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JULY 2020
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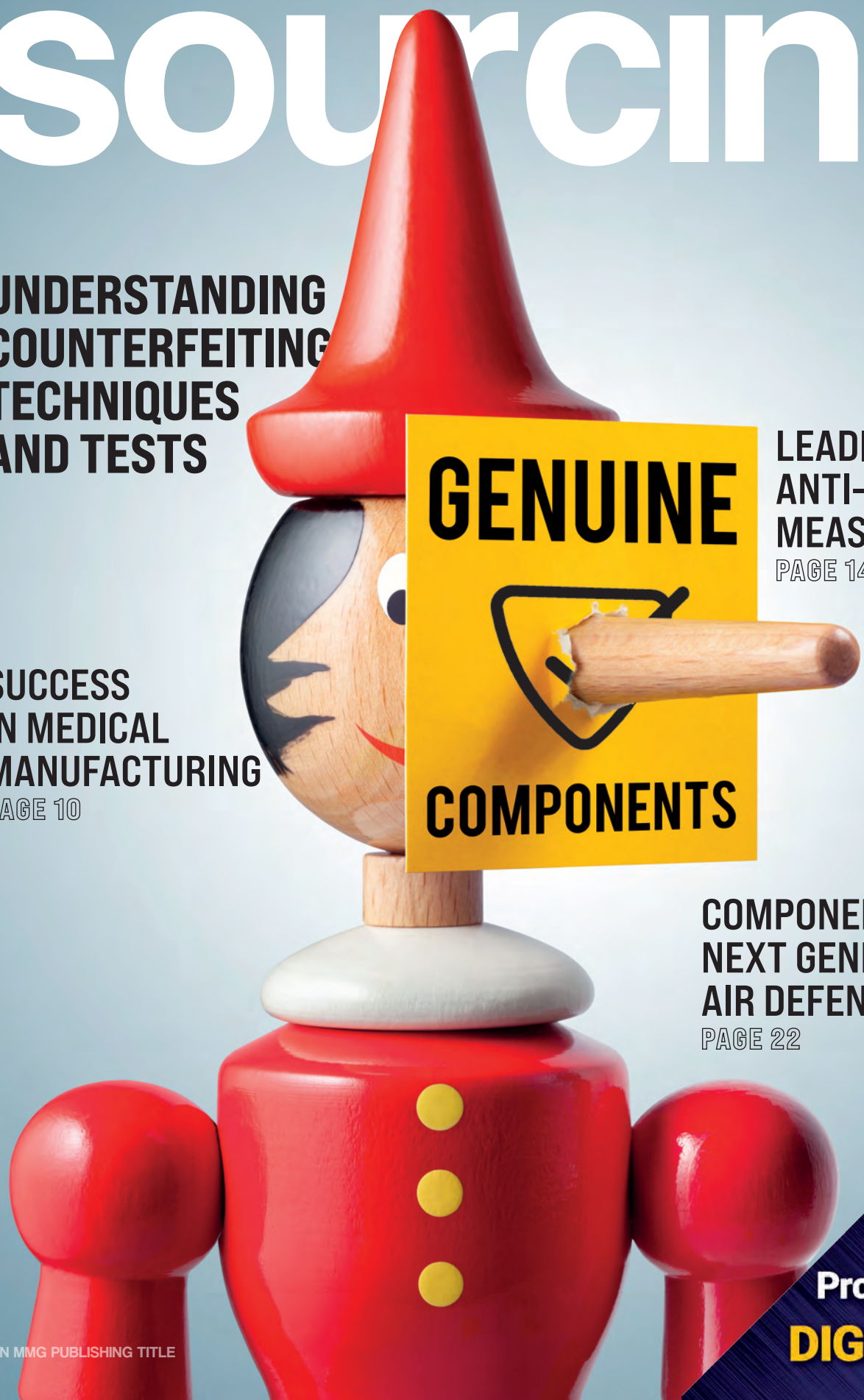

UNDERSTANDING COUNTERFEITING TECHNIQUES AND TESTS

LEADING IN ANTI-COUNTERFEIT MEASURES
PAGE 14

SUCCESS IN MEDICAL MANUFACTURING
PAGE 10

COMPONENTS FOR NEXT GENERATION AIR DEFENSE
PAGE 22

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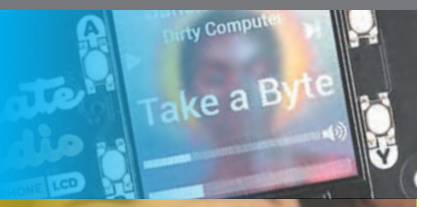
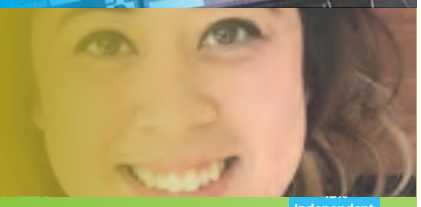
ECIA MEMBER
Supporting The Authorized Channel

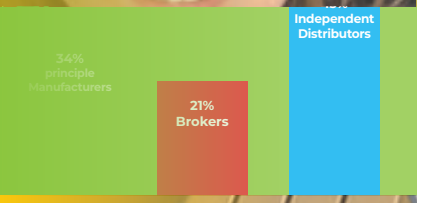
On the cover – July 2020

Understanding counterfeiting techniques and tests

Contents







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Editor's Word

Paper and print everywhere

Medical, social and economic impacts aside, Covid-19 has revealed some interesting aspects to life. One or two of them have the potential to be uncomfortable truths.

Thanks to forced homeworking and video conferencing I have had the pleasure of peeking inside more living rooms, kitchens, bedrooms, studies and box rooms than I would have previously seen in my whole life. Politicians, celebrities, newsreaders, medics, experts, the general public and more, I've seen it all.

I'm fascinated by how untidy some rooms are. I want to know why anyone would choose 'that' color for a wall. I'm eager to discover the backstory to the photo on the mantlepiece.

However, what really caught my eye was books, books and more books. More often than not, the wall behind the presenter would be a bookcase. Everyone seems to be buying books. Everyone seems to be keeping books. Everyone seems to want their Zoom background to be books.

This is all wrong. For 20-years the great and good have repeatedly advised me to escape the world of print publishing while I can, before digital becomes all consuming. Why the divide between what I'm being told versus what I've just witnessed. My guess is that until recently these 'expert advisors' didn't have mass access to people's living rooms.

So, until I can Zoom into any home, at any time, and not see a single book, let alone an overflowing bookshelf, then I hold my confidence in print.

Now, flick the page and enjoy your read.

Jon Barrett

N

ES News

View current editions online – www.electronics-sourcing.com

Sounds great

Mouser is now stocking Pimoroni Pirate Audio accessories. The audio pHAT boards are designed to deliver high-quality audio, playback control and LCD screens in an assembled solution compatible with Raspberry Pi models with a 40-pin GPIO header.

The board range includes a speaker, stereo amplifier, line-out and headphone amp. The PIM485 Audio Speaker board is a compact, all-in-one sound system that features a miniature mono 1W speaker, Maxim MAX98357A I2S digital-to-audio converter (DAC), amplifier, high-resolution display, and playback control buttons. For more power, the PIM484 3W Stereo Amp combines two MAX98357A DACs to provide 3W output per channel. In addition to push-fit terminals for connecting external speakers, the board includes a switch for stereo/mixed-down mono modes.

The PIM483 Audio Line-Out board lets users upgrade existing hi-fi amps, speakers and powered monitors with 24-bit/192kHz digital audio. The board, based on a Texas Instruments PCM5100A DAC, delivers line-level digital audio over I2S and includes a 3.5mm stereo jack. The PIM482 Headphone Amp is based on a Diodes PAM8908 stereo headphone amplifier and TI PCM5100A DAC. The board integrates a 3.5mm stereo jack and a low-gain/high-gain switch to create a hackable portable media player.

mouser.com

Supply chain cybersecurity solution

UL has announced its Supplier Cyber Trust Level solution, designed to help organizations minimize supply chain cybersecurity risk by focusing on the trustworthiness of suppliers' security practices.

Supplier Cyber Trust Level analyzes supplier's security practices across multiple trust categories resulting in a documented Trust Level rating which demonstrates trustworthiness across the software and hardware development lifecycle, hosted systems, information management systems and third-party management.

There is currently no single certification or framework that adequately addresses the complexities of securing an enterprise wide supply chain. Individual, separate security industry standards and certifications often address only a portion of the overall cybersecurity posture, which means they do not address other security aspects often critical for the supply chain. The UL Supplier Cyber Trust Level assessment enables a holistic view of suppliers' security posture, while providing a fair and consistent evaluation for organizations of the cybersecurity posture from supplier to supplier.

ul.org

Production disruption declines sharply

ECIA's chief analyst, Dale Ford, has issued the latest report based on bi-weekly surveys of members' response to Covid-19. The survey ended May 26 reflects a mixed trend. While overall concern regarding impact on the supply chain has moderated significantly, the expectation for the duration of the impact has lengthened and anticipated lead times have extended.

The number of companies reporting strong confidence in order backlogs evaporated in the most recent survey as large majorities reported 'average' confidence. End market demand continues to be the greatest concern regarding supply chain health while electronics systems production disruption declined sharply in reported concerns.

The automotive and industrial markets continue to represent the segments of greatest concern with expectations of a decline in automotive remaining roughly the same at 71 per cent and industrial decline outlook deteriorating significantly to 68 per cent. Despite expectations for weak end-market demand, the confidence in order backlog remains solid in every product segment but not as robust as in the prior survey.

