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### Contact



#### EDITORIAL

**Managing Editor:** Jon Barrett  
jonb@electronics-sourcing.co.uk  
**Contributing Editor:** Amy Barker  
amyb@electronics-sourcing.co.uk  
**Editorial & Production:** Thomas Smart  
thomas.smart@electronics-sourcing.co.uk  
**Editorial & Production Assistant:** Ben Kitching  
ben.kitching@electronics-sourcing.co.uk

#### ADVERTISING

**Area Sales Executive:** Emma Poole  
emma.poole@electronics-sourcing.co.uk  
**Director of Sales:** Charlotte Morgan  
charlotte.morgan@electronics-sourcing.co.uk  
**Marketing Manager:** Amy Leary  
amyleary@electronics-sourcing.co.uk

#### CIRCULATION

**Circulation Manager:** Vicky Leary  
vicky.leary@electronics-sourcing.co.uk  
**Circulation Account Manager:** Liz Poole  
liz.poole@electronics-sourcing.co.uk

#### DESIGN

**Graphic Designer:** Josh Hilton  
josh.hilton@electronics-sourcing.co.uk

#### PUBLISHER

**Mark Leary**  
mark.leary@electronics-sourcing.co.uk  
**Office Manager:** Denise Pattenden  
denise.pattenden@mmgpublishing.co.uk

Issue 165, Vol.15 No.03

Published 12 times per year  
by MMG Publishing Limited  
ANNUAL SUBSCRIPTION:  
EU Countries €60 Rest of World £90

MMG PUBLISHING LTD  
Suite 2, 1-3 Warren Court, Park Road,  
Crowborough, East Sussex TN6 2QX  
Tel: +44 (0)1892 613400  
Fax: +44 (0)1892 613402  
Printed by: Pensord Press Ltd  
Electronics Sourcing is printed on  
sustainably sourced paper stock  
ISSN 2043-9504  
© 2019 MMG Publishing Ltd



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ABC AUDITED  
2005/2017



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## Editor's Word



### Economic heroes

Ever since I arrived in the world of product design and manufacturing I've been confronted by a repeating mantra that 'the United Kingdom is now a consumer led, service economy'. Once this phrase was sufficiently repeated, our politicians and population had little choice but to believe it. The net result is that discussion about our 'national industrial strategy' has slowly slipped out of our consciousness and into the shadows.

I live to design and make things. It helps give meaning to my life. So, the downgrading of my beloved 'manufacturing' by fellow country men and women should make me very angry. Luckily, it doesn't thanks to my logic. The simple fact is that the provision of any service is underpinned by lorry loads of manufactured products. From a singer's microphone to a stock broker's datacenter. The only decision is what percentage of those products purchased in the UK should also be made here.

Funnily enough, a knight in shining armor has just ridden to the aid of manufacturing industrial strategy: Brexit. Suddenly, politicians and the broadcast media are screaming from the hill tops about the importance of manufacturing industry. The general population is being made aware that we do make things, from aircraft wings and television sets to cars and tanks.

The mere thought about possibly losing this capability at some undefined point in the future appears to be sending people into spasms of anxiety. I say good. It's about time the people who help design and make things are recognised for what they are: hard working economic heroes.

*Jon Barnett*

View current editions online

[www.electronics-sourcing.co.uk](http://www.electronics-sourcing.co.uk)



## Accelerating availability in Europe

RS Components has signed a franchised distribution agreement with CTS to support its Electronic Components Group in Europe. Customers across the region will gain faster access to a range of CTS electronic devices, targeted for use in the transportation, industrial, medical and communications sectors.

CTS components now in stock at RS include frequency control products; electromechanical devices; as well as control components; speciality resistors; and a range of thermal management products including heatsinks and thermal interface materials.

Vice president industrial interconnect and test at RS, Eric Smith, said: "RS has committed to holding an extensive inventory of components from CTS, giving major OEMs and other customers in Europe the benefit of CTS products with RS service."

[uk.rs-online.com](http://uk.rs-online.com)

## Connecting with aerospace and defence buyers

Connector specialist, Intelliconnect, has been awarded silver performance standard to the SC21 aerospace, defence, security and space industry supply chain programme.

Managing director, Roy Phillips, said: "This is a major achievement for a business of our size without having the support of a prime defence subcontractor. In the current political and economic environment it will ensure our position at the top table of suppliers to the aerospace and defence industries. Every member of our team played their part in achieving this award and they should all take great pride in their achievement."

[www.intelliconnect.co.uk](http://www.intelliconnect.co.uk)



## Rail converters ready to roll

Available in Europe through TTI, Murata's IR series DC/DC converters are designed specifically for use in industrial and railway applications. Models include the IRQ100 series 100W model in an industry-standard quarter brick, and IRH150 series 150W, and IRS50 series 50W sixteenth brick package.

The IRQ and IRH products deliver fully regulated DC outputs of five, 12, or 24V DC, from a 3:1 wide input range of 57.6 up to 160V DC. Highly shock and vibration tolerant, the converters meet the requirements of EN50155 for nominal Vin voltages of 96V DC and 110V DC including brownout and transient conditions. Housed in a fully enclosed package, the converters also meet the requirements of EN60068 regarding damp heat and dry heat and benefit from a maximum baseplate operating temperature of 100°C, full load. The IRS range, 50W model features multiple baseplate options, with I/P V range options of nine to 36V or 18 to 75V DC.

[www.ttieurope.com](http://www.ttieurope.com)

## Ready for RoHS 3?

Anglia continues to work towards full RoHS 3 compliance in readiness for the 22 July 2019 deadline and can confirm that the majority of product it supplies is already compliant with the new, more rigorous regulations. Details of each supplier's status is documented on Anglia Live.

Quality manager of Anglia, Claire Stevenson, commented: "We are continuously updating our website as we receive information. Fifty eight of our suppliers have already confirmed their products are fully compliant. They represent over 70 per cent of the product lines we can supply. Many of the remaining suppliers have provided compliance road maps showing that they will be fully compliant by the deadline.

"Customers can continue to use RoHS 2 compliant products up until 22 July. After this date they will need to ensure products are RoHS 3 compliant. Certificates of RoHS compliance can be downloaded from Anglia Live allowing customers to complete their own compliance documentation."

Announced in 2016, RoHS 3 expands the list of prohibited substances from six to ten by adding four new types of phthalates. Although it is an EU directive, it has been widely adopted and will still apply to the UK industry even after Brexit.

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## In Brief

### Find sensors fast

ATC Semitec has launched a new website to help both design engineers and buyers identify the ideal temperature sensor for their new product introduction or product upgrade. The mobile friendly site can be searched by market application, product type or via one of the manufacturers that ATC represents. The technical team can also help by confirming specifications, availability and pricing. [www.atcsemitec.co.uk](http://www.atcsemitec.co.uk)

### Supply, support and service

The Harting Technology Group has entered into a global distribution agreement with Heilind, following a successful partnership in North America. With its focus on connectors and electromechanical components, speciality distributor Heilind, features over 170 manufacturers in its portfolio. The partnership will benefit Harting customers by providing access to Heilind's rapid supply, technical support and an exceptional service. [www.harting.com](http://www.harting.com)

### RF cable by the metre

Lane Electronics can now provide Huber+Suhner's RF Enviroflex and Spuma coaxial cables in any length from just one metre, with no minimum order quantity. Availability in such short lengths and quantities is ideal for evaluation, trials, prototyping and low volume production runs. Typical applications for these cables include fixed and mobile communications, transport including railways, aerospace and defence, test and measurement, medical and general industrial. [www.fclane.com](http://www.fclane.com)

### SSDs store more

Rutronik UK has added Intel's 660p solid state drive series with QLC 3D-NAND architecture to its portfolio. This is Intel's first SSD with this architecture, with devices characterised by a high storage density and large capacities. The solid state drives in M.2 form factor with PCIe and NVMe are available with 512GB, 1TB and 2TB storage space. The 660p series also boasts read and write speeds of up to 1,800Mb/s. [rutronik.com](http://rutronik.com)



## Availability powers next-gen designs

Digi-Key Electronics is to provide worldwide, 24-hour availability on Navitas Semiconductor products, accelerating market penetration of the company's GaNFast power ICs.

Designed to combine MHz-frequency and efficient operation, GaNFast power ICs support smaller, faster, lighter, and lower cost power conversion in mobile fast chargers and adapters, internet of things, TVs, electric and hybrid vehicles, LED lighting and new energy solutions.

Vice president of sales and marketing for Navitas, Stephen Oliver, said: "GaNFast ICs are the ideal, easy-to-use, robust, 'digital-in, power-out' solution and now, with Digi-Key's best-in-class service, this technology is readily available to every power electronics designer around the world."

[www.digikey.com](http://www.digikey.com)

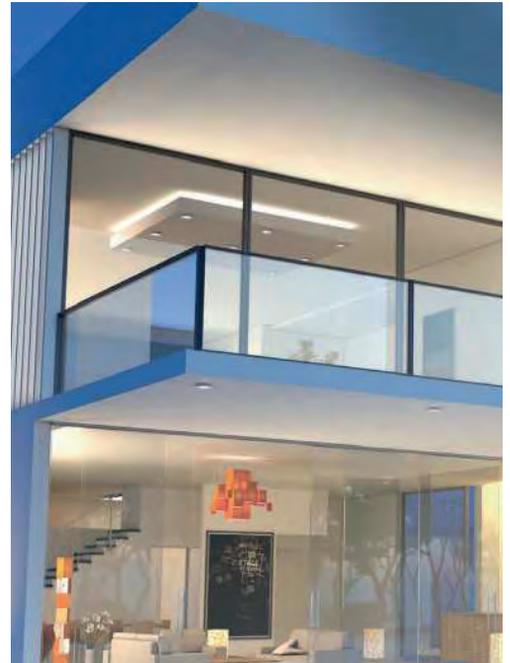
## Fast delivery of IoT voice recognition

Premier Farnell is now shipping the Matrix Voice, a platform solution designed to simplify the creation of internet of things applications based on sound driven behaviours. Developed by Matrix Labs to lower the barriers to entry in his area, Matrix Voice is available in Europe from Farnell element14.

Powered by a Raspberry Pi computer, or used as a standalone device with the ESP32, the Matrix Voice specifically targets the development of voice recognition and detection projects, allowing users to utilise existing platforms such as Google Assistant or Amazon Alexa. Users can integrate custom voice and hardware-accelerated machine learning into their applications easily. Beamforming, noise cancellation, far-field speech recognition, and de-reverberation capabilities ensure high quality performance.

Global head of emerging businesses for Premier Farnell and Farnell element14, Hari Kalyanaraman, said: "Platforms such as the Matrix Voice give makers and entrepreneurs a real head start, enabling them to shrink their product development cycle and accelerate time to market."

[www.element14.com](http://www.element14.com)



## Get ready to explore the connected home

Mouser Electronics has launched a new eBook in collaboration with Molex entitled *Welcoming the Connected Home*. In the eBook, experts from Molex and Mouser examine future trends in home automation and strategies for designing internet of things enabled devices, as well as specific smart home solutions from Molex.

With the adoption of connected home technologies, the global smart home market is expected to be valued at more than \$50 billion by 2022. From connected appliances to security systems and home assistants, the smart home allows residents to interact with and program living spaces to react to their needs.

The new eBook explores both current strategies and future possibilities with articles on how to connect devices to the IoT, an exploration of intelligent integration, and Molex products designed to serve specific smart home applications. Products detailed include antennas and wire-to-wire connectors that support home automation applications.

[www.mouser.com](http://www.mouser.com)

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# Hunt for equivalents is over

*Customers value long term availability information above details of equivalent components, according to chief executive officer of Anglia Components, Steve Rawlins*

The saying, 'comparisons are odious,' can now be extended to the component comparisons that were popular a few years ago. It seems customers have moved on. If an ST or AD device is specified on the bill of materials, an ST or AD device is what they want; nothing else will be acceptable. Commodity components, like chip passives, are regarded as generic, but customers are manufacturer specific for silicon. Five years ago, they may have accepted an equivalent replacement if their first choice wasn't available, but now comparisons are only used to benchmark pricing. Distributors therefore have a key role in helping customers specify the BoM so that the need for equivalents arises infrequently, if ever.

## Getting the BoM right

Mostly, time spent finding equivalents is a consequence of the original specified device being made obsolete. As a distributor, Anglia's job is to help customers avoid this outcome by making the correct long term choices.

To make their decision, customers need to know which devices are likely to be available for the lifetime of the design. For example, purchasers may be able to obtain small pack quantities of devices that are already discontinued, which is great for service engineers, but dangerous for designers. Switched on distributors like Anglia provide detailed availability information online, alongside technical specifications. In addition to product change notifications or product termination notifications, this includes live current stock levels, stock

due, expected arrival date, and supplier lead times.

Having reviewed this information, customers need quick and easy access to samples of all the alternatives they are considering. With short design cycles, waiting a week or two for a sample or a dev kit to arrive can significantly extend time to market. Services like Anglia's Ezysample provide free samples on a same day shipment basis.

## Avoiding obsolescence

The decline in component comparisons also reflects the growing diversity of solutions available from semiconductor manufacturers.

In a highly competitive market, semiconductor manufacturers differentiate their solutions by adding functions and enhancing performance to address specific perceived market opportunities. This means that fewer devices from rival manufacturers really are fully equivalent, increasing the risks associated with selecting an alternative to the original device. Even if a device is electrically equivalent, and a match in terms of form, fit and function, there may still be a variation in the detail of the specification that makes a difference.

As a result, customers increasingly recognise that device selection is fully a design decision and purchasing isn't qualified to second-guess their choices. Any 'equivalent' should be assessed by the original design team to ensure that it really is acceptable in the context of the design.

If designers ensure that

the parts on the BoM are actually available on the open market, purchasing can focus on obtaining the specified devices from competitive suppliers that they deem reliable. They will consider reliability of supply, long term competitiveness and flexibility as well as support with inventory management. Relationships are key here as dialogue can make an

immense difference when lead times lengthen and allocation bites.

Anglia has historically invested a lot of effort in identifying equivalents to popular parts, but customers now make little use of this type of information. What they really value is solid, reliable forward availability information — allowing them to make the right long-term choices around which to build their design.

[anglia.com](http://anglia.com)



CEO of Anglia, Steve Rawlins



Anglia offers comprehensive availability information on its website



**The decline in component comparisons reflects the growing diversity of solutions available from semiconductor manufacturers**

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# Buyers look to niche distributors for products and technical expertise

*In-depth product knowledge, ease of doing business and flexibility are some reasons why buyers choose to do business with niche connector distributors*



James Carbone

It's no secret that many electronics purchasers at OEMs and electronics manufacturing services providers, often purchase from large broad line distributors because they provide a virtual one-stop shop for many semiconductors, passives, electromechanical devices and connectors.

