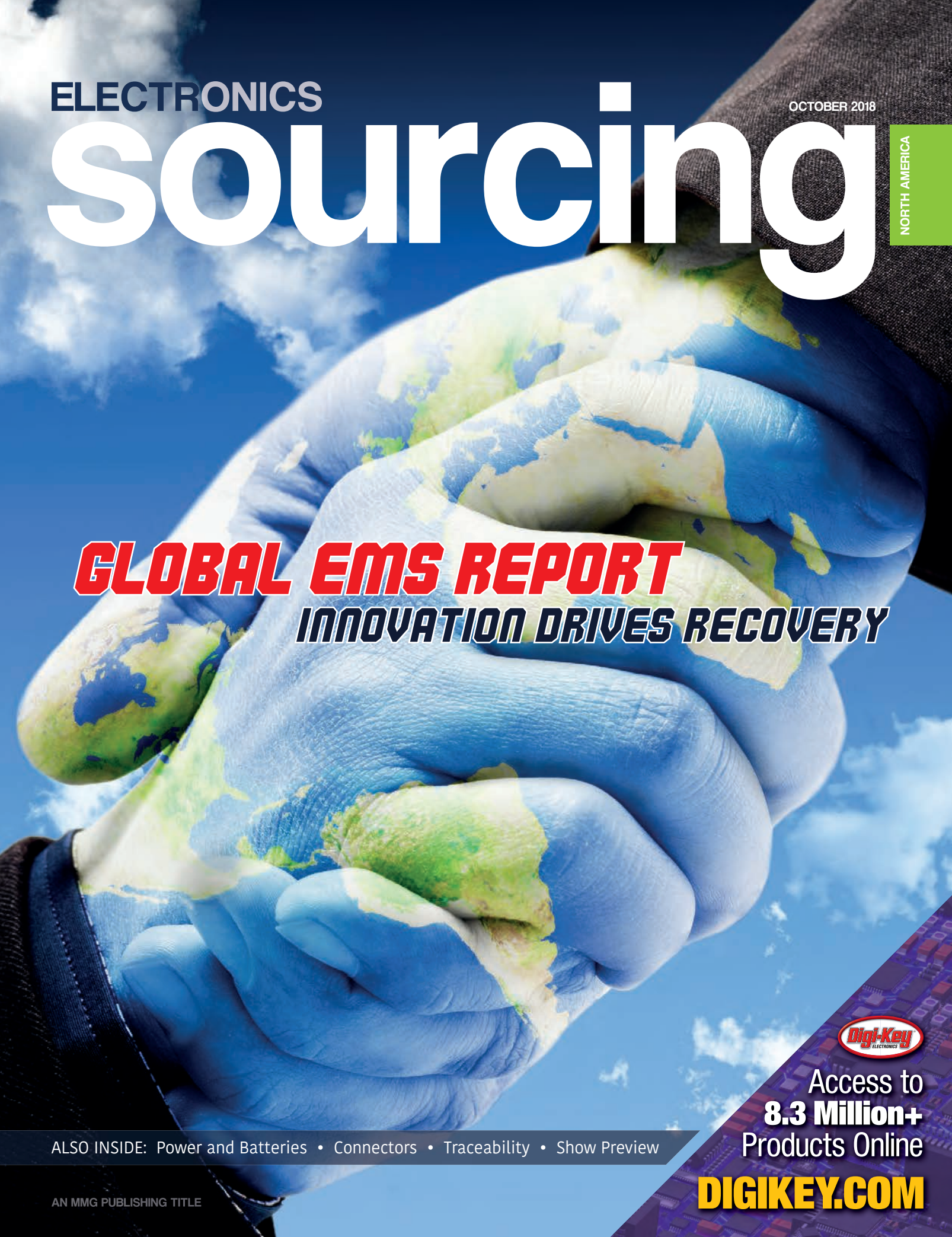
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GLOBAL EMS REPORT
INNOVATION DRIVES RECOVERY

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On the cover – October 2018

Global EMS Report: Innovation drives recovery

page 10

Contents

04
Global Economy
Pressures mount as trade wars continue

06
News
Replication eliminates requalification costs

16
Power and Batteries
Avoiding the cost of failure

30
Supply Chain
Real-time tracking sheds new light

42
Buyers' Guide
All the facts and figures to help you buy

Contact

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What are the alternatives?

Imagine a world where a bill-of-materials remained fixed for life, only archived when the product reached its end-of-life. How relaxing would that be? Sadly, annoying issues like technology change, customer demand, obsolescence and allocation mean that most bills-of-materials are rather more 'fluid'.

So, what are the options when alternative components must be sourced? Finding appropriate alternative parts is undoubtedly an unwelcome task that saps time and resources. However, it needn't be a disaster. The best solution depends on the nature of the component, the reason it is unavailable and knowing who and what to ask.

For example, asking the device manufacturer itself for advice on forward, backward and sideways compatibility is a good start point, provided they are accessible. Moving to the distribution channels, there are a range of options. A niche distributor is likely to offer the benefit of decades of cross referencing experience backed by a library of technical documentation.

Larger, national, distributors will have specialist field applications engineers who have been trained by the device manufacturers to make assessments and recommendations.

Looking to the catalogue distributors, options range from fully automated BoM scrubbing software to semiautomated parametric comparison tools.

Finally, you could just outsource the problem to a CEM or kitting company.

Due to the importance of this subject we have commissioned our technical editor to write a detailed article on alternative sourcing, comparing the benefits and limitations of each technique.

Jon Barrett

Pressures mount *as* global trade wars continue



Victoria Kickham is a freelance writer specializing in manufacturing, distribution and supply chain issues

Buyers should expect higher prices, longer lead times through the end of the year as demand remains strong and the threat of tariffs looms

Global Economy • By Victoria Kickham

Supply chain pressures continued into the fall, as businesses grappled with the ongoing global trade wars and impending tariff-related activity. Price increases are among the greatest concerns in the North American manufacturing sector, where raw material and component prices have been steadily increasing. As of August, the Institute for Supply Management's Prices Index had increased for the 30th straight month, for example. Although the increase had slowed somewhat compared with July, buyers across a range of industries reported paying more for a wide range of materials, including electronic components. And while pricing pressures continued to varying degrees elsewhere in the world, many organizations continue to blame tariffs—or the threat of them—for the growing cost of keeping up with business demands.

In an early September report on the manufacturing outlook in the Eurozone, economist at IHS Markit, Chris Williamson, said: "Worries about trade wars and the damaging impact of tariffs, as well as Brexit and other political worries, all contributed to a dampening of business optimism about the year ahead. On the price front, input cost pressures remained elevated, despite the rate of inflation easing to a three-month low."

IHS pointed to similar concerns in the United States, with tariffs and trade wars commonly cited as factors behind companies building safety stocks of inputs to ensure supply or lock-in lower prices, exacerbating supply shortages and also driving prices even higher. In a separate September report on the US manufacturing outlook, Williamson added: "Almost two-thirds (64 per cent) of companies reporting higher input prices explicitly blamed tariffs as the cause of increased costs. Almost one-in-three went on to cite tariffs as the cause of having to hike prices to customers."

The situation remained fluid in the electronic components industry heading into the fall. Digi-Key's president and chief operating officer, Dave Doherty, said the tariffs have not had as direct an impact on the company as he would have expected by now and that Digi-Key will only pass along costs that touch it directly. He says he is more concerned about the growing list of end products affected by the tariffs and how that will play out among Digi-Key's customer base.

Doherty said: The full impact [of the tariffs] is yet to come, but it's clearly building. If there's a warning sign on the horizon, it is the tariffs on end products. Could [the tariffs] dampen the demand for our customers' products, then dampen the need for the electronic components required to produce their products? That's something I'm keeping an eye on."

As of early September, the United States had threatened to impose another round of tariffs on $200 billion worth of Chinese goods, with China threatening reciprocal moves.

Avnet's global president, electronic components, Phil Gallagher, agrees that the tariff situation remains a moving target. Over the summer Phil said: "We're deciphering a lot right now," adding that, like others, Avnet will pass the cost of tariffs through to the customer. Phil added: "So far, the industry is navigating through it. We'll get through it. We always do."

Despite pricing concerns, buyers in the manufacturing community agree that business remains strong and is likely to continue on that path into 2019. Buyers surveyed for ISM's monthly *Report on Business*, for instance, continued to cite an increase in new orders and production levels throughout the summer, and also noted low unemployment levels across the industry. Such strong demand is affecting the channel's ability to keep supply lines flowing—another situation suppliers and distributors say they expect will continue into 2019.

Doherty said: "We're still seeing [that] lead times are not coming back in at all. Our suppliers are saying it will be [the first or second quarter of 2019]. Our customers should be cautious that there's still strong demand in the market overall."

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N ES News

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Replication eliminates requalification costs

Rochester Electronics and Analog Devices have teamed up to help customers avoid the high cost involved in requalifying existing products by replicating an obsolete ADSP-2101 digital signal processor.

After the DSP went to end of life status, Rochester Electronics worked with ADI and an industrial customer to replicate the device to satisfy existing production requirements. Initially demand was satisfied with existing wafers, die and finished goods material. Once this was exhausted, Rochester Electronics was supplied with the source design, technology and test databases to efficiently replicate and then ship the device, only nine months after receiving the intellectual property. This effort kept the customer's production schedule on time.

To achieve this streamlined approach Rochester Electronics' device replication process eliminates the time required to redesign, requalify or recertify older designs. Instead it utilizes original manufacturer authorized IP to create a device that is form, fit and functionally equivalent to the original device with no software changes necessary.

www.rocelec.com



Certification highlights commitment to quality

Provider of high reliability and harsh environment interconnect solutions, Ametek SCP, has undergone multiple audits to update its ISO certification to ISO9001:2015.

Preparation for the audits included a review of operating procedures and work instructions to ensure that they align with Ametek quality policies. Senior leadership also presented a long-term strategic plan and demonstrated the procedures used to collaborate and coordinate with other Ametek sites on team efforts. Overall, the lead auditor was impressed with the level of professionalism and commitment demonstrated by the entire Ametek team.

Commenting, engineered interconnects and packaging business unit vice president, Liam Shanahan, said: "We are very pleased, and our customers should be as well, that the audits highlighted our team's commitment to delivering high-quality products, as demonstrated by the strong positive feedback we received from our auditor."

Among the areas of excellence noted by the auditor were leadership commitment and engineering.

www.ametek.com



Multi-sensor simplifies predictive maintenance

Mouser Electronics is now stocking the Bosch Connected Industrial Sensor Solution, a robust, multi-sensor device designed to enable internet of things applications in harsh environments.