The bright spot was infection control. A status of 'well established' or 'advanced' was reported by 78 per cent of respondents.

www.ecianow.org

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N
ES News

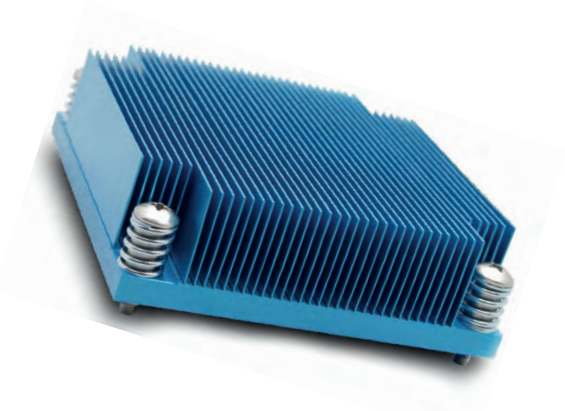
In Brief

PCB sales up 4.3 per cent
IPC has announced its April 2020 findings from its North American Printed Circuit Board Statistical Program. The book-to-bill ratio stands at 1.19. Total North American PCB shipments in April 2020 were up 4.3 per cent compared to the same month last year. Compared to the preceding month, April shipments fell 18.2 percent. PCB bookings in April increased 19.9 percent year-over-year, but fell 7.3 per cent from the previous month.
www.ipc.org

Quality control
Independent component distributor, VRG Components, has been awarded ISO 9001:2015, demonstrating its commitment to providing quality electronic components to its customers. The process started early in 2019 with the addition of Quality Assurance Manager and certified ISO auditor, Michael Robertson who led the initiative with management team leaders as they aligned the company's processes and procedures with the standard.
www.vrgcomponents.com

Turn down the heat
Heilind Electronics has signed a global distribution agreement with Laird Performance Materials. Laird serves electronics companies with thermal interface materials; electromagnetic interference shielding materials and magnetic ceramic solutions; RF and microwave absorbers; precision and structural metals; and industry-leading multifunctional products. The global agreement is designed to better serve end users through leveraging Heilind's sales capabilities and engineering expertise.
www.heilind.com

Supply chain finance
HPD LendScape has announced a new supply chain finance solution designed to make it simpler and faster for lenders to onboard and support buyers and suppliers, giving North American businesses more streamlined access to working capital. Suppliers can interact with buyers and funders in real time and increase visibility of accounts receivables, while buyers can create bespoke processes tailored to each supplier.
www.hpdlendscape.com



Thermal solutions ready to ship

Sager has announced the addition of Advanced Thermal Solutions to its line card. ATS is a thermal solutions provider, offering a portfolio of thermal products and solutions.

Advanced Thermal Solutions' vice president of sales and business development, Steve Nolan, said: "We're excited to partner with Sager Electronics and its specialized group, Sager Power Systems. In Sager Electronics, we have the opportunity to work with a distributor with a highly trained, technically experienced sales force focused on thermal management."

Sager's director, supplier marketing and product management, Aldo Guarino, added: "Advanced Thermal Solutions provides innovative, high-quality and cost-effective thermal management and packaging solutions. The addition of ATS to the Sager line card will enable us to provide further thermal expertise for our customers' most complex thermal applications, and it is an excellent complement to our thermal product portfolio."

www.sager.com

A flexible approach to heaters

Digi-Key has expanded its thermal management product line by adding flexible heater manufacturers including All Flex, TurboFlex Heaters and others. Digi-Key's two largest flexible heater supply partners, All Flex and TurboFlex, represent more than 330 different options.

Digi-Key states it now offers the largest supply of flexible heaters in the country, with nearly 500 different models, sizes, shapes, material types and power alternatives.

President of TurboFlex Heaters, Jahn Stopperan, said: "Digi-Key is in an ideal position to get our flexible heaters into the hands of engineers and designers who are actively designing new products and need flex heaters quickly in order to keep their project moving forward."

All Flex' vice president of sales and marketing, Jamin Taylor, added: "Digi-Key provides another strong market avenue for All Flex products due to their widespread market position with OEMs of all sizes. Our capabilities in providing design assistance and thermal solutions are an excellent fit with Digi-Key's customer base."

www.digikey.com

Easy-to-use power modules

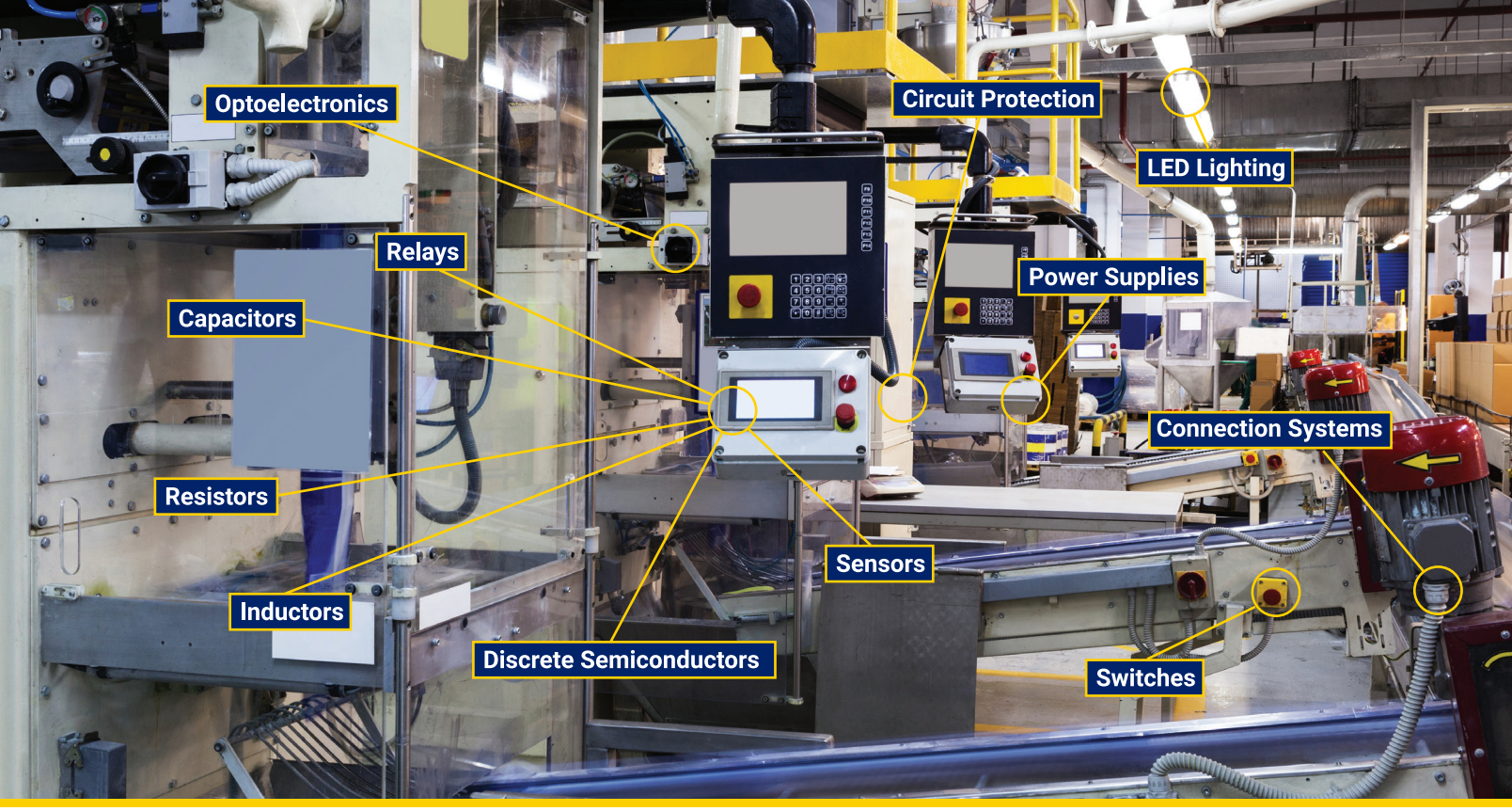
Newark has enhanced its semiconductor portfolio with a new range of compact, energy efficient power, motion control and sensor solutions by MPS.

Newark's global head of semiconductors and SBC, Lee Turner, said: "MPS is a true innovator in the semiconductor market, and this new agreement allows us to deliver the highest quality power solutions to customers in industrial, telecom, cloud, automotive and consumer applications while further bolstering Newark's global power portfolio.

"This state-of-the-art range further demonstrates our continued commitment to provide our customers with the most innovative power solutions that can accelerate the design process and can help bring products to market faster. Many of our design-oriented customers enjoy having the flexibility to use high quality, integrated solutions when designing applications so they can focus on other critical hardware or software components."

MPS specializes in small, efficient and easy-to-use power modules, commonly used in systems to support industrial applications, telecom infrastructures, cloud computing, automotive and consumer applications.

www.newark.com



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Some independent distributors see sales increases because of pandemic

Component demand from "essential" industries such as medical OEMs have boosted sales for independent distributors

James Carbone

Independent distributors say they have seen healthy demand and robust sales increases despite the slowdown in production at some global OEMs and electronics manufacturing services (EMS) providers because of the coronavirus pandemic.

Much of the sales growth for independent distributors has been driven by "essential" industries such as medical equipment, mobile computers and networking equipment.

"Electronic component demand has remained steady throughout the year and business has been brisk," said Todd Burke, president, Americas for independent distributor Smith, based in Houston. However, demand has not been steady across the board.

"Decreases in consumer demand have caused the smartphone and oil and gas markets to experience uncertainty," said Burke. However, Smith is seeing increased demand for components, including passives, microprocessors, and field programmable gate arrays from medical OEMs and their EMS providers.

"We also expect solid-state drive (SSD) demand to continue trending upward throughout the second half of the year as demand increases for cloud services that utilize hyperscale data center infrastructure," he said.

Availability is ample for most components, although there are shortages and longer lead times for some parts due to country lockdowns and shutdowns of some component production caused by the pandemic, he said.

"There are some spot shortages for commodities that are heavily used in server and enterprise applications," said Burke. "So far, we haven't seen any evidence of panic purchasing, but certain types of memory modules, SSDs, and CPUs are having supply difficulties."

Some distributors say there are spot shortages of MLCCs, chip resistors, microprocessors and some memory ICs.

With supply tight, there have been some price increases for multilayer ceramic capacitors, resistor arrays, memory and FPGAs, said Burke.

Uncertainty caused by the pandemic has increased demand for supply chain programs. Burke said there was significantly higher demand for programs such as vendor managed inventory and inventory hubbing in 2019. "The global pandemic has caused even more of a need for these services as customers look for ways to safeguard their supply chains while simultaneously not letting on-hand inventory get out of balance," said Burke.

Burke added that coronavirus will likely continue to impact the industry through the year, he expects Smith's business will remain healthy. "As manufacturers around the globe continue to come back online and consumer demand recovers, we expect electronic component sales to remain steady," he said. Smith will continue to provide customers supply chain support which will allow the distributor "to navigate market conditions," he said.

"Electronic component demand has remained steady throughout the year and business has been brisk"

Todd Burke, president, Americas for independent distributor **Smith**

Growth without shortages

Another independent distributor that has had sales growth during the pandemic is Fusion Worldwide, based in Boston. "The first quarter of 2020 was one of our better quarters," said Luke Lesaffre, director of sales for the Americas for Fusion. "We achieved good numbers without the benefit of a widescale shortage of anything. Our April 2020 was a top five month for us."

Lesaffre said the mobile computing market has been a strong segment for Fusion during the pandemic. "We've always been a company that was strong in computing," he said. "That is an area that has been positively impacted by the coronavirus. Business has been strong primarily for notebooks" because more people are working at home and have upgraded their computers, he said. "We've seen a tremendous amount of business," he said.

Enterprise computing, including servers, and cloud services providers has also been a strong segment, said Lesaffre. Lesaffre said while component demand was strong through May, it appeared to be peaking in early June. "We are starting to

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see some signs of softening and growth tapering a bit. We think there may be a gradual flattening throughout the year compared to hockey-stick growth," he said.