Often, large, broadline distributors provide the value-added and supply chain services that can cut costs for an OEM or electronics contract manufacturer. However, with certain products, many buyers choose to use smaller niche distributors that may carry a limited number of products from a select group of component manufacturers.

Such niche distributors often have a deep knowledge of the products they carry and can offer buyers and engineers advice on which components are the best fit for an application.

One niche product area that some distributors focus on is connectors. About a dozen of the top 50 North American-based distributors derive more than 50 per cent of their revenue from connectors. Some specialist connector distributors serve specific industries such as defense, aerospace and industrial. Some focus on specific products such as circular connectors.

One connector specialist is SMD Inc., based in Irvine, Calif. "About 90 per cent of our business involves some type of interconnect product," said Rich

Unruh, president. "We used to be a passives distributor, but around 2005, we started to focus on the interconnect side of the business," he said.

SMD has posted strong revenue growth in recent years. "We moved into the top 25 distributors list last year. A lot of that is driven by growth in the interconnect market," said Unruh.

He said much of its business is with the automotive industry. It has an exclusive contract to carry Yazaki connectors in North America and many of the manufacturer's connectors are used in automotive applications. Automotive is about 30 per cent of SMD's total business. "We did \$45 million last year, so it's a significant part of our business," said Unruh. SMD also serves industrial, medical and instrumentation OEMs.

"We have all kinds of customers including companies that build elevators, air-conditioning units, sprinkler systems and other equipment," he said.

#### Focus on North America

About 93 per cent of SMD's business is in North America and the rest is international. "We focus on the customer base that is building in North America," said Unruh.

SMD's business is split about 50-50 between OEMs and EMS providers, he said. Many of SMD's customers are small to midsize contract manufacturers. "I don't call on Flextronics, Jabil or



Rich Unruh, president of connector distributor SMD Inc.

**"About 90 per cent of our business involves some type of interconnect product"**

Sanmina or those other big guys," said Unruh. "I do some business with them, but not a lot. However, there are sub-\$100 million EMS providers that we are engaged with," he said.

He said smaller EMS providers and OEMs "appreciate a smaller distributor who is flexible and pays more attention to them than the big four or the big five distributors." "A lot of smaller companies just don't get the support from the larger guys that they require, certainly from a flexibility standpoint," said Unruh.

He said SMD has developed a loyal customer base over the years. "Some of our top customers we've been doing business with for 10 to 15 years or even longer on an ongoing basis," Unruh said.

#### Value added expected

Being a specialised connector distributor often means it's necessary to provide value-added services to customers. "The value-added service that we provide to our customers is the fact that the connector is actually custom assembled to their specification," said Wayne Nelson, general manager at Benchmark Connector, based in Sunrise, Fla.

He said about 90 per cent of Benchmark's business is circular connectors. "The connectors are available in either male or female and have five or six different shell styles. There're also three or four different finishes so there's a lot of combination. That's the value-added part."



"We also have D-sub connectors that we carry and other rectangular shaped connectors," said Nelson.

He said most of the connectors that Benchmark sells are military grade. "They are light and have a specification calling out the parameters and electrical characteristics. In some cases, customers want to modify connectors in some way, said Nelson.

Benchmark is a value-added distributor for Aero Electric Connector, J-Tech, Spacecraft Components, Elecsys and a stocking distributor for ADI, Detoronics, SI-Connects, Cristek and Preci-DIP.

Most of Benchmark's business is with the defense and aerospace companies, said Nelson. It also supplies connectors to companies that build equipment used in harsh environments such as oil rigs and motor sports.

Benchmark has developed long-term relationships with its customers because it provides a high level of service and technical expertise, according to Nelson.

"We've been doing business with some of our customers for 10 to 15 years or even longer" he said.

Some niche connector distributors say the key to their success is providing value to customers as well as suppliers. "We are driven by customers to

provide the best offering in the unique space that we occupy," said John Hufnagle, vice president of North American sales and engineered solutions for PEI-Genesis, based in Philadelphia. Most of PEI-Genesis' sales are for connectors.

#### Bring value with connectors

"We don't strive to be all things to all people. We focus on where we can bring value," said Hufnagle. "We have a very focused offering of connectors." That focus differentiates PEI-Genesis from larger broadline distributors.

"A broad line distributor carries an array of products ranging from capacitors, resistors, to semiconductors to connectors, but the only thing we primarily carry is connectors," he said. "We view ourselves a very powerful extension of the manufacturers we represent because we are specialised distributor."

PEI-Genesis carries connectors used in mil-aero systems and in other harsh environment applications. It carries connectors made by Deutsch, ITT Cannon, Conesys and Amphenol among others.

PEI-Genesis assembles connectors for customers and offers value-added services such as kitting and cable assembly. "Value-added services can be anything from technical support to special packaging," said Hufnagle. "Internal application engineering would be a value-



Wayne Nelson, general manager of Benchmark Connector.

**"We've been doing business with some of our customers for 10 to 15 years or even longer"**

added service. Having resources specific to answer customers' technical questions is a value-added service," he said.

In fact, many OEM customers rely on distributors for technical expertise during design. Bernard Gizzi, president of Electronic Connector Company (ECCO), based in Chicago said ECCO often is involved in the design of customers' products.

Much of ECCO's business involves building circular connectors for OEM customers, said Gizzi. ECCO builds connectors for Aero Electric/Conesys, Amphenol, ITT Cannon and Cinch.

Over the years ECCO has developed a deep understanding of many of its customers' products. If a customer has a problem when designing a product, ECCO can offer solutions. For instance, if a customer has a problem terminating a wire because of space limitations, "we can suggest a different insert pattern, for better manufacturing/assembly," said Gizzi.

#### The specialist advantage

Gizzi said there are advantages for customers to do business with a smaller specialist connector distributor such as ECCO. "Big distributors do a great job of being a supply chain partner," he said. But they can be weaker

"because they are too stretched." They carry many types of products and have tens of thousands of customers.

ECCO and other niche distributors, have fewer product lines and have an in-depth knowledge of the products that they carry.

ECCO is certified by manufacturers and the government to assemble connectors and services OEMs in the military, aerospace, transportation and industrial segments. "Industrial is the number one segment," said Gizzi. It includes companies that are making some type of industrial machine, construction equipment, a robot, things that are industrial in nature," he said. The second largest segment for ECCO is defense and aerospace, followed by medical and energy, he said.

"I have about 800 unique customers that I do business with in a given year," said Gizzi. "It's not like I have a limited number of customers that generate all of the revenue. It's a pretty broad base."

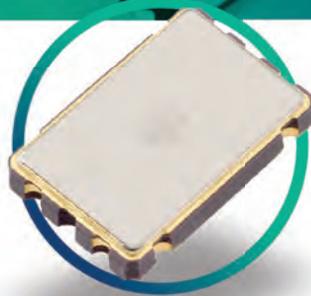


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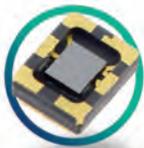
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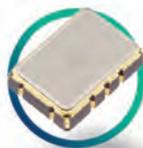
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## Frequency

# The future is smaller and faster

*Widespread demand for wireless technology calls for smaller frequency components and more exacting product specifications. We asked Golledge Electronics how these demands are affecting the industry*

### Q What trends have influenced frequency components over recent years?

In the last ten years, the frequency control market has developed significantly. Greater demand for wireless technology has been notable in diverse industries including freight and animal tracking, drone development and wearables, as well as the more traditional sectors of automotive and audio.

These wireless technologies have driven three major trends: increased miniaturisation, decreased component price, and increasing product specifications. For instance, in 2008 a typical temperature compensated crystal oscillator request may have been for a 7.0 by 5.0mm component with stability of  $\pm 2.5$ ppm; these days it's more likely to be a 2.5 by 2.0mm component with stability of  $\pm 0.5$ ppm. Burgeoning systems on chip solutions have also caused significant increases in demand for crystals and away from oscillators.

### Q Passives lead times remain stretched, what is the status of frequency devices?

Timely and accurate information is key when it comes to managing lead times. Standard lead times in the frequency industry can be up to 16 weeks, especially where new frequency development, or products with custom specifications, are required.

As a global supply chain partner, Golledge spends time gathering as much information about customer requirements

as possible. This will include estimated annual usage, forecasts into the lifetime of the project and any shipments which are critical for a project. This helps optimize our manufacturing, stocking and delivery profiles, in many cases allowing us to reduce lead times to seven weeks or under, even for custom product.

Finally, we try to hold as much stock as possible of standard frequencies and offer buffer stocking of any specialist items for same day shipment to ensure clients can manage just in time or to ease any unexpected changes in manufacturing timescales. Our European stocking hub offers next day delivery to key countries in Europe and most countries worldwide within two to three days.

### Q What trends are driving innovation in this sector?

Because of the market trend towards on-chip oscillators, crystal technology will continue to offer much lower price and current consumption than substitute technologies, so we expect to see inexorable demand for continued miniaturisation and reduced crystal component height.

In addition, with increased demands on frequency spectrum technology, we also expect to see extreme signal precision become more prevalent. In particular, the demand for SAW duplexers with their space-saving single package Rx/Tx filtering is likely to increase as ever more technologies are designed into a single device.



**Timely and accurate information is key when it comes to managing lead times**

**Q** If purchasers are looking to improve their buying processes, what would your tips be?

The most important thing purchasers can do is talk to their suppliers. In the frequency control industry suppliers may need a greater degree of involvement with design engineers. Understanding the underlying needs of the circuit and other project constraints helps us advise on what samples are appropriate for proof of concept and prototyping, or the most robust technical and commercially viable solution for a project's longer-term needs.

Finally, Brexit is obviously on a lot of purchasers' minds right now, particularly regarding deliveries throughout the next quarter. Purchasers should talk to their supplier, assess the robustness of their logistics and agree contingency stocking and scheduling arrangements.

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# Suppliers keep pace with frequency evolution

*Electronics Sourcing asked sales and marketing director at Euroquartz, Andy Treble, how the frequency components market has changed and how it will evolve in the future*

**Q** How have frequency components changed over the last decade?

The obvious answer is that things have got smaller, but there has also been steady development in lowering the current consumption of oscillators, reducing operating voltages and improving phase noise and jitter characteristics. Low power, battery-operated systems, and the push for reduced power consumption, has been the main driving force.

In addition, oscillators have become more sophisticated in their output format, especially at the higher frequency end of the spectrum with the development of LVPECL/LVDS and the latest HCSL output waveforms.

**Q** What are lead times like in this sector?

Lead times are currently stable and have been for some time however, certain specific product types may come under pressure if there is a sudden spike in demand from the mobile phone sector for instance.

**Q** How will frequency products evolve and develop in the future?

There is no doubt that higher frequencies and more in-built features are likely to be developed for future applications. For instance, there may be a focus on oscillators with higher drive capabilities to allow for frequency distribution around circuits. Products exhibiting low phase noise and jitter are also in demand for many data processing applications

and oscillator designers are constantly improving these characteristics.

**Q** Have you witnessed many counterfeit frequency components entering the supply chain and how can they be identified?

In recent years counterfeit product has become a real issue, especially for the semiconductor industry. Legacy or obsolete parts bought on the grey market are particularly exposed to exploitation by counterfeiters.

The risks are extensive as counterfeit components come in many forms. For example, counterfeits can be defined as any item that is purposely misrepresented as genuine with the intention to deceive. It could refer to a product that has been reclaimed and



**The best advice would be to ensure that the quality and reliability of the product supply are assured and that there is a clearly defined traceability route**

These miniature crystal oscillators respond to demand for ultra-low current products

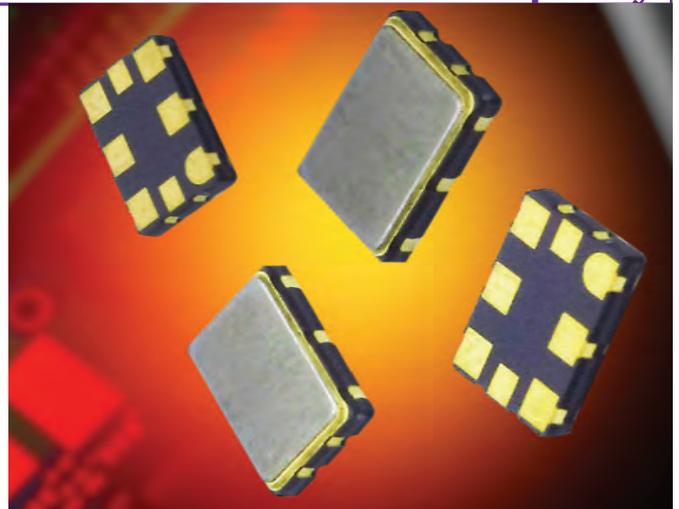


purports to be new, an illegal or unauthorised copy of an original part, or a part that claims to have undergone full military screening but which has not. Parts whose appearance has been altered or disguised in order to mislead are also counterfeits.

In the crystal and oscillator sector, we have not seen too much evidence of this, but we have to maintain constant vigilance to ensure that it does not become a problem in the future. Procedures are therefore in place to ensure that such products do not get into the supply chain.

based manufacturer and supplier, have opted to invest in internal production capacity. This will help produce more homegrown product to combat any supply issues and ensure the company is ready for any new opportunities that arise in the future.

[www.euroquartz.co.uk](http://www.euroquartz.co.uk)



**Q** What advice would you give to purchasing professionals sourcing frequency components?

The best advice would be to ensure that the quality and reliability of the product supply are assured and that there is a clearly defined traceability route. It is important to ensure that products are supplied from the same factory every time to ensure consistent performance in the circuit. And if problems do arise, it is important to have confidence that the supplier will resolve the issue quickly and efficiently and that suitable corrective measures are put in place.

**Q** What strategy has Euroquartz developed as a result of Brexit?

The turmoil surrounding Brexit and the potential for change in US legislation under the current US president have created an environment of uncertainty.

Policies to offset the negative impacts of Brexit depend largely on the size of your company and the product being supplied. Some companies have established European hubs in countries like the Netherlands to counteract any shipment delays or potential tariff increases. This is an added cost burden however and, as there is no clear picture as to what the eventual outcome will be, a considerable risk.

Instead, companies like Euroquartz, an independent UK-



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# Technology exchange helps insure supply continuity



John Denslinger's 40-year electronics career ranges from time with passives specialist Murata Electronics, to managing manufacturing plants in Mexico. John is a trained industrial engineer

In this article, John Denslinger explores the practical steps customers, manufacturers and distributors can take to underpin supply continuity

Supply Continuity • By John Denslinger

**I**n times of component shortages, I'm always amazed at the number of customers with substantial, metric-based supply chain engagements scrambling to secure sub-one cent passive components just to keep production lines running.

