an EMS facility has met certain criteria to manufacture medical devices within a safe environment. Having achieved ISO 13485 in November 2017, Dynamic

EMS was a perfect candidate and after initial discussions, it was awarded the contract.

Supporting innovation

Chongsu Lee commented on his collaboration with Dynamic EMS, explaining: "As a start-up, the future is a bit uncertain, which can make finding a manufacturing partner challenging, but from the moment we met Dynamic EMS, we were made to feel welcome. From our primary conversation to placing our initial order with Dynamic EMS, we had our systems manufactured and shipped directly to our customers within three months. That is unheard of in the electronics manufacturing industry."

Describing how the relationship between the two companies has evolved, John Dignan concluded: "We worked from Chongsu Lee's initial sketch, through to design for manufacture. Liaising with our original component manufacturers, we ensured a robust pipeline and worked with our



Founder and CEO of Pacla Robo Physio, Chongsu Lee, had a great idea but no supply chain connections

vertically integrated partners for mechanics. We even locally sourced high-quality upholstery used for upmarket interior design. It's been a true pleasure to become Pacla Robo Physio's manufacturing partner of choice, and we are looking forward to enabling their production for scope, scale, and speed."

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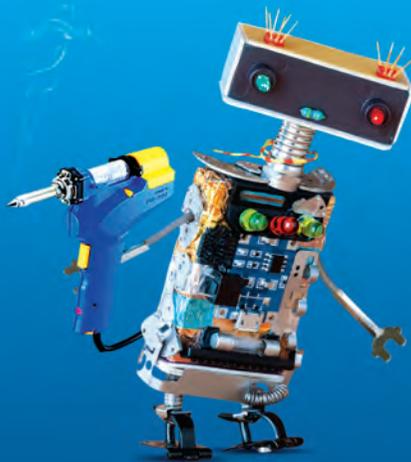

The International Institute of Obsolescence Management (IIOM) has been helping companies to address the problem of obsolescence in long life-cycle industries since 1997, when the Component Obsolescence Group (COG) was formed. Its corporate members include asset owners & operators, system integrators, component manufacturers and obsolescence solution providers in 18 countries. That's more than 240 companies and a community of more than 650 specialists.

The short life-cycle of electronic components, driven by consumer markets, makes sustaining of systems used in long life-cycle industry sectors increasingly difficult, but it is not just about electronic components – globalisation and consolidation of the supply chain, supplier bankruptcy, new regulations such as REACH affect electrical and mechanical components and equipment as well.



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A case for cyber securing our industry



John Denslinger is a former executive VP Murata, president SyChip Wireless, and president/CEO ECIA, the industry's trade association. His career spans 40 years in electronics

This month John Denslinger argues for an 'operational alliance' within which electronics companies collaborate to cyber-secure the industry

Cyber security • By John Denslinger

Is the electronic component supply chain secure from cyber threats? That question came to mind as I read a recent article published in the *Harvard Business Review*. The author, Daniel Dobrygowski, head of governance & policy for the World Economic Forum Centre for Cybersecurity, is obviously a person with deep understanding of the digitally connected world. His article proceeds to highlight the hi-tech industry forming its own cybersecurity alliances and pacts. My immediate reaction: why isn't our government taking the lead? It would seem the consequences of cyber-attacks are of national interest. Our personal safety and critical infrastructure are at risk. So are institutional, financial and legal systems. Each is a ready target for bad actors. The reality is most western governments are still more focused on developing offensive capabilities than building responsive counter cyber measures to protect us and our businesses.

Let's face it, the future digital network will only increase in complexity and entice increasingly destructive cyber-attacks. Anyone familiar with our industry understands me completely when I say our companies tend to be fiercely competitive and keenly individualistic. That being the case, is it really possible to form meaningful alliances to tackle cybersecurity issues? If so, what kind of alliance makes the most sense?

To answer that question, let's draw from Mr Dobrygowski's experience and discuss two possibilities that might be appropriate for our industry:

Operational alliances—a small-group structure focused on intelligence and related technical data sharing. Information is exchanged freely to raise collective awareness of cybersecurity issues and speed adoption of counter security technologies.

Normative alliances—a structure of very large-platform companies targeting solutions to cybersecurity vulnerabilities with the intent

of creating a more secure, global digital environment for customers, institutions as well as nations.

To be clear, the global digital network transformed our industry and made us more productive. B2B, B2C and C2B eCommerce transactions take place 24/7/365. Uploads/downloads between business and customer systems is commonplace and the frequency continues to accelerate. Business is global. Speed is critical. Privacy is paramount. So too is reliability of transferred data sets. In the digital network, we are vulnerable. The next cyber target making headline news might be one of our own! If that happens, you know customers will demand counter-measures from every company and their supply chains.

With so much at stake, our industry should strongly consider banding together for the greater good. Protection from government cyber efforts can't be counted on. The industry must safeguard itself. IT solutions of one company may quickly recognize cyber threats, hacks and breaches. Another company may have developed state-of-the-art cybersecurity tools. Another may be capable of tracking digital footprints and identifying threat sources. And still another, the speed and resources to prevent cyber intrusions before any damage is done. What if we could share what we know and armed the industry with the best cyber safeguards? I think customers would value the concept greatly as it better protects them and their supply chain more comprehensively.

In my view, the Operational Alliance appears to be a good fit for our industry. ECIA might be the perfect forum to host such an alliance. It's about time we collaborate and cyber-secure our industry.

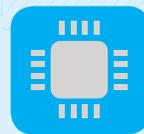
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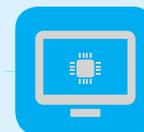
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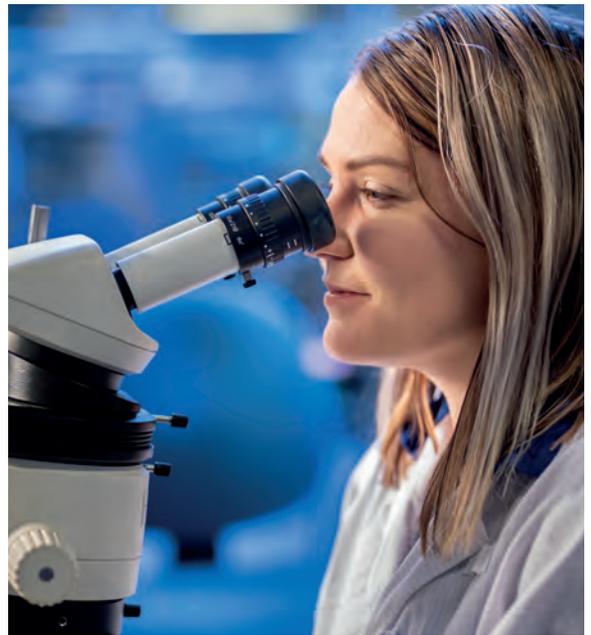


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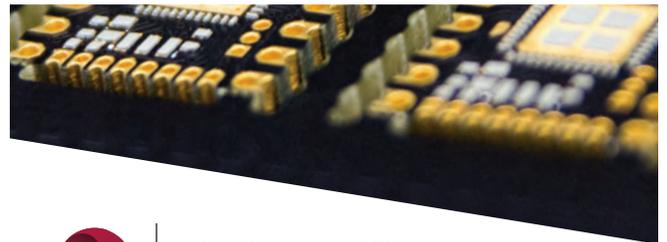
Switch on to energy harvesting

ZF Friedrichshafen is sponsoring a series of seminars regarding "Innovations in Smart Homes and Buildings", during which ZF will discuss its energy harvesting product range. The seminars, which are hosted by ON Semiconductor, will take place in several locations worldwide, including the UK, on 5 November, in Milton Keynes.

In this first seminar series, which is jointly sponsored by Bosch Sensortec, delegates will explore various technologies that are transforming and digitising consumer and industrial markets within the internet of things. Technical presentations and hands-on demonstrations will focus on energy-efficient applications for access control, surveillance and interaction.

At each of the 11 locations, ZF will be presenting its energy harvesting solutions. Participants will have the opportunity to get a hands-on experience of the battery-free and wireless products, and to discuss projects and potential applications with the ZF team.

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Staying one step ahead

Managing director at GTK UK, John Morath, explains how buying trends, emerging markets and trade wars are changing the way OEMs want to manage their supply chain

Q What have been the biggest industry shifts over the last few years?

We continue to see a shift in manufacturing from East to West as China is no longer the low-cost location it was due to wage inflation and rising material costs. New manufacturing markets are emerging in locations such as Vietnam and Indonesia, but we are also seeing manufacturing moving to Eastern Europe. Europe based customers are increasingly choosing to have their products made in Europe, which offers several advantages particularly for new product introduction (NPI).

More recently the US/China trade war has also made OEMs drill down into their supply chain provenance.

Q What about technology trends?

From a product perspective, we are seeing a dramatic increase in demand for displays, especially touchscreen technology, in both consumer and industrial electronics. As IoT/smart technologies are being adopted across a range of emerging markets such as self-service kiosks, security, healthcare and smartphones, this has fuelled growth, despite the general global market slowdown.

We are also seeing a growth in wireless and handheld designs, which has resulted in smaller design footprints and

the increased use of antenna products.

Q How have these changes affected the electronic component supply chain?

Suppliers that have been reliant on Far Eastern manufacturers are being forced to rethink their position and strategy. At GTK our global footprint means we can offer OEMs a variety of different 'build models' to suit their requirements. This can include part-building an assembly in one location and completing it in another, whilst remaining price-competitive.

Display manufacturers are expanding their geographic reach as their domestic markets become saturated. More and more OEMs are including displays in their new product designs and many are on a rapid learning curve about this technology. As the market matures, customers are becoming more discerning about product quality and performance. At GTK our technical experts can help OEMs select the most suitable display for their new product, often adding functionality and saving cost. We can also assist with choosing the right connectivity product to connect the display to the PCB.

Those customers affected by the US/China trade war because of their reliance on Chinese manufacturing are reviewing their current supply chain and looking for



IoT is driving an increase in demand for displays

alternatives. We have been able to react quickly to our customers' changing needs and move some production out of China into Taiwan and other locations.

Q What is the latest news from the GTK?

There's a lot of exciting things going on at GTK including continued investment in automated manufacturing in our Romanian facility, which opened in 2016. This plant focuses on mid-high-volume cable assembly production and box build. Combined with our UK facility and manufacturing partnerships in the Far East, it gives us a global manufacturing footprint.

In December 2018, GTK was acquired by Volex, which means we have access to Volex's product set, engineering expertise, technologies and production facilities, expanding our global manufacturing footprint even further. This allows us to tailor our production and supply chain logistics to meet pretty much any customer's requirements.