A brutal market

Lesaffre said some customer segments were adversely impacted by the pandemic. "Automotive has been brutal," he said. Many auto plants closed down during the pandemic. "We don't do a ton of business with automotive. Most of our business in automotive is aftermarket business," he said.

Carleton Dufoe, CEO and founder of independent distributor NewPower Worldwide, based in Nashua, NH, said component demand varies depending on the customer. "Some of our customers' business fell off the cliff, while other customers' business exploded and they could not get parts fast enough," he said.

He said NewPower has a lot of medical equipment customers that build ventilators and other medical products and demand from those customers has been strong.

Companies that were hit the hardest are those that make nonessential goods such as desktop computers, he said. However, business has been strong from mobile computer manufacturers because more people are working at home and students are being taught virtually over the Internet rather than in the classroom which has boosted demand for portable computers.

"Anyone making a notebook has seen demand go through the roof. And conversely anyone who is making desktops has seen this business drop off," said Dufoe.

He added NewPower's sales to the industrial business sector, telecom and networking continues to be strong and "our services business has been through the roof. We have a lot of testing, kitting, repair business. We've also have taken on some kitting projects," he said.

Dealing with excess

Dufoe said that customers whose business fell off after the COVID-19 outbreak have excess inventories and many aren't sure what to do with it. Some have sought the advice of NewPower. "What they wanted from us is inside information" about what can be done with their inventory, said Dufoe. Such customers want to know "what's the best-case scenario. What's the worst," he said. "They are looking for a solution."

Dufoe said NewPower helps customers make decisions about inventory with its homegrown SCOUT system which can determine how much inventory can be sold at different price points. The system can tell customers if there are any customers for the parts they hold or a limited number of customers.

Dufoe said he is optimistic about NewPower's business for the rest of the year. "In 2019, we finished with $318 million in sales. Our goal for this year is to eclipse $400 million. We are on track. We finished May at about $200 million," he said.

Increased demand from medical manufacturers tightens supply

Many electronics purchasers turned to independent distributors over the last three months after some component factories shut down or slowed production of needed parts during the height of the coronavirus pandemic.

The factory shutdowns and cutbacks in production resulted in tightness of supply and shortages of a number of components, ranging from field programmable gate arrays and microprocessors to MLCCs and resistors.

In some cases, supply tightened because of the increased demand from medical equipment manufacturers who are building ventilators, patient monitoring equipment and other products needed to treat people who contracted COVID-19.

"One of the issues that we are seeing is many semiconductor manufacturers have prioritized their allocation to the manufacturing of needed medical equipment and rightly so," said Paul Romano, COO of independent distributor Fusion Worldwide, headquartered in Boston. The allocations are going to "medical builds globally" and that is keeping "some semiconductors from OEMs and EMS providers in other industries, he said.
In addition, there have been component factory shutdowns in Malaysia, the Philippines and Thailand. That has impacted supply of some components such as connectors, and other passives. The shutdowns have created "significant backlog demand of components, said Romano. Many of those factories are slowly coming back on line, but many are only at half capacity, according to Romano.

"That creates a major change in the whole supply chain because component manufacturers are only able to produce half or less of components that they had planned to produce," he said. He said there are shortages of MLCCs, tantalum capacitors, some connectors and voltage regulators.

"A lot of notebook memory is short so different verticals and segments are affected," said Romano.

An added wrinkle for the supply chain is factories in different parts of the world are resuming production at different times. "On the demand side, there are a lot of factories in China that shut down in January and February, but now are up and running, which is creating a lot of demand" for components, said Romano. However, in other parts of the world factories that build electronics equipment were not yet open as of early June.

On the supply side, factories in China are producing chips and other components, but other regions are not, he said.

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Unprecedented success in medical device manufacturing

Digi-Key's vice president of global supplier management, David Stein, illustrates how the company is supporting suppliers and customers through Covid-19 supply chain challenges

Demand for medical equipment put tremendous pressure on supply chains and certain components. Suppliers who were running out of product requested we quarantine inventory for customers building critical medical technology. We provided this for medical and other key customers in dire straits, ensuring they had the components they needed when they needed them most.

This abnormal situation puts pressure on popular devices and they become scarce. Digi-Key's product management team worked closely with customers to identify options to keep their manufacturing processes moving. For example, one customer building ventilators specified a certain temperature sensor on its BoM. That part had already sold out but we had three other variations that our product management team felt could be substituted. Samples were sent overnight and the customer's design team used the parts to continue producing ventilators.

Digi-Key also partnered with Z2Data to offer priority support and component data for companies creating devices such as ventilators and testing solutions. By offering these services at no cost, Digi-Key helped medical device manufacturers source components quickly and ramp up production. Through the partnership, Z2Data offers no-cost access to its database of over one billion electronic components through its Part Risk Manager and Supply Chain Watch tools. These tools help organizations meet market demand by: managing their BOM; making informed part selection decisions; finding cross-references and alternatives; and tracking inventory availability of parts alongside real-time pricing and lead times.

Digi-Key also reallocated its engineering resources to help create a new, open-source ventilator called the Coventor, in partnership with physicians at the University of Minnesota and several other companies. At about the size of a cereal box, the inexpensive and rapidly scalable device will help meet the demand for ventilators in the treatment of Covid-19 patients.

After physicians at the University of Minnesota reached out to Digi-Key the company quickly assigned a team to help with the life-saving project. Digi-Key's team of engineers focused on identifying parts and addressing supply chain issues, including identifying vendors who could provide the needed components with a much quicker turnaround time than normal.

From design through production, Digi-Key helped not only select the parts but design the Coventor and provide the parts needed for production. Supporting the majority of parts on the BoM helped jumpstart the project and keep it moving. Digi-Key's sales team also played an important role, providing one point of contact.

Thanks to strong collaboration and speed, the Coventor was the first ventilator approved for use under the US Food and Drug Administration's Emergency Use Authorization for the COVID-19 outbreak. It took just one month from concept to FDA approval: unheard of in the medical device world. The team also made sure this would be an open source device so manufacturers around the globe can quickly copy it: an unprecedented move in the medical device market.

www.digikey.com

Digi-Key played an important role during the design and manufacture of the Coventor open-source ventilator

At about the size of a cereal box, the inexpensive and rapidly scalable device will help meet the demand for ventilators in the treatment of Covid-19 patients

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Evolving counterfeit threats and how to avoid them

TTI's VP quality, Kevin Sink and Symmetry Electronics' quality & operations manager, Megan McCaw, walk readers through the standards and processes for avoiding counterfeits

More than a decade ago, the military and aerospace industry encountered a new threat: counterfeit components. Parts were harvested from scrap PC boards, cleaned up, re-marked and sold as new. While not technically counterfeit, their structural and electrical integrity was compromised. Also, they were often re-marked to suggest they were superior such as commercial parts sold as mil-spec and standard temperature ranges extended.

The industry responded by educating its members via symposiums and creating of a family of industry standards. AS5553 was the first counterfeit mitigation standard, targeted toward users and installers of electronic components. By following its recommendations, a company could deploy better purchasing, inspection and obsolescence control practices. Test labs learned how to detect counterfeits and the supply chain began to differentiate between authorized and independent distribution as part of risk control.

Today, standards tailored for the supply chain include: AS6081 (independent distribution); AS6496 (authorized distribution), AS6171 (test labs) and AS6174 (products beyond electronic components). Related guidance shows how to implement an anti-counterfeit program, assess supplier risk and align one's program with DoD requirements. Symposiums, web forums and databases highlight evolving risks. Finally, there are governmental prosecutions to bring counterfeiters to justice.

Symmetry Electronics, an authorized distributor in the TTI family of companies, found that since 2018, there has been a gradual five per cent annual increase in the number of customers requiring counterfeit mitigation policies. Many are contract manufacturers, whose end customers also require mitigation.

Once the community reached a critical mass of knowledge, implemented standardized processes and began to constrain buys to authorized channels, the incidence of reported counterfeits began to fall. The bad news is that counterfeiters evolve. While simple methods, like blacktopping, are frequently detected, counterfeiters developed more complex methods. True counterfeits have emerged: brand new die processed into packages and marked with a brand maker. In many ways, because the dies are later generation, they outperform the originals. This raises the concern of state actors who might place malicious code in firmware, giving them information or control that compromises the unit.

The most effective counter to this threat is to buy from authorized channels and plan for obsolescence. Symmetry Electronics sources product directly from its approved original component manufacturers (OCMs). Incoming inspection ensures parts are authentic, in original factory packaging, with appropriate manufacturer labels and markings. When a part is returned by a customer, lot and serial numbers are inspected to ensure original parts are being returned.

To stop non-conforming parts getting into the gray market where they could be mis-represented, Symmetry Electronics destroys scrapped material.

As parts become obsolete over time, OCMs formally alert Symmetry Electronics in writing and suggest newer solutions. These notices are passed to customers. Rather than incorporating obsolete parts in a customer's designs, OCMs encourage a swap out of end-of-life (EOL) product to avoid obsolescence.

www.semiconductorstore.com

TTI's VP quality, **Kevin Sink**

Symmetry Electronics' quality & operations manager **Megan McCaw**


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Leading the way in anti-counterfeit measures

In this article Mouser Electronics' vice president of quality, Chuck Amsden, introduces the company's standards-based approach to anti-counterfeiting

Mouser customers can order with confidence, knowing the global authorized distributor has rigorous processes in place to prevent counterfeit products entering its inventory. Over 800 semiconductor and electronic component manufacturers count on Mouser to help them introduce their products and customers can expect 100 per cent certified, genuine products that are fully traceable to each manufacturer.