Pressure? After all, schedules are schedules and the next quarterly report is due tomorrow. Likewise, for factory and quality assurance management, it must be quite disheartening to see workers hand placing shortage components on boards already processed through highly automated lines. As if procurement anxiety wasn't enough, there is that unaccounted productivity loss across the entire company, as well as, that distasteful factory-floor negative variance all left in the wake of short supply.

It's nothing new. Supply and demand imbalances exist all the time: some severe, some aberrational. Yet it occurs to me to ask one simple question: 'does anyone take time to conduct a serious forensic analysis after a severe supply shortage?' Surely, there must be countermeasures to the problems encountered, but where does one start?

For those tasked with sourcing components, ask yourself: how robust is my supplier engagement and is it delivering to my expectations given the speed at which technology advances today? At an early age one learns evolution is the survival of the fittest. By experience, one also learns technology innovates the continual advancement of fit, form and function. All too often the evidence suggests customers rely too heavily on evolution while the manufacturer operates largely in the technology spectrum. Can the two objectives be more effectively linked for win-win?

Frequent communications between customer and supplier is good but not enough. Sharing performance metrics is vital but again not a solution by itself. Best to establish and maintain multi-level engagements that build trusted relationships, mutual respect for company cultures, commitment and long-term loyalty. These are some of the keys that position you, as the customer, for an uninterrupted supply stream. Keep in mind, these partnerships are often triangular: customer, manufacturer and distributor. Each plays a vital role and each has an expectation to be met. Without a doubt, it will take time, money and resources over a long run. Think of the investment as insurance, knowing that insurance is always beneficial hedging that downside you hope never happens.

As the buyer of components, what should you expect from your partners? Price and delivery are obvious replies but do approach it more strategically than that. Like a job interview, get to know your supplier in depth. First, ask for capacity plans and allocation policies on components that make up the greatest unit volume on the BOM. Ordinarily, 'the spend' is not that high but a disruption in supply quantity could be crippling. Second, inquire about technology and product roadmaps. Understand where the manufacturer is heading and determine whether your design and engineering direction is synced. If not, consider hosting technology exchanges well in advance of EOL or new board layouts. Next, review the manufacturer's cost reduction plan. It's understood, procurement groups are often measured on PPV. Manufacturers are very open to sharing planned cost savings. And lastly, understand both the manufacturer's and their distributor's inventory policy. Pipelining supply is not that difficult with reasonably accurate forecasts.

Avoid the next shortage. A little insurance goes a long way to insuring your supply continuity.



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# Committed to offering choice

*Specialist supplier, RJS Electronics, is determined to offer choice when it comes to switches, from illuminated pushbuttons to programmable LCD options*

With a product line up that includes illuminated pushbutton switches, LCD graphic and text displays, programmable LCD switches, relays, connectors and custom cable assemblies, RJS Electronics provides a variety of human machine interface options.

Keen to showcase its full range of solutions, the company recently exhibited at the *Southern Manufacturing and Electronics Exhibition* in Farnborough. There purchasers were able to see the products at work, rather than online or in a catalogue, enabling them to determine the quality and

the feel of the products for themselves.

Of particular note on the RJS stand was the company's latest addition to its range, the Q5. This RGB LED backlit programmable LCD switch boasts a 64 by 32-pixel graphic display, with a large viewing area of 17.26 by 12.78mm<sup>2</sup>.

The switch interface uses the standard industrial protocol, with each pixel individually addressable by the user. For maximum choice, it has the potential to display 65,536 backlight colours, thanks to the programming supplied with the product.

With a lifetime of at least three million operations, the Q5 is designed to provide a quality switch, as well as excellent display properties, making it a highlight of the RJS stand, where visitors could see the clarity of the colours displayed.

[www.rjselectronics.com](http://www.rjselectronics.com)



## CEM

# Collaboration key to designing out cost

*Contract electronics manufacturer, Fermionx, aims to add value by designing out cost and investing in the latest efficiency driven technology. We asked how this is achieved.*

**Q** Can Fermionx provide performance figures to help buyers tasked with selecting a new CEM provider?

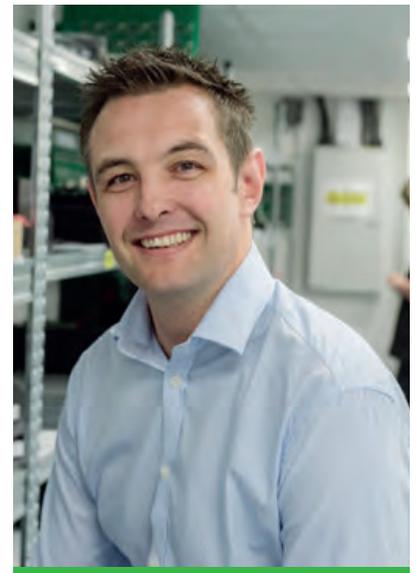
Fermionx publishes a factory performance report on key quality metrics. The vast majority of our work is PCB assemblies, surface mount and conventional assembly, so we include metrics on delivery and accuracy as they help buyers when reviewing

against their current providers. We also include background info, such as machine downtime, all of which is available from our website.

**Q** Does Fermionx have a specialist area of expertise?

Most CEMs have a core business focus, often as a result of the management team's expertise. Because we manufacture our own

brand products across diverse industries, we haven't focused on specific areas, but on where we can add value to our customers' manufacturing requirements. Specialising in small to medium volumes, investing in surface mount technology and automated optical inspection equipment gives us speed and flexibility to ensure we are responsive. We support clients in industries such as oil and gas, medical, detection and monitoring, automotive,



Dan Crother, Managing Director of Fermionx

marine, aerospace, lighting and audio.

### Q What does 'design for manufacture' really involve?

Design for manufacture describes the principle of designing a product in such a way that makes it easier to manufacture. It focuses on evaluating and identifying potential issues in manufacture and addressing these during the design process, thereby avoiding the risk of changes to tools, components or suppliers during the manufacturing stage. For instance, imagine the look of dismay if the design team signed off a design, but the production team said they can't make it for the sell price because the material specified cannot be sourced as required. Design for manufacture is key to avoiding these types of costly issues.

### Q How is manufacturing software evolving?

The continued growth of Industry 4.0 and the internet of things is resulting in the convergence of manufacturing processes and software. Fermionx uses a bespoke e-maCs manufacturing system that provides inventory and cost controls. Material procurement presents the largest proportion of product spend and is crucial to getting it right for our

customers, as well as our own brand products. We are always looking at ways to drive efficiencies through our processes and software solutions, from 3D printing in prototype development to quality checking via sensor technology.

### Q What should buyers look for in a new CEM provider?

Whether you are looking for a designer or sourcing a PCB, developing and maintaining a strong relationship with your CEM is key. A good relationship saves time and money in the long run, boosting your bottom line and giving you the opportunity to focus on growing your business. It is important to have a clear understanding of how issues are to be resolved, so having discussions at the outset can be crucial to avoid difficult situations further down the track. Fermionx always works to 'hand back solutions, not problems,' so we put our customers interests at the heart of everything we do.

### Q What percentage of clients work with your design team?

We have worked with design engineers for many years at Fermionx, and we started offering design as an in-house contracted service in 2018. Having worked with customers' design teams and on our own brands, we have a good understanding of

what customers need. As we develop our processes, the response from customers to date has been positive. One of the key advantages is that we have a well-established manufacturing team that helps us deliver design for manufacture. Current projects range from printed circuit board assembly to full product design, as well as a refresh of a legacy ATEX product and design reviews for own brand and customer products.

### Q How do you see CEM services developing over the next few years?

CEM services have been constantly evolving in recent years due to technology developments, global market shifts and political events. One of the most pressing challenges is component supply. Balancing the need to support customer productivity with the challenge of maintaining stock controls and stock holding is key. More than ever, component availability challenges have driven increased supply chain integration and communication between CEM and customer to ensure long term success. We have seen a lot in the last 40 years and are ready to face the next 40 with a focused team and an appetite for knowledge, progress and growth.

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# It's never too early to tackle obsolescence

*Electronics design and manufacturing specialist, Corintech, explains how selecting the right subcontractor can help engineer out obsolescence before it arises*

In the fast-paced world of electronics engineering, issues of component obsolescence can affect relatively recent designs, let alone those with a long-term lifespan.

Ideally, the availability of every component will be considered by the engineering team responsible for the design process. When unexpected market trends mean a component becomes obsolete, however, a subcontractor's procurement experts should flag up any accessibility issues discovered when costing the bill of materials. Bearing this in mind, it can be beneficial to select a project partner with extensive capabilities in electronics design, procurement and manufacture. Combined input from these disciplines will optimise the solution.

## Suggesting alternatives

When obsolescence occurs, there are two options available. The first is to research alternative drop-in replacements for the obsolete component. Here, a wide sourcing network is extremely valuable as it provides a

range of possible alternatives. Using these alternatives, your subcontractor should be able to quickly manufacture product samples for verification and sign-off.

If alternative components are not available, the engineering design team may wish to complete a technical review of the circuit and PCB design to propose the smallest design changes necessary to accommodate a different component with proven ability.

When considering alternative or redesigned components, it is important to remember that complex, costly and time-consuming approvals may be invalidated by design changes and testing may need to be repeated. On-site pre and full-compliance testing facilities can be advantageous here as this will accelerate the process and reduce delays.

## Planning ahead

While obsolescence issues can slow a product's development, it can be beneficial in the long run. If handled correctly, switching to alternatives can

reduce costs in sourcing, improve performance, and shorten lead times in the future. Because of this, a good procurement team will always plan ahead by performing design for manufacturing analysis and suggest alternative routes if a component seems likely to become obsolete in the future.

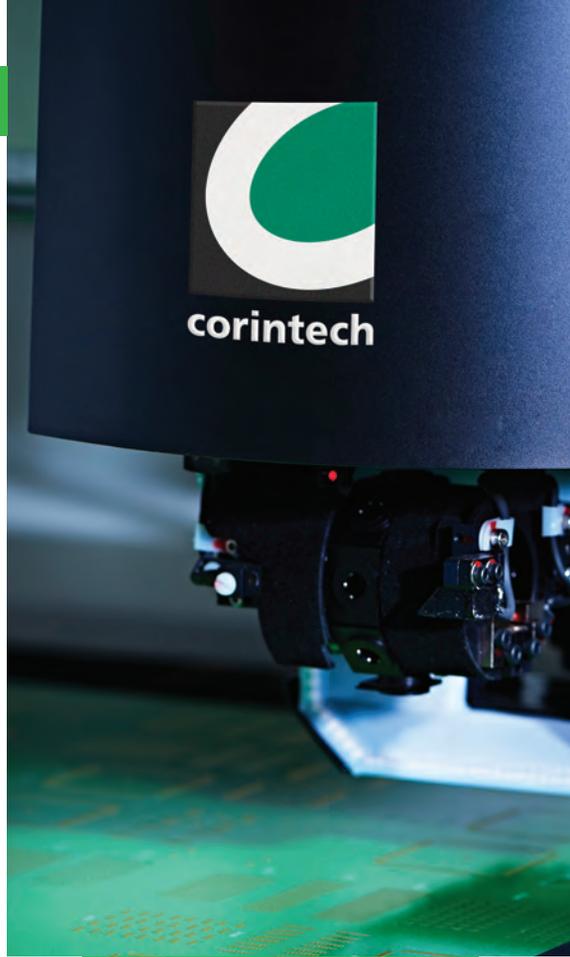
Corintech boasts global purchasing networks across Europe, the Far East and the USA, providing a range of supply options. The company maintains close, long-term relationships with suppliers and as such, can access letters of intent regarding a component's projected life. It can also negotiate last time buy holding of obsolete stock for up to two years, to allow more time for alternative developments.

Furthermore, having the design, product engineering, procurement, manufacturing, and quality control teams on one site allows Corintech to raise concerns and offer solutions faster. On-site compliance testing and fast-turnaround UK manufacturing facilities also

A good procurement team will always plan ahead by performing design for manufacturing analysis

mean it can prototype and re-test adapted or alternative designs before scaling up to full volume production to make any changes as smooth as possible.

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# Delivering on efficiency

*As the industry looks for ever greater efficiencies from its manufacturing partners, Ultra Electronics explains how CEM purchasing expertise can make a difference*

**Q** When clients first contact Ultra, what role does the purchasing team play?

All new bids are subject to multi-disciplinary review to ensure that a fully supported offer can be made to the customer. Purchasing is key to this; the team ensures that our existing supply chain can support the customer's material and component requirements or works to identify, audit and on-board suppliers to meet specialist needs where necessary.

**Q** What input does the buying team have on component selection?

As a contract manufacturer, Ultra Electronics helps realise the designs of a diverse customer base. In many

instances these designs are mature and subject to regulatory approval or oversight. In such circumstances, purchasing will help identify possible alternatives that could potentially improve cost or performance.

**Q** When end of life or obsolescence situations arise, how is the client notified?

Ultra Electronics offers obsolescence management as part of our value proposition, ensuring we offer customers a rigorous solution to mitigate any risk. We do this by using tools to identify obsolescence and EOL risks. We then work with our trusted supply base to help identify suitable replacements or establish costs for a lifetime buy.

**Q** When putting together a quotation for a new client, how is this calculated?

Quotations are based on a mix of material costs, component placement, labour effort, test and ancillary processing. All business functions across Ultra contribute to the process, which ensures we submit a robust and fully approved quotation to clients, and that the price quoted is the price paid.

**Q** Is Ultra's buying team experiencing extended lead times and what effect does this have on the production line?

As for all organisations in the industry, recent extension in lead times have been difficult to manage. However, Ultra's

Ultra's production flexibility and detailed planning ensures that deliveries are not compromised by extended lead times



**We work with our trusted supply base to help identify suitable replacements or establish costs for a lifetime buy**

production flexibility and the detailed planning undertaken between sourcing and operations has ensured that deliveries have not been compromised. To complement this, we also provide forward thinking procedures such as alternative component sourcing and verification, advanced procurement utilising agreed buffer stocks, and rigorous and collaborative supplier management.

**Q Over the last 24 months, has Ultra increased or decreased its preferred supplier list?**

Ultra has maintained its approved supplier list at a fairly static level. Our experience shows us that, as market conditions change, we need to maintain flexibility within our supply chain. Many of our suppliers are local and some have been supplying this site for over 40 years.

**Q How has the purchasing team's role changed in recent years?**

Purchasing is playing an increasingly important role within Ultra as the industry looks for ever greater efficiencies and savings. We're placing greater focus on managing the overall performance of suppliers to ensure production is adequately supported, although price remains a key factor. That's because Ultra understands that strong and

financially stable suppliers play a key role in helping us deliver value to our customers.

**Q How do component manufacturers and distributors support the Ultra buying team?**

Most manufacturers and distributors provide fantastic support to the industry and although, like most, we have had some bad experiences, it is how we respond to those that is important. The continued development of technology designed to provide clarity on pricing and component availability is a great help, especially in the current market conditions.