Integrated within this microelectromechanical multi-sensor solution are: a gyroscope, accelerometer, magnetometer, temperature/humidity/air pressure sensor, microphone and light sensor. Engineers can activate or deactivate each sensor individually and configure the sensors' sampling rates and thresholds to suit a variety of applications. Features include a 32-bit Arm Cortex-M3 microcontroller with 1MByte of internal flash, a Bluetooth low energy radio and USB connectivity for data transmission.

Ideal for integration in a range of hardware-agnostic gateways and clouds, the CISS provides valuable data to optimize maintenance processes and enhance productivity. It is ideal in Industry 4.0 applications including preventative maintenance, industrial retrofitting, digital twinning and condition monitoring.

www.mouser.com

Agreement increases antenna access

KP Performance Antennas has signed Ontario-based Crossover as an authorized stocking distributor covering North America. Through Canadian company, Crossover, purchasers will have access to the KP antenna range, which offers complete solutions for wireless network needs from the tower to the subscriber. The full range includes a portfolio of sectors and omni antennas compatible with most popular radio platforms, through to options for improving overall network performance on the subscriber side with a complete line of reflectors, parabolics and yagi antennas.

Crossover executive vice president, Darin Gibbons, commented: "KP has an excellent reputation in the service provider community. We're excited to support clients with stock of KP's base station and subscriber antennas, including its offerings in the license-exempt bands."

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N ES News

In Brief

Designed for collaboration
Analog Devices has begun work on its new global headquarters in Wilmington, Mass. The expanded facility will feature new laboratories, design and manufacturing and cross-functional collaboration space. In addition to 13,700m² for research and development, the site will include a 4,700m² hub designed to encourage employees from all departments to connect and innovate.
www.analog.com

Ahead on quality
StratEdge has achieved ISO 9001:2015 certification for the design, production, and assembly of its high-performance semiconductor packages for microwave, millimeter-wave, and high-speed digital devices. As a company that manufactures high-precision, high-frequency packages, StratEdge aims to stay ahead of the curve in its capabilities, practices and procedures. This certification validates that process.
www.stratedge.com

Optocoupler is automotive grade
TTI has introduced an AEC-Q101 qualified phototransistor optocoupler from Vishay. The VOMA617A combines a high current transfer ratio of 50 to 600 per cent with low 5mA forward current, ideal for automotive system control applications. Supplied in a SOP-4 package, the device boasts a 30 per cent PCB real estate saving compared to a DIP-4 package.
www.ttieurope.com

Fab doubles 6in SiC capacity
X-FAB Silicon Foundries plans to double the capacity of its six-inch silicon carbide process at its Lubbock, Texas fab in response to increased demand for high efficiency power semiconductors. In preparation, X-FAB has purchased a second heated ion implanter, which will facilitate an expected production release in Q1 2019.
www.xfab.com

Call for clarity on Prop 65

The ECIA's global industry practices council has compiled information to encourage members to consider measures surrounding Proposition 65 in California. Described as the Safe Water and Toxic Enforcement Act, Proposition 65 covers over 900 substances that have been identified as a risk to public health, including over 100 substances found in electronic components and products.

According to the advisory, the law has engendered a substantial increase in litigation. Over $25 million in settlements were awarded in 2017 and litigation is expected to nearly double that in 2018 following tougher labeling and warning requirements approved in 2016 for products manufactured after 30 August and sold in California.

The ECIA global industry practices council and its environmental subject matter expert group have found that current written positions may not fully reflect the requirements of the law, the substance list, or the required toxicology data.
www.ecianow.org

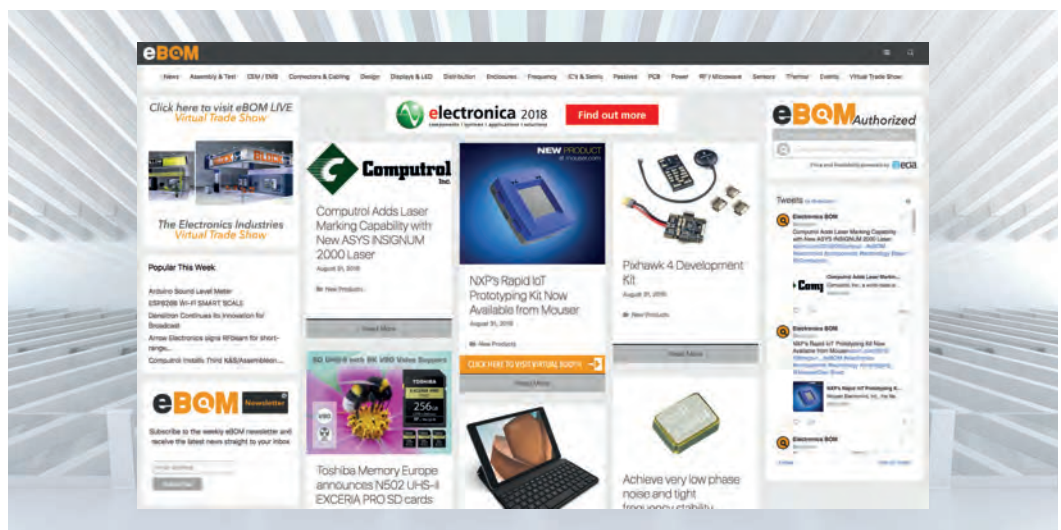
Making medical power a priority



Sager Electronics is now stocking Mean Well's MFM series five to 30W AC/DC medical grade power supply. This high density, on-board supply features operation from 80 to 264V AC, a low no load power consumption less than 0.075W and efficiency of up to 91 per cent. It also boasts Class II double insulation, 5G anti-vibration, high EMC performance and 4kV AC isolation. The design observes IEC/EN60601-1 and ANSI/AAMI ES60601-1 third edition, with two times MOPP isolation and ultra-low leakage current of less than 80µA. All this means typical applications for the MFM series include portable medical devices, mobile clinical work stations, medical computer monitors and medical examination instruments.
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Find out what's new at eBOM.com, the recently created website designed to cover all aspects of the electronics industry. Alongside news, new product releases and technical papers, the site's eBOM Authorized price comparison tool enables users to search, compare and purchase the lastest electronic products instantly.

So, what else is new at eBOM.com? Due to increased worldwide traffic, the site now features a 'select language' option, allowing users to choose from over 100 languages. Ease-of-use has also been enhanced with a clearer horizontal menu bar to improve navigation and bold 'read more' buttons on press releases.

Lastly, visitors will find a new 'events' page with details of the events at which eBOM will be exhibiting in the coming years. On November 13 to 16 2018, for example, eBOM will be exhibiting at Electronica on stand C5400 – come say hi!
eBOM.com

MLCC Shortage Information

Section 301 Tariff Developments

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TTI MarketEYE now has two new special sections to give you access to current information concerning the two hottest topics in the industry – the **MLCC shortage** and **Section 301 Tariffs**. In these sections you'll find the latest governmental, industry, and media reports on the subjects, as well as coverage and analysis from TTI's MarketEYE subject matter experts.

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Innovation drives CM recovery

Over recent years, contract manufacturing has been in decline. Findings, however, reveal a recovery fueled by new technologies such as wireless infrastructure, as well as the continued rise of the ubiquitous smart phone

The findings published in New Venture Research's annual electronics manufacturing services report, *The Worldwide Electronics Manufacturing Services Market 2018 Edition*, make encouraging reading. Over the course of 2017, the worldwide contract manufacturing services market increased by 10.8 per cent in total revenue, resulting in a combined electronics manufacturing services and original design manufacturer revenue of $471 billion. So after some years of decline, it seems the CM market recovered substantially in 2017.

Recovery drivers

To identify these key trends, the report examines the leading 100 EMS and ODM suppliers across 52 countries, looking at 48 product industries and more than 900 manufacturing locations. From this research, New Venture reveals the CM market was sustained by strong demand for smart phones, which resulted in an increase in assembly revenue of $14 billion in 2017.

Other strong growth areas include wireless infrastructure, where capital spending exceeded an additional $3 billion in orders in 2017 as carriers prepare for the next-generation 5G networks. Enterprise LAN system assembly were also strong in 2017, with cloud computing prompting demand for distributed data centers worldwide.

Thanks in part to these growth segments, the industry was profitable for the eighth year in a row, coming in at $8.4 billion for 41 EMS public companies and 18 ODM public companies. Foxconn remans the giant of the industry, accounting for nearly half of all the money made by the EMS industry in 2017 and EMS companies accounting for approximately 78 per cent of the total.

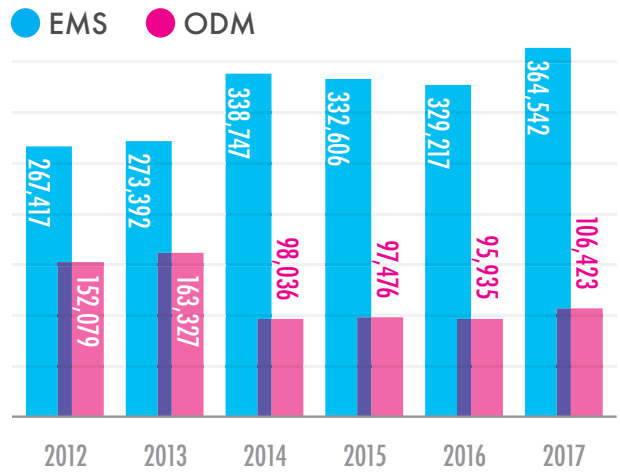
Overall, the outlook remained positive, with only four EMS companies and two ODM companies losing money in 2017. Looking at some of the other high flyers, we see that Pegatron ranked second in net income for EMS companies at $527 million, followed by Flex at $320 million. In the ODM space, Quanta Computer, Delta Electronics and Qisda ranked highest in earnings.

Right-sized for recovery

Reassuringly, plant closures were insignificant in 2017, as most companies appear to have right-sized their operations or closed facilities resulting from completed acquisitions. There were some new openings, which were clearly related to new business opportunities, while closures were driven by economic performance requirements such as right-sizing the company.