Finally, in September, we launched the Volex V-Novus Hybrid power cord product range, which combines ergonomic design with versatility, as well as being price competitive. This product set is a natural extension to our portfolio, as many of our existing customers need power cords.

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Managing director at GTK UK, John Morath

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Smart sourcing for environmental management

Thanks to the proliferation of 'smart' technology, specifying enclosures for environmental control systems often means protecting electronics in harsh environments, says Spelsberg UK

Industry 4.0 is a buzzword across almost every market sector; and for good reason. It describes the integration of digital communication with industrial processes to create a network of 'smart' tools and components that can improve efficiency, quality, productivity and safety.

The development of smart technology has also influenced environmental management processes — from simple home thermostats to the largest industrial processes. Ironically, a key challenge when designing environmental control solutions is protecting the electronics from harsh environments. For this reason, Spelsberg UK's enclosure support can be invaluable.

Outdoor installation
While the UK is rarely

exposed to the extremely cold weather experienced in some parts of the world, we still regularly have prolonged periods of sub-zero temperatures. This means that water can freeze, leading to burst pipes and interruptions to water supply. An effective option for operators of industrial plants and commercial premises is to install thermostats to measure temperatures and activate trace heating systems.

For industrial applications subject to harsh treatment, Spelsberg UK manufactures and supplies the HT range of housed thermostats. This turnkey solution delivers a fully adjustable thermostat housed within a high-strength polycarbonate TK enclosure. It's ideal for use with smart thermostats that can feed information back for use in other processes.

In fact, any external monitoring technology for smart systems will require an enclosure that can protect electronics from the elements. Spelsberg's range of GEOS enclosures is lightweight, durable and features an innovative sealing system for weather protection.

The GEOS range offers all the qualities you'd expect of a weatherproof enclosure: UV protection, IP67 ingress protection, IK09 impact protection and excellent corrosion resistance. Where it really excels, however, is its Drain Protect seal system, which diverts collected moisture from the environment via a drainage channel to the rear of the enclosure, away from the access point.

Rapid customisation
Smart Technology is evolving

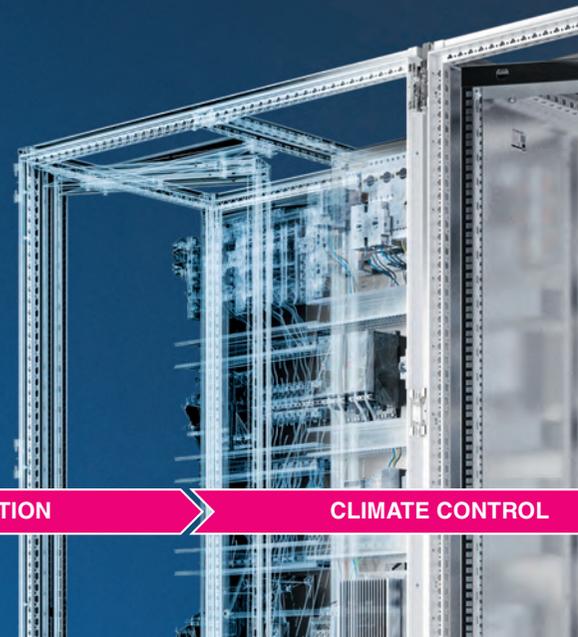


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at a rapid rate, with many new systems requiring specific entry points and mounting solutions. To accommodate these changes, Spelsberg offers a suite of design, customisation and installation services to complement the standard range of GEOS enclosures – as well as many other enclosures found in Spelsberg’s standard range.

Managing director at Spelsberg UK, Chris Lloyd, commented: “We’ve invested heavily in our in-house capabilities to ensure that we can offer the fastest lead time on customised enclosures in the UK. We have several CNC machine tools as well as a full time assembly line, which allows us to build turnkey

solutions that are ready for installation upon delivery. Our expert sales engineers will work with customers during the design stages to help ensure that the perfect enclosure is specified.”

Although many smart systems for environmental management will be external, the majority are installed inside. Here, enclosures still face challenges. Specifically, it’s important that engineers can adapt a system to usage patterns that are frequently altered and technology that is always changing.

Modular architecture
It is sensible to develop a modular architecture for hardware, so that most of the system remains undisturbed

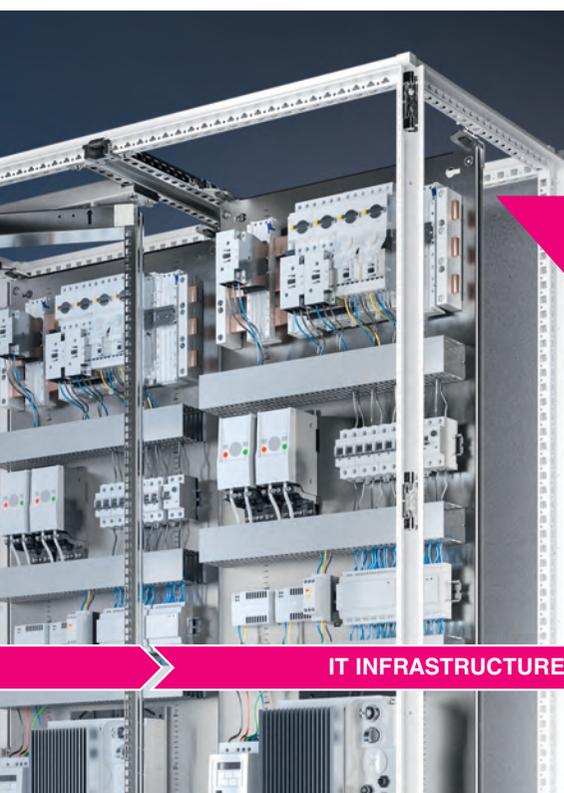
when minor or local changes are being made. Furthermore, a wise choice of electrical enclosure, such as the Spelsberg AK distribution housing, will facilitate quick and simple changes to physical hardware.

AK enclosures can be easily mounted adjacent to each other so that large bespoke control panels can be built up and later adapted to meet changing requirements. Additionally, perspex doors at the front of each enclosure provide access to any user interfaces whilst protecting the internal wiring. Finally, the AK distribution housing series is certified to EN 60670-24, which defines special requirements for energy-consuming and

protective devices to ensure safety with voltages up to 400V and feed current of up to 125A.

Chris Lloyd concluded: “Environmental management has been one of the key beneficiaries of smart technology. Today’s smart buildings and factories are able to continually optimise heating, ventilation, refrigeration and a whole host of other environmental factors. We work hard to keep up with our customers by offering enclosures that deliver the best protection with the highest levels of flexibility.”

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Simple solutions for Industry 4.0

Rittal has unveiled its new AX compact and KX small enclosures to meet the needs of Industry 4.0. Ideal for use in switchgear applications, the two new products address growing demand for greater flexibility and product availability.

The two latest additions to the Rittal enclosure portfolio contain several improved features. To accommodate the rising number of sensors and actuators being deployed in the switchgear industry, the AX and KX are more spacious than their predecessors. With more sensors and actuators there is also a greater quantity of cables to be housed. A modular design, along with improved cut-outs and larger gland plates, creates more space.

Integrated locators in the side panels provide for interior installation rails. As the rails have a 25mm spacing, the AX and KX can use accessories from the VX25 portfolio, keeping the inventory of smaller parts to a minimum.

Ideal for use where only a few components are to be housed in terminal boxes and bus enclosures, KX small enclosures start from 150 by 150 by 80mm. AX compact enclosures are between 120 and 400mm deep, with a maximum size of 1,000 by 1,400mm.

Overall, Rittal states the new design features make these compact enclosures more robust and ensure greater resistance to dynamic loads.

www.rittal.co.uk



Specify easy access

Metcase has launched a new version of its Combimet 19in rack cases featuring a wraparound top for superior aesthetics and easier access to components. The new U-shaped top reduces the number of case parts and removes the need for visible top screws. Other features include ergonomic front handles and earth connection points on all panels.

The new solid top Combimet 19in is supplied unvented as standard, fully assembled and in a choice of two colours: light grey and black. It is currently available in a standard 1U height and two depths: 265 and 365mm. Custom sizes can also be specified. Accessories include a PCB mounting kit, PCB/panel fixing screws, 19in mounting kits and mounting plates.

Applications for this 19in aluminium enclosure include networking, communications, industrial computers, sound and studio, laboratory instruments and industrial control.

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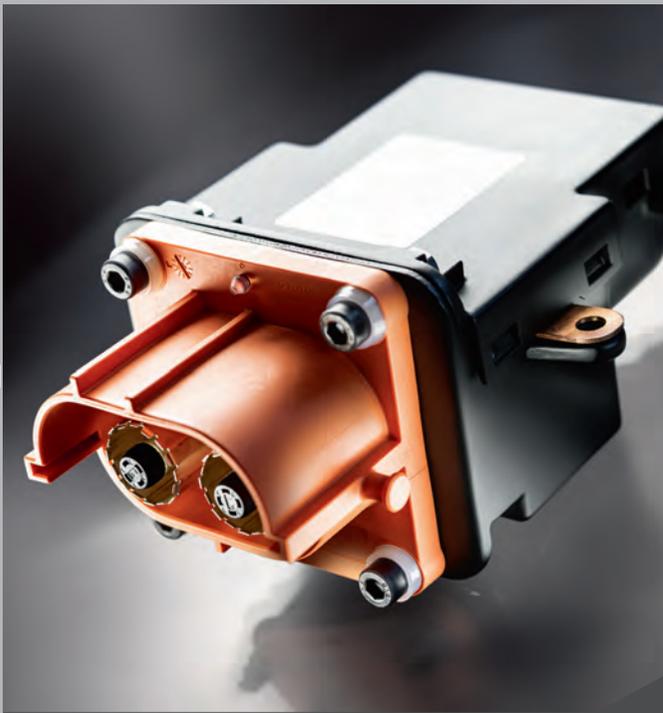
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Simplify EV purchasing

In response to the rapid growth of electric vehicles, Schurter addresses some of the technical challenges surrounding the technology, including electromagnetic compatibility, with its latest FPAB filter series.

Due to the high currents occurring in electric vehicles, manufacturers are confronted with ultra high magnetic field. Currents in the vehicle can reach up to 500A, with the main source of interference usually being the inverter that drives the motor. There are also many other systems that emit interference, however, including the battery management system and on-board electronics, such as ABS.