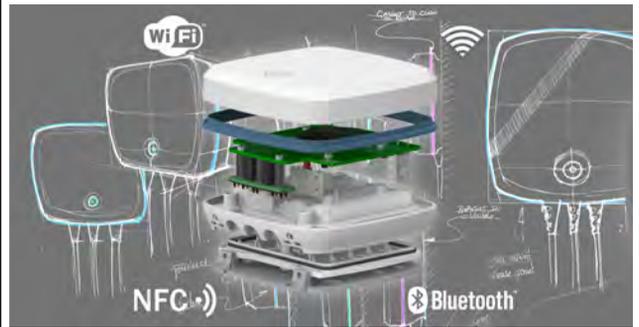
In the longer term, further development in areas such as the internet of things, automotive and communications in general, will only increase the demand for smaller, faster components. This will continue to affect older component types such as 1206, 0805 and 0603, leading to increased lead times and reduced availability. The current shortages in supply have naturally driven some costs up, however, there is still value to be had, and those suppliers that have applied more modest price increases will certainly see a longer term benefit.

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# Designing in supply chain skills

*Supply chain design and engineering expertise are essential to ensuring continuity of component supply. ES asked Sanmina's vice president, customer supply chain management, Tom Pendergrass, how outsourcing provides a solution*

## Q What role does Sanmina's purchasing team play in assisting new clients?

Supply chain design is one of the most important services we offer. In some cases, this means developing a complete supply chain for a product, while in other scenarios, it means redesigning the supply chain to increase flexibility or eliminate risk. We find that even large companies sometimes don't have the right portfolio of global suppliers to launch a product in new global markets, or have different components or subassemblies in a new product than their traditional products.

Medical, automotive, aerospace and some industrial products have an operational life of more than ten years. In these industries, continuity of component supply is critical. Unfortunately, some components originally designed into a system may be discontinued before the system reaches end of life. Customers with legacy products may therefore want the bill of materials analysed to identify obsolescence risks. Sanmina's component engineers identify parts that are already obsolete, or at risk of going obsolete, as well as single source components that expose a supply chain to risk in the case of unforeseen events. The team makes recommendations to add alternative components to the approved manufacturer list or to re-design for compatibility with alternate parts.

Some customers require more supply chain flexibility. For example, a customer may

ask Sanmina to re-design the supply chain to accommodate demand fluctuations of  $\pm 25$  per cent within a certain period of time. In these cases, the supply chain team will analyse the lead-time profile of all components, adding time for freight and manufacturing. Components that do not support the flexibility requirements are identified, then we work with suppliers to reduce lead times and develop agility programs to make additional components available in shorter timeframes.

In some cases, customers have developed an innovative product, but need access to a global supply base of components. In these situations, Sanmina provides complete supply chain design. Our preferred supplier list provides a global supply chain of qualified and audited suppliers that demonstrate technology leadership, flexibility, quality, delivery and cost performance.

## Q What input does the buying team have on component selections and support?

We work with customers during product design and throughout a product's life. Sanmina's component engineering team provides a link between design engineering and supply chain design. Where possible, they help customers select manufacturers from Sanmina's preferred supplier list. These suppliers offer better performance in terms of quality, technology, on-time delivery and price and are also able to design more flexible supply chains.

Our component engineers combine their knowledge of the product design and its planned operational service life with manufacturers' technology road maps to propose appropriate suppliers and components. They analyse the product specifications and work to understand the design intent.

The expected life of the product has a big impact on component selection. Components designed for consumer products usually have short lifecycles and may not be appropriate for products with an expected service life of ten years. Typically, when manufacturers specify components for use in industries such as automotive, aerospace or medical, they provide assurance of supply for seven to 10 years or more.

Components that operate in harsh environments also require a higher specification than components used in consumer devices. The medical, aerospace and automotive industries have stringent regulatory requirements and knowledge of these criteria is essential when selecting a component manufacturer. Our component engineers understand regulatory standards in each of these areas.

The location of end markets, total landed cost analysis and the location of manufacturing also have an impact on component supplier selection. Larger bulky components are normally sourced close to the manufacturing plant to make the supply chain more cost effective in terms of freight.



Continuity of supply is critical when building complex systems with as many as 10,000 different components

**Q What happens when end of life or obsolescence situations arise?**

Our automated system manages notification of end of life or obsolescence. The information that suppliers provide when they notify us about component end of life usually includes the final order acceptance date and data about any replacement components.

When we receive the part change notification, our material requirements planning system reports which Sanmina facilities are purchasing that component. This is one of the benefits of having all plants running on the same IT system worldwide. Supplier notifications are sent to any plants using the component and the program management team then works with customers to introduce the alternative component and execute last time buys for the end-of-life part.

This automated tool works well for components that are going obsolete, however, in some cases, manufacturers reduce capacity for older components, without immediately discontinuing supply. We are experiencing this in the multilayer ceramic chip capacitor market at the moment, with some suppliers placing parts on allocation. Here, we

are working to ensure customers do not use these components in new designs. When possible, we encourage them to redesign existing products using alternative components.

**Q Is the Sanmina buying team experiencing extended lead times and what are the knock-on effects?**

Lead times for certain components have extended over the last nine months or so. While lead times are improving now somewhat, we were managing components for several months where the lead times were in excess of one year. At Sanmina, we have 500 surface mount production lines and sometimes place over 25 million components per hour. The real challenge occurs when customers want an upside within a certain component's lead time. Being able to increase component supply in three to four weeks, when the lead time on the component is 26 weeks or more, is really difficult.

From a supply chain perspective, there are three things we do to protect component supply and optimise the chances of achieving upside when required. First, we ensure that our plant purchasing teams are working with the correct component



**Medical, automotive, aerospace and some industrial products have an operational life of more than ten years**



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data. The teams re-confirm lead times with suppliers on a regular basis. Second, we work with customers so that they understand the lead time profile of their product and encourage them to be as accurate as possible with their forecasts. Third, we try to add multiple sources for each component, which maximises the chances of finding component supply in

the case of upsides.

Our component engineers also work with customers' design engineers to select alternative components to replace those with extended lead times. Recently, we worked with a medical customer on a new generation of an existing system. Many of the capacitors used featured

older technology where the manufacturer had reduced capacity and extended lead times beyond 26 weeks.

We found alternative components, significantly reducing overall lead times. In another case, we suggested a smaller case capacitor as an alternative. Although the smaller capacitor required a printed circuit board re-design, the benefit was a reduction in lead time of 50 per cent.

### How has the purchasing team's role changed at Sanmina over the last five years?

We have adapted our services based on changing customer expectations and requirements. When outsourcing began, most OEMs had their own factories and supply chain management teams. Today, there are a significant number of customers that do not have a background in electronic supply chain management because they don't have their own factories and may even have contracted the product development to a design house. In these situations, working with a partner who has a preferred supplier list, an established process for selecting suppliers and a supplier management process is a significant benefit. For these customers, working with Sanmina means they have access to an instant supply base, advanced global supply chain management systems, preferred and qualified suppliers and proven supplier management programs.

[www.sanmina.com](http://www.sanmina.com)

### Has Sanmina increased or decreased its preferred supplier list over the last 24 months?

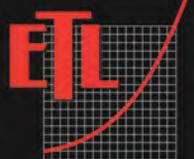
There have been no dramatic changes in the number of our preferred suppliers over the last two years. We have a strategy of selecting preferred suppliers for the long term. They typically provide strategic advantages in terms of performance, quality and cost and are willing to work with Sanmina to increase flexibility. These long term partnerships paid off this year, when we were faced with challenging passive component supply constraints.

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# It pays to purchase wisely

Contract electronics manufacturer, Protronix EMS, offers invaluable advice on component purchasing, enabling smooth supply for continuous production

**Q** How can the Protronix EMS purchasing team help new clients?

It is vital to establish any potential delays in sourcing the bill of materials quickly. The customer may be unaware of supply issues with parts they have designed into their product.

**Q** Does the purchasing team work with the design engineering team early on?

We always suggest open discussion across departments, between ourselves and our customers' technical team. It may be possible to recommend replacement parts that we have in stock, from premium

manufacturers, usually of an improved specification over the original.

**Q** Are extended lead times affecting production?

With surface mount capacity of circa 100,000cph, the supply of components is essential to keep the factory producing. There does now appear to be a slight easing in availability of material, but long lead times should be considered normal in 2019.

**Q** How has the purchasing team's role changed?

Five years ago, when a new BoM landed on the desk, there were usually multiple sources of available stock to

choose from. A just in time process was easy to manage, but the last year or so, this has not been the case. An improved strategy and tighter controls were established to enable production continuity.

**Q** What support do component manufacturers and distributors offer?

We recognise that there simply has not been the product available for manufacturers and distributors to satisfy demand in the past 12 months. This is where our established supplier network and purchasing power has come into its own.

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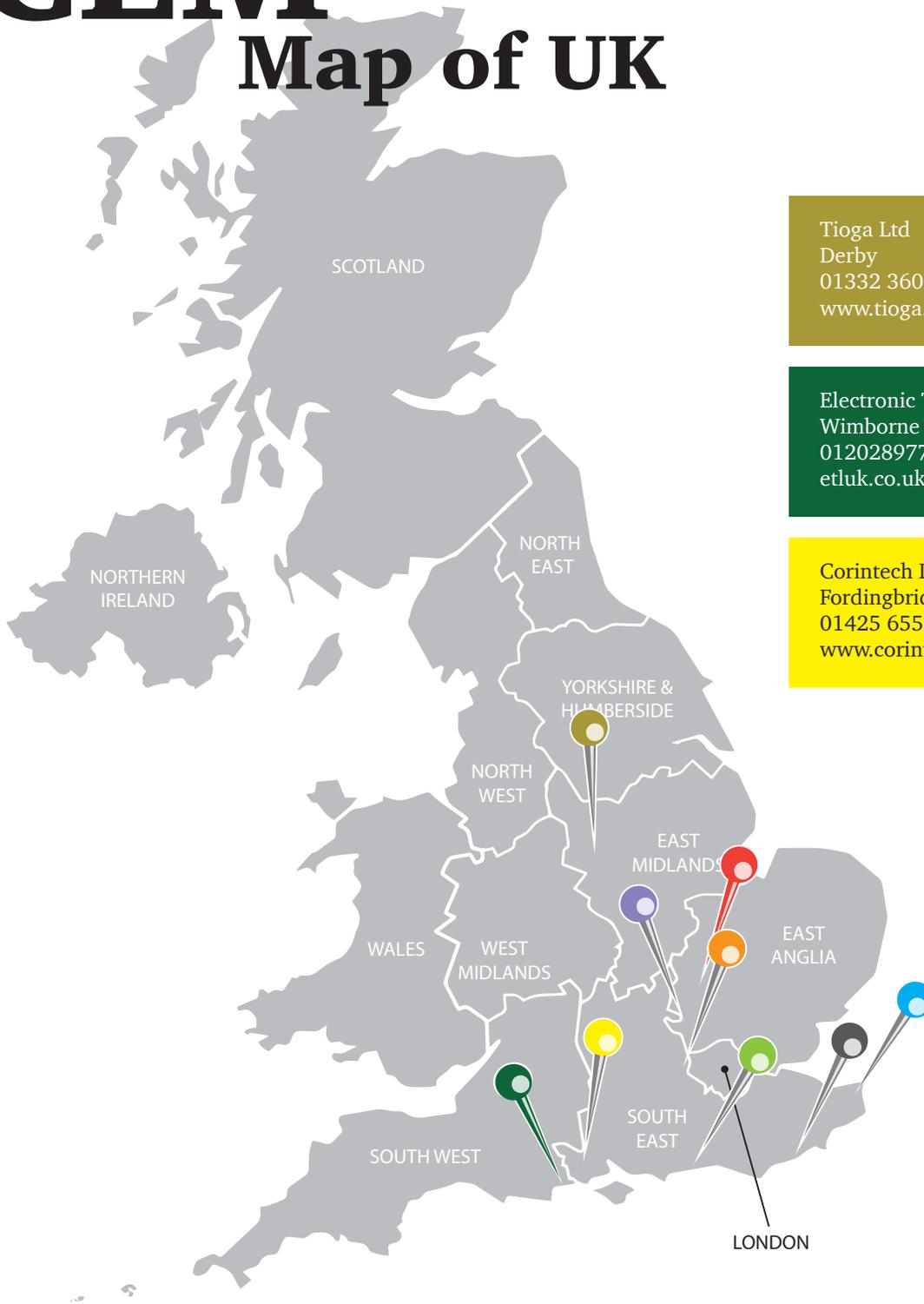
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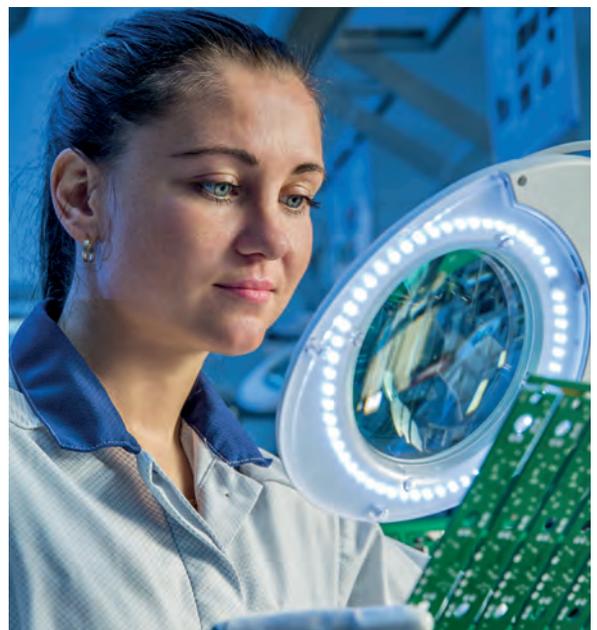
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# Support tailored for UK innovation

Electronics Sourcing asked Rutronik's UK and Ireland managing director, Jezel Hardern, how the company differentiates its offering for the UK and the emerging technologies that flourish here

## Q How does Rutronik serve UK purchasers?

Rutronik is the third-largest distributor in Europe, and

continues to grow. As one of the more recent international distributors to set up operations in the UK, Rutronik has worked to establish areas of expertise

to differentiate itself and offer support to new and emerging technology companies.

We also increased our UK

team, adding a second office, in Swindon, to boost the existing presence in Bolton. Around 60 per cent of the total available distributor market in the UK and Ireland is attributable to the south of England. This additional office helps better serve the country, supporting customers and suppliers in the south.

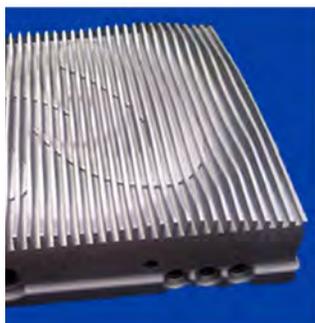
## Q What is Rutronik's core market?