Looking to the future,

> **Communications and computer products will continue to drive the largest growth in the electronics industry**



The worldwide contract manufacturing market from 2012 to 2017 ($M)

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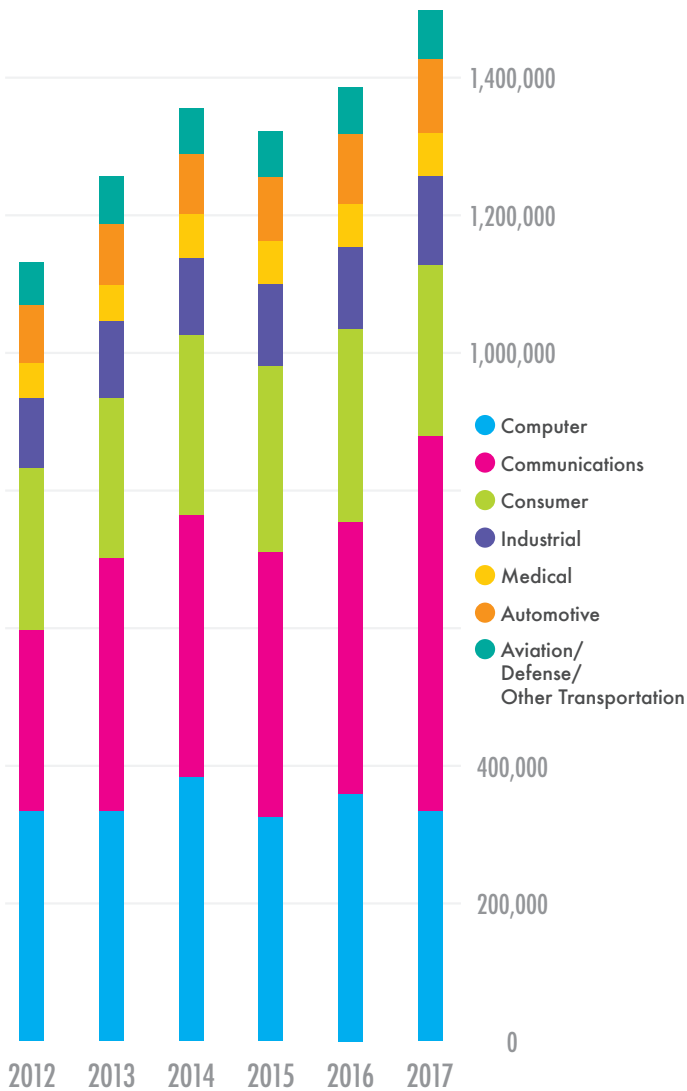
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it seems there's no let-up in this positive trend. Overall market demand for electronic products is projected to continue growing throughout the forecast period. In fact, New Venture Research expects overall combined market growth to be at a compound annual growth rate of 7.5 per cent over the next five years.

Communications and computer products will continue to drive the largest growth in the electronics industry. In 2022, the total industry is expected to reach $1.7 trillion in annual assembly value, as consumption and replacement of electronic products continue, and new products stimulate demand.

In conclusion, although the trend to move price-sensitive manufacturing to low-cost regions has subsided, this will continue to impact the industry for all suppliers in the foreseeable future. Nevertheless, it seems outsourcing has become a critical element in keeping the electronics assembly industry expanding, with an ever-present goal to drive costs down each year.

www.newventureresearch.com



Note the increasing importance of communications when the total available market for electronics assembly from 2012 to 2017 is broken down by segment ($B)

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Distributors double down on IoT

Electronics distributors are providing technical expertise and services to OEMs to help them implement Internet of Things technology into their products

James Carbone

Distributors say that while the Internet of Things (IoT) has yet to produce hockey stick-like growth in sales, it is still having a significant impact on business and will be responsible for up to 40 per cent of distributors revenue in the future.

To ride the expected wave of sales growth from IoT applications, distributors are not just providing customers with sensors, Wi-Fi modules, microcontrollers and other components needed to implement IoT. They are also offering services to help customers identify IoT applications with their products and to design IoT solutions and implement them. Some distributors have also partnered with carriers such as AT&T and Verizon to offer data plans needed for IoT.

Many distributors say sales growth from IoT has been modest because customers are trying to determine how best to use IoT technology. "Every business is trying to figure out how to use IoT to build better products and services, said Ashish Parikh, director of IoT platforms and solutions for Arrow Electronics, based in Centennial, Colo.

"Everyone is looking at using this technology of connected devices where you can remotely manage the devices, update them, and get information and insight to solve problems," he said.

He added Arrow is seeing more IoT business from customers in retail, industrial, healthcare and transportation. "We have seen a pretty steady increase in the number of customers and in the footprint of what customers are buying," said Parikh. "Wi-Fi connectivity and sensor sales have been increasing."

IoT customers often buy sensors, Wi-Fi modules, microcontrollers as well as a range of interconnect, passives and electromechanical (IPE) devices. "It is estimated in the industry that probably 5 to 7 per cent of overall component sales are actually going into IoT applications," said Lou Lutostanski, vice president of IoT for Avnet, based in Phoenix. He said that percentage will likely grow in the coming years, but so far there has not been the stellar sales growth for components used in IoT applications, which some industry analysts and executives had earlier predicted.

"I think hockey stick growth is very possible, but not until companies go mainstream with IoT," Lutostanski said. "There are people doing IoT projects, but few of them are mainstream. I believe when IoT goes mainstream, there will be an incredible ramp up in sales for all semiconductors and IP&E products," he said.

Lutostanski added one thing that is slowing down IoT adoption is companies are confused about IoT technology and business applications for IoT. "IoT is not about technology, it's about business transformation," he said. Many companies are trying "to use IoT technology without understanding why they're doing it," according to Lutostanski. He said a company must first have a business case to use IoT successfully.



"It is estimated in the industry that probably 5 to 7 per cent of overall component sales are actually going into IoT applications"

Lou Lutostanski, vice president of IoT for Avnet

Make the IoT case

Having a business case for IoT is "the blueprint for everything else that you do and if you don't know why you're doing something, but you start doing it anyway, it's going to fail," said Lutostanski.

Some OEMs have identified business cases for IoT in their industrial products and equipment and other companies have invented new products that take advantage of IoT capability.

"In the industrial segment, IoT is all about predictive maintenance," said Robbie Paul, director of strategic program development - IoT for Digi-Key, based in Thief River Falls, Minn. By using IoT-equipped industrial equipment and factories, companies can identify problems with the equipment before they become serious. One example is motors.

"There are billions of motors of all kinds in factories and it turns out the predictive variable in motors is vibration," said Paul. If vibration levels for a motor exceed the acceptable spec, the motor will overheat and fail. Using sensors and other IoT technology, excessive vibration levels of motors can be detected so the motor can be replaced or repaired before it fails.

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Attracting new customers
While industrial automation has been a traditional segment for distributors, IoT is attracting customers to distribution from other customer segments. One example is agricultural equipment. Some distributors are selling IoT related components to equipment manufacturers that make IoT capable farm equipment that helps reduce fertilizer, pesticide, herbicide and water costs for farmers.

Such equipment can monitor fertilizer, pesticide and water levels of soils and transmit that information to a computer or smart phone so the farmer can water crops or apply the necessary fertilizer or pesticides.

Some farmers are using small IoT-equipped robots on wheels to help eliminate weeds on farmland and reduce herbicide costs. The robot has a camera, GPS, and a computer and moves through rows of crops and distinguishes weeds from crops and sprays the appropriate amount of herbicide on the weeds and not the crops, said Paul. Herbicide cost is reduced by about 90 per cent because the spraying the weeds is precise and there is little waste, he said.

More industrial and agricultural equipment companies are finding ways to use IoT which will further drive sales for Digi-Key and other distributors over the next 5 to 10 years.

Paul said that IoT is already having a positive impact on Digi-Key's business. "IoT is one of the driving forces for increased electronic sales this year. Automotive is the other driver," he said .

He said Digi-Key's IoT sales were up 38 per cent year-over-year for the first half of 2018 f and "that's a few points higher than Digi-Key sales overall."

IoT is also resulting in more customers for Digi-Key. "So far right now we have about 100,000 customers that buy what we consider to be IoT products. It is growing at a faster clip than overall customer acquisition for Digi-Key," said Paul.

Enhancing IoT services
Other distributors report that they are also attracting more IoT customers and are enhancing their capabilities to service those customers. The focus is not just on selling components, but also providing services to IoT customers to help them implement IoT technology in their products.



"In the industrial segment, IoT is all about predictive maintenance"

Robbie Paul, director of strategic program development - IoT for Digi-Key

Ashish Parikh, director of IoT platforms and solutions for Arrow Electronics

"Every business is trying to figure out how to use IoT to build better products and services"



For instance, Lutostanski said Avnet has a consulting service to help customers understand the business reason for doing IoT. He said Avnet's IoT advisory service can evaluate a customer's readiness and "develop a transformation roadmap with the customer on the front end for a fee. Avnet will also do "IoT device design and build services where we talk about manufacturing and the integration of inventory management of the devices being deployed," said Lutostanski.

Avnet also offers customers IoT cloud and digital services to help customers understand "the cloud platform, analytics, artificial intelligence, the machine learning ,the user interface the user experience and the IoT connectivity," he said.

Avnet helps deploy IoT in products and provides "firmware, security patches, technical assistance and field utilization maintenance for all the devices to make sure that all devices maintain functionality and are upgraded over time," said Lutostanski.

He said by providing an end-to-end solution for customers, Avnet hopes to accelerate the adoption of IoT and "once it becomes mainstream, there will be many opportunities for significant growth." Lutostanski said by 2030 IoT will be up to 40 per cent of the distributors' sales revenue.

Arrow also wants to make it easier for customers to implement IoT and a lot of its efforts focuses on connectivity. "Last year we introduced our connectivity services, which makes it easier for customers to not only procure the modules, but also services from us," said Parikh.

He said about four years ago, Cathy Morris, Arrow's chief strategy officer, "pulled the leadership team across Arrow Inc., and said IoT is not just about components. It's also about connectivity, the ability to analyze data and manage it."

As a result, Arrow's IoT strategy "pulls together the products and services across all business units," said Parikh. "Global components is one of the business units, but to build an IoT solution we need connectivity, the ability to manage where that data goes, how the devices are managed and how they are updated," he said.

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Why modular power wins

A key advantage of modular power solutions is the ease of sourcing just one component instead of many, increasingly difficult to obtain, discrete components, but the benefits don't end there, as Recom explains

Datasheet deficiencies
Product datasheets are an informative resource and often contain one or more 'typical' application diagrams. What these diagrams don't generally include, however, is the number of external components that might be required to design a fully functioning device. These 'typical' applications also tend to be based on fixed loads, whereas real-life applications often have very dynamic loads.

For instance, take an application example of a low output voltage design, at 1.2V. A sudden load change can cause the output voltage to nearly double if the output capacitance is not significantly higher than the recommendation in the datasheet. A typical working design may need four to six output capacitors wired in parallel.