One way to protect against electromagnetic interference is to use external EMC filters to attenuate undesirable interference signals. In automotive environments, however, such a filter must be particularly robust. It may need to withstand vibration, impacts and shocks as well as large temperature variations. In addition to these parameters, it must be lightweight and compact.

To meet these demands, Schurter introduces its latest filter series, the fully customisable FPAB. This single-stage filter is impermeable to dust and moisture, utilising a well-sealed, lightweight automotive connector from Tyco. All connections are screwed to withstand vibrations.

schurter.com



One connector for IoT and PoE

Bel group company, Stewart Connector, has introduced new single and multiport RJ45 connectors to support 2.5G Base-T Ethernet communications. This range is claimed to be the first to include configurations for use in most 2.5G enterprise, data centre, internet of things, and wireless applications.

Designed to address cross talk and return loss issues that are common in 2.5G applications, the new RJ45 connectors also support PoE applications from 15 up to 100W, which is often a requirement for today's IoT applications. All single and multiport configurations are fully shielded and configurations with LED options are available.

www.belfuse.com

Specify a single connector for signal and power

NYK Component Solutions has introduced a new range of hybrid hyperboloid connectors from IEH. The HBH modular connector series has been developed to deliver flexibility and is able to combine signal and power contacts within the same housing in demanding applications. All socket contacts utilise hyperboloid technology with contact sizes from .016 to .169in and current ratings from 3.5 to 100A.

Utilising a flexible, modular design enables the best contact configuration to meet the needs of the application, says NYKCS. Straight, right-angle PCB mount, crimp, solder cup and compliant contacts are available, along with a blind mate version where required.

This modular connector series can be configured online using a tool on the IEH website. Customers can design a connector to precisely suit their application and download a 3D model of the chosen configuration.

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'EDAC Europe are looking forward to further developing our strong distribution channel with the signing of this agreement with Powell... their excellent reputation in the electronics market means customers will enjoy the benefit that both our companies working together will bring them'

Paul Redshaw, EDAC (Europe) Managing Director

The EDAC logo is rendered in a bold, metallic, three-dimensional font with a blue-to-white gradient and a slight shadow effect.

EXCITING NEWS AT EDAC EUROPE

EDAC Europe are delighted to announce a new fully authorised franchise agreement with Powell Electronics (Europe).

EDAC have been providing high quality interconnect solutions for a wide range of commercial and industrial markets for over 50 years. Our product offering has evolved and grown. We now have one of the largest ranges of interconnect products on the market as well as high quality custom solutions.

The agreement gives Powell access to the comprehensive

range of the EDAC and MH products, which include waterproof connectors, USB, HDMI, Card-edge, Rack & Panel, D-sub, RJ45/Magnetic Jack products and the custom capability to provide value-add services including cable assemblies and bespoke interconnect designs.

*We look forward to growing our business
with EDAC's superior quality products"*

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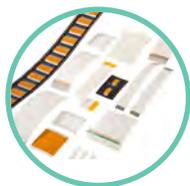
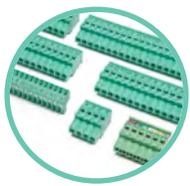


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Connectors

Connector choice demystified

Selecting the right connector can seem daunting to those without an electro-mechanical background, but with the basics in place it needn't be baffling, says Selwyn Electronics

Connectors, although often overlooked until the last stages of product design, are vital for the reliability and performance of every piece of electronic equipment. Deciding on the right connector can be a daunting task for anyone who doesn't have a connector or electro-mechanical background, but to simplify the task, the myriad of connector choices can be broken down into a few distinct groups.

When searching for or specifying a connector, the first, and most important question, is where the connection is required. The answer will probably be one of the following: board to board, device to board, cable to board or cable to cable. Although these groups can be broken down into more specific sub-groups, these are the starting points for

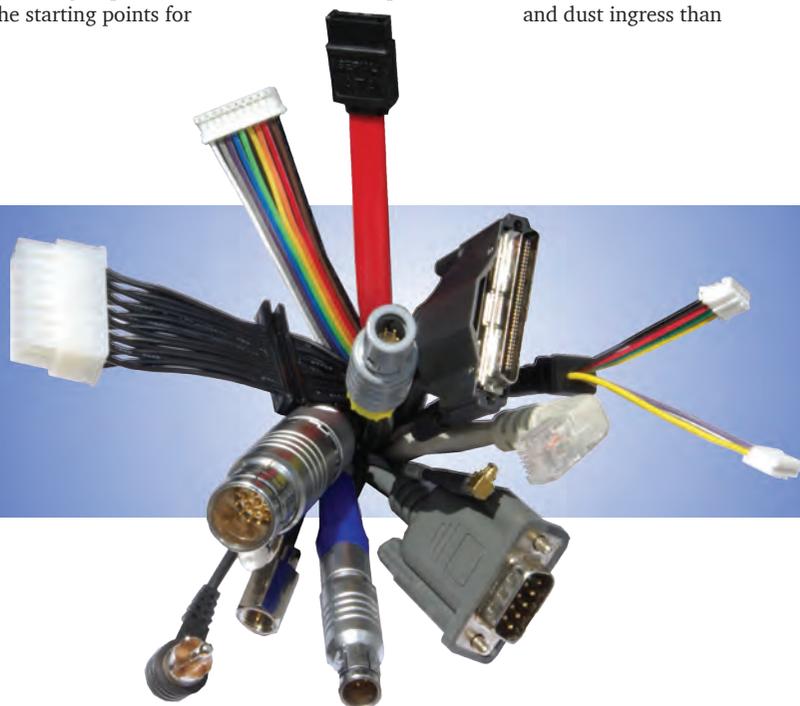
any specification.

Back to basics
Board to board connectors, as the name suggests, are used to interconnect PCBs, and are normally fairly basic connectors that do not require any locking or environmental protection. The main differences are the size and the termination, which can be either surface mount or through hole soldering.

Device to board connectors are fitted to the PCB to allow components, usually integrated circuits, to be socketed. This is not as common as it used to be because most components are now attached directly to the PCB, but sometimes if the IC is expensive, or if devices need to be tested or adapted to a different package style, then a socket is still required.

Cable to board connectors, including cable to panel devices, have grown significantly in recent years, with many options and styles now available. Some common styles included in this group would be D connectors, USB, HDMI, RJ45/ethernet and circular. Important factors when specifying include locking style, environmental protection, ease of handling and, increasingly, transmission speeds. RF or coaxial connectors would sit here.

Circular connectors are a growth area in this category as they can have more contacts within a smaller area, are easy to handle and can offer 360 degree cable shielding more reliably than rectangular connectors. It is also easier to seal circular connectors from water and dust ingress than



Connectors

rectangular connectors, and with water protection becoming a more common prerequisite, this is another benefit of choosing a circular connector. One important development with circular connectors is an ability to handle the high-speed data transmission rates needed for ethernet, HDMI and USB signalling. This is achieved through the shielding design and the style and layout of the contacts, allowing this type of signalling to be used in harsh environments where traditional connector styles could never be used, or when more secure locking is needed.

Cable to cable connectors are normally avoided, but can be used when product assembly requires, such as in large automotive cable looms or when different cable types need to be joined. They are also sometimes used when a cable needs to be easily disconnected, when pulled on. These connectors would normally be plastic crimp type connectors, or another use for circular connectors.

Simplify selection

Once you have established where the connection is needed, connector choice should be drastically simplified. It's then just a case of deciding on the number of contacts, environmental issues and signal type.

Selwyn Electronics' website has been constructed around these group, and sub-group choices, to simplify the task of finding the right connector on-line. And if this doesn't simplify things enough, there is always the option of calling a friendly connector expert to help.

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Connectors

Customisation without cost

Hitaltech has expanded its Conex-it range of board to board connectors with new products, all available with a host of customisation options

With tens of thousands of connection permutations available, Hitaltech's expanded Conex-it rigid interconnect range helps make purchasing simpler, with rigid and flexible connectors now available from a single source.

Supplied with the quality, availability and speed of delivery manufacturers have come to expect from Hitaltech, purchasers can choose from a variety of customisation options for the Conex-it range including pin lengths, platings, colour and orientation. To help buyers navigate this process, an online Connector Selector tool makes it easy to find the right connector for any application.

According to Hitaltech, the new range adds a whole new element to its existing Conex-it range of wire to board interconnect products, which have been a first choice for manufacturers of white goods, automotive, industrial control and energy metering systems for the last 10 years.

Low cost design freedom

Managing director of Hitaltech, Andy Fitzer, explained: "The Conex-it range is one of the UK's largest selection of rigid, board to board connectors. Manufacturers can choose from tens of thousands of components, all available with a huge variety of connection options to give complete design freedom. Each delivers the quality our clients expect from Hitaltech at low cost. And because Conex-it is our own range, we can offer the whole board-to-board interconnect package, whether it's flexible or rigid."

Despite the vast range, customisation options are surprisingly flexible. Andy continued: "We can tailor pin lengths and offer special platings and insulators very easily, but we can offer far more fundamental customisation options too. Choose the shape, colour, geometry or orientation; the options really are limitless which means there's always a connector

for every application."

Selection made simple

Such a huge range could potentially bring its own challenges. How do purchasers find the right connector when the options are almost endless? The new Conex-it website, and in particular its Connector Selector feature, enables users to easily identify the right connector for their application.

Andy revealed: "Once a manufacturer has narrowed the connector field, they can ask us for a sample, so they can put the connector to the test and identify whether they need to talk to us about customisation.

"Hitaltech has always been more than a supplier of connectors and enclosures. With the latest Conex-it range, we remain supplier, advisor and partner in our clients' design and manufacturing processes."

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Chipmakers' spending plans key to forecasting supply and price trends

Large investments by semiconductor suppliers often mean buyers can expect lower prices and short lead times for many chips

Many strategic semiconductor buyers spend a great deal of time trying to determine if prices and lead times for the crucial integrated circuits and discrete semiconductors that their companies need for production will increase or decline over the next 18 to 24 months.

Learning the capital expenditure (capex) plans of key chip suppliers and the current capital spending trends in the overall semiconductor industry can give buyers insight into future changes coming in supply, lead times and prices and help them develop strategies to manage those changes.

Big increases in capital spending often occur when component shortages occur and chipmakers determine that the shortages are likely to continue for a while. Semiconductor manufacturers then add more production lines, upgrade existing ones with new equipment to boost production or build entire new fabs.

In recent years, many chipmakers have been transitioning from 200mm wafers to 300mm wafers because they can produce more usable chips on larger wafers, thereby increasing capacity and supply.