In addition to components, we now offer tailored solutions, logistics concepts and technical support. As with many distributors, internet of things applications have been a major focus over the past year. Rutronik's strategy has been disciplined, however, focussing on where it can deliver differentiated value to design-led customers. This has resulted in a broad sensor portfolio for IoT. Major franchise signings in the UK, such as Molex, have also augmented this in terms of the RF solutions, antennas and connectivity offerings they bring.

Rutronik has been actively working with the start-up community to develop close ties with those building IoT products. By offering support — including workshops — Rutronik aims to assist those start-ups that have previously been unsuccessful in turning credible products into viable businesses. We have recruited technical and commercial staff to help deliver this support.

## Q What stock levels does Rutronik aim to provide?

By planning well in advance, distributors can schedule their supply of critical parts availability for some years ahead. Rutronik has supply, located in Germany, planned up to the end of 2020. As a privately-held company led by the family of the founder, long term relationships are extremely important; this applies to staff, customers and suppliers. True to this ethos, during recent



[www.gelec.co.uk](http://www.gelec.co.uk)



Rutronik managing director UK and Ireland, **Jezeł Hardern**



## Existing product change notices are always visible, along with data sheets, application manuals, and product links

component shortages, Rutronik held significant stocks of many lines in short supply, allowing it to continue shipments and reduce pressures on its customers and suppliers alike.

### Q What obsolescence services does Rutronik offer?

With the aid of intelligent search functions on [www.rutronik24.com](http://www.rutronik24.com), developers can quickly and easily find suggestions for alternative replacement items in the event of discontinued components or long delivery times, including a detailed list of any deviating parameters. Existing product change notices are always visible, along with data sheets, application manuals, and product links.

### Q Are Rutronik's UK franchises the same as mainland Europe?

Franchises have historically been signed from our German headquarters and then rolled out to other geographies, which means that all Rutronik's franchises are represented in the UK. There are, of course, some variations between countries, depending on the industries

present there and the resulting demand for different product types.

### Q What advice would you give purchasers sourcing components?

It undoubtedly pays to keep suppliers advised of any forecasts, or to have some kind of logistics arrangement in place. Rutronik constantly monitors orders to provide quick reactions to changes and escalation teams are in place to help effect whatever alterations are required.

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*Continual investment in new hardware ensures Action Circuits maintains maximum throughput, even when programming the latest technology devices*

In today's complex and ever-changing electronics manufacturing environment, the highest quality standards must be maintained to properly program devices.

As a major provider in the European device programming service industry, Action Circuits boasts many years of experience, ensuring that every part is processed and handled to the highest quality standards.

The process starts with the creation of a first article agreement. This ensures that Action Circuits captures any relevant settings specific to the customer's requirements. Once this is complete, parts are programmed and shipped, typically on the same day.

### Hardware investment

Devices are programmed on a range of hardware using silicon manufacturer approved algorithms. Action Circuits operates the latest technology including fully automated robotic programmers, which enables the company to offer an optimal service, matching customer requirements with the correct hardware.

As part of the programming operation, devices are verified twice. Action then has the option to laser mark a customer's part number, or logo onto each device. Alternatively, it can apply a heat resistant label, or for small components, a coloured paint dot.

Whether customers require programming in prototype quantities, small production volumes or programming for mass production, Action Circuits aims to offer

unrivalled levels of quality and throughput for any type of programmable device available on the market today.

### Supporting device development

When looking for a company to burn software into chips, it may seem a simple process, but it is essential to choose a company with up-to-date algorithms, as well as optimum ESD protection and handling procedures to ensure parts are not damaged during the process.

There are many device types and several associated file formats used to program data into these devices. New formats are always emerging, like the Actel APA devices with the STAPL file format. There are also common formats, such as PIC devices, which range from the PIC16C54 and PIC12C508 through to the PIC12F, PIC16F84, PIC16LF, dsPIC and rfPIC family devices.

TI also has a large range of TMS430 devices that Action Circuits can program in large volume batches, while also retaining support for TIBPAL devices. Furthermore, Action offers full support for the National COP range of microcontrollers, as well as fully supporting Spansion NAND flash and NOR flash.

With technology continually moving forward, there is a constant demand for investment, with new device package styles requiring new socket modules, or multiple socket modules for volume programming.

### Rapid service

Whatever devices need to be programmed, Action Circuits

aims to offer a service second to none. Once the program has been delivered via email, including all the settings required, and devices have been received, Action Circuits can begin to process customer requirements. A first article agreement process helps ensure samples are customer approved. This is invaluable since increasingly complex options and security settings for many devices, make it essential that customers can rely on Action to program memory or microcontrollers with the correct settings every time.

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There are many device types and several associated file formats used to program data



Devices are programmed on a range of hardware using silicon manufacturer approved algorithms

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# Ready for some serious networking?



*ECSN chairman, Adam Fletcher, reminds readers to polish their football boots and dust off their smart suit because it's time for the Electronic Components Industry five-a-side football tournament and ECSN annual dinner*

Way back in September 2015, the *Electronics Sourcing* team first broached the subject of an Electronic Components Industry five-a-side football tournament and proposed organising it to complement the Electronic Components Supply Network annual dinner and networking event. At first, I had my doubts; after all, football isn't everyone's bag. But I should have had more

faith. 2019 will be the fourth year of this collaboration and the two events have grown in popularity each year. ECSN, *Electronics Sourcing* and sponsor, Gelec, therefore invite readers to join us in Brighton on Thursday 23 May for another entertaining, informative and enjoyable day networking with colleagues and friends across our industry.

Those who do will gather at the Sussex Football Association HQ in Lancing, West Sussex at 10:00 for a pre-kick-off briefing by football professionals from Brighton and Hove Albion. If previous years are any guide, a range of industry colleagues will be kitted-up and ready to compete in this friendly five-a-side tournament with all ages and abilities represented. Organisations can enter their own teams of five players, but entries from individuals are also welcome. Professionals from the Brighton and Hove Academy, under the leadership of Guy Butters, participate in every match, coaching individual players and encouraging team-building in every sense. During lunch, the overall winning team is declared, and prizes are awarded.

conversation and earnest discussion. After dinner, our keynote speaker is Brian Wood, a former Colour Sergeant with the Princess of Wales's Royal Regiment. Brian was awarded the Military Cross for gallantry in combat in recognition of his courageous leadership under enemy fire in Iraq. In his inspirational and entertaining presentation, Brian will suggest how the lessons he learned can be applied in our industry. The evening concludes with Guy Butters briefly reviewing our collective footballing performance and presenting the trophy to the winning team, followed by an auction of professional football memorabilia, with proceeds going to the charity 'Albion in the Community.'

Next, we head to Jurys Inn, Brighton Waterfront Hotel, to attend meetings with colleagues and suppliers, or perhaps just stroll along the seafront, before re-convening in the hotel bar. At 18:00 ECSN market analyst, Aubrey Dunford, will deliver his update on the UK, European and international electronic components markets. Don't miss his analysis of global and domestic market data and considered review of industry trends and the macro-economic environment into the second half of the year.

Finally, dinner among industry colleagues and friends where we'll enjoy a three-course meal accompanied by great

Why not join us for this lively event and take full advantage of the opportunity to meet with a cross-section of colleagues, suppliers and friends across the electronic components supply network. To register for places, email Jill Waite at [enquires@encn-uk.org](mailto:enquires@encn-uk.org).

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## Passives

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TTI Europe is now offering Yageo's automotive grade PU series high power, low ohmic shunt resistors. Manufactured using an e-beam welding process, the resistors feature a central open-air design, which is said to be key to achieving excellent heat dissipation.

The series also boasts low resistance down to 0.2mohm, a tolerance of  $\pm$  one per cent, and TCR as low as  $\pm 75\text{ppm}/^\circ\text{C}$  with a power rating of up to 10W. Resistors are available in three case sizes: 2512, 3921 and 5931.

PU series resistors are AEC-Q200 qualified and pass military grade tests to MIL-STD-202. This ensures

they can withstand a wide temperature range from  $-65$  to  $275^\circ\text{C}$ ; over 1,000 times temperature cycling  $-55$  to  $125^\circ\text{C}$ ; and 1,000 hours at 85 per cent relative humidity and  $85^\circ\text{C}$ . These quality assurances make the PU series a perfect solution for industries that demand high precision and high stability such as automotive, power systems, telecommunications and industrial equipment.





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# YAGEO

# What to consider when outsourcing cable assembly

Over 98 per cent of assemblies produced by GTK are customised, providing valuable insight into the potentially knotty process of outsourcing cabling. Business manager for cable assemblies, Tom Hennessey, explains

For many OEMs designing new products, the cable assembly is a component part of their

product but not necessarily an area of expertise. For instance, they may not be aware of all

the different options for cabling and connectivity or have the in-house capability to manufacture

cable assemblies reliably or cost-effectively. This is where outsourcing offers distinct benefits.

When contemplating outsourcing cable assembly requirements, there are several factors to consider.

## Clarify specifications

First, look carefully at the cable assembly specification. OEMs need to provide a clear specification of the cable assembly required, ideally featuring a drawing or sketch of the assembly. They also need to provide information on the environment or application where the cable assembly will be used as this will influence the components and production processes used.

If the assembly must meet any specific industry standards or approvals, this must be detailed, particularly for military, aerospace and medical sectors, which have their own standards, such as AS9100 and ISO13485.

## Consider capabilities

With the specifications clarified, there are several different factors involved in vendor selection. It's wise to look at how long the vendor has been in business and establish what accreditations it holds, particularly if specific industry approvals are required.

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Next, look at the vendor's experience and technical expertise. Establish whether cable assembly is part of the vendor's core business and whether there are experienced in-house technical experts that can discuss design ideas and come up with alternatives that add value to the design. A fast turnaround prototyping service can also be critical to prove a new product design without delaying its launch.

If customisation is required, the vendor must demonstrate an appropriate level of service, which could involve bespoke cable assemblies including corporate branding, labelling and packaging.

Thinking about a long-term partnership, establish whether a vendor with a global footprint would be beneficial. Increasing globalisation often means OEM design resources are in a different geography to the end-product destination. This

may be particularly important in Europe as we approach the planned Brexit date of 29 March.

Lastly, consider any logistics and packaging requirements. Can the vendor hold buffer stocks, ship to multiple locations or supply product to agreed lead times? Can packaging requirements be met cost-effectively? Some OEMs require simple bulk packaging for assemblies going straight to the production line, for example, while others require retail-style packaging.

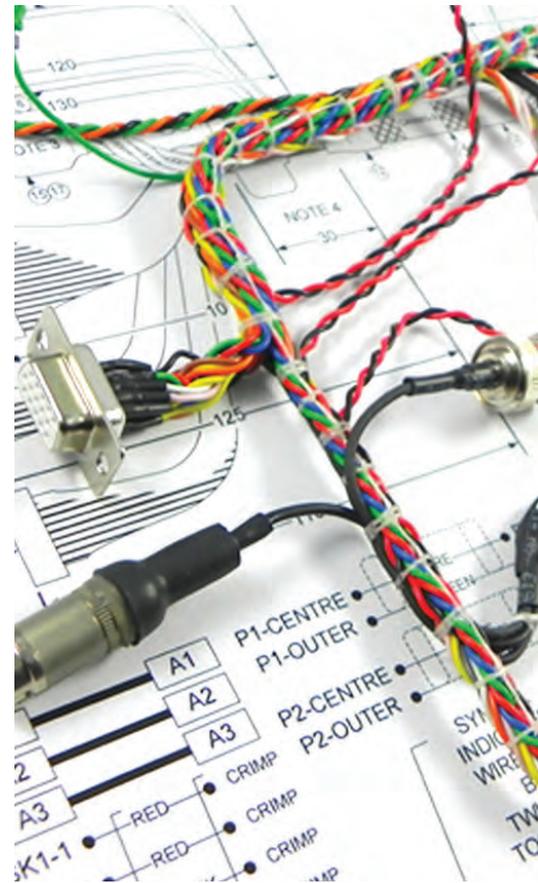
### Find a match

In addition to these factors, OEMs also need to consider the relationship 'fit' with a supplier. Invest time in meeting shortlisted vendors to establish how easy it would be to work with them long term, and whether they can add value to your designs.

Over the years, GTK has

developed some long-standing partnerships with customers resulting in work on fourth or fifth generation designs. In short, the more open the relationship and dialogue between supplier and customer, the more value GTK can add to the design, either in added features or functionality, streamlined production processes or reduced costs. To achieve this outcome, GTK's experts are on hand to share their specialist knowledge and make a positive impact on final cable assembly designs.

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# Don't overlook the essentials

From nailing down application requirements to lead times and avoiding fakes, ES quizzed Memory Protection Devices president, Tom Blaha, on the basics of battery holder sourcing

**Q** What impact has the trend towards miniaturisation had on battery holders?

Thru-hole mounted components are giving way to surface mount devices that permit lower profiles and higher density, however, surface mount technology makes soldering more of a challenge, especially for battery holders that require highly reliable solder connections to handle the weight of a battery.

**Q** What is the current average lead time for MPD products?

Lead times vary from products that are in stock and ready for immediate shipment to two to four weeks for many standard products. For a more predictable supply chain, we often recommend a just-in-time delivery program that helps keep customer inventory levels lean while ensuring appropriate reserve inventory within our warehouses.

**Q** How quickly can MPD ship quick turn orders for battery holder products?

Our products are sold through leading distributors

that keep a huge inventory of product on hand and can provide same day service in most cases. For example, Digi-Key is renowned for providing 20-minute turnaround for order entry, picking, packing, and preparation for shipment.

**Q** What should buyers look for when comparing battery holders?

Often, two battery holders will look essentially alike, when in fact, significant differences exist in terms of the quality of the raw materials, the care of manufacturing, and the



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quality assurance or quality control processes used to maintain product consistency. The best way to ensure that a battery holder will perform as promised is to conduct thorough due diligence when reviewing potential vendors.

### Q What certifications or standards are essential for battery holders?

Certification requirements vary depending upon on the application. For example, a 'throwaway' advertising specialty item can have fairly low quality standards, however, if the battery holder is being used in a life-saving medical device, such as a portable defibrillator, then the battery holder must be manufactured to the highest quality standards, including ISO-9001 and UL94 certifications, to name a few.

### Q How will battery holders develop in the future?

The ongoing trend is towards electronic devices becoming smaller, lighter, and more environmentally friendly, using less plastics and metals, while offering higher impact resistance.

### Q How can purchasers identify counterfeit MPD battery holders?

Certain companies are using our part numbers to create a bait and switch scheme with unbranded battery holders being unknowingly substituted as MPD products. To help prevent counterfeiting, our battery holders contain a unique mint-mark that is embedded in the plastic.