EMC unknowns
Another benefit of using a module rather than discrete components relates to electromagnetic compatibility, since engineers cannot determine in advance whether a design will pass electromagnetic interference compliance testing.

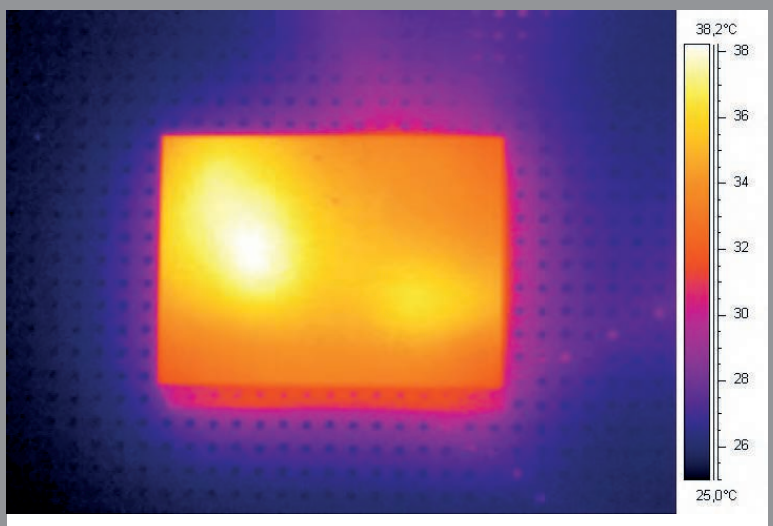
French mathematician, Joseph Fourier, states that any high frequency square wave can be reduced to a series of higher frequency sine waves. The higher the operating frequency, the greater the number of harmonics and the greater the chance that one or more of these harmonics will cause a resonance in the printed circuit board layout's inherent inductances or capacitances. Since a switching frequency of one to 2.5MHz is no longer uncommon with electronic applications, accurately predicting EMC can be difficult.

Thermal challenges
One advantage of the latest generation of converters is their incredibly small size. Unfortunately, this very benefit can also be a disadvantage, since the process of matching precisely placed pads on the PCB and adjusting the solder stencil correctly for optimal solder paste application can be challenging. If the paste is not accurately positioned, then voids and incomplete solder joints are possible.

In some newer modules, however, thermal management has already been determined. One method is a four-layer PCB with filled and plugged-vias and µ-vias, allowing the engineer to use a standard two-layer PCB and have a favorable operating temperature range. The vias conduct heat from the pads to the top and bottom ground planes, without sacrificing solder joint reliability.

In summary, utilizing a power module has three distinct benefits: predictable performance with few external components, easier EMC filtering, and a more reliable soldering process. Furthermore, modular solutions are often less expensive, less time consuming and provide a more reliable power supply solution.

www.recom-power.com

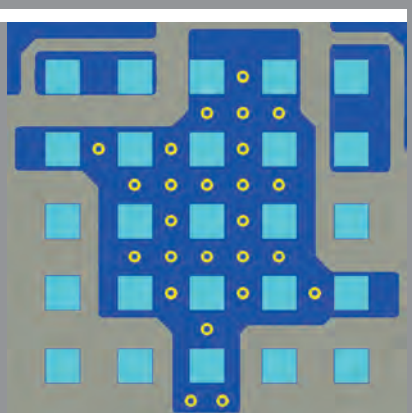


The smaller the converter, the more challenging thermal management becomes



A power module solution can simplify electromagnetic interference issues

Vias conduct heat from the pads to the top and bottom ground planes, without sacrificing solder joint reliability





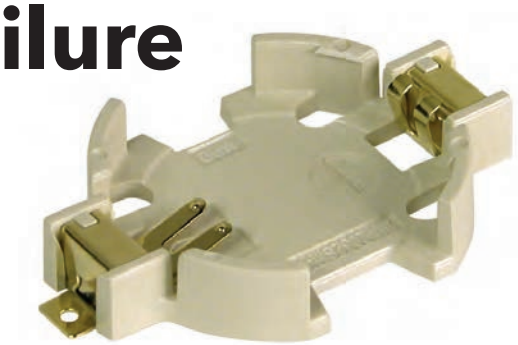
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Avoiding the cost of failure

President of Memory Protection Devices, Tom Blaha, advises buyers to think long and hard about cutting corners on quality only to incur the risk of costly system failures



As electronic devices continue to shrink, battery holders are becoming thinner and lower profile

Let's face it, there is a huge difference between a battery holder designed for use in a low cost advertising specialty item and a battery holder that is integral to a life-saving medical device or industrial application.

Cost is everything for an inexpensive trade show premium item, but if the device is intended for long-term use, especially in rugged environments, and is backed by a warranty and the reputation of your company, then you need to think long and hard about cutting corners on quality, only to incur the risk of costly system failures. The results can include: angry social-media savvy customers; expensive repairs, rework and replacement costs covered under warranty; loss of business reputation; and even potential legal risks associated with a catastrophic product failure or a large scale product recall.

Battery holders are not created equal, so it's important to keep tabs on their design and manufacture, given that these items team up with the battery to ensure a reliable long-term power supply.

Miniaturization demands quality

As electronic devices continue to shrink in size, battery holders are becoming thinner and lower profile. In order to provide a reliable electrical connection with the smallest footprint possible, the quality of the raw materials used to manufacture these holders is becoming critical.

Since it is difficult to detect a money-saving mix of virgin and recycled materials, it is essential to verify that the highest grade of thermally stable plastics are being utilized in the injection molding process. Superior quality raw materials allow the battery holder to perform more reliably in extreme temperatures, or under shock and vibration conditions.

Beware of counterfeits

Battery holders are often





assembled by third party subcontractors, which increases the risk of counterfeiting. Purchasers therefore need to demand full product traceability all the way from raw materials to finished assembly. This should include proper documentation that the battery holder has undergone rigorous quality control and quality assurance inspections throughout its manufacture, including environmental and vibration testing. In the case of medical devices, the product must conform to FDA CFR 21.

To further protect against counterfeiting, it's wise to perform random incoming inspections to ensure lot-to-lot consistency, including routine visual inspections for proper identification markings. Also, be on the lookout for excessive flashing that occurs when excess plastic extrudes through the mold, as this can prevent a battery from making a solid electrical contact.



Demand full product traceability from raw materials to finished assembly

Discolored contacts may be a sign of corrosion. Gold plating over nickel is preferable because it provides the greatest level of corrosion resistance and helps protect against bi-metallic effects that can occur when two dissimilar metals come into contact. An acceptable compromise may be to specify contacts finished with nickel-plating over steel, as this adds some corrosion resistance at lower cost. Those that go this route, should make sure that the nickel plating is highly polished and that the plating thicknesses are as specified.

Invest in quality

Extreme vigilance is especially important for life-critical medical devices and industrial applications where product failure is not an option. If the contacts break easily, become easily disconnected, or twist out of position when modest pressure is applied, then you have a serious quality problem.

Trying to save a few dollars is always tempting and can be very acceptable for certain low-risk applications, however, it is invariably a bad idea to cut corners if it leads to dissatisfied customers and potential lawsuits. It pays to invest a few cents more to ensure a better quality battery holder that meets and exceeds all customer and regulatory requirements and provides years of reliable performance.

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Thermal Management

Increased protection for filter fans

STEGO FFH086 hose-proof hood

The new FFH 086 hose-proof hood from STEGO Inc is an effective protective cover for filter fans, as well as intake and exit filters. It increases the protection of your applications to IP56, thereby protecting against penetration of dust and against water projected by a hose.

The FFH 086 hose-proof hood is designed for outdoor use and for industrial applications with harsh environmental conditions. The use of stainless steel ensures protection against extreme/harsh weather conditions and is also impact resistance. The hose-proof hood fits perfectly onto our filter fan series FPI 018, FPO 018 and FF 018 and, of course, also onto devices with standard dimensions from other manufacturers.

Our hose-proof hood is equipped with these three practical features:

Filter mat change from outside: To change the filter mat, you only have to remove the hose-proof hood, opening the control cabinet is not necessary

The food safe, external silicone gasket, facilitates cleaning

Approved quality and safety through testing by renowned institutes, e.g. UL.

Have a look here to get an impression of the versatile capabilities of the FFH 086 hose-proof hood!

www.stego.de/us/



Supply chain must haves

We asked vice president of engineering and manufacturing at STI Electronics, Mark McMeen, which purchasing support services he relies on most, and where he feels the distribution industry could do more



How has the purchasing role at STI changed over the last five years?

A) The purchasing role has changed significantly; component shortages mean STI buyers must not only find alternative components, but also demonstrate that the components are from master franchise distributors. As counterfeit and gray market components have become mainstream in the secondary markets, the ability to procure certified components from master franchised distributors has become more important. Certification of compliance provides traceability from the original component manufacturer, through certified distributors, to the contract manufacturer. This trail is the new link in the distribution channel. There is also emphasis on testing secondary market components to ensure they are non-counterfeit and to verify they are not gray market used components. Component age limits are also important, so a lot code cannot be older than two to three years on passives and one to two years for active components.

Have you increased or decreased your preferred supply list and why?

A) Preferred supplier and approved vendor lists are growing with the need to add alternate components and suppliers. Approved test facilities have also been added to ensure secondary market components are viable and meet expectations. These new companies, or company divisions, procure from secondary markets then perform testing to ensure the components are not counterfeit or gray market products, before certifying and validating parts. These facilities are also testing electrical parameters to ensure the components are not seconds or defective components from the original manufacturer.

What service do you request most frequently from distribution companies?

A) The newest service that has grown over the last five years is engineering support to identify alternative components that will work in a certain location or to identify other vendor sources of similar components to help address component shortages. This is becoming a big service for master franchise distributors.