Inevitably what happens is chipmakers add too much capacity, resulting in oversupply, short lead times and falling prices. When that occurs, suppliers reduce capex even if demand continues to be strong. Eventually, the declines in capex result in

tight supply, longer lead times, and in some cases shortages, as well as higher prices. Then suppliers increase capital spending and a new cycle begins.

Good supply times

In 2019 buyers are enjoying oversupply conditions that resulted from heavy investment in new capacity by chipmakers in 2017 and 2018. The good news is buyers can expect ample supply will continue for another year or more because of large investments in new equipment, production lines and fabs by semiconductor integrated device manufacturers (IDMs) and foundries over the past three years.

Semiconductor capital spending increased sharply from \$67.8 billion in 2016 to \$95.6 billion dollars in 2017. Investment in new fabs and equipment continued to grow in 2018 when capex reached a record \$109.5 billion, according to researcher IC Insights. As frequently happens during periods of capital spending growth, too much capacity was added for the amount of demand in the market, resulting in oversupply and falling prices for some chips.

As a result, chipmakers are now cutting back on capital expenditures (capex). In 2019, total semiconductor capital expenditures are forecast to slip 8 per cent to \$97.8 billion and 11 per cent to \$87.3 billion in 2021, according to IC Insights. The capex cutbacks will likely mean tighter supply, longer

lead times and potentially higher prices in late 2021 and 2022, but in 2020 chip supply will be ample as capacity will continue to rise because of investment made in 2017 and 2018.

For instance, DRAM capacity is expected to increase 1 per cent and be followed by a 3 per cent rise in 2020, the researcher said. It's expected that 3D NAND capacity growth will increase by 4 per cent and jump by double digits in 2020. Installed capacity for MPU is expected to increase by 3 per cent in both 2019 and 2020. Optoelectronics, (primarily image sensors) capacity will increase by 9 per cent in both 2019 and 2020, according to IC Insights.

"Currently the industry has a little too much capacity available," said Brian Matas, vice president of research for IC Insights. "The spending we've seen over the past two, maybe three, years has resulted in the industry not only meeting, but exceeding demand."

He said the industry will be "in good shape from a capacity standpoint" for at least another 18 months before supply-demand equilibrium is achieved. "Across all IC products, it should be a buyer's market throughout 2020 although there is a slight chance of some tightening of supplies for leading-edge memory and/or server processors in the second half of next year," said Matas. Later in 2020, suppliers will need to consider raising their capex budgets

again, he said.

Earmarking investment

Semiconductor companies typically earmark a certain percentage of their sales for capital expenditures in order to increase capacity. Capital spending as a percentage of sales was 19-21 per cent since 2010. "For 2017-2019F, we have capex as a percent of sales at 21 per cent all three years," said Matas. However, the percentage varies widely by supplier and IC type.

Typically, the big three DRAM suppliers, the big five flash suppliers, and the top four foundries, make the most capital expenditures. Memory IC manufacturers Samsung, SK Hynix and Micron invest in new equipment to make the next generation of ICs that are typically designed using smaller process geometries than the previous generations, according to Matas.

Newer designs often mean the chips use less power, provide more performance, and basically offer more bang for the buck. They also are physically smaller, which is what system OEMs want to place into their new boxes. These new devices bring higher profits, he noted.

In recent years memory suppliers have focused on 3D memory chips and have had to upgrade to new equipment including new lithography and etching equipment that can make the deep aspect-ratio cells associated with 3D memory, Matas said. Moreover, using smaller process nodes requires more mask steps and more

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Making 3D devices requires more mask layers, requires a larger footprint within the fab. That means existing fabs need to be retrofitted or memory suppliers have to build new fabs for 3D NAND or DRAM devices, he said.

Foundries, which build chips for multiple semiconductor companies, also need to invest a lot to keep up with design technology advances as more IDMs decide to outsource production of semiconductors because of soaring manufacturing costs. As a result, foundries must be prepared for the steady growth of their services, especially for leading-edge processes since many of their customers want their devices made using the smallest possible process nodes, according to Matas.

While the top five non-foundry suppliers—Samsung, Intel, SK Hynix, Micron, Toshiba/WD—collectively spent 26.6 per cent of sales on capex in 2018, the percent of sales on capex by the “big four” foundries has been “through the roof since 2010,” said Matas. The big four include TSMC, UMC, GlobalFoundries and SMIC.

TSMC’s capex as a per cent of its sales averaged 40 per cent per year since 2010. However, with oversupply, TSMC will cut back on its capital expenditures in 2019 to about 33 per cent of sales.

The foundry average will be about 32 per cent sales in 2019, IC insights said. The overall semiconductor industry average as a percentage of sales will be about 22 per cent, the researcher said.

Memory makers invest the most

Capex as a percentage of sales is highest for foundries, but memory IC manufacturers overall account for the largest percentage of semiconductor capex investment. Memory is forecast to represent 43 per cent of total semiconductor industry capital spending this year, down from 49 per cent in 2018, according to IC Insights.

Samsung, SK Hynix, and Micron have added capacity for both DRAM and NAND flash, while Intel, Toshiba Memory/Western Digital/SanDisk, and XMC/Yangtze River Storage Technology all boosted 3D NAND flash capacity over the last year and a half. However, this year DRAM and NAND flash memory markets have entered a period of overcapacity and prices per bit have weakened, resulting in a cut back in capital spending to 2019, the researcher said.

Capex for DRAM and flash is expected to drop 19 per cent in 2019 and 21 per cent in 2020. Total memory capital spending is expected to be \$41.6 billion in 2019, a decline of \$10.4 billion from

last year, IC Insights said.

The cutbacks in spending are an attempt by memory IC manufacturers to stop price erosion. How far memory prices continue to fall will be determined in large part by how much memory suppliers cut capital expenditures and if the lower prices result in additional demand. Increased demand could result the cessation of price declines.

Capital expenditures by memory IC manufacturers and other IDMs and foundries are often used to equip new fabs or to upgrade existing ones with high-end machines used for advanced lithography ($\leq 10\text{nm}$) and 3D process technology for 3D NAND, 3D DRAM, said Matas. Such equipment is expensive and constitutes a “good share of the total amount of capex spending over the past few years,” he said.

TSMC, Samsung and, to a lesser extent Intel, SK Hynix and Micron are the primary buyers of this equipment and will likely be among the very few that will continue to allocate big money for high-end equipment purchases, said Matas. Other chipmakers are allocating money to upgrade to 300mm wafer manufacturing and/or to move their particular process nodes to the next generation on their roadmaps. For many, this means moving to $\leq 22\text{nm}$ process nodes, according to Matas.

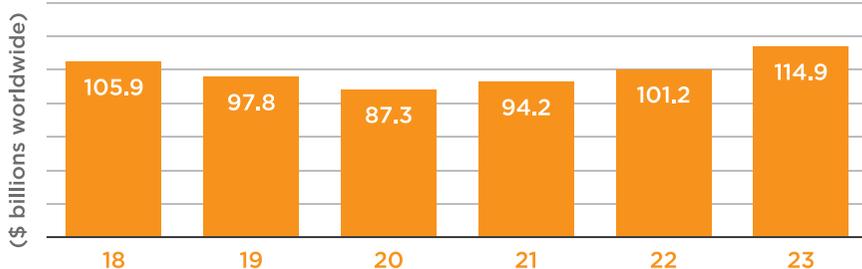
Equipment investment falls

Because of cutbacks in capital spending, global sales of semiconductor manufacturing by original equipment manufacturers are projected to drop 18.4 per cent to \$52.7 billion in 2019 from last year’s historic high of \$64.5 billion, according to trade association SEMI.

Wafer processing equipment sales will fall 19.1 per cent in 2019 to \$42.2 billion and other front-end segment, consisting of fab facilities equipment, wafer manufacturing, and mask/reticle equipment, is expected to decline 4.2 per cent to \$2.6 billion this year, the association said. The assembly and packaging equipment segment will plummet 22.6 per cent to \$3.1 billion in 2019. Semiconductor test equipment will drop 16.4 per cent to \$4.7 billion this year, said SEMI.

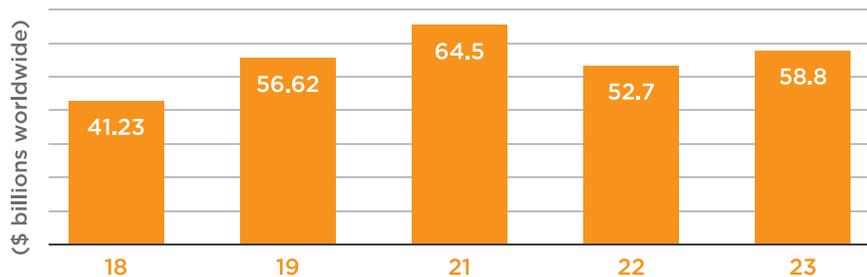
The decline will be short lived as sales are expected to increase 11.6 per cent in 2020 to \$58.8 billion on the strength of spending by memory IC manufacturers and by increased purchasers of equipment by fabs in China. China’s chip equipment capital spending will rise from \$11.69 billion in 2019 to \$14.5 billion in 2020, according to SEMI. Semiconductor equipment spending in Korea will increase from \$9.22 billion in 2019 to \$11.75 in 2020. While equipment sales in

Semiconductor capex will bounce back



Capital spending by semiconductor manufacturers will decline this year and next increase again beginning in 2021. Source: IC Insights

Chip equipment demand will resume growth in 2020



While the global market for semiconductor equipment will drop in 2019, it will recover in 2019 and continue to rise through 2023. Source: SEMI

Japan will rise \$9 billion in 2020 from \$6.14 billion in 2019. The new equipment is needed because chipmakers will increase the number of semiconductor production lines over the next four years from about 136 in 2019 to 172 in 2023, the association said.

Much of the spending will be for 300mm fab equipment, as more chip production transitions from 8-inch wafers to 12-inch wafers. Such a transition means that chipmakers will increase supply as they can produce more chips on 300mm wafers than with 200mm wafers. The transition helps reduce the cost of production and lower prices for semiconductor buyers in addition to increasing semiconductor supply.

Like semiconductor equipment, shipments of silicon wafers will also decline in 2019 but bounce back in 2020, said SEMI.

“Silicon shipment volumes are expected to decline this year as the industry works through accumulated inventory and weaker demand,” said Clark Tseng, director of Industry Research and Statistics at SEMI. “The industry is expected to stabilise in 2020 and regain growth momentum in 2021 and 2022.”

Shipments of polished and epitaxial silicon shipments will total 11,757 million square inches in 2019 and rise to 11,977 million square inches in 2020, according to SEMI. Water shipments will increase to 12,390 million square inches in 2021, and 12,785 million square inches in 2022.