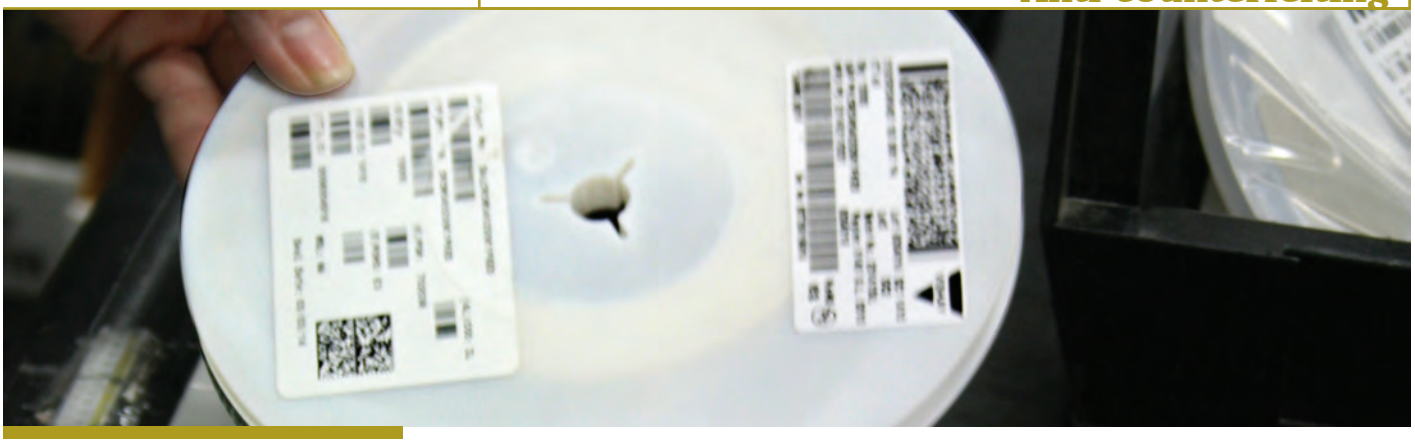
Mouser is the electronic component industry's first authorized distributor to receive accreditation to AS6496, the aerospace industry's high standard for anti-counterfeit measures in authorized electronic component distribution. The standard sets requirements for the avoidance, detection, mitigation and disposition of counterfeit products in the authorized distribution supply chain. This international standard requires authorized distributors to have a counterfeit mitigation policy and a counterfeit electronics parts control plan. Industries and individuals looking to reduce the risk of counterfeit electronic parts entering the supply chain can accomplish this by using authorized distributors accredited to AS6496.

Mouser Electronics' vice president of quality, Chuck Amsden, said: "By becoming accredited to AS6496, Mouser demonstrates that we are committed to providing customers with only authorized, genuine components. From sales to shipping, Mouser is committed to providing our customers with the right product, on time, every time. Our mission is to be the source most preferred by engineers and buyers to design, prototype, test and manufacture electronics."

Mouser received the AS6496 accreditation in Fall 2018 from the Performance Review Institute (PRI), as part of the Counterfeit Avoidance Accreditation Program (CAAP). The CAAP audit was based on audit criteria (AC7403) created jointly by PRI, the Electronic Components Industry Association (ECIA) and aerospace OEM representatives.

CAAP is a cooperative industry effort to mitigate the risk of introducing counterfeit parts into the supply chain and the cost for compliance throughout the aviation, space and defense industries. The program was established to enable organizations like Mouser that purchase components and assemblies

Mouser Electronics' vice president of quality **Chuck Amsden**



Mouser stock associate identifies and pulls components

to demonstrate that they have systems in place to identify counterfeit products, and to minimize the risks associated with them. CAAP accreditation reassures customers of the organizations' vigilance and ability to act appropriately.

The threat of counterfeit components entering the supply chain has been a growing concern in recent years as demand increases and fake parts are harder to detect. That's why it's more important than ever to buy from an authorized distributor.

Mouser is also registered to AS9100D/ISO 9001:2015 and ANSI/ESD S20.20-2014, the industry's gold standards for quality, control and electrostatic discharge (ESD) protection. Mouser's AS9100D/ISO 9001:2015 Quality Management System adds additional aviation, space and defense industry requirements, including procedures and processes for the prevention of counterfeit parts. Registration to these standards provides customers with the confidence that Mouser is an authorized distributor of the highest quality components by providing traceability, risk management, process control, customer support, product availability, and document and record control.

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Understanding counterfeiting techniques and tests

As 4 Star explains, it's important for buyers to be wary of non-trusted sources and use risk-based analysis for vendor and test plan selection

Over the past 10 to 15 years several common types of counterfeiting stand out. Most counterfeits can be considered recycled parts, possibly with correct part numbers but refurbished by sanding and re-marking or blacktopping and re-marking. This is usually done to create a homogeneous lot, often marked with incorrect, higher rated characteristics such as speed and temperature ratings. Leads are typically refurbished or possibly re-attached. Such recycled parts are often subject to extreme environmental and ESD conditions and generally unreliable.

Counterfeiters may use part substitution schemes where good, working devices are substituted for other components. New components are re-marked, re-packaged and re-labeled to change their advertised specifications such as going from commercial to military grade. This results in functional parts that don't meet expected performance characteristics.

During component manufacturing processes, out of spec or defective parts are identified and segregated to be scrapped. However, sometimes, parts meant for destruction have been intercepted and placed back into the supply chain. These rejects appear good but will not function correctly.

Overproduction of parts, called a ghost shift or unrecorded production, occurs when an otherwise legitimate manufacturer over-produces parts beyond the contracted amount. These parts, hidden from the original component manufacturer (OCM), may contain inferior materials, be missing testing and sorting steps, and have been produced by untrained workers.

Sometimes, non-functional parts such as pre-production test parts or samples are used by counterfeiters to look like real parts. These parts are often produced by the OCM or their contract manufacturer, so they appear perfect, unused and unaltered. However, internally, they are usually incomplete and non-functional, missing bond wires and/or die. Such counterfeits can usually be detected by techniques such as x-ray or decapsulation.

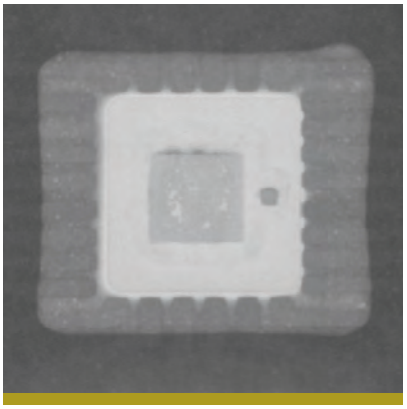
More sophisticated counterfeiting

When individual components are small and unmarked from the OCM, such as MLCCs and other surface mount passive devices, lesser specification parts or lower quality third-party manufactured parts are relabeled or repackaged to appear branded or higher specification. Because of their small size and relatively simple electrical characteristics, these substitutions may go unnoticed without high-level electrical or destructive testing and comparison against golden samples.

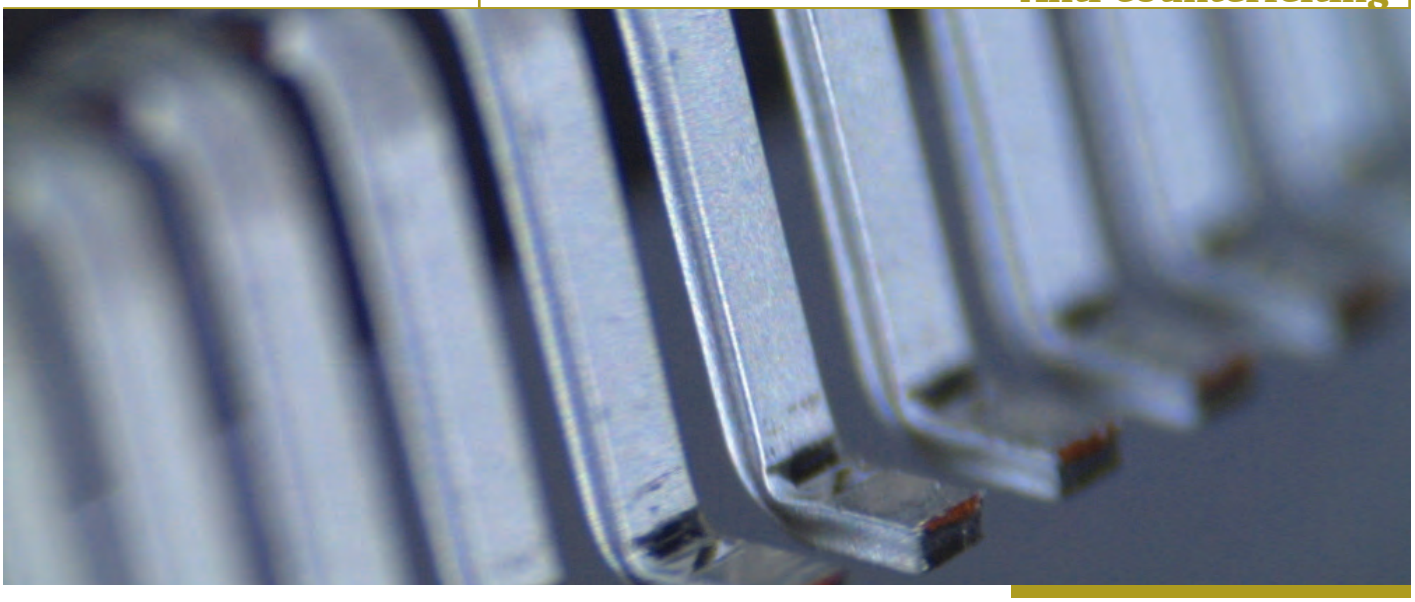
Clone devices, where counterfeiters illegally acquire intellectual property or reverse engineer OCM designs are effectively exact copies of an original device. Since they are newly manufactured, they pass the traditional surface and marking tests that simpler counterfeits do not. Most clones will pass basic electrical testing, so the best method of detection is building image databases of known-good die and x-ray images to compare with, or by performing full functional electrical testing across a range of specified temperatures.

A subset of clones, tampered parts, are more theoretical in nature. Tampered parts are basically sophisticated clones, based on complex parts like FPGAs. They have additional functionality added, such as the ability to record data or to relay information to a third party. While not widely found, such parts are suspected to be the work of government or state-sponsored participants with significant resources and

Resurfaced and blacktopped part after testing



Example of a good die



Example of good leads

technology. Like with clones, higher level comparative testing like x-ray and die examination are typically used for detection.

Solutions to counterfeiting

Buy smart. Know your vendors and understand who is authorized by the original component manufacturers to sell their parts. Purchasing from authorized sources is the safest way to avoid counterfeits.

When parts are unavailable from authorized sources with full certification and traceability, utilize an independent distributor with a certified in-house lab, or an outside test lab that specializes in counterfeit detection. Inspections and tests should be performed based on industry best practices and standards such as IDEA-STD-1010, AS6081, and AS6171. The basic requirements for testing include:

- Documentation and packaging inspection
- Researching of reported counterfeits on industry databases such as ERAI and GIDEP
- Detailed external visual inspection of components including comparison to manufacturer specifications
- Surface and marking analysis
- Radiological inspection (X-ray)
- Lead finish and material evaluation (XRF or EDS)
- Destructive internal analysis for die examination

Understanding counterfeits types, and the tests used to combat them, offers buyers a high level of assurance of getting good parts.

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> **Know your vendors and understand who is authorized by the original component manufacturers to sell their parts**

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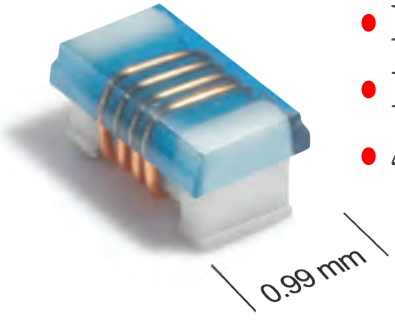

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Everyone is essential to recovery

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

In this article John Denslinger argues the best solution to a sustained recovery is a marketplace where all economic activity is seen as essential

Recovery • By John Denslinger

Essential versus non-essential must be one of the more disparaging labels applied to America's workforce and commerce in this new era of lockdowns. While I fully understand the good intentions safeguarding the health and well-being of the general population, the contrast should cease there. My take is that everyone is essential. Every opportunity to make a living is essential. Every business, big or small, is essential. Can anyone really argue each is indispensable to recovery, to growth, and to the absolute vitality of our industry?