Mark McMeen is vice president of engineering and manufacturing at STI Electronics



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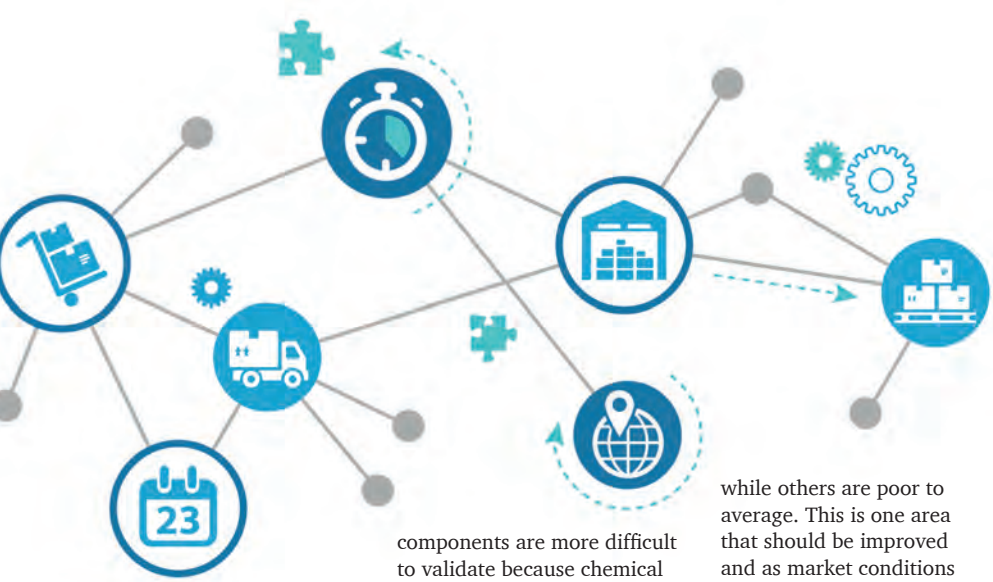
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Is obsolescence and counterfeiting a problem in the electronics supply chain?

A) Obsolescence is an increasing problem for the industry as components are phased out in favor of smaller form factor devices. Counterfeiting is not seen in our master franchise distributors because they maintain clean chains of traceability. Components procured in the secondary or gray markets, however, may pass initial tests for authenticity, but would fail in the age and previous use category. Gray market components are more difficult to validate because chemical decapsulation is required to review the integrated circuit or die markings to determine the original date of manufacture. STI has a full service analytical and materials laboratory in-house, making it easier to ensure we are not using gray market or counterfeit components.

What services would you like the supply chain to provide?

A) The availability of engineering support to find alternate components and sources is on a company by company basis and varies by component type as well. Some companies are excellent while others are poor to average. This is one area that should be improved and as market conditions demand it, it will become a discriminating factor between component distributors.

What feedback would you give to distributors or principal component manufacturers?

A) My advice is to develop a stricter traceability method and chain of authority protocol to prevent lot code manipulation within the pedigree history. This increased safeguard would significantly increase confidence in component history, from source to end user. I personally think the open source block chain approach should be used because this prevents manipulation of the chain of authority, thereby preventing counterfeit or gray market components from entering the supply chain. Although this is a radical departure from the norm, traceability needs to be decentralized. Open source would help to prevent manipulation of past pedigree history by having it recorded in multiple sites.

stiusa.com

The availability of engineering support to find alternate components and sources is on a company by company basis and varies by component type as well



Sidestep obsolescence stress





Rochester Electronics' vice president of sales and marketing, Colin Strother

Vice president of sales and marketing, Colin Strother, explains how Rochester Electronics can help purchasers avoid many of the issues surrounding component obsolescence and counterfeiting

Q How can Rochester Electronics help purchasers tackle their biggest concerns: obsolescence and counterfeiting?

A) In 2006, Rochester Electronics launched an anti-counterfeit awareness campaign exposing the risks associated with counterfeit and substandard products. We initiated the Semiconductor Industry Association's Anti-Counterfeiting Task Force and actively promote best procurement practices to combat counterfeits. Rochester also offers bill of materials analysis to long-term system customers, providing insight and feedback to help them stay ahead of obsolescence.

Q What solutions can Rochester provide to procurement professionals in the Americas?

With many components showing longer lead times and shortages, I'd like to focus on Rochester's in stock active semiconductors. With over five billion devices in stock, we solve supply chain disruption by ensuring a risk-free solution from an authorized source of supply.

Rochester also provides a continuous source of supply, with a large range of end of life semiconductors, in addition to a range of authorized manufacturing solutions and services.

Q Can you manufacture new semiconductor designs and bespoke components?

A) For legacy voltages of five and 3.3V, Rochester Electronics is authorized by LSI to manufacture new gate-array and cell-based application specific integrated circuit designs using its source technology and libraries. This allows Rochester to support customers where they have legacy voltage systems using their design IP that they wish to continue, without major board redesign.

Q What are the three most frequently asked questions and what are the answers?



A) Number one: you really have that in stock? Rochester specializes in providing solutions around hard to find products, be they EOL, or active with long lead times or shortages. Customers are delighted to find the product they need from an authorized source of supply.

Number two: you can really make that? Customers are surprised to find a continuous source of supply for devices that have long since passed EOL by the original manufacturer.

Rochester has over 12 billion die in stock, with the capability to manufacture over 70,000 device types using information transferred directly from the original component manufacturer. With the original manufacturers' approval, Rochester can also re-create the original device to provide a form, fit and function replacement, guaranteed to the original data sheet.

Number three: can you source this for me? Every time we are asked this question, we say no. Rochester only provides 100 per cent authorized, traceable, certified and guaranteed product.

Q Does Rochester offer pack and hold or logistics services?

A) Yes, Rochester can tailor scheduling and logistical solutions for both in-stock inventory and manufactured products to ensure a continuous supply that matches customer requirements. We also offer long term storage services for customer owned finished goods, wafer/die and intellectual property.

Finished goods are stored in a dedicated area with secure access and 24/7 surveillance, all in a temperature and humidity-controlled environment. Wafer and die are stored in nitrogen purged wafer dry boxes. Intellectual property is stored within Rochester's secure digital archives. We also offer media restoration, data recovery and format conversions.

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Small connectors, big ideas

With PCB space at a premium, purchasers are looking for miniaturized plug connectors with enhanced functionality. Rutronik product sales manager connectors and cables, Raphael Kallus, discusses the options

For many years, the industry standard for plug connectors was 2.54 or 5.08mm pitch, but today smaller pitches as low as 0.5mm are in demand to conserve board space and enable greater contact density. Currently, the potential for smaller pitches of 0.4 and 0.2mm is limited in Europe, but in the Far East these smaller pitches are in demand for smartphones and consumer electronics.

Modern plug connectors not only need to be smaller, but also provide greater stability, performance and convenient connection. For instance, an active latch mechanism provides a secure mechanical connection in applications where there are strong tensile forces or vibrations. These active latch housings feature standard headers to ensure interchangeability, while their high-temperature plastic construction means they can withstand operating temperatures of up to 125°C.

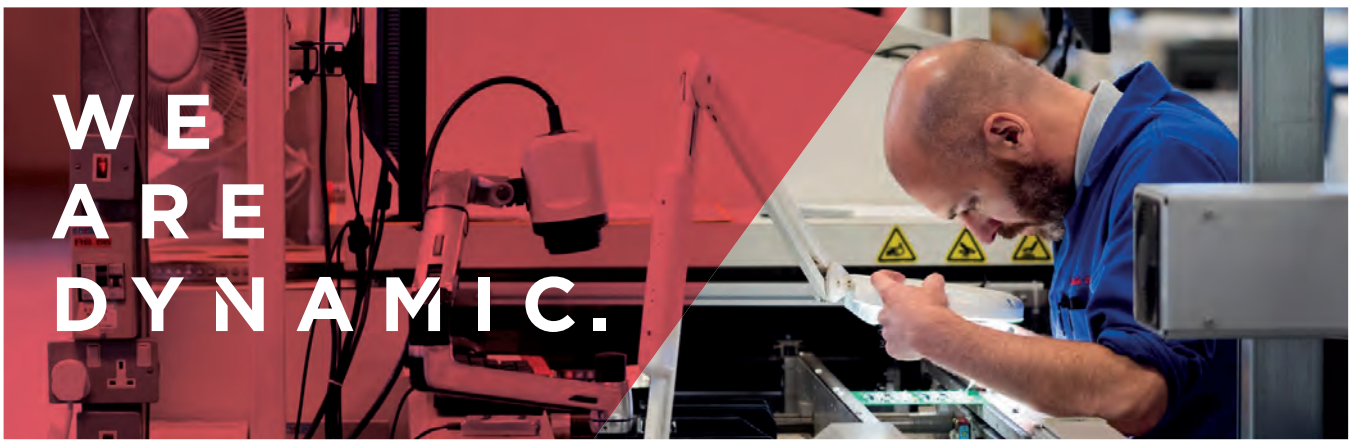
Reliable connections

Reliable signal communication under all operating conditions is essential in automotive engine control devices, especially safety-critical components such as the airbag, anti-lock braking systems and anti-slip regulation. Connectors with terminal position assurance, for instance, are supplied with a locking mechanism in the form of a lever that prevents the contacts from accidentally disconnecting during vibration.

For automotive, transportation and factory automation applications that require high vibration resistance, both the 2.00mm DuraClik series by Molex and the



These Amphenol Industrial plug connectors feature IP68 protection



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The Molex DuraClik series is said to provide space savings and reliable contacts in high-vibration applications

1.27/1.50mm Minitek Microspace series from Amphenol ICC have LV214 certification. The form-fit design of the DuraClik series is said to provide significant space savings and reliable contacts in high-vibration applications. Minitek Microspace plug connectors also feature primary and secondary contact retention, error-free polarization and a visual mismatch prevention system to eliminate improper connections. They boast a PCB footprint half the size of comparable plug connectors.

In harsh environments, ingress protection may also be a consideration. The SSL 1.2 series from Amphenol Industrial features IP68 protection when plugged, making it ideal for use in wet and dirty environments. Again, pre-assembled solutions provide considerable space savings on the printed circuit board.

Less is more

Another potential way to save space is by eliminating the plastic coating on housings. Contact protection is often unnecessary because the boards are inaccessible when installed or encapsulated. Where the plastic does not perform any locking or retention function, this can eliminate unnecessary plastic, and cost, from the design.

Bearing this in mind, the patented AVX Stript plug connectors are among the lowest cost solution in this segment. They require neither the space nor the assembly costs required for plastic insulated connectors. Instead, insulation displacement connector technology enables gas-tight, connections with secure contacts that can also withstand vibration and encapsulation and are available with poke-home wire to board technology.

For wired connections, the miniature Griplet IDC plug connector from Amphenol ICC also presents a low-cost solution. Due to its flat, compact design with a height of 3.7mm and a footprint of 4.0 by 6.1mm, it is ideal for limited-space applications in harsh environments. Double connection points with tension relief ensure stable operation even under extreme temperature, impact, and vibration conditions.

In this price-driven market, both manufacturers and customers can benefit from working with a distributor to provide the advice, value-added services and logistical handling required to navigate this tough component segment.

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Rely on traceability to limit recall disruption

Chief operating officer at Morey, George Whittier, explains how effective traceability can limit the damage to your brand when product recall just cannot be avoided

Despite everyone's best efforts, product recalls can, and do, still happen. In fact, according to the Consumer Product Safety Commission, as many as 400 products are recalled every year. In addition to causing a temporary inconvenience, such recalls can do significant damage to a brand's reputation, with more than 80 per cent of consumers becoming upset with companies that issue product recalls.