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Harness the power of wiring expertise

Working with a cable assembly manufacturer provides access to components as well as specialist technical advice, explains Telegärtner UK

Despite a move towards living in a wireless society, there seems to be no escape from the myriad of cables and assemblies that surround us, each individually customised for a specific application. Whether coaxial assemblies used in broadcast applications, or fibre optic assemblies used in telecommunications, from the deep sea to the ISS, it is without a doubt that cable assemblies play a pivotal role in shaping the world in which we live.

Cable assemblies, also known as wiring harnesses or looms, are used to transmit signals or electrical power. Due to the endless number of different applications where cable assemblies are used, they are made according to exact customer specifications to offer a suitable solution for each requirement. Whether used in medical, marine,

telecoms or any other industry environment, the key is to use cable assemblies that are of high quality and meet the standards of the industry where they are deployed.

Cable assembly expertise

Working with a cable assembly manufacturer that can provide technical support when choosing components and cable, as well as design suggestions for existing and new harnesses, is vital. This helps ensure that assemblies not only meet the current expectations but also evolve to meet future demands.

Furthermore, close cooperation with a manufacturer that is experienced in various types of assemblies, whether coaxial, multiwire or overmoulded, offers purchasers a one-stop-shop solution for all requirements.

One important aspect when choosing a cable assembly supplier is to ensure effective support to enable a smooth transfer from prototyping in the initial stages of the project right through to full scale production.

Custom capabilities

Offering just such a comprehensive service, Telegärtner UK boasts in-depth experience and knowledge gained over 30 years across a variety of assembly types, including coaxial, multiwire, data, overmoulded and panel assemblies. With the ability to provide high quality, competitively priced cable assemblies for diverse market sectors including telecommunications, rail, industrial, medical, broadcast and marine, Telegärtner UK's expertise can be utilised to offer custom-made assemblies according to individual requirements.

With production sites in the UK and Slovakia, Telegärtner UK offers rapid prototype and pre-production services. Its skilled production staff follow IPC620C workmanship standards with continuous improvement in production and test equipment. This, combined with extensive support and suggestions on materials and assembly design, underpins Telegärtner's strategy of mutually beneficial long-term cooperation.

So, for purchasers looking for more than a just supplier, Telegärtner UK can provide high quality support from implementation and design, right through to project delivery.

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Microprocessor market will bounce back despite slow PC growth

MPU demand will rebound in 2020 resulting in higher tags for processors used in computers and a return to sales growth



James Carbone

Weaker demand and oversupply will result in the global microprocessor market declining about 2 per cent in 2019 as revenue falls from \$54.1 billion in 2018 to \$53.25 billion in 2019, according to researcher Gartner Inc.

However, the MPU market will bounce back in 2020 when sales climb to \$54.5 billion and continue to grow steadily through 2023 when revenue reaches \$58.6 billion, the researcher said. Unit shipments will also rebound. Processor unit shipments in 2019 will fall to 486.9 million from 491.9 million in 2018. Shipments will rise to 500 million in 2020 and grow to 531 million in 2023, Gartner said.

Part of the decline in MPU revenue in 2019 is due to a weak PC market, which has been slowing for years. Despite slow growth in PCs, the MPU market had been growing steadily until 2018 because of strong demand for microprocessors used in servers for data centers run by

hyperscale cloud providers such as Google, Amazon, Microsoft, Facebook and Alibaba and others, said Alan Priestley, research vice president for Gartner Inc.

“They account for a huge volume of product. What happened in the second half of 2018 and the first half of 2019, the hyperscalers’ slowed down their consumption” of servers impacting demand for microprocessors, he said.

“It looks like in the second half of this year server demand is coming back but for the total year, the microprocessor market will be down compared to 2018,” said Priestley.

He noted the MPU market is comprised of the computer segment, which includes servers, desktops, mobile computers, and the embedded market, which includes microprocessors used in other types of electronics equipment.

“The embedded market is a lot smaller part of the market,” said

Priestley. In 2018, the embedded market totaled about \$5 billion compared to \$49 billion for the computer market, according to Gartner.

“The embedded market is more fragmented and is much more affected” by economic conditions, said Priestley. As a result, the embedded MPU business has slowed because of declining economic growth worldwide.

The server market is more affected by the large cloud computing providers, which had been increasing purchases of servers, resulting in robust demand for MPUs and is not as dependent as much on strong overall economic growth.

Mixed pricing scenario

Buyers who purchase microprocessors for embedded applications can expect modest price declines through 2023. For instance, the average price for an MPU used in an embedded system will drop from \$23.70 in 2018 to \$22.00 in 2019 and

to \$21.50 in 2021. However, the average price for an MPU used in servers and PCs will rise from \$174.80 in 2018 to \$176.35 in 2019, then increase steadily through 2023 when the average price will be \$194.17.

MPU tags vary depending on the application performance level. For instance, the highest end Intel Xeon microprocessor for servers has a list price of more than \$17,000, while a low-end Celeron processor lists for \$42.

“The difference between these processors is core count,” said Priestley. Microprocessors used in high-end servers have 28 cores while low-end Celeron MPUs have two cores. The higher the number of cores, the greater the workload the processor can handle. “Some workloads need a lot of cores and some don’t,” he said.

The average price for server microprocessors will increase because server manufacturers will use more powerful, higher-

By the Numbers



\$54.1 billion

The size of the global microprocessor market in 2018.
Source: Gartner



\$176.35

The expected average selling price of a server microprocessor in 2019.



486.9 million

The number of microprocessors that are expected to ship in 2019. Source: Gartner



\$58.6 billion

The forecast size of the worldwide microprocessor market in 2023. Source: Gartner



1%

The expected growth rate of servers in 2019.
Source: IHS Markit



performance microprocessors in systems. Such MPUs have higher prices and drive up the MPU average price. In fact, the long-term strategy of MPU makers Intel and AMD is to produce more processors in the mid-range and high-end, according to Shane Rau, research vice president, computing semiconductors for researcher IDC.

“That has had a positive effect to raise average prices,” he said. However, with demand being weaker than last year there has been some competition between Intel and AMD and “I’ve seen some pricing competition in the midrange and high-end,” said Rau. “In the second quarter, I noticed a notable sequential decline in processor ASP,” he said. However, it will likely be a short-term trend once microprocessor demand picks up.

Demand for MPUs will rise because server demand will increase next year. Server shipments will likely end 2019 rising about 1 per cent after growing 7.9 per cent last year. IHS Markit forecasts 8 per cent growth in server shipments in 2020.

Rau noted that microprocessors designed to be used in servers are used in other types of electronics equipment as well.

About 70 per cent of processors are actually used in servers, while the remaining 30 percent are used in other data center systems including storage, workstations and networking systems among others, he said.

More servers to ship

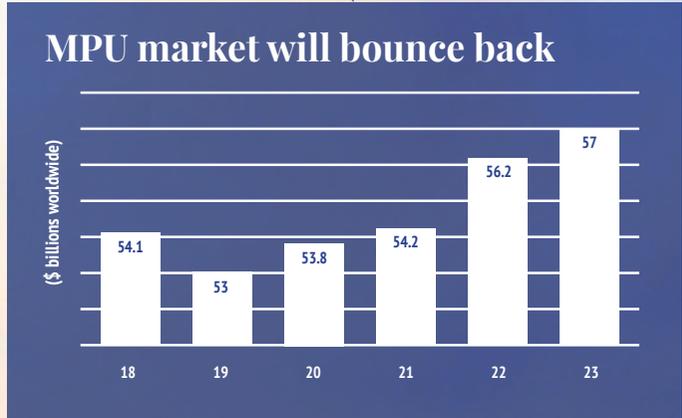
He said server processor revenue will decline 1.5 per cent this year to \$19.6 billion but will grow 2.9 per cent in 2020 to \$20.15 billion.

“Demand in 2019 was weak compared to 2018,” he said. In 2018, server processors grew 25 per cent because of robust demand by server manufacturers. But the very end of last year we noticed a significant slowdown in demand for server class components, including processors. That trend continued in the first half of 2019,” he said.

Enterprise OEMs and cloud service providers reduced their purchases of servers. Some companies were waiting for new server processors, such as Intel’s Cascade Lake Xeon processors and AMD’s new version of its Epyc processors.

There was expected to be a “significant increase in demand in the fourth quarter,” said Rau. That demand will carry over into 2020 and continue for several years. Rau expects server revenue to

The global microprocessor market will dip in 2019 but rebound and post steady growth through 2023. Source: Gartner Inc.



rise between 2.7 per cent and 4.1 per cent per year through 2023.

Also driving microprocessor demand over the next five years will be the growth of connected devices in Internet of things applications including the rollout of 5G technology, smart cards, artificial intelligence and machine learning techniques, said Vlad Galabov, principal analyst, data center compute and cloud research for IHS Markit. As a result, while the MPU market will decline in 2019, it will bounce back in 2020 and post a compound annual growth rate of 4.4 per cent through 2023, Galabov said.

The PC market will not be as much of a factor in MPU growth. “We expect a downward, sloping curve for the long run because the PC market is mature. People are doing more and more computing on their smart phones,” said Galabov.

Growth for application-specific MPUs

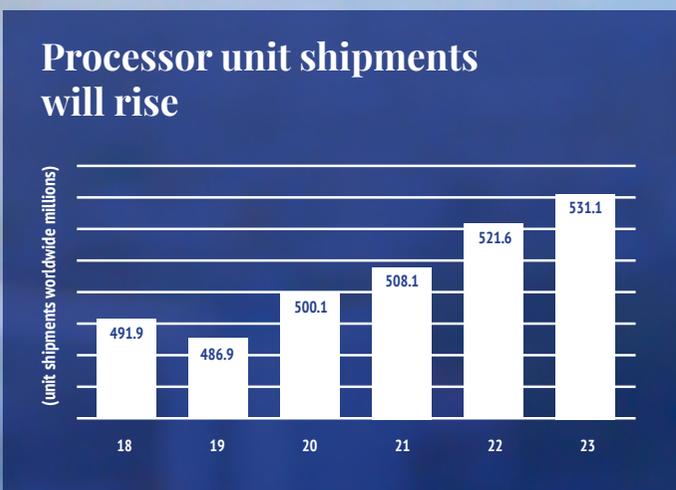
One segment of the MPU market that will contribute to microprocessor growth will be application-specific microprocessors. Revenue in the segment totaled about \$1.3 billion, “so it’s quite small compared to the overall MPU market,” said Galabov. However, the segment will

grow over the next five years. The compound annual growth rate for application-specific microprocessors will be 12.9 per cent,” said Galabov. They will expand beyond videogame consoles and will be used in automotive systems as well.