The early decision in 2020 to lockdown a thriving economy created a staggering unemployment problem where more than 40 million people filed unemployment claims through May. Many were furloughed or temporarily laid off expecting a return to work soon. Others, not as fortunate, were immediately terminated and it's likely more will discover their jobs eliminated in the months ahead. The sheer magnitude can be summed in a recent *WSJ* article headline: Decade of job gains erased in April. No sector of the economy escaped this devastating ambush. If not for a massive work-from-home phenomenon, the unemployed casualty level would have been much worse.

Fortunately, the electronics industry was deemed essential early in the pandemic lockdown. Therefore, our employees, businesses and supply chains probably fared better than many of our customers and probably their customers as well. That is the point: customers are critical to our recovery. They are the ones creating demand. It takes a healthy customer base across all sectors of the economy to spur the type of growth needed for everyone to prosper, but according to Deutsche Bank only 30 to 40 per cent of lost output and employment in the US will be recovered by year end 2020. That means, near term, the road to recovery will be challenging.

So why make such a big deal about essential vs non-essential? In a word, demand. It is demand from essential activity that drives this wonderfully intricate, American economic engine. To the contrary, non-essential activity does not. In a recent Thomas Insights report, 64 per cent of the manufacturers surveyed said the shutdown of non-essential business negatively impacted overall demand. It further detailed the sectors most affecting the decline as transportation, automotive, construction and agriculture. Make no mistake, that is a lot of ground to make up in some rather large segments.

Naturally, we hold out hope for a quick V-shaped recovery, but a gradual (hockey-stick) rebound is more logical. Steepening the slope of the curve hinges on how quickly we apply 'essential' to all aspects of America's economic activity. Bottom line, we need every person working and every business operating to stimulate maximum demand for goods and services.

Granted, government stimulus programs helped immensely steadying the ship and providing a lifeline to employers and employees alike. Still, the best solution to a sustained recovery is free enterprise, resumption of domestic and international commerce, and marketplace equilibrium where all economic activity is once again seen as essential.

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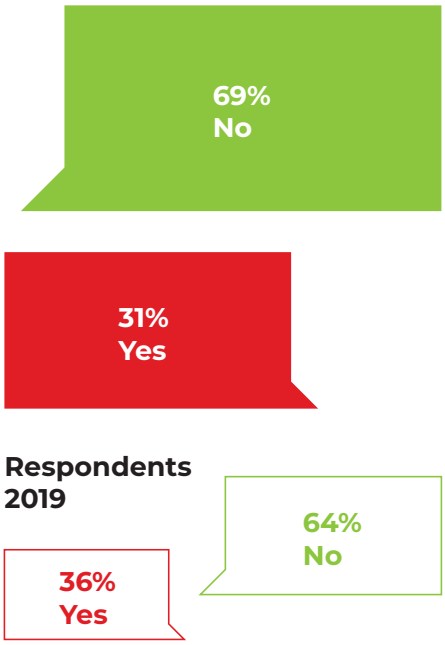
Q: Do you buy from brokers?

A:



Reading into the reader

Thomas Smart, special projects editor at **Electronics Sourcing's**

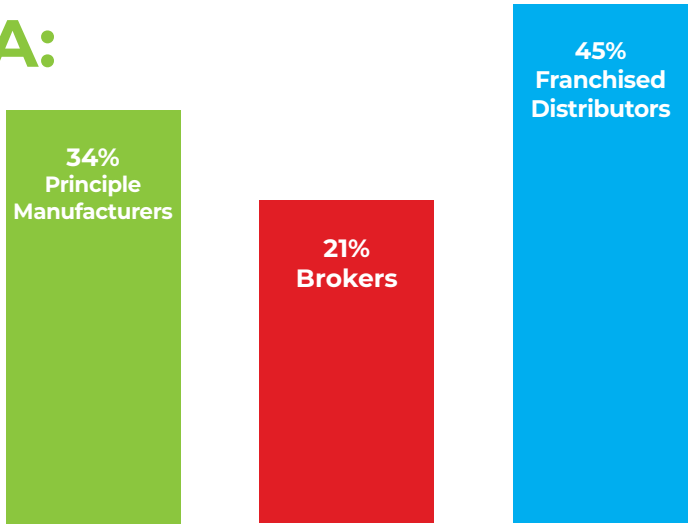
Electronics Sourcing's special projects editor, Thomas Smart, examines industry trends revealed in the magazine's latest annual reader survey

This year saw a consolidation of readers support for print, with 86 per cent preferring the printed publication. Only five per cent preferring the digital edition. Readers stated key benefits of print were bookmarking stories for future reference, the back catalogue of information and the ability to compare manufactures and distributors in the Buyers' Guide section.

Another emerging trend is purchasers' deepening relationship with design teams, with purchasers offering more input at early stages of the design process. This early involvement: helps prevent hard to find components reaching the bill-of-materials; reduces lead times and ensures preferred component manufacturers and distributors are used. On average, readers work with

Q: Please indicate the percent of business placed through...

A:



Respondents 2019

36% Principle Manufacturers
25% Brokers
39% Franchised Distributors

Q: What is your biggest concern with regard to sourcing electronic components in today's marketplace?

A:

Obsolescence

Tariffs and unforseen costs

Unreliable source, too many middlemen

Component alternatives too time consuming

Availability, price and lead time fluctuations

their design team on 12 projects per year, a 50 per cent increase on last year's survey.

Moving away from brokers

The survey highlighted a continual move away from brokers. Readers are placing 21 per cent of their business through brokers, compared with 25 per cent in 2019 and 27 per cent in 2018. Stated reasons for this decline included: diminished stock traceability; increased risk of counterfeit components entering the supply chain; and substandard, used or refurbished components.

Biggest industry concerns

Availability, price and lead times remain the three biggest purchasing concerns. An unforeseen issue which added to these concerns was the US vs China tariff war. Other concerns included: unreliable supply chains; obsolescence; finding alternative components, lack of stock on hand; EOL mitigation; counterfeits; disruptions in the supply chain; and factory moves.

Purchasers expand preferred suppliers and stick with them

Purchasers are increasingly relying on preferred suppliers when sourcing for new projects, with 76 per cent confirming they use a preferred supplier list, up from 71 per cent the previous year. Also, 48 per cent of those saying yes are seeing their list expand, while 27 per cent see it remain static and 25 per cent are seeing it decrease.

Which components will next generation air defense depend on?

TTI's VP military and aerospace segment, Roger Raley, examines the components and capabilities that future aircraft will rely on for safe, efficient operation

We are looking at a decade where over 10,000 defense aircraft are expected to be delivered worldwide. With those aircraft come amazing new capabilities, including unprecedented levels of networking and computing power.

Before the first of these new sixth-generation aircraft enters the arena, manufacturers have the challenge of choosing the high-quality, highly reliable components that enable these fighters, drones and support aircraft to carry out their missions.

Instead of waiting for newer technologies to evolve, the US Air Force's Next Generation Air Dominance (NGAD) program is focused on building the best jet fighter within a few years, utilizing technology that's currently in development. Thus, we can expect to see intense competition among aircraft manufacturers who will present initial designs, then refine them in hope of creating the sixth-generation fighter aircraft by 2030.

This presents a challenge to our industry: to create durable, advanced components for interconnect, sensing and RF communications. We know the capabilities sought-after in today's air defense systems, and we're familiar with the materials-selection and environmental challenges they face.

Based on general military trends, these challenges include the use of modular systems and components to reduce preparation and turnaround time between missions, and to easily upgrade airframes as new systems are developed.

Wholesale replacement of manned combat aircraft with unmanned vehicles isn't likely. However, next-generation air defense fighters will rely on the networking and communications systems found in UAVs. These aircraft will receive targeting and reconnaissance information from drones in a combat situation. In some cases, pilots might control those drones to defend the aircraft while the human crew completes a mission objective.

To support these design goals and new systems, electronic components suppliers will be expected to deliver:

- Connectors that withstand increased mating cycles and wiring harnesses that provide superior data speed with negligible noise and signal loss
- Sensors that deliver fast, accurate data and withstand vibration, temperature and pressure and RF
- Compact antennas that withstand flight conditions while maintaining constant connection with other aircraft, ground stations and satellites.

Next generation air defense will see individual aircraft becoming nodes in a network that encompasses the entire battle space, capable of sending and receiving data beyond the theater of operations. This means fighter aircraft may need to relay data not only from other aircraft and drones, but from ground forces and other allied units as well.

While UAVs will become more capable and widely relied-on, we still rely on human pilots and aircrew in defense. This will be especially true in a combat situation where the lives of warfighters and civilians are at stake.

Electronic components suppliers and distributors will play key roles in the development of the next generation of fighter aircraft. Not only will we supply more durable, lighter and more capable components, but we will learn and evolve our technologies in conjunction with manufacturers to meet the challenges of air defense in the 2020s and beyond.

ttiinc.com

TTI's VP military and aerospace segment, **Roger Raley**

While UAVs will become more capable and widely relied-on, we still rely on human pilots and aircrew in defense

Four times the capacitance

Kemet has extended its KC-Link range using Konnekt high-density packaging technology to meet growing demand for fast-switching wide bandgap semiconductors, EV/HEV, LLC resonant converters, and wireless charging applications.

This technology combines KC-Link's robust and proprietary C0G base metal electrode (BME) dielectric system with Konnekt's transient liquid phase sintering (TLPS) material to create a surface mount multi-chip solution suited for high-density packaging and high-efficiency applications, producing up to four times the capacitance compared to a single multi-layer ceramic capacitor.

Kemet vice president and technical fellow, Dr John Bultitude, said: "The low ESR results in best-in-class ripple current capability. Combined with Konnekt technology, this solution delivers thermal stability and mechanical robustness through increased efficiency by combining multiple capacitors into a single high density, ultra-low loss package."

www.kemet.com

Ready for space

New Yorker Electronics has released the new VPG foil resistors (model 303337) ultra-high precision military and space-grade resistor. These surface mount resistors suit demanding applications, such as when a precision resistor is required to quickly reach thermal equilibrium in circuits either requiring fast response times or experiencing rapid current changes.

Typical applications include commercial and military avionics; switching linear power supplies; power amplifiers; power management systems; feedback circuits; measurement instrumentation; and associated automatic test equipment.