When it comes to appeasing frustrated customers and limiting overall disruption, traceability can provide an effective solution. The following three questions will help you to explore the role of traceability in product recalls.

1. Why is it important to consider traceability when selecting a manufacturer?

Figuring out which products are prone to a specific issue isn't always easy. Take cars, for example. With so many different parts in every vehicle, manufacturers often resort to recalling a specific model and year. Although this strategy can help ensure each defective part is identified, it comes at quite a cost. Even if only several hundred vehicles are dealing with the problem, every customer with that car must go through the hassle of a safety check. The result? Elevated recall costs along with decreased customer loyalty and trust.

Such setbacks can be avoided however, by partnering with manufacturers that use real-time traceability. Capable of determining which component is causing problems, identifying the defective component batch, and ultimately which vehicles or devices need to be recalled, real-time traceability promises to simplify the recall process. Instead of disturbing a broad range of consumers, manufacturers can quickly focus on those who are truly in need of assistance.

2. What is my role in traceability and product recalls?

Manufacturers can make or break a product recall. Those who rely on traceability stand to bring efficiency to the recall process, while manufacturers who go it alone risk agitating long-time customers and even bringing down the bottom line.

Ensure a successful approach by working alongside manufacturers who make the most of traceability. The more adept your team is at helping such manufacturers figure out where products were sourced, and which batch holds the defective parts, the better chance you have of ensuring a smooth product recall.

Establish your own traceability processes to increase both downstream and upstream awareness. This comprehensive view of the supply chain will help you and your manufacturers pinpoint where things went wrong. If, for example, a specific machine on the production line is churning out defective parts, it's likely time for improvements. It may also be worth identifying components that are compatible with your own tracing process to pave the way for easier integration moving forward.

3. How can I improve my traceability processes to prepare for future recalls?

Traceability and tracking go hand in hand. Without one, it's nearly impossible to execute the other. Supplement the serial numbers used to trace components with both internet of things and telematics technology. Designed to track product serial numbers, IoT can help alleviate some of the stress associated with discovering which components are in which products, as well as where specific components were shipped.

Take things a step further by utilizing telematics to seamlessly track products past the point of shipment. Rather than guessing when or where a shipment was made, you can provide manufacturers with real-time updates. This extra insight will go a long way toward limiting the number of products recalled.

Unnecessarily high costs and a decline in customer satisfaction often dominate the recall process, however with traceability such complications could be eliminated. Usher in greater efficiency and accuracy with traceability processes that make it easier to keep tabs on products and components in real time.

www.moreycorp.com



Chief operating officer at Morey, George Whittier

"With so many different parts in every vehicle, manufacturers often resort to recalling a specific model and year

PCB industry growth continues apace

Reassuring results from the IPC's North American printed circuit board statistical program indicate continued expansion in this sector

Industry shipments and orders continued to grow at a strong pace according to the June 2018 findings of the IPC's statistical PCB program in North America. Readers will be encouraged to learn that the overall book-to-bill ratio for June is 1.05.

Commenting on the findings, IPC director of market research, Sharon Starr, confirmed that the North American PCB industry growth trend continued in June.

Looking more closely at the results, total North American PCB shipments in June 2018 were up 12.6 per cent compared to the same month last year. This year-to-date, shipments were 10.5 per cent above the same period last year and compared to the preceding month, June shipments increased 18.0 per cent.

PCB bookings increased 5.6 per cent year-over-year and year-to-date order growth was 12.8 per cent above the same period last year. Encouragingly. bookings in June were also up 5.4 per cent from the previous month.

Sharon Starr commented: "Sales growth was positive year-over-year for the 10th consecutive month and order growth has been positive for the past 13 months. The book-to-bill ratio retreated in June due to stronger sales growth than order growth, but it remains above parity for the 17th consecutive month, which is a positive indicator of continued growth for the remainder of this year."

This year-to-date, shipments were 10.5 per cent above the same period last year

www.ipc.org



Future belongs to MEMs?

Quartz oscillators were the go-to product for timing, but with the advent of micro-electromechanical solutions, options have multiplied. TTI's Andrew Skelly and Ed Baca discuss which technology will win out

For generations, the quartz oscillator has been the go-to standard for timing. Apply an electric current to a quartz crystal and it vibrates at a precise frequency, simply and easily. Quartz can sync timing across a board, device or even network, and has been the industry standard for decades. With the ability to compensate for varying environmental factors, and maintain well established parameters for voltage and temperature, quartz oscillators have been handling timing functions with minimal issues for the last few decades.



TTI product manager, Andrew Skelly

Production differences

The only real issue with quartz is its organic creation; quartz crystals must be grown, then cut to size and shape and polished to create the oscillator for a device. This takes time and precision for each piece.

Over the last few years micro-electromechanical systems devices have begun to make an impact, with MEMS oscillators offering some performance and price differences compared to quartz. That's because MEMS components are etched from silicon, rather than grown, and can be mass produced at a much greater level than organic counterparts.

This larger production capacity lowers costs and allows MEMs oscillators to reach quartz accuracy levels at the same price point. But simply swapping one technology for another doesn't make much sense when there's no price or performance difference and when the existing solution works just fine.

TTI product manager, oversees oscillators, Andrew Skelly, commented: "The long history of quartz in the oscillator market is one of proven durability and performance. For many designers it's a case of, if it isn't broken, why fix it?"

Performance advantages

Technical marketing engineer for the internet of things group at TTI, Ed Baca, sees the future belonging to MEMS: "This growing technology addresses the few areas where quartz crystals may not be the optimum solution. MEMS are rugged, easier to produce in quantity and can be just as affordable, with the same performance level."

In fact, in some newer designs, MEMS provide valuable benefits. Because

> **Over the last few years micro-electromechanical systems devices have begun to make an impact, with MEMS oscillators offering some performance and price differences compared to quartz**

they are etched from silicon, MEMS oscillators can be created to perform at specific frequencies, allowing stable performance parameters across an entire production run. Although this electromechanical solution works at a micron level, it is still more rugged than the crystal core of a quartz-based component. MEMS also require less energy, and are more efficient, than comparable quartz solutions, which is significant when looking to extend battery life in low-power applications. Furthermore, MEMS can offer a smaller footprint than a quartz oscillator when necessary, but they are also cased for drop-in replacement of quartz components.

As a further benefit, MEMS can reduce electromagnetic interference. Ordinarily, multiple timing needs must be handled though a phased lock loop, with oscillators located in different areas of the board. MEMS can be located near the chip, handling operations locally without the need for longer power runs, thereby reducing EMI.

Today's engineers have many options when considering oscillators. Whether for a clean-sheet design or a drop-in replacement in an existing board, there has never been a wider choice.

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Today's engineers have many options when considering oscillators. There has never been a wider choice



TTI technical marketing engineer, Ed Baca

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Expect demand and capacity for organic light emitting diodes to increase

More electronics manufacturers are opting to use OLEDs because the display technology delivers a superior picture and uses less energy than LCDs

James Carbone

The global market for organic light emitting diodes (OLEDs) will post strong growth through 2022 as more cell phones, smart watches, televisions and other electronics equipment will use the display technology rather than liquid crystal displays (LCDs).

However, despite robust growth in demand for OLEDs, total OLED revenue will remain a fraction of sales of LCDs. The worldwide OLED market is forecast to increase from $20.9 billion in 2018 to $25 billion in 2019, according to researcher IHS Markit. Strong demand for OLEDs will continue over the next three years and the global OLED market will reach $35 billion by 2022, the researcher said. At the same time, the LCD market will decline from about $95 billion in 2018 to $87.8 billion in 2022, IHS Markit said.

However, the OLED market has already eclipsed sales revenue of basic LEDs. The global LED market totaled $13.2 billion in 2017 and will rise to $19 billion in 2022, said IC Insights.

Jerry Kang, senior principal analyst, emerging display technologies and OLED for IHS Markit, said OLED sales are driven largely by the smart phones market. Brand name cell phone manufacturers, including Apple and Samsung have switched to OLEDs in their high-end phones such as the iPhone X and Galaxy 9, although OLEDs are more expensive than LCD displays.

The active-matrix OLED used in the iPhone X costs about $110 and is the most expensive component in the phone, according to IHS. The OLED in the Galaxy S9+ is also the most expensive component in the Samsung-built device, costing $79, the researcher said.

Cell phone makers are switching from LCDs to OLEDs because OLEDs offer a better picture quality, a high contrast ratio and color representation compared to LCD. More OLEDs will also be used in other applications currently dominated by LCDs.

OLED use rises

OLEDs are increasingly being used in smart watches and other wearable electronics, computers, digital cameras and head-mounted displays, which are used in virtual reality devices.

However, smart phones are the biggest user for OLEDs, according to Claire Wen, principal research analyst at Gartner Inc. More than 422 million active-matrix OLEDs were shipped for use in cell phones, compared to 30 million units for smart watches in other wearable electronics and 3.5 million for head-mounted displays in 2017, said Wen. About 1.7 million were shipped to television manufacturers.

"Smartphones are the main type of electronic equipment adopting active matrix OLEDs and will have a 63 per cent AMOLED adoption rate by 2021, up from a 22 percent adoption rate in 2016," said Wen

Demand for LEDs is rising in smart phones and other devices because compared to LCDs, OLEDs offer overall better image quality, higher brightness, a fuller viewing angle, a wider

By the Numbers

$20.9 billion
The size of the worldwide organic light emitting diode market in 2018. Source: IHS Markit

1%
The percentage of all organic light-emitting diode shipments that went to television manufacturers. Source: Gartner Inc.

422 million
The number of active-matrix OLEDs shipped to smart phone manufacturers in 2017. Source: Gartner Inc.

40%
The projected share of the worldwide global market that Chinese companies will have in 2021. Source: Gartner Inc.

30%
The amount OLED supply will increase each year through 2021. Source: Gartner Inc.

$35 billion
The forecast size of the global OLED market in 2022. Source: IHS Markit

22%
The rate of use of OLEDs and smart phones in 2016

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color range and much faster refresh rates, better durability and a broader temperature range, according to the website OLED-info. They can also be flexible and stretchable.

OLED uses a series of organic thin films and when electrical current is applied, light is emitted. They don't require a backlight, which LCDs do. LCD use LEDs for backlighting. Because backlighting is not required, OLEDs are more power efficient and slimmer than LCDs.