One unknown factor that could impact microprocessor sales, as well as sales of other semiconductors, is the ongoing trade dispute with China. Intel says rising trade tensions between the U.S. and China have led to increased tariffs and trade restrictions which have an impact on some of the chipmaker’s products.

“The U.S. has previously imposed, and continues to impose, restrictions on the export of U.S.-regulated products and technology to certain Chinese technology companies, which have included, and continue to include, certain of our customers,” Intel said in a financial filing. “These restrictions have reduced Intel’s sales and continuing or future restrictions could adversely affect our financial results,” the company said.

The restriction could result in some companies developing or adopt technologies that compete with Intel’s products, the company said.



Unit demand shipments of microprocessors will fall in 2019 but increase in 2020 as demand from server manufacturers rises. Source: Gartner Inc.

Buyers' Guide

Manufacturer	Distributor	Telephone	Website	Franchised Distributor	No. of Lines for Principle	Stock Value for Principle	Minimum Order Value	% Lead Free for Principle Range	No. of Technical Support Staff	Total No. of Staff	Buffer Stock Facility
CABLE ASSEMBLY & HARNESSING											
FTDI	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	N/A	50	1,500+	Y
Molex	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	300	N/A	£0	97%	50	1,500+	Y
CIRCUIT PROTECTION											
Bourns	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5,000	N/A	£0	58%	50	1,500+	Y
EPCOS/TDK	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5,000	N/A	£0	58%	50	1,500+	Y
Littelfuse	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	35,000	N/A	£0	67%	50	1,500+	Y
DISPLAYS & LEDs											
NLT Technologies Ltd	Review Display System Ltd	01959 563345	www.review-displays.co.uk	Y	All	N/A	£0	N/A	6	25	Y
ENCLOSURES											
Bud	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,500	N/A	£0	80%	50	1,500+	Y
Hammond	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	12,500	N/A	£0	100%	50	1,500+	Y
Hammond	Switch Electronics	01482 862255	switchelectronics.co.uk	Y	500	N/A	£0	70%	2	6	Y
Metcase Enclosures	OKW Enclosures	01489 583858	www.metcase.co.uk	N	288	£40,000	£0	N/A	5	22	Y
OKW Enclosures Ltd	OKW Enclosures	01489 583858	www.okw.co.uk	N	1,955	£40,000	£0	N/A	5	22	Y
Rolec Enclosures	OKW Enclosures	01489 583858	www.rolec-enclosures.co.uk	Y	935	£40,000	£0	N/A	5	22	Y
Teko Enclosures	OKW Enclosures	01489 583858	www.teko.co.uk	Y	1,860	£40,000	£0	N/A	5	22	Y
FREQUENCY MANAGEMENT											
ABRACON	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,000	N/A	£0	91%	50	1,500+	Y
AEL Crystals Ltd	AEL Crystals Ltd	01293 789200	www.aelcrystals.co.uk	N	N/A	£200,000	£50	100%	3	15	Y
ECS	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	500	N/A	£0	99%	50	1,500+	Y
Epson	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	500	N/A	£0	59%	50	1,500+	Y
Geyer Quartz Technology	Geyer Electronic UK Ltd	01794 329341	www.geyer-electronic.com	N	N/A	N/A	£0	100%	6	50+	Y
Golledge Electronics Ltd	Golledge Electronics Ltd	01460 256 100	www.golledge.com	N	N/A	£800,000	£0	100%	3	24	Y
Jauch Quartz	Digi-Key Electronics	0800 587 0991	www.digikey.co.uk	Y	500	£250,000	0	100	15	130	Y
HEATSINKS											
Aavid	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	67%	50	1,500+	Y
ICs & SEMICONDUCTORS											
Altera	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,600	N/A	£0	60.00%	50	1,500+	Y
Analog Devices Inc.	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	9,500	N/A	£0	83.00%	50	1,500+	Y

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Buyers' Guide

Manufacturer	Distributor	Telephone	Website	Franchised Distributor	No. of Lines for Principle	Stock Value for Principle	Minimum Order Value	% Lead Free for Principle Range	No. of Technical Support Staff	Total No. of Staff	Buffer Stock Facility
Atmel	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,700	N/A	£0	58.00%	50	1,500+	Y
Avago Technologies	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	400	N/A	£0	84.00%	50	1,500+	Y
Broadcom	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	69%	50	1,500+	Y
Cirrus Logic	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	300	N/A	£0	80.00%	50	1,500+	Y
Cypress Semiconductor	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,400	N/A	£0	63.00%	50	1,500+	Y
Diodes Incorporated	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,600	N/A	£0	98%	50	1,500+	Y
Exar	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,100	N/A	£0	95.00%	50	1,500+	Y
Fairchild Semiconductor	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,500	N/A	£0	90.00%	50	1,500+	Y
Freescale Semiconductor	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,500	N/A	£0	42.00%	50	1,500+	Y
FTDI	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	97%	50	1,500+	Y
IDT (Integrated Device Technology)	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,100	N/A	£0	97%	50	1,500+	Y
Infineon	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	800	N/A	£0	66.00%	50	1,500+	Y
Intel	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	500	N/A	£0	78%	50	1,500+	Y
International Rectifier	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	600	N/A	£0	87.00%	50	1,500+	Y
Intersil	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,900	N/A	£0	50.00%	50	1,500+	Y
ISSI	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	98.00%	50	1,500+	Y
Lattice	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	69%	50	1,500+	Y
Maxim Integrated	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	11,200	N/A	£0	67.00%	50	1,500+	Y
Microchip	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	12,600	N/A	£0	91.00%	50	1,500+	Y
Microsemi	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	400	N/A	£0	90%	50	1,500+	Y
Monolithic Power Systems (MPS)	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	600	N/A	£0	40%	50	1,500+	Y
NXP	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	3,900	N/A	£0	91%	50	1,500+	Y
ON Semiconductor	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5,100	N/A	£0	87%	50	1,500+	Y
Power Integrations	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	600	N/A	£0	59%	50	1,500+	Y
Qorvo	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	300	N/A	£0	90.00%	50	1,500+	Y
ROHM Semiconductor	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,400	N/A	£0	55.00%	50	1,500+	Y
Silicon Laboratories	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,500	N/A	£0	96%	50	1,500+	Y
Skyworks	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	300	N/A	£0	91%	50	1,500+	Y
Spansion Inc.	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	600	N/A	£0	93.00%	50	1,500+	Y
STMicroelectronics	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	4,500	N/A	£0	99%	50	1,500+	Y
Texas Instruments	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	36,900	N/A	£0	41%	50	1,500+	Y
Toshiba	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	500	N/A	£0	100.00%	50	1,500+	Y
INDUSTRIAL GRADE MEMORY MODULES											
InnoDisk	Simms	01622 852 848	www.simms.co.uk	N	300+	N/A	N/A	N/A	3	N/A	Y
INTERCONNECTION											
3M	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	3,100	N/A	£0	16%	50	1,500+	Y
Amphenol	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	25,600	N/A	£0	53%	50	1,500+	Y
Anderson Power Products	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	800	N/A	£0	50%	50	1,500+	Y
Cinch Connectivity Solutions	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,900	N/A	£0	82%	50	1,500+	Y
Delphi Connection Systems	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	3,300	N/A	£0	67.00%	50	1,500+	Y
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Huber+Suhner	Lane Electronics	01403 790661	www.fclane.com	Y	766	£116,000	£0	100%	6	38	Y
ITW McMurdo	Lane Electronics	01403 790661	www.fclane.com	Y	866	£219,000	£0	100.00%	6	38	Y
JAE Electronics	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,200	N/A	£0	32%	50	1,500+	Y
Kycon	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	99%	50	1,500+	Y
LEMO	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,900	N/A	£0	65%	50	1,500+	Y
Molex	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	16,900	N/A	£0	75%	50	1,500+	Y
Neutrik	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,000	N/A	£0	86%	50	1,500+	Y
Phoenix Contact	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	12,000	N/A	£0	99.00%	50	1,500+	Y
Polamco	Lane Electronics	01403 790661	www.fclane.com	Y	218	£146,000	£0	100%	6	38	Y
Positronic	Lane Electronics	01403 790661	www.fclane.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	Y
Souriau	Lane Electronics	01403 790661	www.fclane.com	Y	1,929	£806,000	£0	100%	6	38	Y
Switchcraft	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,200	N/A	£0	69%	50	1,500+	Y
TE Connectivity	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	30,900	N/A	£0	40%	50	1,500+	Y
OBSOLESCENCE / HARD TO FIND											
	America II Europe	01462 707070	www.americaiiurope.com	N/A	1,900	\$1B	£0	75%	59	500+	Y
	Cyclops Electronics	01904 415 415	www.cyclops-electronics.com	N/A	177,232	£5M	£100	75%	3	78	Y
Rochester Electronics	Rochester Electronics	+44.1480.408400	www.rocelec.com	Y	299	N/A	\$250		10	400+	Y
	SeSemi Electronics LTD	01264 731009	www.sesemi.co.uk	Y	2800	N/A	£100		3	12	Y