The resistors are available in tolerances of 0.1, 0.2, 0.25, 0.5 and 1.0 per cent, based on project need. Model 303337 produces a precise voltage, directly proportional to measured current levels, with significantly reduced component sensitivity to applied power changes, including PCR and thermal resistance values.

www.newyorkerelectronics.com

Sensor market will decline four per cent in 2020

Overall weaker demand caused by the global coronavirus pandemic will negatively impact sensor demand

James Carbone

While sensors are being designed into more electronics equipment, sensors sales will decline this year for the first time in 11 years because of falling demand caused in large part by the COVID-19 pandemic.

Sensor revenue grew about three per cent to $9.4 billion in 2019 but will drop four per cent to $9 billion in 2020. However, the global sensors market will rebound next year when revenue rises 10 per cent to $9.9 billion, according to market researcher IC Insights. Unit shipments will also decline four per cent but increase 13 per cent from 25.3 billion this year to 28.6 billion in 2021, the researcher said. If unit shipments fall this year it will be the first time since the 1990s that sensor shipments declined.

"It is a little unusual for sensors to have a down year," said Rob Lineback, senior market analyst for IC Insights. "It runs against the general trend that we have seen over the last 10 years." Sensors revenue has increased every year since 2009.

While unit shipments and revenue will decline in 2020, pricing will be flat compared to last year. The average price for sensors will be $0.36, the same as 2019, according to IC Insights. Prices should decline in 2021, but buyers should not expect as much price erosion as in the past. The average price should decline about 2.1 per cent per year between 2019 and 2024 compared to a 5.1 per cent average from 2015-2019. By 2024, the average sensor price will be $0.32, according to IC Insights.

The sensor market, as well as the overall semiconductor market, is declining in large part due to COVID-19. Besides sickening and killing millions of people, coronavirus has ravaged the economies of many countries as companies have shut down or slowed production and laid-off millions of employees.

Automotive takes a hit

The automotive industry has been especially hard-hit as auto plants shut down lines for several weeks resulting in huge declines in demand for many electronic components, including sensors. Prior to the pandemic, "automotive had been weak," said Lineback. Global automobile shipments had declined about 3.9 per cent in 2019, according to auto industry researcher VDA. Another research firm, LMC Automotive said car sales will decline 20 per cent in 2020 because of the pandemic.

Prior to 2019, sensor demand had grown as more cars were designed with driver assistance capabilities and other systems that required sensors. The increase in the number of sensors in vehicles had offset weaker car sales in 2019, but a steep decline in car sales in 2020 will mean automakers will not need as many sensors and sensor sales will decline.

"The automotive market was already facing a production plateau before the pandemic, and COVID-19 further negatively impacted that trend," said Marcellino Gemelli, director of business development for Bosch Sensortec. Bosch is the number one sensor manufacturer in the world.

The slowdown in sensor demand by automotive won't be permanent and Bosch is continuing "to develop semiconductor and sensor technology that supports the further development of new vehicle technologies – like driver assistance systems to further increase safety and convenience," he said. Because of the trends

By the Numbers

8.2%
The compound annual growth rate for global sensor revenue from 2019 through 2024

-4%
The percentage that the global sensors market will decline in 2020

$0.36
The average selling price of a sensor in 2020

10%
The revenue growth rate for sensors in 2021

25.3 billion
The number of sensors that will be sold worldwide in 2020

$12.9 billion
The forecasted size of the worldwide sensors market in 2020

Source: IC Insights

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of increasing electrification and automation in vehicles, demand for chips, including sensors, in vehicles is expected to rise in the coming years, said Gemelli.

Sluggish sales of smart phones and consumer electronics equipment are also impacting sensors demand. "Smart phones have been a major sensor platform for growth," said Lineback. "It still is although the growth rate isn't as strong as the past," he said.

"We have 5G handsets coming up and there will be a lot more sensors in those," he said. It's unclear how quickly 5G handsets will grow in popularity, but smart phone unit shipments should recover in the second half of the year as markets get back to some kind of growth mode," said Lineback.

Besides smart phones, industrial electronics equipment uses sensors, which is helping to offset some weakness in the sensor market, said Lineback. Internet of Things applications and other automated control systems are using more sensors. The growth of artificial intelligence, and machine learning applications will also help drive sensor growth.

The industrial market is the biggest driver of sensors. It includes factory automation, commercial systems for logistics and medical equipment among others.

CE forecast is murky

Consumer electronics equipment including wearables and fitness devices is a major driver of sensors, but sensor demand from the segment has declined.

"On the consumer front, the 2020 forecast is very difficult to predict," said Gemelli. "The complex supply chains are under stress and while there has been a surge in sales of some consumer devices such as tablets to assist shelter-in-place education and remote office operations, we are also seeing signs of discretionary spending decreasing in other consumer electronics products," he said.

Previously expected growth for the consumer segment will not be reached, said Gemelli. In 2021, discretionary spending including spending on consumer, "will have a hard time recovering lost ground," he said.

The good news for sensor manufacturers is, despite the pandemic, there is decent if not robust demand for some sensors. Edoardo Gallizio, director of marketing, analog, MEMS and sensors group for STMicroelectronics, said there is healthy demand for pressure sensors, which are used in a wide variety of applications, ranging from ventilators to airbags in cars.

Pressure sensors revenue will decline four per cent this year, but rise about 11 percent in 2021, according to IC Insights.

Gallizio added there is strong demand for temperature sensors "especially for digital and high precision sensors." Temperature sensors are used in a wide range of applications including medical devices, automobiles, HVAC systems, and microphones, among other systems.

Emerging segments or sensors

Gemelli said Bosch is seeing a steady growth in the demand for inertial and barometric sensors in the "hearables" segment which includes TWS (True Wireless Speaker) as well as other wearable devices such as smartwatches," said Gemelli. He said end users will consume more digital media because of 5G connectivity which will serve as the " backbone to new services." Such media requires sensors.

"We will also be seeing the introduction of new media formats such as AR (Augmented Reality) that require an accurate motion detection of the users' heads and hands, primarily through interconnected MEMS motion sensors," Gemelli said. As connectivity services increase, there will also be more applications in the field of smart home (environmental monitoring) and smart industry (predictive maintenance), he said.

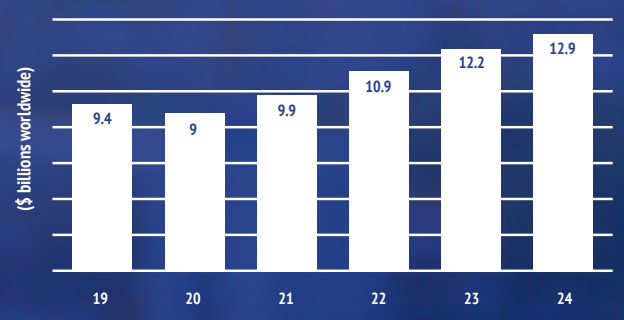
With overall sensor demand being weak this year, availability and capacity is not an issue and it probably won't be a problem for buyers in 2021 either when demand is expected to increase. Suppliers say they will be adding capacity to meet rising demand.

Currently, most sensors are made on 150mm wafers, but production will transition to 200 mm wafers over the next several years. Transitioning sensor production to larger size wafers "will boost worldwide capacity in the next growth cycle," said Lineback.

Bosch is finishing a 12-inch wafer fab in Dresden, Germany. The fab is actually not targeted to run MEMS sensors wafers, but it will free up capacity in the existing 6-inch and 8-inch wafer lines in Reutlingen, Germany, for sensors production, said Gemelli . "We will take the opportunity of this extra 8-inch capacity to expand our MEMS manufacturing capability if needed," he said.

Some suppliers are looking to make sensors using 300mm wafers in the next five years, but production yields must be "high right off the bat because of pricing pressures in most sensor product categories," he said. He added that 300mm wafers probably won't be used for sensor application until later this decade.

Sensors market will rebound



The worldwide sensors market will decline 4 per cent this year, but then grow steadily through 2024 when total revenue will reach 12.9 billion
Source: IC Insights

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Coronavirus adds to the sourcing challenges of medical industry buyers

Shutdowns and cutbacks in component production during the pandemic and unprecedented demand for medical equipment caused sourcing headaches for many medical OEM and EMS purchasers

Electronics purchasing in the medical equipment industry has always been challenging because of strict quality and regulatory requirements and long product lifecycles, but the recent coronavirus pandemic has made sourcing in the industry even more demanding.

Demand for medical equipment including ventilators, patient monitoring and anesthesiology equipment and other medical products increased during the pandemic. At the same time, many component manufacturers shutdowns factories or slowed production of semiconductors and other components needed by medical OEMs and their electronics manufacturing services providers.

As a result, there have been shortages and long lead times for a range of components, including processors, multilayer ceramic capacitors, field programmable gate arrays, and memory ICs. Medical equipment manufacturers have had to leverage their relationships with suppliers and purchase more products from distributors because of tight supply.

"We saw an unprecedented demand for devices important in the diagnosis and treatment of COVID-19 patients, such as ventilators, anesthesia equipment, patient monitors, CT and mobile X-ray systems," said Carrie Uhl, chief procurement officer for GE Healthcare. As a result, the medical equipment supply chain has been stretched with the incredibly high demand for parts," said Uhl.

"GE has been able to manage through supply issues by working directly with suppliers to understand the specific challenges they're facing," she said. "Our teams worked across the organization to understand and mitigate risks for each part and component in our supply chain to make sure we could continue to supply our customers with the equipment they needed," said Uhl.

Demand for medical equipment has also been a challenge for EMS providers building systems and subsystems for medical OEMs. One such provider is Jabil Circuit, based in St. Petersburg, Fla. Many of Jabil's healthcare customers are involved in either the prevention, identification, or treatment of COVID-19.

"As healthcare OEMs began responding to the increased worldwide demand on these products, Jabil experienced significant upsides and new orders," said Keith Lipinski, supply chain director, Jabil Healthcare. "As the world moved into partial lockdown, Jabil had to navigate through the complex network of constraints, identify materials needed to address COVID-19, and work to prioritize manufacturing centers as 'essential services' for healthcare production," said Lipinski.

Jabil has developed close relationships with key suppliers over the years and was able to get access to materials and capacity to meet production demands, he said. "Working together with our supply base, Jabil has been able to respond with speed, agility, and commitment to deliver product as quickly as possible," he said.

Unique challenges

Another EMS provider impacted by the surge in demand for medical equipment was Kimball electronics, headquartered in Jasper, Ind. Tom Ferris, director of medical EMS market for Kimball, said during the coronavirus pandemic, Kimball experienced increased demand from medical OEM customers "specifically for those related to respiratory care and patient monitoring products."

The pandemic presented sourcing challenges that usually don't occur during

> **We saw an unprecedented demand for devices important in the diagnosis and treatment of COVID-19 patients, such as ventilators, anesthesia equipment, patient monitors, CT and mobile X-ray systems**

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stable market conditions, said Ferris. During the pandemic, there have been short-term spikes in demand for some components used in medical equipment to treat COVID-19 patients.