### Q What advice would you give to someone who is new to sourcing battery holders?

Work closely with the design engineers to make sure that the correct battery holder is being specified in the first place. For example, if the application is intended for extreme environments, then it pays to spend a little more for higher quality plastics and gold-plated contacts that offer greater corrosion resistance. Once you've defined the product requirements, then you can focus on the supply chain. MPD products are sold through

approved distributors listed on our website. Any distributor can claim to supply our products, but we only sell through franchised distributors. When negotiating with a distributor, be sure to communicate all your needs, including special packaging requirements, kitting of sub-assemblies, drop shipping, JIT delivery, or vendor managed inventory programs. Be sure to maintain open lines of communication and continually

forecast future demand to keep product manufacturing and the supply chain on schedule for timely deliveries.



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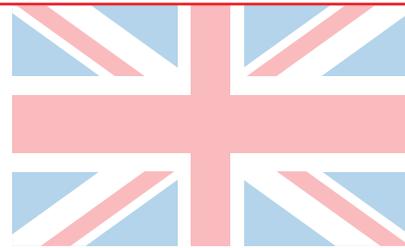


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# Home in on home-grown skills



*Britain has a rich industrial heritage backed by specialist distributors and manufacturers. As Charcroft explains, the UK's niche capabilities are an advantage in these challenging times*

Backed by its industrial heritage, Britain's home-grown successes continue to serve the industry to a high standard. Specialist UK-based distributors and manufacturers such as Charcroft Electronics, for example, provide a bespoke, tailored service with all staff, stock and manufacturing based in the UK. This centralisation enables British companies to be flexible by offering order-scheduling, UK-held buffer stocks and call-off as required, all of which can help to service customers facing challenging lead time and availability issues.

Moreover, with the Brexit date of 29 March looming, the question on everyone's lips is 'how will it affect us?' British based manufacturers utilising UK-based procurement could be in a better position come the end of March, as local-partner companies can take steps to mitigate the risk of a hard-Brexit.

## UK expertise

Despite the pressures of an impending exit from the EU, elements of British industry continue to flourish, particularly the British audio market. This sector is unique in that products are not necessarily required to meet high-specifications or certifications, but instead, must satisfy the high expectations of the end user, where the emphasis is on sound quality.

Charcroft customer, Rega, is one such producer, operating at the forefront of the high-end audio movement. This UK specialist works with around 650 suppliers, 80 per cent of which are also located

in the UK. Rega has dedicated significant research to developing its high-end range of audio products, such as the Aura MC, a fully adjustable, three-stage symmetrical pre-amplifier.

Cohesion between British based businesses, such as Rega and Charcroft, encourages this home-grown innovation and development. For instance, Charcroft worked with Rega to ensure the capacitors provided to the Aura MC system were performing to the highest possible standard in order to support Rega's emphasis on quality. Charcroft's in-house capability also continues to support Rega through the manufacture of accurate, high-stability components. Offerings such as the 'naked' resistor and other specialist components, screening services and matching, add clarity and balance to Rega's high-value audio systems.

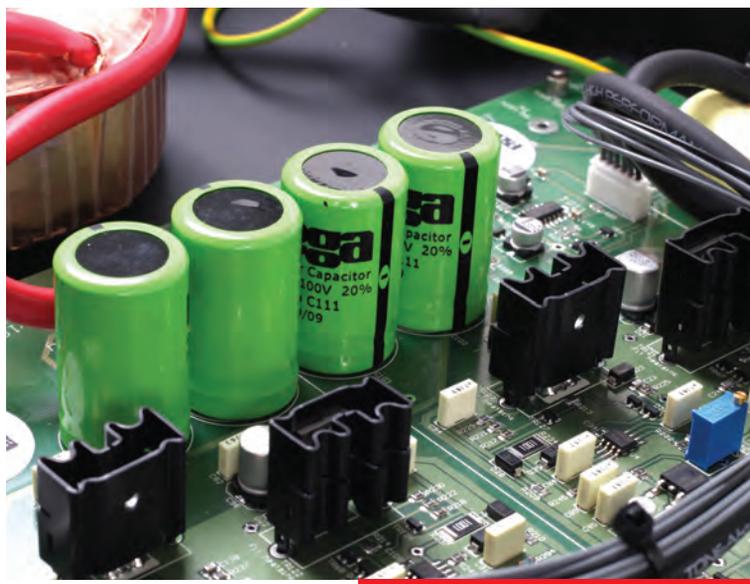
## Building relationships

Ongoing relationships between British based manufacturers and distributors can only serve to enhance home market sectors, while also serving customers through continued flexibility, locally based technical support, and rapid response times.

Opportunities provided by British based businesses within local communities are also something to celebrate. The importance of technical expertise within the industry cannot be underestimated, and the more home-grown talent that can be nurtured and developed, the better. Businesses such as Charcroft and Rega offer in-house opportunities for development, with on the job

training, support on external qualifications, and technical and industry understanding. This development and retention of staff and skills will only serve to support the UK-based electronics industry into the future.

[www.charcroft.com](http://www.charcroft.com)



Technical expertise in the industry cannot be underestimated; the more home-grown talent that can be nurtured, the better

Relationships between British based manufacturers and distributors can only serve to enhance home market sectors

# Stay one step ahead with training

*In the current climate of political and economic uncertainty, how do you ensure your company stands out from the rest? Advanced Rework Technology believes training is the answer*

Ensuring personnel are trained to the latest acceptance, workmanship documents and standards is the best way to ensure your company remains competitive. IPC training is industry recognised and traceable to the company and trainer, which also helps satisfy customer and audit requirements.

Whether a manufacturing company is small or large, ART UK has a course available to suit all kinds of product, drawing, contract or procurement requirements.

Not only does ART claim a spot as the longest running IPC approved training centre in the UK, it is one of only two approved training centres globally to be authorised to conduct training for all of the IPC training programmes. This includes: Certified Interconnect Design and Design Plus, and both the J-STD 001, Requirements for Soldered Electrical and Electronic Assemblies Space Addendum, and IPC/WHMA-A-620, Acceptance of Cable and Wire Harnesses Space Addendum.

ART also prides itself on the bespoke training courses that it can tailor to suit individual company and their product needs. If IPC training is not necessary, experienced staff and trainers at ART UK can work with customers to

design a syllabus that covers the discrimination and/or workmanship skills needed to enable personnel to produce products that stand head and shoulders above the rest.

### Staying up to date

To ensure accuracy and to reflect any change in industry trends and technologies, IPC documents and standards are produced by industry members and updated at regular intervals.

ART UK staff are IPC standards and training committee members, but the company also has the advantage that managing director, Debbie Wade, is a master IPC trainer and chairs a large number of committees including, European IPC Standards Steering. This committee allows industry members within the European region a recognised platform to assist with generating the criteria and processes contained in the IPC documents. It also provides a networking opportunity to discuss legislation and challenges within Europe, and how current or new standards could bridge these issues.

Other committees where Debbie plays a role include the European IPC training committee, IPC/WHMA-A-620 training committee, IPC-A-640, acceptance requirements

for Fibre Optic Assemblies Training Committee and IPC Product Assurance Committee.

Debbie is a past recipient of the IPC Presidents Award, but in addition, ART highlights that all its staff have been recognised in the industry for their leadership and contributions in the development of IPC standards/documents and associated training programmes.

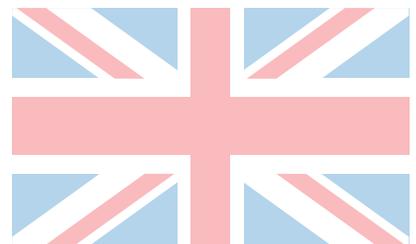
As a result, ART is able to offer several different services and courses including: IPC-A-600, Acceptability of Printed Boards, IPC 6012, Fabrication Specification for Rigid Boards, IPC-A-610, Acceptability of Electronic Assemblies, IPC/WHMA-A-620, Acceptability of Cable and Wire Harnesses, 620 Space Addendum, IPC 7711/21, Rework, Repair and Modification of Printed Boards, J-STD 001, Requirements for Soldered Electrical, J-STD 001 Space Addendum.

To compliment the courses offered, ART also offers various additional services to support customer excellence and help keep clients one step ahead. These include audit preparation, process and quality consultancy and inspection reports.

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Courses are available to suit all kinds of product, drawing, contract or procurement requirements





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Requirements for Soldering Electrical and Electronic Assemblies



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# Simple tips for complex connector sourcing

*Due to the complexity of options and technical specifications, sourcing circular connectors and their accessories can be time consuming. NYKCS provides a brief guide to choosing the most appropriate solution*

High performance electrical plugs and sockets with a circular housing and multiple contacts are used to interconnect systems in a range of electro-mechanical scenarios. In the defence and aerospace industries, some of the most commonly used products are MIL-DTL-26482, 5015 and 38999 connectors. An understanding of these specifications will underpin the selection process.

### Specifications explained

Any MIL-DTL connector will have been designed and

manufactured to meet a detailed and complex military specification. Connectors with this designation have high-performance levels and will be subject to rigorous quality controls throughout the manufacturing and supply chain.

MIL-DTL-38999 connectors consist of four series, with either bayonet, threaded or Breech Lok coupling mechanisms. These environmentally resistant connectors feature removable crimp contacts and have an

operating range of -65 to 200°C.

Specifically, MIL-DTL-38999 Series I connectors are bayonet coupled, scoop proof and have high-vibration properties. Series II are also bayonet coupling, but due to their low profile, light weight construction, they are non-scoop proof. They are ideal in low-vibration and moisture environments. Series III connectors use a Tri Start threaded coupling for fast coupling and de-coupling. They are scoop proof and can



**NYKCS can help to identify the best product for an application, be it mil-spec or a commercial equivalent**



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Charcroft Electronics has been established as a specialist distributor and manufacturer of electronic components for over 40 years. Entirely UK based, providing the complete offering from facilities in Llanwrtyd Wells, Powys – providing jobs for local people, supporting the local-community in the heart of Wales.

## Manufacturing:

From the BS and CECC-approved production facility, incorporating the VPG Precision Centre, Charcroft manufactures custom passive assemblies,



audio and precision foil resistors in addition to silver mica and legacy ceramic capacitors. This unique UK service offers bespoke solutions to suit customers' requirements – with no minimum order quantities, short lead times and in-house testing and measurement capabilities.

## Distribution:

AS9120B approved franchised distributor for passive, semiconductor, sensor, electromechanical components and power-supplies. With all stock received, stored and shipped from the UK.



## Support:

UK based staff; dedicated Sales team with a national network of qualified Product Specialists & experienced Account Managers working from initial design stage through to production procurement and supporting legacy requirements.



**Debbie Rowland**

Director

[debbie.rowland@charcroft.com](mailto:debbie.rowland@charcroft.com)



**Roger Tall**

Passives, Hi-rel Semis & Opto Specialist  
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be used in high temperature, moisture or vibration environments. Finally, Series IV quick disconnect connectors feature a Breech Lok mechanism. These scoop proof, lightweight connectors are designed for blind mating applications, and have high-vibration and moisture performance.

The MIL-DTL-26482 specification covers a range of miniature circular bayonet lock connectors. Series I

features non-removable solder contacts and series II uses removable crimp contacts. Both are quick disconnect, environmentally resistant, electrical connectors with an operating range of -55 to 125°C.

MIL-DTL-5015 can be described as the first military circular connectors standard. Connectors can have front release or rear release crimp contacts and can also be supplied with solder contacts.

Used for electrical power, electronic, and control circuits, this range is widely used in industrial, civil, and defence applications as it is readily available and versatile, with an operating range of -55 to 125, 175, or 200°C.

Products such as MIL-DTL-83723 and their derivatives the EN2997 and ESC10 variants are also widely used, often selected for their high levels of

vibration performance and EMI shielding.

**Application constraints**

Selecting the right connector for an application will clearly depend on electrical, mechanical and environmental requirements. Features for consideration include: physical size, weight, shape, voltage and current ratings, as well as EMI/RFI and environmental performance, such as vibration and expected



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mating frequency. These parameters will help to define the best connector family for the application.

In most cases, the plug connector will be fitted to a cable and connect to a mating receptacle. The plug can be fitted with pins or socket contacts, depending on the flow of current. Receptacles to mate with the plug are available in various shell styles, with a variety of mounting options. These include flange mounting, wall mount, panel mount or box mount, which fit on the front or rear of a panel or box and are normally four-hole mount. Solder mount or

weld mount receptacles are also available as hermetic connectors that offer sealing in extreme pressure and temperature environments.

Having selected the most suitable connector, it is also critical to identify appropriate accessories to ensure the end-to-end performance of the complete assembly. A plug, for example, requires a connector backshell or cable clamp to secure the terminated cable and achieve the required level of EMI/RFI performance, sealing and mechanical protection.

**Supplier selection**  
Critical systems require

products to operate in harsh conditions. Mil-spec products are therefore specified for their technical capabilities, performance and quality. Conversely if such high levels are not required, then a mil-spec component may not be the best choice.

Connector specialist, NYK Component Solutions, aims to help engineers and buyers identify the best product for their application, be it mil-spec or a commercial equivalent. The company boasts years of experience in the specification of connectors and interconnect products as well as being an approved value add

assembling distributor for Conesys MIL-DTL-38999 Series III connectors. As a franchised distributor of Compaero products, NYKCS can also provide a variety of connector backshells and accessories. Backed by approval to AS9100 Rev D for value added assembly and AS9120 Rev B for sales, logistics and distribution, this helps ISO9001 2015 approved NYKCS offer valuable advice to simplify the daunting task of circular connector selection.

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# Expect ample supply and stable prices for TFT-LCDs

*A spike in demand for a particular size LCD panel size could create a temporary period of tight supply in 2019*



James Carbone

Electronics purchasers can expect it to remain a buyers' market for thin-film transistor liquid crystal displays (TFT-LCD) at least through this year as capacity remains high and supply ample for most size LCD panels.

However, there could be temporarily tightness of supply for some panel sizes if there is sudden high demand for a specific panel size. For instance, if there is a spike in demand for LCD panels used in smart phones, manufacturers could devote more capacity to that panel size resulting in reduced supply for other size LCD panels.

But overall the LCD market will remain adequately supplied. "For the broad LCD panel market I would say it is definitely a buyer's market," said Linn Huang, research director at International Data Corp (IDC).

Average selling prices will decline contributing to a drop in overall LCD revenue. In 2018 TFT-LCD revenue totaled \$88.9 billion,

but in 2019 sales revenue will drop to \$86.5 billion and by 2022 TFT-LCD revenue will be \$77.7 billion, according to researcher IHS Markit.