The downside of OLEDs is that they are more expensive to manufacture, have less of a lifetime than LCDs and can be hard to view in direct sunlight. But manufacturers are working to improve performance, reduce manufacturing costs and to extend lifetimes of the displays.

Cost differences narrows

OLEDs are replacing LCDs in electronics equipment although they cost more, according to industry analysts. "The cost difference between LCD and OLED vary by the display specification," said Kang.

"Some rigid AMOLEDs for HD scale have started to catch up to LTPS (low temperature polysilicon LCD, but some flexible AMOLEDs for QHD scale are 1.5 times higher than LTPS LCD," he said.

Kang added that panel makers don't want to equalize the price of AMOLED with LCD "anytime soon, because they believe AMOLED is superior" and is worth the higher price.

However, the cost of OLED's is declining which will make them more appealing to electronic equipment manufacturers and demand will increase over the next three to five years.

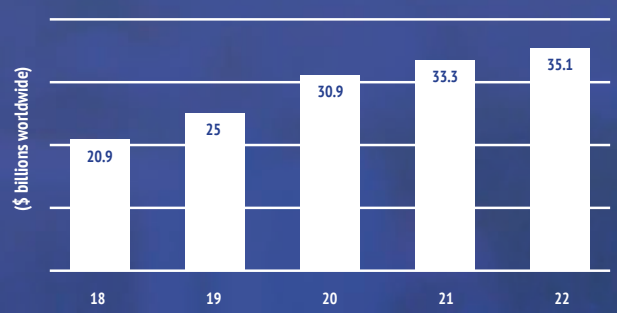
The good news for OLED buyers is that there is enough capacity in place to meet demand and more will be added over the next three years.

"Worldwide active matrix OLED supply will see a compound annual growth rate of 30 per cent from 2017 through 2021," said Wen. She said Samsung has been aggressively converting its existing LCD production lines into AMOLEDs.

China eyes OLEDs

In addition, China is investing in OLED production. "China believes that AMOLEDs will give it an unprecedented opportunity to dominate a technology display supply chain," said Wen.

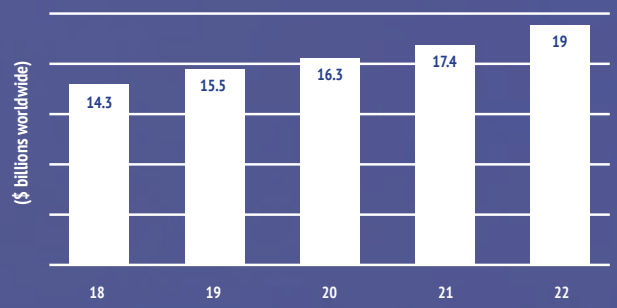
OLEDs to post robust growth



The worldwide market for organic light emitting diode displays will rise steadily through 2022 when revenue will top $35 billion
Source: IHS Markit

LEDs will have a compound annual growth rate of 7.5 percent through 2022 when the market will reach $19 billion
Source: IC Insights

Steady growth for LEDs



She added, "if you look at capacity worldwide, Korean companies this year account for almost 80 per cent of worldwide capacity for active-matrix OLED," said Wen. China accounts for about 20 per cent.

However, China is investing more in OLED technology and manufacturing and in 2022, Korean OLED capacity share will be less than 50 per cent and China's share will increase to 40 per cent, according to Wen.

"Chinese companies are investing in the technology and the most aggressive one is BOE," she said. "BOE Technology Group is a leading manufacturer of LCDs and makes displays for Apple iPads and MacBooks and is looking to be a supplier for iPhones, too.

Apple currently buys OLED from Samsung.

Most OLED capacity being added by manufacturers is for displays for smart phones and other smaller electronics equipment rather than larger devices such as televisions. However, eventually OLED manufacturers will produce larger OLEDs for televisions because of superior picture quality that will make OLED TVs more in demand. In 2017 only about 1 per cent off OLEDS were used in televisions, according to Wen.

Samsung, LG and EverDisplay are the leading manufacturers of OLEDs, but LG is the only manufacturer that is building OLEDs for televisions. In fact, LG is the leading manufacturer of OLED televisions, but it also supplies OLEDs to other TV makers.

The company makes 55", 65" and 77" 4K OLED panels.

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Real-time tracking sheds new light on supply chain visibility

Marketing manager at Tive, Dagny Dukach, reveals how one electronics manufacturer used Tive's sensor-driven tracking solutions to tackle in-transit damages and delivery delays



Marketing manager at Tive, Dagny Dukach, explains the benefits of real-time tracking in the electronics supply chain

For many electronics manufacturers, in-transit damages and delays are an all-too-common reality. For one large global manufacturer, the issue was sufficiently damaging that it decided to invest in a digital visibility solution to shed some light on the dark corners of its supply chain.

Damages and delays

Based in Europe, this manufacturer ships electronic products from a contract manufacturer in Asia to distribution hubs, and then on to end customers all around the world. The company relies on sea freight, rail and trucks, and its shipments often last several weeks or even months as they make their way between international facilities.

Contained in these shipments are electronics goods that are sensitive to being dropped or handled roughly, and these goods would sometimes arrive damaged. Other products are less fragile, but unexpected delays in transit would often lead to unhappy customers. In addition, it would often be impossible for the manufacturer to determine when or where along the supply chain the damages and delays were occurring, and which routes or carriers were responsible for problems, making it difficult to eliminate the root cause of the issues.

Enhanced visibility

To address these challenges and gain visibility into its global supply chain, the company turned to sensor-driven tracking specialist, Tive. Using cellular-connected multi-sensor trackers and a real-time data analytics platform, the manufacturer was granted insight into the precise location and condition of its shipments at all times.

The manufacturer started by attaching Tive trackers to shipments traveling from European distribution centers to customers. The trackers made it possible to monitor goods in real time and receive immediate alerts if a shipment experienced potentially harmful shock levels or was likely to arrive late. If a shock event occurred, the manufacturer could determine the exact time and location of the issue, and work with its carriers to resolve the issue.

Hiccups resolved

Over time, comprehensive analysis of data from various routes helped the company to identify exactly which shipment routes tended to lead to more delays or harmful shock events. For example, in one case the company identified that a carrier used multiple routes on one lane, with the longest route taking more than five times longer and experiencing almost 10 times as many strong shocks. Armed with this data, it was able to work with its logistics partners to reduce transit times and potential damage. Tive's supply chain visibility solution provided the manufacturer with the data it needed to perform comprehensive route analysis and eliminate the root causes of systemic supply chain issues, be it an unreliable carrier, a damage-prone route, or some other issue.

"Working with Tive has given us insight into how our supply chain actually works, and has given us the tools we need to optimize from end to end," a representative from the electronics manufacturer commented.

Real-time alerting and data analysis across all shipments and routes is helping this electronics manufacturer avoid unpleasant surprises and eliminate the root cause of issues to optimize the supply chain going forward. Ultimately, this makes it possible to limit production delays, reduce waste, and provide an improved experience for the end customer.

www.tive.co





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Phone: 480-643-2000



ABOUT

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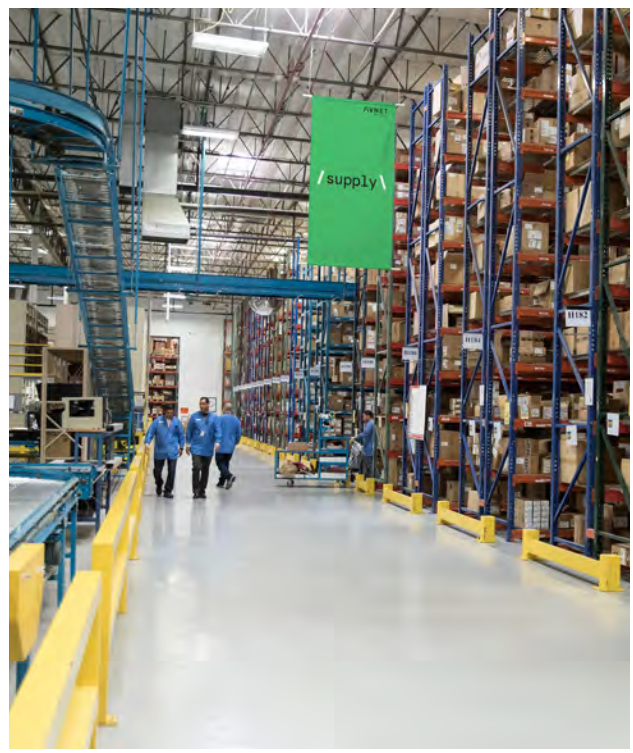
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Eastern Europe viewed as alternative for low-cost electronics manufacturing

Hungary, Bulgaria and other former Soviet Union controlled countries offer low-cost, state-of-the-art electronics manufacturing

James Carbone

While the Asian-Pacific region is regarded by many in the electronics industry as the go-to location for low-cost labor, Eastern Europe has emerged as an alternative locale for the manufacturing of electronics equipment that will be sold in Europe.

Many OEM buyers involved in outsourcing decisions for their companies are finding that former Soviet-bloc countries such as Hungary, the Czech Republic, Poland, Bulgaria and others have competent workforces, reliable infrastructures and brand-name global EMS providers that offer the same manufacturing services that they do in North America and Asia.

As a result, the EMS industry in Eastern Europe is expanding and is forecast to grow from about $34 billion in 2017 to $43.6 billion in 2022, according to New Venture Research. "Poland is an attractive location because it's not only low-cost, but it has a good educational system and good infrastructure," said Randall Sherman, president and CEO of New Venture Research, based in Nevada City, Calif. Poland's electronics manufacturing services business totalled about $3.4 billion in 2017, he said.

Hungary had the highest EMS revenue in 2017. Large global EMS companies such as Foxconn, Flex, Jabil and others provided about $17.7 billion of manufacturing services for OEMs at facilities in Hungary. Flex has six manufacturing locations in Hungary, while Foxconn has four, said Sherman.

Romania had more than $2.1 billion in EMS sales in 2017. Flex, Celestica, Plexus and Benchmark all have facilities in the country.

The equipment that EMS providers manufacture in Eastern European countries "is primarily for the European market," said Sherman. "They offer a low-cost alternative to Asia. They are capturing the assembly value," he said.

Sherman said EMS providers in Eastern Europe build a range of equipment for OEMs including industrial automation equipment, medical devices, automotive and aerospace systems among others. They also build some cell phones for the European market, but it's not a major focus.

EMS providers often do board assembly and box build for OEM customers in Eastern Europe. "They like to do box assembly, but with complex products that's not always possible," said Sherman. Complex electronic systems often have to be integrated and tested.