Manufacturer	Distributor	Telephone	Website	Franchised Distributor	No. of Lines for Principle	Stock Value for Principle	Minimum Order Value	% Lead Free for Principle Range	No. of Technical Support Staff	Total No. of Staff	Buffer Stock Facility
OPTO ELECTRONICS											
Avago Technologies	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	8,200	N/A	£0	89%	50	1,500+	Y
Cree, Inc.	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	22,500	N/A	£0	74%	50	1,500+	Y
Dialight	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	9,800	N/A	£0	99%	50	1,500+	Y
Kingbright	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	3,100	N/A	£0	100%	50	1,500+	Y
Lumileds	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,100	N/A	£0	99%	50	1,500+	Y
NEC	Review Display System Ltd	01959 563345	www.review-displays.co.uk	Y	200	£200,000	£0	100%	5	20	Y
Newhaven Display	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	65%	50	1,500+	Y
Osrnam Opto Semiconductor	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,800	N/A	£0	99%	50	1,500+	Y
VCC	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5,000	N/A	£0	92%	50	1,500+	Y
Vishay	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	3,100	N/A	£0	99%	50	1,500+	Y
PASSIVES											
AVX	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	70,700	N/A	£0	58.00%	50	1,500+	Y
Bourns	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	49,500	N/A	£0	98%	50	1,500+	Y
Coilcraft	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	10,400	N/A	£0	98%	50	1,500+	Y
Cornell Dubilier	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	33,000	N/A	£0	65.00%	50	1,500+	Y
EPCOS / TDK	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	31,000	N/A	£0	74.00%	50	1,500+	Y
Fair-Rite	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,000	N/A	£0	94.00%	50	1,500+	Y
Kemet	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	135,800	N/A	£0	93%	50	1,500+	Y
KOA Speer	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	107,900	N/A	£0	82%	50	1,500+	Y
Laird Technologies	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,800	N/A	£0	50.00%	50	1,500+	Y
Murata	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	67,300	N/A	£0	99%	50	1,500+	Y
Nichicon	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	21,600	N/A	£0	47.00%	50	1,500+	Y
Ohmite	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	17,300	N/A	£0	99.00%	50	1,500+	Y
Panasonic	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	67,900	N/A	£0	69.00%	50	1,500+	Y
Taiyo Yuden	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	6,400	N/A	£0	82%	50	1,500+	Y
TDK	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	25,300	N/A	£0	85.00%	50	1,500+	Y
TT Electronics	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	32,800	N/A	£0	55%	50	1,500+	Y
United Chemi-Con (UCC)	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	13,900	N/A	£0	99.00%	50	1,500+	Y
Vishay	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	119,800	N/A	£0	76%	50	1,500+	Y
Würth Electronics	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	4,500	N/A	£0	63%	50	1,500+	Y
Yageo	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	45,300	N/A	£0	99%	50	1,500+	Y
POWER & BATTERIES											
Bel Power Solutions	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,400	N/A	£0	94.00%	50	1,500+	Y
Cincon	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5,500	N/A	£0	60%	50	1,500+	Y
Cosel	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	11,800	N/A	£0	99%	50	1,500+	Y
CUI Inc.	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	3,900	N/A	£0	100%	50	1,500+	Y
FRIW0 Gerätebau GmbH	Haredata Electronics	01423 796240	www.haredata.co.uk	Y	250 - 500	€1M	£250	100%	7	14	Y
Jauch Quartz		01276 605900	www.jauch.com			£500,000	0	95	15	130	Y
Mean Well	Ecopac (UK) Power Ltd	01844 204420	www.ecopacpower.co.uk	Y	6,000	£2M	£0	100%	8	30	Y
Mean Well	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	4,500	N/A	£0	75%	50	1,500+	Y
Murata	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5,200	N/A	£0	93%	50	1,500+	Y
RECOM	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	23,300	N/A	£0	92%	50	1,500+	Y
Schaffner	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	900	N/A	£0	98%	50	1,500+	Y
SL Power	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,100	N/A	£0	87%	50	1,500+	Y
TDK-Lambda	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	4,600	N/A	£0	99%	50	1,500+	Y
TRACO Power	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	3,400	N/A	£0	95%	50	1,500+	Y
SENSORS											
All Sensors	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,300	N/A	£0	70.00%	50	1,500+	Y
ams	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	400	N/A	£0	77%	50	1,500+	Y
Analog Devices Inc.	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	500	N/A	£0	78%	50	1,500+	Y
Bosch	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	94.00%	50	1,500+	Y
Freescale Semiconductor	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,000	N/A	£0	66%	50	1,500+	Y
Honeywell	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	15,500	N/A	£0	80%	50	1,500+	Y
Maxim Integrated	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	900	N/A	£0	N/A	50	1,500+	Y
Melexis	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	N/A	50	1,500+	Y
Omron	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5,700	N/A	£0	N/A	50	1,500+	Y
Sensirion	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	N/A	50	1,500+	Y
TE Connectivity	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,100	N/A	£0	N/A	50	1,500+	Y
SWITCHES & KEYBOARDS											
ALPS	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	400	N/A	£0	70.00%	50	1,500+	Y
Apem	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	96%	50	1,500+	Y
C&K Components	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,500	N/A	£0	84%	50	1,500+	Y
Carling Technologies	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	300	N/A	£0	87%	50	1,500+	Y

Buyers' Guide

Manufacturer	Distributor	Telephone	Website	Franchised Distributor	No. of Lines for Principle	Stock Value for Principle	Minimum Order Value	% Lead Free for Principle Range	No. of Technical Support Staff	Total No. of Staff	Buffer Stock Facility
CHERRY	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	200	N/A	£0	77%	50	1,500+	Y
EAO Ltd	EAO Ltd	01444 236000	www.eao.co.uk	N	5,000	£500,000	£150	100%	6	22	Y
E-Switch	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	94%	50	1,500+	Y
Grayhill	EAO Ltd	01444 236000	www.eao.co.uk	Y	2,300	£150,000	£150	99%	6	22	Y
Grayhill	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	400	N/A	£0	84.00%	50	1,500+	Y
Honeywell	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	98%	50	1,500+	Y
NKK Switches	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,100	N/A	£0	94%	50	1,500+	Y
Omron	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	900	N/A	£0	68%	50	1,500+	Y
TE Connectivity	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	400	N/A	£0	98%	50	1,500+	Y
TERMINAL BLOCKS											
Marathon Special Products	Global Supply Services	01904 436 488	www.global-supply-services.com	Y	8,000	£800,000	£100	100%	3	11	Y
THERMAL MANAGEMENT											
ADDA	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	800	N/A	£0	59.00%	50	1,500+	Y
Delta Electronics	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	500	N/A	£0	28%	50	1,500+	Y
ebm-papst	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,200	N/A	£0	99%	50	1,500+	Y
Sanyo Denki	EAO Ltd	01444 236000	www.eao.co.uk	Y	300	£150,000	£150	99%	6	22	Y
Sanyo Denki	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,900	N/A	£0	N/A		1,500+	Y
Sunon	G.English Electronics Ltd	0208 855 0991	www.gelec.co.uk	Y	3,500	£1,000,000+	£0	100%	10	28	Y
Sunon	Thermaco Ltd	01684 566163	www.thermaco.co.uk	Y	3,500	£230,000	£100	100%	6	12	Y
TRANSFORMERS & INDUCTORS											
Best Windings	Best Windings	0044 (0)1394 448424	www.bestwindings.co.uk	N	300	N/A	£100	N/A	2	14	Y
WIRELESS SOLUTIONS											
Anaren	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	86.00%	50	1,500+	Y
B&B Electronics	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	87%	50	1,500+	Y
Bluegiga Technologies	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	93.00%	50	1,500+	Y
Digi International	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	200	N/A	£0	92%	50	1,500+	Y
Laird Technologies	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	76%	50	1,500+	Y
Linx Technologies	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	99%	50	1,500+	Y
Microchip	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	85%	50	1,500+	Y
Murata	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	100%	50	1,500+	Y
Panasonic	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	91%	50	1,500+	Y
Redpine Signals	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	94%	50	1,500+	Y
RF Digital	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	100%	50	1,500+	Y
Texas Instruments	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	75%	50	1,500+	Y
Wi2Wi	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	100	N/A	£0	36%	50	1,500+	Y

Contract Manufacturers Buyers' Guide

Manufacturer	Telephone	Website	Turnover	Location	Employees	Number of Surface Mount Lines	Approvals	BGA Capacity	Lead Free Manufacturer	Prototyping	Design Capability	Full Turnkey Cables and Harnessing
AWS Electronics Group	01782 753200	www.awselectronicsgroup.com	£40m	UK & Slovakia	430	11	AS9100, ISO9001, 13485, 14001, TS16949, IPC-A-610 Class 3, NADCAP	Y	Y	Y	Y	Y
Challenger Solutions Ltd	01245 325252	www.challengersolutions.com	£8m	Essex/SE	95	7	AS9100 Rev D, ISO9001:2015, ISO 14001:2015, UL, CCC, IPC-610-G Class 3	Y	Y	Y	Y	Y
CML Innovative Technologies (uk) Ltd	01284 714700	WWW.CML-IT.com	£12M	UK/EU/China	65		ISO9001 TS16949 UL	N	Y	Y	Y	Y
Corintech Ltd	+44 (0)1425 655655	www.corintech.com	£7.5m	UK	72	3	AS9100, ISO9001, IPC-A-610 Class 3	Y	Y	Y	Y	Y

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Contract Manufacturers Buyers' Guide