Unit demand will also decline. Overall TFT-LCD unit shipments will drop from 2.7 billion in 2018 to 2.6 billion in 2019, according to IHS Markit. Shipments will continue to drop through 2022 when 2.44 billion TFT-LCD units will ship. While unit shipments and revenue will decline, total TFT-LCD area shipments, as measured in millions of square meters, will rise steadily through 2022. In 2018, 210.9 million square meters of LCDs shipped, IHS Markit said. By 2022, 230.8 million square meters of LCDs will be purchased because of the general trend toward larger size LCD panels.

The good news for buyers is that there will be very little change in TFT-LCD average selling prices over the next several years. In 2018, the average price was \$32.99. The ASP will rise slightly

to \$33.15 in 2019, but then decline through 2022 when the average price will be \$31.85, IHS Markit said. However, there will likely be price declines for large 65- and 75-inch display panels .

The price forecast varies depending on the size of the panel and by customer segment. For instance, a large TFT-LCD panel for an LCD-TV will rise from \$107.81 in 2018 to \$113.77 in 2020, before declining to \$109.42 by 2022. However, a panel used for a computer monitor will decline from \$66.91 in 2018 to \$60.76 in 2022.

Demand for large-size, high-end panels will remain strong driven by rising demand for gaming-PC and professional-purpose monitors. Some LCD panel makers are devoting more capacity to monitor panels replacing existing TV panel production to make up for "poor performance of that business," said Robin Wu, principal analyst at IHS Markit.

There is also strong demand for

public, automotive and industrial displays. Demand from those applications grew 17.5 per cent by area and 28.6 per cent by units in 2018, said Wu.

He said TFT-LCD manufacturers view those applications as a "a new cash cow" that make up for the price erosion that has occurred in panels used in televisions, desktop monitors and notebook computers.

## Panel shipments for monitors rise

However, IHS said that some LCD panel makers will continue to focus on the monitor and notebook PC panel businesses. Panel shipments for monitors will increase 5.3 per cent, while shipments for notebook PCs will rise 6.6 per cent. TV panel shipments will grow just 2.6 per cent, according to the researcher.

The good news for buyers who purchase panels for televisions is that more capacity will come on line this year which will boost competition and could lead

## By the Numbers



**\$88.9 billion**

*the size of the thin-film transistor liquid crystal display market in 2018.*



**\$33.15**

*The average selling price for a TFT-LCD panel in 2019.*



**\$47.33**

*the average price of a TFT-LCD panel used in a notebook computer in 2018.*



**\$77.7 billion**

*The forecast size of the global TFT-LCD market in 2022.*



**2.7 billion**

*the number of LCD panels shipments in 2018.*



to even more aggressive price reductions.

In 2019, three new 10.5-generation fabs are expected to start mass production, according to Wu. ChinaStar, BOE and Foxconn/Sharp have built the fabs and all of them will manufacture TV panels, further boosting television panel supply, he said.

Because of stiff competition with TFT-LCD television displays, some manufacturers will focus on LCDs for computer monitors and notebook PCs.

Huang said there was “renewed vigor” by major monitor manufacturers because demand for monitors was stronger in 2017 and 2018. An increase in monitor demand means greater demand for LCD panels which is welcome news for LCD manufacturers producing panels for monitors because the monitor market had been steadily declining before 2017.

With demand rising, the monitor market has stabilised. “That may be a misleading word because the market is still generally down, but

it’s down a lot less,” said Huang. He noted that the monitor market is no longer closely tied to the PC market as it was 10 years ago. “The performance of the PC market has material impact on the monitor market, but I would argue that impact has been diminished greatly over time,” said Huang.

**No more bundling**

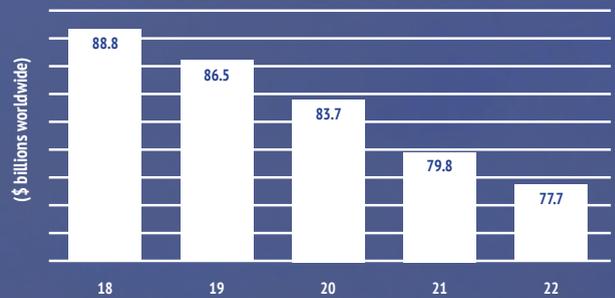
In the past, PC sales used to have a bigger impact on monitors because PC companies used to bundle monitors with PCs. If someone bought a PC, the monitor was included.

So when the PC market boomed, so did monitor sales. “When the PC market was doing terrible, so was the monitor market,” said Huang. “Over time, the impact of the performance of the PC market on monitor has waned,” he said.

Flat-panel LCDs replaced CRTs with desktops and other computers. Flat panels have a longer lifecycle than PCs, so PC manufacturers now sell desktops and other computers without monitors because PC buyers often do not need new displays. Computer buyers might decide to

Source: IHS Markit

**TFT-LCD market to decline**



buy new monitors several years after a PC purchase often opting to buy a bigger display.

Huang said no one panel size dominates computer monitors. In fact, there are six primary panel sizes that used: 18.5, 19.5, 21.5, 23, 24 and 27-inch. Those sizes account for about 80 per cent of LCD panel volume and no one panel size accounts for more than 21 per cent of shipments.

LCD panels measuring 18.5 inches are the least expensive, costing about \$60-\$70, but account for a small percentage of overall LCD panel shipments because of the trend towards larger size computer displays, he said.

“On the monitor side there has been this inevitable migration upwards to bigger screen sizes so there’s something constantly pushing the mix upward,” said Huang.

**Overcapacity to continue**

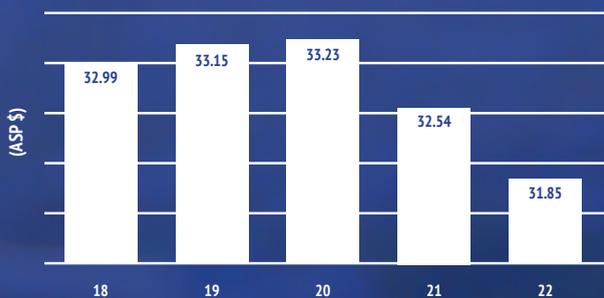
Regardless of panel size, there has been overcapacity of LCD panels for about a decade and

overcapacity will likely continue. In 2017 and 2018 when demand increased, overcapacity was less of an issue but, “overcapacity in general is still a long-haul issue.” LCD panel overcapacity results in lower prices and less revenue for manufacturers.

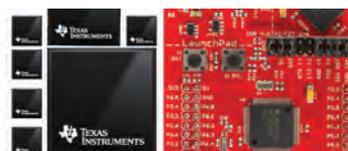
Huang said overall industry overcapacity does not necessarily mean oversupply. “There have been moments of brief shortages even though the panel industry has been at overcapacity for a while,” he said.

For instance, this can occur if Apple releases new product and some panel manufacturers transition production from larger size panels to smaller ones needed for iPhones. That could lead to a shortage of panels for monitors, he said.

**Average LCD tags to fall**



Source: IHS Markit



# New product development is key to EMS revenue growth in Canada

*Some OEM buyers involved in outsourcing decisions are looking to EMS providers in Canada to help bring new products to market*

Electronics manufacturing services (EMS) providers in Canada say while many OEMs choose to manufacture in Canada to sell products into the Canadian market, many are also turning to them to develop new products that will be sold globally.

In addition to state-of-the-art manufacturing facilities, many EMS providers in Canada also have design centers or programs to support OEMs' new product introduction efforts. The idea is to offer OEM customers greater value by assisting in the design of new products, building prototypes and then helping the OEM transition a new product into volume manufacturing.

For instance, global EMS provider Flex, which is based in Singapore, has two design centers in Canada, one in Ottawa and another Markham, Ontario. Its "Sketch to Scale" program provides assistance to OEMs with design concept, advanced design engineering and new product introduction capabilities.

Smaller EMS providers also offer NPI and design help to OEMs developing products in Canada. For instance, Vexos is a global EMS provider with manufacturing in the U.S., Mexico, China and Canada where it builds equipment for Canadian-based OEMs. "Our business in Canada certainly has been growing," said Wayne Hawkins, senior

vice president and general manager for Vexos' Markham manufacturing facility.

"We had strong growth over the last few years," he said. "Last year revenue increased by about 10 per cent. It has been a very good environment over the last couple of years."

He said Vexos builds printed circuit board assemblies as well as entire systems and we "do full test for the end application to make sure quality requirements are met." Connectivity and RF products and industrial equipment "would be the majority of what we do in Markham," said Hawkins. It also builds medical and security products.

He added that Vexos is seeing "a lot of new business opportunities because of the growth of Internet of Things" as more industrial products are being connected to the Internet.

OEM customers also want Vexos to help them develop new products.

"We are located close to design centers of our customers where quick turn NPI service" is needed to help customers launch new products, he said. There is a lot of new product development in the Toronto area as well as Kitchener and Ottawa.

## **Building prototypes**

He said Vexos works with

OEMs building prototype products and then helps "them ramp up production to get their products to market." The EMS provider assists OEMs in transitioning their new products from small production to volume production at its "sister location in Shenzhen, China to reap the benefits of lower-cost manufacturing if a customer needs to kick something to higher volumes to get cost efficiencies," said Hawkins.

Another EMS provider that helps its customers develop new products in Canada is Sanmina, which is based in San Jose, Calif., but has facilities in Canada, including a design center in Ottawa. The center specialises in developing RF, optical and microelectronic products for customers. The engineering team at the center develops RF and optical products for telecommunications, industrial, medical, clean energy and defense and aerospace OEM.

Many of Sanmina's customers want to leverage the EMS provider's expertise in RF and optical technology and its new product development know-how when they design a new product.

Many of Sanmina's OEM customers in Canada are technology focused companies. "We help them with design and new product introduction and then potentially assist them transferring those newly



**Wayne Hawkins**, senior vice president and general manager for **Vexos**.



**Our business in Canada certainly has been growing. We've had strong growth over the last few years**

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developed products to other lower cost locations that Sanmina has,” said Stewart.

“Canada is the significant region for Sanmina,” said Jeremy Stewart, director business development for Sanmina’s operations in Ottawa. “Across the globe we have many large multinational customers that control the supply-chain out of Canada or have operations here in Canada,” he said. But some customers like to develop their products in Canada because of the high degree of high-tech expertise in the country, especially in Ottawa.

“People call Ottawa the Silicon Valley of the North because it is a significant technology hub,” said Stewart. “There is a lot of research and development taking place in Ottawa as well as Toronto and in Montreal to some degree,” said Stewart,

#### Leveraging expertise

Many, although not all, of Sanmina’s customers want to take advantage of that expertise. Customers that Sanmina services in Canada fall into three categories, said Stewart. “The EMS provider has OEM customers that are headquartered in Canada and manufacture in Canada or globally,” said Stewart. Other customers are multinational OEMs and want to develop high-technology new products and introduce them to the market quickly.

“We’re very active with them on new product introduction to help them launch their products,” he said. The third category is OEM customers that “want us to manufacture their products and leverage our RF/optical, microelectronics design and manufacturing capabilities that we have here which is a real differentiator for us in Ottawa,” said Stewart.

While telecommunications is the largest industry Sanmina services, “we also support industrial customers here

which is broad customer vertical for us,” said Stewart. Sanmina also supports medical and defense and aerospace OEMs with its RF, microwave and radar expertise and manufacturing capabilities.

Those OEMs leverage Sanmina’s technical capabilities with RF and optical technologies in different ways. In some cases, customers “collaborate with our engineers” on new products, said Stewart. In other cases, Sanmina develops products for them in its labs and “and literally turn around prototypes in a couple days.”

He said Sanmina is starting to see an opportunity in the automotive industry because of its optical and RF capabilities as automotive OEMs develop self-driving vehicles.

“We’re involved in design and new product development for multiple lidar systems on the automotive side,” said Stewart. Lidar is a technology that measures distance to another vehicle or pedestrian by illuminating the car or person with a pulsed laser light and measuring the reflected pulses with a sensor. Autonomous vehicles in the future will use lidar for obstacle detection and collision avoidance to navigate safely on the road through the use of rotating laser beams.

#### Seeking design support

Internet of Things and industrial customers are also seeking design support. “In our industrial segment, there is a connectivity evolution occurring with industrial products tying into IoT,” said Hawkins.

In addition, there are new customers with “niche products that are IoT applications,” he said. “A lot of them are new ventures involving new emerging companies and a higher risk. It could be a great opportunity or a they could

die quickly,” but some of the new IoT products will be part of Vexo’s future growth, said Hawkins.

There are also opportunities with traditional segments he said. “We are seeing more growth potential around security products,” said Hawkins.

There are new products involving security access controls and cyber security for the defense industry and businesses. Such products will be opportunities for EMS providers that have high-level optical capabilities and manufacturing expertise with fine-pitch technology and flexible printed circuit board assemblies.

While helping OEM customers design and develop new products may be important to EMS revenue growth long-term, some EMS companies say recently imposed tariffs on Chinese goods imported to the U.S. may spur some short-term sales growth for some Canadian EMS providers.

Hawkins said Vexos is getting more quotes from U.S. companies inquiring about manufacturing in Canada since tariffs of Chinese goods went into effect in the U.S.

“U.S. companies are looking at a 25 per cent tariff of products coming from China,” he noted. “Some U.S. companies are asking ‘what are the “opportunities and options to avoid that?’” said Hawkins. “Certainly, leveraging a Canadian EMS site to build products and ship them into the U.S. and avoid some tariffs” is an option, he said.

He noted that Canadian labor costs are lower than in the U.S. “There are some cost reduction opportunities utilising Canadian EMS providers, maybe not to the extent of China or Mexico but you’re getting the benefit of a highly skilled workforce, engineering, and serviceability,” said Hawkins.



**Jeremy Stewart**, director business development for **Sanmina's operations** in Ottawa.



**Canada is the significant region for Sanmina. Across the globe we have many large multinational customers that control the supply-chain out of Canada or have operations here in Canada**

# EMS industry in Canada is small but growing

The electronics manufacturing services industry in Canada is small compared to other regions such as China or the U.S., but many of the world's largest EMS providers build electronic systems in Canada for the domestic market.

For instance, Celestica, which is headquartered in Toronto, has almost 1 million square feet of manufacturing space in Canada, according to New Venture Research. Celestica has a new site in Newmarket that handles manufacturing and new product introduction. Flex has a facility in Toronto that has about 426,000 square feet and another factory in Ottawa with 220,000 square feet of manufacturing space, the researcher said. Sanmina also has a manufacturing facility with about 136,000 square feet of manufacturing space.

There are also many smaller EMS providers that are either based in Canada or have facilities there. For instance, Creation Technologies, headquartered in Vancouver, British Columbia, has manufacturing facilities

in Vancouver, Toronto and Mississauga.

Vexos, which is headquartered in New York, has manufacturing facilities in Markham, Ontario. SMTc, based in Toronto, has a design and engineering center in Toronto.