The surges in demand have created "many challenges from a supply chain perspective to the overall market," said Ferris. "We leveraged our supply relationships with our component partners, our tools and processes, as well as our internal teams, to actively work solutions that fulfill our customers' needs," he said.

COVID-19 will likely be a temporary challenge for medical industry buyers as more component manufacturers are reopening and increasing production. Many analysts believe business will be back to normal next year. However, buyers at medical OEMs and EMS providers will continue to have unique supply chain challenges compared to buyers in other industries because of government regulations concerning medical products, long lifespans of medical equipment, and overall stricter quality requirements for parts used in medical equipment.

Ferris said medical OEM customers require the "highest quality and reliability" from EMS providers. He notes EMS providers serving medical OEMs must adhere to ISO 13485 requirements as well as U.S. Food and Drug Administration regulations. "Many are now expecting compliance to MedAccred and looking for operations adhering to Good Manufacturing Practices (GMP)," said Ferris.

MedAccred is an industry managed supplier quality accreditation program focusing on critical manufacturing processes whose goal is to improve the quality and consistency of medical devices. The MedAccred program is managed by the Performance Review Institute (PRI).

ISO 13485 is a global quality management system standard that spells out the practices companies must follow in the design and manufacture of medical products. Good manufacturing practices (GMP) are the practices required in order to conform to the guidelines recommended by agencies that control the authorization and licensing of the manufacture and sale of medical devices as well as other products such as pharmaceuticals and other products.

Rigorous qualification

Ferris said depending on the end product there may be more rigorous qualification for components used in medical products. Often components that are used in computer or industrial equipment are not allowed to be used in medical products because they do not meet the stringent durability, liability, and quality requirements of the medical equipment industry.

In many instances medical OEMs specify automotive grade components because of the rigidity of the testing requirements, said Ferris.

Medical industry buyers say strict quality requirements are all important because a defective part could result in a wrong diagnosis or the failure of a medical product which could result in death of the patient.

"What differentiates healthcare from other industries is our end customer is also the patient," said Lipinski. "Our product could have a major impact on someone's quality of life, so the burden to deliver a quality product on time could be arguably at the highest level given today's environment," he said.

Besides choosing suppliers that can build highly reliable parts on robust manufacturing processes, purchasers must also select suppliers that commit to producing components for 10 or more years. That can be challenging because the electronics industry is largely driven by the consumer market, which is different than the medical market, said Uhl.

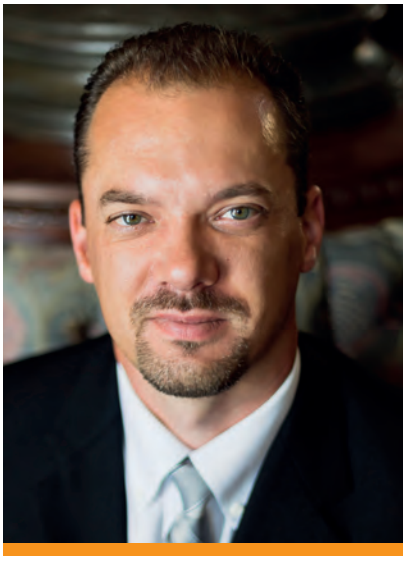
For instance, in the consumer market the rate of development of emerging technologies is very rapid and the lifespan of a consumer product is relatively short. "However, our medical products require a long application life," she said. Not all component manufacturers want to produce parts for years and volumes are small, especially if there is a limited number of customers for those components.

She notes that while the medical segment is growing, it represents a small percentage of the overall electronics market. As a result, "obsolescence management is key." said Uhl.

Because medical product lifecycles are long, most medical OEMs require EMS manufacturers to support components for up to five years post production of the product," said Ferris. "That same requirement flows through the supply chain to the component manufacturers," he said.

A significant gap

Lipinski said lifecycles of medical equipment are typically 10 to 12 years but have been often known to stretch well beyond that period.



Keith Lipinski, supply chain director, **Jabil Healthcare**

"As healthcare OEMs began responding to the increased worldwide demand on these products, Jabil experienced significant upsides and new orders

"When compared to electronic component life cycles which can range from 6 months to 7 years, there is a significant gap," he said. As a result, medical OEMs often need to commit to large last time buys to make sure they have enough parts to support manufacturing of medical products.

"Of course, this has always been a risky move without a crystal ball that sees market demands, regulatory changes, and the potential for component quality issues," said Lipinski. "It's often a balancing act on what is the right quantity, how long will it last, what will be next?"

Because of long product lifecycles, obsolescence is a critical issue that medical industry buyers must manage. Kimball's buyers must closely monitor and manage end-of-life and last time buy options, said Ferris. In some cases, Jabil will help customers redesign a product "to mitigate the impact of obsolescence." He added that in new product introduction, Kimball will work with medical OEMs to "expand the approve vendor list (AVL)" to make sure there are no single sources for components.

"We offer supply chain services and engineering services where alternate components can be recommended to be specified," said Ferris. He added Kimball tries to provide its medical OEM customers with solutions that consider cost, quality, risk, longevity of supply, and lead time of components for our customers.

"By optimizing the bill of materials with multiple sources for each component, we reduce the needs for future re-validation in cases of obsolescence," said Ferris.

Identifying risky parts

Uhl said part of GE's strategy to manage product obsolescence is to identify at-risk components and technology throughout the entire product lifecycle beginning with new product development. She said supply chain and sourcing teams are involved with new product development. "Our product teams bring together leaders from across GE Healthcare to ensure each aspect of the product lifecycle is considered, including strategic suppliers, manufacturability and serviceability across the life of the product—all of which impact total landed cost for the business," said Uhl.

The company has a process to effectively manage bills of material to avoid line down situations, unplanned re-designs and costly last-time buys, said Uhl. "The component lifecycle process is ingrained in our product DNA." Component lifecycle is reviewed during design, at new product introduction, bi-annual reviews throughout the life of the product, as well as with daily alerts on end of life notifications, according to Uhl.

Lipinski said there are several major trends in healthcare which will significantly change supply chain management and product development. Those trends include rapidly accelerating technology adoption, growth in aging population, value-based care, the consumerization of healthcare, and patient choice.

An aging population represents the highest percentage of healthcare spending and as a result, there is a move towards Value Based Care, which standardizes healthcare processes through best practices and including the mining of data and evidence to determine which processes work and which don't. Teams of doctors and healthcare professionals communicate with one another through the help of care coordinators to treat patients with more efficiency and less wasted time and effort.

As part of that effort the industry is moving quickly to integrate Internet of Medical Things applications and in-home therapy devices.

The Internet of Medical Things (IoMT) is the collection of medical devices and applications that connect to healthcare IT systems through online computer networks. IoMT devices, include such devices as heart monitors and pacemakers among other devices, collect and send patient health statistics over various networks to healthcare providers for monitoring, analysis, and remote configuration.

One example of IoMT is telemedicine in which patients are monitored at home and don't have to go to the hospital or doctor's office if they have a medical question or a change in their condition.

Other examples of IoMT include tracking patient medication orders and the ability to locate patients when they are in the hospital through the use of mHealth devices. IoMT applications are enabled by RFID and near field communication tags that can share information with IT systems.

Medical industry buyers will be challenged to find capable suppliers that produce highly reliable components for telemedicine devices at a competitive cost.

Tom Ferris, director of medical EMS market for **Kimball Electronics**

> **We leveraged our supply relationships with our component partners, our tools and processes, as well as our internal teams, to actively work solutions that fulfill our customers' needs**

Manufacturer	Distributor	Telephone	Website	Franchised Distributor (Y/N/M)	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	Pack and Hold
ACOUSTIC COMPONENTS											
BeStar Electronics Ind. Co. Ltd.	BeStar Technologies Inc.	520-439-9204	www.bestartech.com	Y	N/A	$250,000	N/A	100.00%	50	900	Y
CABLE & WIRING											
3M	Mouser Electronics	800-346-6873	www.mouser.com	Y	23235	N/A	$0	0.46	50	1,000+	Y
Alpha Wire	Mouser Electronics	800-346-6873	www.mouser.com	Y	8,106	N/A	$0	93.00%	50	1,000+	Y
Belden Wire & Cable	Mouser Electronics	800-346-6874	www.mouser.com	Y	5,863	N/A	$0	97%	50	1,000+	Y
Molex	ECCO	773-767-2200	www.eccoconnectors.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Molex	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
TE Connectivity	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
CIRCUIT PROTECTION											
Bel Fuse	Bel Fuse	+1 201 432 0463	belfuse.com/circuit-protection	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bourns	Mouser Electronics	800-346-6873	www.mouser.com	Y	4,462	N/A	$0	68.00%	50	1,000+	Y
Eaton	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
EPCOS	Mouser Electronics	800-346-6873	www.mouser.com	Y	3,487	N/A	$0	100%	50	1,000+	Y
Littelfuse	Mouser Electronics	800-346-6873	www.mouser.com	Y	28,790	N/A	$0	67%	50	1,000+	Y
Schurter	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Vishay	Mouser Electronics	800-346-6873	www.mouser.com	Y	31,445	N/A	$0	68%	50	1,000+	Y
DISPLAYS & LEDs											
BIVAR	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Broadcom	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Cree	Mouser Electronics	800-346-6873	www.mouser.com	Y	12,390	N/A	$0	99.00%	50	1,000+	Y
Dialight	Mouser Electronics	800-346-6873	www.mouser.com	Y	6,179	N/A	$0	84.00%	50	1,000+	Y
Displaytech	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Electronic Assembly	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Kingbright Company, LLC	Mouser Electronics	800-346-6873	www.mouser.com	Y	301	N/A	$0	100.00%	50	1,000+	Y
Lumileds	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Newhaven Display	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Osram Opto Semiconductors	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,690	N/A	$0	100.00%	50	1,000+	Y
VCC	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Vishay	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
ELECTROMECHANICAL											
ALPS	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Apem, Inc.	Mouser Electronics	800-346-6873	www.mouser.com	Y	4,326	N/A	$0	83.00%	50	1,000+	Y
C&K Switches	Mouser Electronics	800-346-6873	www.mouser.com	Y	27,230	N/A	$0	90.00%	50	1,000+	Y
E-Switch	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Grayhill	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Honeywell	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
IXYS	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Keystone Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y