Manufacturer	Telephone	Website	Turnover	Location	Employees	Number of Surface Mount Lines	Approvals	BGA Capacity	Lead Free Manufacturer	Prototyping	Design Capability	Full Turnkey Cables and Harnessing
Custom Interconnect Ltd	01264 321321	www.cil-uk.co.uk	£14m	Andover (Hampshire)	130	6	ISO 9000, IPC610, ISO 13485	Y	Y	Y	Y	Y
DJ Assembly	01904 436 456	www.djassembly.com	£1.25m	North Yorkshire	15	2	ISO9001:2008, IPC-A-610 Class 3	Y	Y	Y	Y	Y
Dynamic EMS Ltd	01383 822911	www.dynamic-ems.com	£9m	Scotland	94	3	ATEX, ISO9001:2015, OHSAS18001, IPC-610-F class 3, ISO14001, ISO 13485, UL	Y	Y	Y	Y	Y
Electrica Limited	0161 343 7575	www.electricalimited.com	£1.75m	Cheshire	26	3	BSI ISO 9001:2015, IPC-A-610 to Class 3, IPC-J-STD-001, Cert IPC Trainer, UL	Y	Y	Y	Y	Y
Electronic Technicians Ltd	01202 897722	www.etuk.co.uk	£3.5m	SE	55	2	AS9100, ISO9001, ISO14001, IPC610/620 Class 3	Y	Y	Y	Y	Y
Elite Electronic Systems Ltd	028 6632 7172	www.eitees.com	£20m	UK	230	5	ISO9001, ISO13485, UL, IPC610/620 Class 3	Y	Y	Y	Y	Y
Esprit Electronics Ltd	02380 455411	www.espritelectronics.com	£9m	S/Malaysia	80	4	ISO9001:2008, IPC610 to Class 3	Y	Y	Y	Y	Y
FerminionX Ltd	+44(0)1903 524600	www.ferminionx.com	£5m	Worthing, W. Sussex	40	4	ISO9001:2015, ISO14001:2015, IPC 610 A Class 2 & 3	Y	Y	Y	Y	Y
G&B Electronic Designs Ltd	01420 474188	www.gandbelectronics.co.uk	£4.2m	Hampshire	60	2	ISO9001, ISO13485, IPC-A-610, IPC-J-STD-001, IPC 7711/7721, BS EN 61340-5-1 (ESD)	Y	Y	Y	Y	Y
Hallmark Electronics Ltd	01782 562255	www.hallmarkelectronics.com	£2m	M	26	2	ISO9000/UL, IPC610/D	Y	Y	Y	Y	Y
Icon Electronics Limited	01423 449080	www.iconelectronics.co.uk	£6.5m	Hampshire & Yorkshire	70	5	AS9100, ISO9001, BS EN ISO/IEC 80079-34:2018 ATEX, IPC-A-610 Class 3	Y	Y	Y	Y	Y
Industrial Electronic Wiring Ltd.	+44(0)1793 694033	www.view.co.uk	£5.5m	Swindon, UK	60	N/A	ISO9001:2015, IPC610, IPC620	N	Y	Y	N	Y
Jaltek	01582578170	jaltek.com	£8m	UK	80	3	AS9100, ISO9001, ISO13485, IPC-A-610 Class 3, Certified IPC Trainer (IPC-A-610/J-STD-001 & J-STD-001 Spare Addendum)	Y	Y	Y	Y	Y
JJS Manufacturing Ltd	01455 555500	www.jjsmanufacturing.com	£35m	Bedford, Luttrethworth, (CZ)	420	3	ISO9001:2015, ISO14001:2015, IPC 610 A class 2&3	Y	Y	Y	Y	Y
Key-Tech Electronic Systems	01592 597711	www.key-tech.co.uk	£5m	Scotland	65	2	ISO9001:2015, J-STD-001, IPC-610/620 CLASS 3, IPC-7711,	Y	Y	Y	N	Y
Nemco Limited	01438 346600	www.nemco.co.uk	£13.4m	SE	120	6	AS9100, ISO9001:2008, IPC610/620 to Class 3, ISO14001-2004, SC21	Y	Y	Y	Y	Y
NOTE including Speedboard	01453 797580 01753 746700	www.note.eu www.speedboard.co.uk	£115m	UK/EU/China	1050	18	IPC610 to Class 3, ISO9001:2015, 13485, 14001, 18001	Y	Y	Y	Y	Y
M-TEK (Assembly) Ltd	01189 455377	www.mtek.co.uk	£2.4m	SE	30	4	ISO9001-2008/IPC-A-610 Class 3/WHMA-620/ISO14001-2004/IPC-7711/7721	Y	Y	Y	Y	Y
Pektron	01332 832424	www.pektron.com	£50m	E-Midlands	350	8	ISO9001, ISO14001, TS16949, BEAB, VCA, TUV, UL	Y	Y	Y	Y	Y
Protronix EMS	01582 418490	www.protronix.co.uk	£2.5m	Luton	10	2	ISO9001:2015, IPC-A610 Class 3	Y	Y	Y	Y	Y
Season Electronics Limited	02392 452222	www.seasongroup.com	£5m/£95m	Havant/Global	65/1800	2/18	(AS9100 & ISO9001 in UK) (TS16949 & ISO13485 at sister sites)	Y	Y	Y	Y	Y
Simtek EMS Ltd	01843 233120	www.simtekems.co.uk	£6m	SE	60	3	ISO9001:2008, ISO13485, IPC-A-610 Class 3 & IPC-7711	Y	Y	Y	Y	Y
Tenkay Electronics Ltd	01903 855455	www.tenkay.co.uk	£4.1m	West Sussex	50	1	ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007	N	Y	N	N	Y
TEXCEL TECHNOLOGY PLC	+44(0)1322621700	www.texceltechnology.com	£15.5m	SE	131	7	ISO9001, ISO14001, IPC610 Class 3,	Y	Y	Y	Y	Y
Tioga Limited	01332 360884	www.tioga.co.uk	£15m	Derby	110	6	ISO 9001:2015, ISO 13485:2016, IPC 610, IPC 7711/7721	Y	Y	Y	Y	Y
Trojan Electronics Limited	01792 469020	www.trojanelectronics.co.uk	£2m	South Wales	20	2	BS EN ISO 9001 2008, ISO 14001 2007	Y	Y	Y	Y	Y
Wilson Process Systems	01424 722222	www.wps.co.uk	£12m	SE	100	4	ISO9001:2015, IPC-A-610 Class 3	Y	Y	Y	Y	Y

PCB Buyers' Guide

Manufacturer	Telephone	Website	Service Provided (ie Broker, Manufacturer &/or Repair)	Location	Approvals	Volume - Small, Medium, Large	Double-sided	Multi-layer 4-10/10-20-30	Meta PCBs	Flex / Flexi-Rigid	Obsolescence Solutions	Modifications	Prototyping
ABL Circuits Ltd	01462 894312	www.ablcircuits.co.uk	M	SE	ISO 9001:2008	SML	Y	4-10	Y	Y	Y	Y	Y
Cambridge Circuit Company Ltd	01223 423100	www.cambridge-circuit.co.uk	M	SE	ISO9001:2015, UL	SML	Y	4-16	Y	Y	Y	Y	Y
Daleba Electronics Ltd	+44(0)1992 510000	www.daleba.co.uk	B/M	UK, Europe, Asia, USA	UL, ISO9001:2008, TS16949:2009	SML	Y	4-30	Y	Y	Y	Y	Y
DK Thermal Ltd	+44(0)1992 514200	www.dkthermal.co.uk	M/R	UK, Europe, Asia, USA	UL, ISO9001:2008, TS16949:2009	SML	Y	N	Y	N	Y	Y	Y
Fineline VAR Ltd	+44(0)1249 815 815	www.fineline-global.com	B	UK / Global	ISO9001:2015 / UL / TS16949 / Nadcap / AS9100 / ISO14001	SML	Y	4-60	Y	Y	Y	Y	Y
GSPK Circuits Ltd	+44(0)1423 321100	www.gspkcircuits.ltd.uk	M/R	UK, Europe, Asia	ISO 9001:2015, IATF 16949:2016, EN (AS) 9100	SML	Y	4-16	Y	Y	Y	Y	Y
LEF Circuits	0116 2891122	www.lefcircuits.co.uk	M/R	M	ISO 9001:2015, UL	SML	Y	4-30	Y	F/R	Y	Y	Y
Photronix Group	01903 231901	www.photronix.co.uk	B	SE	ISO9001:2015, ISO14001:2004, AS9100-B, NADCAP/TS16949:2002	SML	Y	4-58	Y	F, F/R	Y	Y	Y
Stevenage Circuits Ltd	01438 761811	www.stevenagecircuits.co.uk	M/B	UK/China	ISO 9001:2008, ISO 14001, EN9100:2009, UL, JOSCAR	SML	Y	4-44+	Y	F, F/R	Y	Y	Y
Tate Circuit Industries Ltd	01889 585627	www.tatecircuits.com	B	UK/China	ISO 9001:2015, UL	SML	Y	4-20	Y	Y	Y	Y	Y

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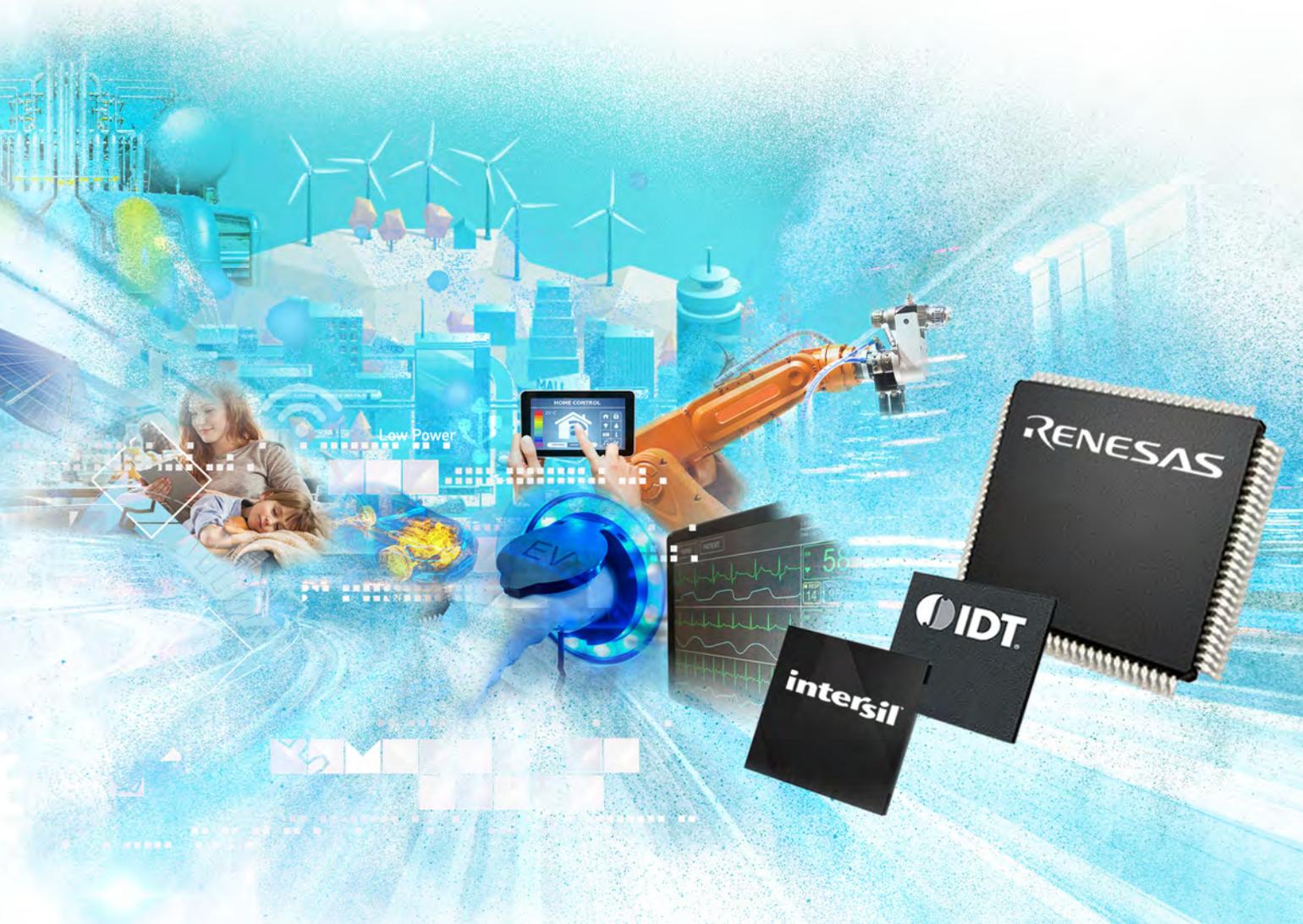


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