The EMS industry in Canada had about \$4.5 billion in revenue in 2017 which is about a tenth of the size of the U.S. EMS market, according to Randall Sherman, president and CEO of New Venture Research, based in Nevada City, Calif. The global EMS market totals about \$365 billion. The Canadian EMS market grows about 3 per cent per year. By 2022 EMS sales revenue will reach \$5.65 billion, he said. "Most of the production is for domestic purposes. There's not a lot of export," he said.

There's also not a lot of high-volume manufacturing in Canada. "Cell phones, computers, networking equipment are not made in Canada," said Sherman. It's more low- to mid-volume manufacturing

high-complexity" products including medical and industrial products, aerospace systems, robotics, test and measurement and process control equipment, he said.

EMS providers in Canada tend to service smaller OEMs. Although there are exceptions, such as aerospace manufacturer Bombardier.

Although growth in the EMS industry has been modest, there could be an uptick in growth as more OEMs in Canada embrace the outsourcing model.

"They have good quality manufacturing capacity in Canada," said Sherman. In addition, the dollar value of the total available market (TAM) for electronics production in Canada including manufacturing by OEMs and EMS providers totals \$63 billion. EMS providers in Canada could "capture a larger share of total available market over time," said Sherman.

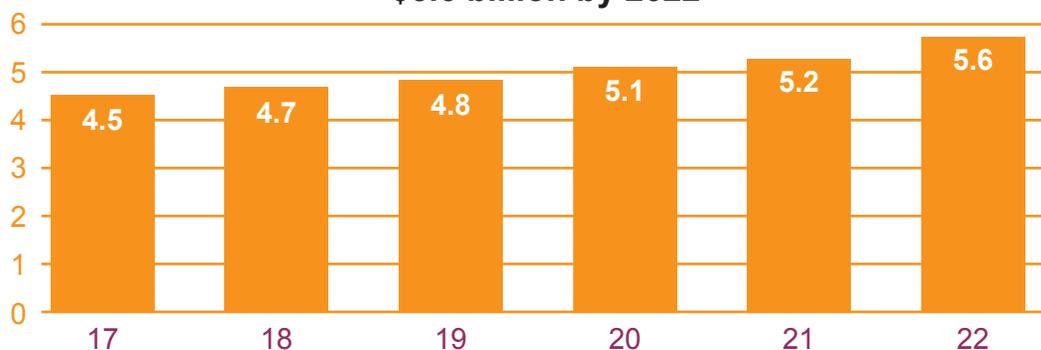
Gelston Howell, senior vice president of marketing

for Sanmina said the EMS provider has a long history of manufacturing for the telecommunications industry.

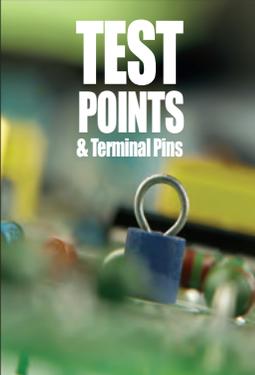
He said the company's growth in Canada was "not due to printed circuit board and surface mount technology, but because of its involvement with high technology and telecommunications. "RF and optical really enable multiple generations of bandwidth improvement for the industry," he said.

He said Sanmina is now leveraging its expertise and optical and RF technologies for medical and automotive OEMs.

## Canadian EMS market to reach \$5.6 billion by 2022



Source: New Venture Research

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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
<b>CABLE ASSEMBLY &amp; HARNESSING</b>											
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
<b>CIRCUIT PROTECTION</b>											
Bourns	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5000	N/A	£0	58%	50	1,500+	Y
EPCOS/TDK	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	5000	N/A	£0	58%	50	1,500+	Y
Littelfuse	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	35000	N/A	£0	67%	50	1,500+	Y
<b>DISPLAYS &amp; LEDs</b>											
NLT Technologies Ltd	Review Display System Ltd	01959 563345	www.review-displays.co.uk	Y	ALL	N/A	£0	N/A	6	25	Y
<b>ENCLOSURES</b>											
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
<b>FREQUENCY MANAGEMENT</b>											
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
Golledge Electronics Ltd	Golledge Electronics Ltd	01460 256 100	www.golledge.com	N	N/A	£800,000	£0	100%	3	24	Y
<b>HEATSINKS</b>											
Aavid	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	700	N/A	£0	67%	50	1,500+	Y
<b>ICs &amp; SEMICONDUCTORS</b>											
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
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



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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
Microwise	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
Spanion 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
<b>INDUSTRIAL GRADE MEMORY MODULES</b>											
InnoDisk	Simms	01622 852 848	www.simms.co.uk	N	300+	N/A	N/A	N/A	3	N/A	Y
<b>INTERCONNECTION</b>											
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
FCI	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	4,300	N/A	£0	94%	50	1,500+	Y
Glenair	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	1,900	N/A	£0	76.00%	50	1,500+	Y
HARTING	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	4,700	N/A	£0	31%	50	1,500+	Y
Harwin	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	2,200	N/A	£0	79%	50	1,500+	Y
Hellermann Tyton	Lane Electronics	01403 790661	www.fclane.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	Y
Hirose Electric	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	6,100	N/A	£0	99%	50	1,500+	Y
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
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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



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<b>INTERCONNECTION (Continued)</b>											
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
<b>OBSOLESCENCE / HARD TO FIND</b>											
	America II Europe	01462 707070	www.americaii europe.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
<b>OPTO ELECTRONICS</b>											
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
Osram 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
<b>PASSIVES</b>											
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
<b>POWER &amp; BATTERIES</b>											
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



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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
<b>POWER &amp; BATTERIES (Continued)</b>											
CUI Inc.	Mouser Electronics	0044 (0)1494-467490	www.mouser.co.uk	Y	3,900	N/A	£0	100%	50	1,500+	Y
FRIWO 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
<b>SENSORS</b>											
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
<b>SWITCHES &amp; KEYBOARDS</b>											
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
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
<b>TERMINAL BLOCKS</b>											
Marathon Special Products	Global Supply Services	01904 436 488	www.global-supply-services.com	Y	8,000	£800,000	£100	100%	3	11	Y
<b>THERMAL MANAGEMENT</b>											
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



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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
<b>THERMAL MANAGEMENT (Continued)</b>											
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		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
<b>TRANSFORMERS &amp; INDUCTORS</b>											
Best Windings	Best Windings	0044 (0)1394 448424	www.bestwindings.co.uk	N	300	N/A	£100	N/A	2	14	Y
<b>WIRELESS SOLUTIONS</b>											
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	Y
Axiom Manuf. Services	01495 242130	www.axiom-ms.com	£40m	SW	300	3	ISO9001, AS9100, ISO13485, ISO14001, SC21, IPC610E, BSI Kitemark, NADCAP, ISO27001	Y	Y	Y	Y	Y	Y
Briton EMS Ltd (OSI Electronics)	01234 266300	www.britonems.co.uk	£12m	Bedford & Singapore	100	3	ISO: 9001, 13485, 14001. AS9100. BSI Kitemark IPC610	Y	Y	Y	Y	Y	Y
Challenger Solutions Ltd	01245 325252	www.challengersolutions.com	£5m	Essex/SE	55	7	ISO 9001, 14001, UL IPC-610, SC21	Y	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	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	Y
CSI EMS Ltd	01376 500050	www.csiems.co.uk	£5m	Essex	50	3	ISO 9001, UL, IPC610	Y	Y	Y	Y	Y	Y
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	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	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	Y



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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
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	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	Y
Elite Electronic Systems Ltd	028 6632 7172	www.elitees.com	£20m	UK	230	5	ISO9001, ISO13485, UL, IPC610/620 Class 3	Y	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	Y
Fabrinet UK	01249 814081	www.fabrinetuk.co.uk	£21m	UK/Thailand/US	210	5/31/2	AS9100/NADCAP/EN13485/OHSAS18001/14001/9001/TS16949/FDA/ATEX	Y	Y	Y	Y	Y	Y
FermionX Ltd	+44(0)1903 524600	www.fermionx.com	£5m	Worthing, W. Sussex	40	4	ISO9001, ISO14001, IPC-A-610	Y	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	Y
Hallmark Electronics Ltd	01782 562255	www.hallmarkelectronics.com	£2m	M	26	2	ISO9000/UL, IPC610/D	Y	Y	Y	Y	Y	Y
Icon Electronics Limited	01423 798294	www.iconelectronics.co.uk	£6.5m	Hampshire & Yorkshire	70	6	AS9100, ISO9001, BS EN ISO/IEC 80079-34:2011 ATEX, IPC-A-610 Class3	Y	Y	Y	Y	Y	Y
Industrial Electronic Wiring Ltd.	+44(0)1793 694033	www.iwco.uk	£5.5m	Swindon, UK	60	N/A	ISO9001:2015, IPC610, IPC620	N	Y	Y	N	Y	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 Space Addendum)	Y	Y	Y	Y	Y	Y
JJS Manufacturing Ltd	01455 555500	www.jjsmanufacturing.com	£35m	Bedford, Luttermworth, (CZ)	420	3	ISO9001:2015, ISO14001:2015, IPC 610 A class 2&3	Y	Y	Y	Y	Y	Y
Lacon Electronic	+44 (0) 7836 338122	www.lacon.de/en	50m	Germany/Romania	500	13	ISO9001, ISO14001, ISO13485, TS16949, OHSAS18001, VG6927, UL	Y	Y	Y	Y	Y	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	Y
NOTE	01453 797580	www.note.eu	£100m	UK/EU/China	1,000	14	ISO9001, 13485, 14001, 18001, IPC-610 Class 3	Y	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	Y
Pektron	01352 832424	www.pektron.com	£50m	E-Midlands	350	8	ISO9001, ISO14001, TS16949, BEAB, VCA, TUV, UL	Y	Y	Y	Y	Y	Y
Protronix EMS	01582 418490	www.protronix.co.uk	£2.5m	Luton	10	2	ISO9001:2015, IPC-A610	Y	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	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	Y
Speedboard Assembly Services	01753 746700	www.speedboard.co.uk	£12.8m	Windsor, SE	99	4	IPC610 to Class 3, ISO9001:2015	Y	Y	Y	N	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	Y
TEXCEL TECHNOLOGY PLC	+44(0)1322621700	www.texceltechnology.com	£14.5m	SE	126	7	ISO9001, ISO14001, IPC610 Class 3,	Y	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	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	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	Y

## PCB Buyers' Guide

Manufacturer	Telephone	Website	Service Provided (ie Broker, Manufacture &/or Repair)	Location	Approvals	Volume - Small, Medium, Large	Double-sided	Multi-layer 4-10/10-20-30	Metal PCBs	Flex / Flex-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	IS 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
Photonix Group	01903 231901	www.photonix.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 583627	www.tatecircuits.com	B	UK/China	ISO 9001:2015, UL	SML	Y	4-20	Y	Y	Y	Y	Y
Tecbridge Circuits	0207 993 6503	www.tecbridgecircuits.co.uk	M Rep.	UK Europe	UL, TS16949(2009), ISO14001(2004), ISO9001(2008)	SML	Y	4-16	Y	N	Y	Y	Y

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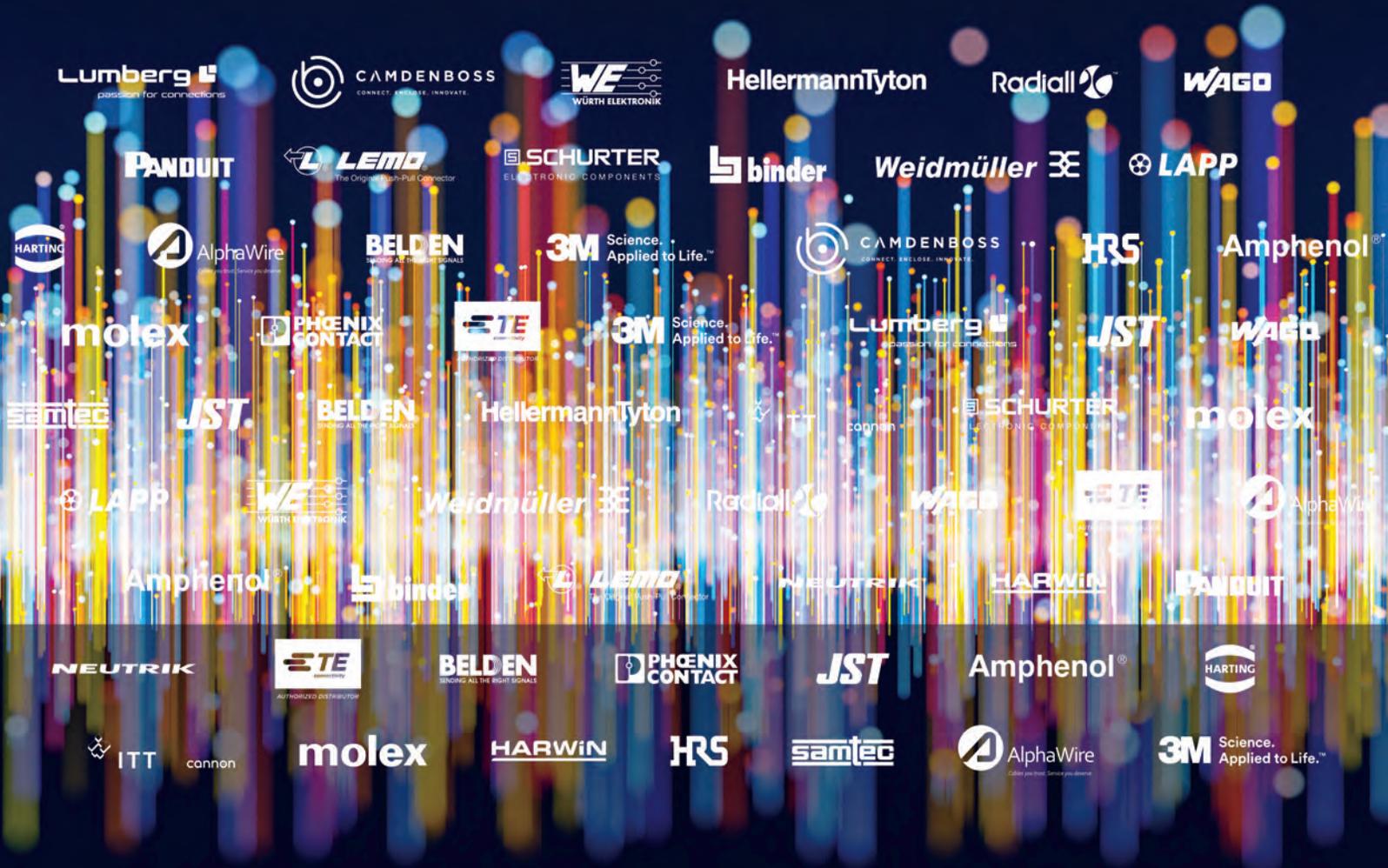
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