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ELECTROMECHANICAL *(Continued)*											
NKK Switches	Mouser Electronics	800-346-6873	www.mouser.com	Y	13,976	N/A	$0	86.00%	50	1,000+	Y
Omron	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Panasonic	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Phoenix Contact	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
PUI Audio	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Schneider Electric	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Sensata	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
TE Connectivity	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Teledyne Relays	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
ENCLOSURES											
Bud	ECCO	773-767-2200	www.eccoconnectors.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bud Industries	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,325	N/A	$0	80.00%	50	1,000+	Y
Hammond Manufacturing	Mouser Electronics	800-346-6873	www.mouser.com	Y	2,839	N/A	$0	82%	50	1,000+	Y
New Age Enclosures	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
FREQUENCY MANAGEMENT											
Abracon Corporation	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,780	N/A	$0	100%	50	1,000+	Y
CTS Electronic Components	Mouser Electronics	800-346-6873	www.mouser.com	Y	3,889	N/A	$0	100%	50	1,000+	Y
ECS Inc	Mouser Electronics	800-346-6873	www.mouser.com	Y	2,070	N/A	$0	100%	50	1,000+	Y
Epson Toyocom	Mouser Electronics	800-346-6873	www.mouser.com	Y	178	N/A	$0	100%	50	1,000+	Y
IQD Frequency Products	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Kyocera	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Silicon Labs	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
ICs & SEMICONDUCTORS											
Analog Devices, Inc	Mouser Electronics	800-346-6873	www.mouser.com	Y	18,749	N/A	$0	95%	50	1,000+	Y
Broadcom Limited	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Central Semiconductor	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Central Semiconductor Corp.	Future Electronics	(800) 675-1619	www.futureelectronics.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	Y
Cree, Inc.	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Cypress Semiconductor Corp	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,325	N/A	$0	81.00%	50	1,000+	Y
Digi International	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Diodes Incorporated	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
FTDI	Mouser Electronics	800-346-6873	www.mouser.com	Y	94	N/A	$0	100%	50	1,000+	Y
IDT (Integrated Device Technology)	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Infineon	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,580	N/A	$0	63%	50	1,000+	Y
Intel	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
ISSI	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
IXYS	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Lattice	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
MACOM	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Maxim Integrated	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Microchip	Mouser Electronics	800-346-6873	www.mouser.com	Y	5,800	N/A	$0	100%	50	1,000+	Y
Microsemi	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Monolithic Power Systems (MPS)	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Nexperia	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
NXP	Mouser Electronics	800-346-6873	www.mouser.com	Y	7,205	N/A	$0	100%	50	1,000+	Y
ON Semiconductor	Mouser Electronics	800-346-6873	www.mouser.com	Y	7,486	N/A	$0	96%	50	1,000+	Y
Power Integrations	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Qorvo	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Renesas Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
ROHM Semiconductor	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
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Silicon Laboratories Inc	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,141	N/A	$0	100.00%	50	1,000+	Y
Skyworks	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
ST Microelectronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	8,145	N/A	$0	96.00%	50	1,000+	Y
Swissbit	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Texas Instruments	Mouser Electronics	800-346-6873	www.mouser.com	Y	29,676	N/A	$0	94%	50	1,000+	Y
Toshiba	Mouser Electronics	800-346-6873	www.mouser.com	Y	800	N/A	N/A	N/A	N/A	N/A	Y
Vishay	Mouser Electronics	800-346-6873	www.mouser.com	Y	53,781	N/A	$0	77%	50	1,000+	Y

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INTERCONNECTION											
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Aero Conesys	ECCO	773-767-2200	www.eccoconnectors.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Amphenol	ECCO	773-767-2200	www.eccoconnectors.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Amphenol	Mouser Electronics	800-346-6873	www.mouser.com	Y	165,853	N/A	$0	31%	50	1,000+	Y
Anderson Power Products	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Aptive (Delphi)	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Bel Magnetic Solutions	Bel Fuse	+1 858 676 9650	belfuse.com/magnetic-solutions	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cinch	ECCO	773-767-2200	www.eccoconnectors.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cinch Connectivity/Bel	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Cinch Connectivity Solutions	Bel Fuse	+1 507 833 8822	+1 507 833 8822	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ERNI Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
FCI	Mouser Electronics	800-346-6873	www.mouser.com	Y	3,394	N/A	$0	73.00%	50	1,000+	Y
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Harwin	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Hirose Electric	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
ITT Cannon	ECCO	773-767-2200	www.eccoconnectors.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ITT Cannon	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
JAE Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	6,02	N/A	$0	100%	N/A	N/A	Y
JST	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
LEMO	LEMO	800-444-5366	www.lemo.com	M	N/A	N/A	N/A	N/A	N/A	1,500	N/A
LEMO	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Mill-Max	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Molex	Mouser Electronics	800-346-6873	www.mouser.com	Y	85,634	N/A	$0	89%	50	1,000+	Y
Neutrik	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,563	N/A	$0	100%	50	1,000+	Y
NorComp	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Phoenix Contact	Mouser Electronics	800-346-6873	www.mouser.com	Y	30,044	N/A	$0	77.00%	50	1,000+	Y
Radiall	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Souriau	Mouser Electronics	800-346-6873	www.mouser.com	Y	10,744	N/A	$0	27%	50	1,000+	Y
Stewart Connector	Bel Fuse	+ 1 717 235 7512	belfuse.com/stewart-connector	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Switchcraft Corporation	Mouser Electronics	800-346-6873	www.mouser.com	Y	300	N/A	$0	55%	50	1,000+	Y
TE Connectivity	Mouser Electronics	800-346-6873	www.mouser.com	Y	123,613	N/A	$0	69%	50	1,000+	Y
OBSOLESCENCE / HARD TO FIND											
	Lantek Corp.	973-579-8100	www.lantekcorp.com	M	186,000	$22M	$0	75.00%	5	62	Y
	Chip 1 Exchange USA, Inc.	949-589-5400	www.chip1.com/es	Y	850,000	N/A	$0	85%	20	150	
	Rochester Electronics	978-462-9332	www.rocelec.com	Y		N/A	$250		10	400+	Y
OPTO ELECTRONICS											
Broadcom	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Cree	Mouser Electronics	800-346-6873	www.mouser.com	Y	582	N/A	$0	99.00%	50	1,000+	Y
Finisar	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Osram Opto Semiconductors	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,927	N/A	$0	99%	50	1,000+	Y
ROHM Semiconductor	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Vishay	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
PASSIVES											
ABRACON	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
AVX	Mouser Electronics	800-346-6873	www.mouser.com	Y	42,454	N/A	$0	72%	50	1,000+	Y
Bourns	Mouser Electronics	800-346-6873	www.mouser.com	Y	38	N/A	$0	78%	50	1,000+	Y
Cornell Dubilier	Mouser Electronics	800-346-6873	www.mouser.com	Y	24,145	N/A	$0	71%	50	1,000+	Y
Coilcraft	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
EPCOS	Mouser Electronics	800-346-6873	www.mouser.com	Y	26,533	N/A	$0	98.00%	50	1,000+	Y
Fair-Rite	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Kemet	Mouser Electronics	800-346-6873	www.mouser.com	Y	77,568	N/A	$0	66%	50	1,000+	Y
KOA Speer	Mouser Electronics	800-346-6873	www.mouser.com	Y	34,078	N/A	$0	58%	50	1,000+	Y
Murata	Mouser Electronics	800-346-6873	www.mouser.com	Y	33,780	N/A	$0	99%	50	1,000+	Y
Nichicon	Mouser Electronics	800-346-6873	www.mouser.com	Y	20,389	N/A	$0	84.00%	50	1,000+	Y
Ohmite	Mouser Electronics	800-346-6873	www.mouser.com	Y	14,293	N/A	$0	55.00%	50	1,000+	Y
Panasonic Electronic Components	Mouser Electronics	800-346-6873	www.mouser.com	Y	14,948	N/A	$0	100.00%	50	1,000+	Y
Signal Transformer	Bel Fuse	+1 516 239 5777	belfuse.com/signal	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Taiyo Yuden	Mouser Electronics	800-346-6873	www.mouser.com	Y	4,620	N/A	$0	98.00%	50	1,000+	Y

Buyers' Guide

Manufacturer	Distributor	Telephone	Website	Franchised Distributor (Y/N/M)	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	Pack and Hold
PASSIVES *(Continued)*											
TDK	Mouser Electronics	800-346-6873	www.mouser.com	Y	6,663	N/A	$0	100.00%	50	1,000+	Y
TT Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
United Chemi-Con (UCC)	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Vishay	Mouser Electronics	800-346-6873	www.mouser.com	Y	102,917	N/A	$0	64.00%	50	1,000+	Y
Wurth	Mouser Electronics	800-346-6873	www.mouser.com	Y	934	N/A	$0	99.00%	50	1,000+	Y
Yageo Corporation	Mouser Electronics	800-346-6873	www.mouser.com	Y	18,246	N/A	$0	100.00%	50	1,000+	Y
POWER & BATTERIES											
Artesyn Embedded Technologies	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Bel Power Solutions	Bel Fuse	Power & Batteries	belfuse.com/power-solutions	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cincon	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Cosel	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
CUI Inc.	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Delta Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
MEAN WELL	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Mornsun	+1-978-567-9610/+1-978-293-3923		www.mornsunamerica.com			N/A	$0	100%	N/A	2000+	Y
Murata	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Phihong	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Phoenix Contact	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
RECOM	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Schaffner	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Texas Instruments	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
TDK Lambda	Mouser Electronics	800-346-6873	www.mouser.com	Y	405	N/A	$0	80.00%	N/A	N/A	Y
TRACO Power	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Vicor	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
REED SWITCHES											
HSI Sensing	HSI Sensing	405-224-4046	www.hsisensing.com	M	75	N/A	$200	100.00%	15	275	N
SENSORS											
ams	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Analog Devices Inc.	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Bosch	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Honeywell Sensing and Control	Mouser Electronics	800-346-6873	www.mouser.com	Y	12,059	N/A	$0	64.00%	50	1,000+	Y
Littelfuse	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Maxim Integrated	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,379	N/A	$0	45.00%	50	1,000+	Y
Melexis	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Microchip	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
NXP	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
ON Semiconductor	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Omron	Mouser Electronics	800-346-6873	www.mouser.com	Y	4,915	N/A	$0	59.00%	50	1,000+	Y
Sensirion	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
STMicroelectronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
TDK	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
TE Connectivity	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Texas Instruments	Mouser Electronics	800-346-6873	www.mouser.com	Y	914	N/A	$0	65.00%	50	1,000+	Y
SWITCHES & KEYBOARDS											
OTTO	ECCO	773-767-2200	www.eccoconnectors.com	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TEST & MEASUREMENT											
B&K Precision	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Fluke	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,008	N/A	$0	94.00%	50	1,000+	Y
Keysight	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Lascar Electronics		814-835-0621	www.lascarelectronics.com	Y	130	$602,000	$0	100%	10	175	Y
Tektronix	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Teledyne LeCroy	Mouser Electronics	800-346-6873	www.mouser.com	Y	194	N/A	$0	96.00%	50	1,000+	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
Pektron	1-248-677-4838	www.pektron.com	$66m	Michigan & UK	350	8	ISO9001, ISO14001, TS16949, BEAB, VCA, TUV, UL	Y	Y	Y	Y	Y	Y

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