"That is something a lot of OEMs are not willing to give up," said Sherman.

Outsourcing reluctance

In fact, many European companies are reluctant to outsource. "There is always the tendency to want to keep production in-house and not outsource," he said. Still many global and some European OEM choose to manufacture products in Eastern Europe that will be sold throughout Europe.

Some EMS providers have facilities in multiple Eastern European countries as well as in Western European nations. Case in point: Flex, based in Singapore, has more than 7.5 million square feet manufacturing space across 19 facilities in Europe, including factories in Hungary, Poland, Romania and Ukraine.

It operates design centers and manufacturing facilities and 10 logistics centers throughout Europe. "Generally, our design, engineering and innovation services are located close to customers, while manufacturing and to a lesser extent logistics services, tend to be carried out in Eastern Europe," said Radenko Prnja, Flex's vice president for EMEA region 1, which includes Italy, Hungary and Romania . "This facilitates the collaborative nature of our work with customers and offers a highly efficient and cost-effective manufacturing service.

He said growth of the Flex manufacturing footprint in Europe is the result of the EMS provider's growth in its core businesses of automotive, medical, energy and industrial. Such core business has driven manufacturing expansion in Hungary, Romania and Ukraine, according to Prnja.

Automotive is driving Eastern European business as more electronics are being designed into vehicles for driver assistance, safety, emissions control, electrification and connectivity, he said. "In the medical sector we see innovation in drug delivery systems and secure, real time monitoring and reporting on patient well being as a driver of new solutions" said Prnja,



"Eastern Europe is witnessing a faster growth rate than its western counterpart or other emerging markets

– Radenko Prnja, Flex's vice president for EMEA region 1

He said while many of the products that Flex builds for OEMs in Eastern Europe are for local markets in Europe, others are designed in Europe and manufactured at other sites around the world.

One reason Eastern Europe is an attractive location for Flex is that it has an improving rail network including a link to China, an excellent road system and a central position between the EU and Asia, said Prnja.

As a result, "Eastern Europe is witnessing a faster growth rate than its western counterpart or other emerging markets." said Prnja

He added that electronics manufacturing in Eastern Europe has now overtaken Western Europe in terms of value and is quickly becoming an attractive end market in its own right.

"Because of the security, benefits and protections from European Union membership, and the lower inflation and increased consumer spending, we've witnessed some new consumer brands preferring to partner with Flex in Eastern Europe," said Prnja.

Competition for labor

However, one challenge that could impact EMS business in Eastern Europe for Flex and other EMS providers is labor. "As the Eastern European countries prosper, unemployment levels decline and competition between employers for skilled people grows," he said. While automation in the manufacturing process is increasing, that alone will not address a labor shortage.

"Collaboration between employers, governments, and universities is vital to ensure the flow of appropriately skilled applicants," he said.

Another global EMS provider that has a large footprint in Eastern Europe is Jabil Circuit, based in St. Petersburg, Fla. The EMS provider has about 3 million square feet of manufacturing space in Europe, the Middle East and Africa including facilities in Poland, Hungary and Ukraine.

Bruno Solar, vice president of EMS Operations, Europe for Jabil, says Jabil's facilities in Europe build systems for OEMs in the automotive and transportation, connected consumer technology and industrial segments.

Those facilities build "complete systems for OEM customers thanks to the integrated supply chain expertise Jabil has established," said Solar.

While Flex and Jabil have facilities in multiple Eastern European countries, Benchmark Electronics, based in Scottsdale, Ariz., has one factory in Brasov, Romania that has operated for the last 10 years. The factory, which employs between 600 to 700 workers, builds boards, subsystems and complete systems for medical equipment, industrial, and aerospace OEMs.

"For industrial, we do intelligence flow control, smart measurement systems," said Mike Buseman, executive vice -president-global operations at Benchmark." We are doing more and more complex integrated assembly work in that facility in the industrial sector."

He added that Benchmark also builds patient monitoring equipment and other medical products at its Brasov facility. Medical will be a greater focus for Benchmark over the next several years.

"Benchmark's engineers around the globe have a strong pedigree in medical products and we do the design work on a lot of the products" which are then built at Benchmark's manufacturing facilities.

"We do everything from printed circuit board work to control circuitry to subassemblies that go into much larger systems," for medical OEMs, said Buseman.

> **Automotive is driving Eastern Europe business**

▸▸ *continued on page 36*



He said that Benchmark will expand operations in Romania. "Our current view is focused on our footprint in Brasov. It is a very good location for us." Buseman said he was "a big advocate of scaling" its existing facility rather than "having a number of smaller sites scattered all over."

He added while Benchmark will expand its efforts in medical, industrial and aerospace, it has no plans to focus on telecom or computing sectors. "What we've seen so far is those customers are still designing in one global location and candidly still biased towards the Asian-Pacific region," said Buseman.

Benchmark is also looking at building equipment for customers with "higher power applications." Such applications could include alternative energy systems and industrial applications that are battery powered.

Growing supply base

EMS providers say while their business is growing in Eastern Europe, so is the local and regional supply base. A local supply base has developed for many non-electronic production materials such as cable assemblies, plastic metal parts and enclosures.



Today, our facilities are manufacturing state of the art telecommunications equipment and automotive electronics

– Dietmar Guenther, executive vice president of Sanmina Manufacturing in Europe

"But electronic components are still the majority what we buy and those are imported from outside the region," said Buseman.

However, sourcing semiconductors, passives and other electronics components is not an issue for EMS buyers in Eastern Europe because the electronics supply base is global, said Dietmar Guenther, executive vice president of Sanmina Manufacturing in Europe.

"Some electronic components such as connectors and some integrated circuits are manufactured in Europe," he said. However, most semiconductors, passives and connectors are manufactured in Asia and are shipped to Europe and other locations, he said.

Guenther said when Sanmina designs a supply chain for an OEM customer, it focuses its on mechanical and larger components and sub-assemblies from suppliers in Europe.

Benchmark purchases semiconductors, passives and other parts directly from component manufacturers, but also buys parts from global and regional distributors in Europe.

"Depending on the distributor we use them in varying degrees for supply chain services and supply chain design" as well as fulfillment, said Buseman.

Sophisticated services

Some veteran electronics industry executives say the EMS industry in Eastern Europe has evolved over the past 10 years and has become more technically sophisticated.

"Ten or fifteen years ago, when you considered Eastern Europe for manufacturing, you were probably thinking about low-cost, and high-volume operations," said Guenther. "Today, our facilities are manufacturing state of the art telecommunications equipment and automotive electronics."

He added that the printed circuit board assemblies produced are



Benchmark's engineers around the globe have a strong pedigree in medical products and we do the design work on a lot of the products

– Mike Buseman, executive vice-president of global operations at Benchmark Electronics

"incredibly complex," requiring placement of 10,000 – 20,000 components per board. "These products require far higher levels of efficiency, quality and automation than 10 or 15 years ago.

Guenther said Sanmina has Eastern European facilities in Tatabanya and Miskolc, Hungary and Brno in the Czech Republic. The facilities manufacture the most complex telecommunications systems available today.

He said two of Sanmina's Eastern European facilities also repair complex systems, including wireline and wireless communications systems, medical imaging, medical blood handling equipment, portable computers and retail scanning equipment.

Guenther added that all of Sanmina's facilities offer design for manufacturing services. "We have design managers in Europe who work with our design centers on PCBA and system design. We also help European customers with technology selection and supply chain design," he said.

Sanmina has been operating in Europe since 2000 and today employs almost 3,500 people in 10 facilities and nearly 1.4 million square feet of manufacturing space.

"Our focus is on highly-complex systems manufacturing. In Europe we manufacture some of the world's most advanced optical and RF telecommunications equipment," said Guenther. It also builds board and entire systems for OEMs in the medical, aerospace and automotive markets.

For medical OEMs, Sanmina manufactures a range of complex systems including blood analysis, blood handlers, molecular diagnostics and navigated brain therapy and glucose monitoring devices.

In addition, automotive electronics systems manufactured by Sanmina are in some of the world's best-known automobiles. "We manufacture a wide range of automotive electronics including body controllers, infotainment systems and climate control systems, again with some produced on fully automated production lines," said Guenther.

He said automotive is a major growth area for Sanmina in Eastern Europe. Because the auto industry is highly regulated, Sanmina's facilities are IATF 16949 certified. IATF16949 is a technical specification that defines quality management system requirements applicable in the automotive supply chain.

"The need for high quality along with lower costs has driven Sanmina to implement several fully automated production lines for automotive subassemblies in eastern Europe," said Guenther.

Are fabs investing enough?

Data from North America's semiconductor equipment manufacturers indicates a climate of overall growth, despite recent billing decreases, reveals SEMI

According to the equipment market data subscription billings report published by global industry association, SEMI, North American semiconductor equipment manufacturers posted $2.36 billion in billings worldwide this July. Despite coming in 4.9 per cent lower than the June 2018 findings, this figure is 4.1 per cent higher than the $2.27 billion of July 2017.

Ajit Manocha is president and chief executive officer of SEMI, an organisation representing companies that provide equipment, materials and services for the manufacture of semiconductors and related technologies. Commenting on the results, Ajit said: "Global billings declined for the second month in a row, which is indicative of customer push-outs. We expect the industry to weather this soft patch and end the year overall with strong growth."

To put these findings into context, SEMI not only publishes a monthly North American billings report, it also issues a worldwide semiconductor equipment market statistics report in collaboration with the Semiconductor Equipment Association of Japan. This reports billings for 24 equipment segments and seven end-market regions. SEMI also has a history of tracking semiconductor industry fab investments in detail on a company-by-company and fab-by-fab basis in its world fab forecast and FabView databases. These tools provide access to spending forecasts, capacity ramp, technology transitions, and other information for over 1,000 fabs worldwide.

www.semi.org

> **We expect the industry to weather this soft patch and end the year overall with strong growth**
>
> – Ajit Manocha, president and chief executive officer of SEMI



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Smart ideas for an interconnected world

Smart, reliable, and secure networking at all levels: that's the focus for this year's Electronica trade fair and conference in Munich, 13 to 16 November



Social theorist, Jeremy Rifkin, will open Electronica 2018 with a keynote

This time round, Electronica aims to go beyond components, systems, applications and solutions. In addition to 17 halls, 13 forums, and four conferences, there will be significant innovations on show, providing extensive opportunities for exhibitors, visitors, employers and new talent to make contacts and be inspired. Over 3,000 companies from more than 50 countries will help provide a glimpse of the future.

Inspiration and experience

With more than 180,000m² of space, Electronica 2018 will be larger than before, with additional halls and a new layout, plus four conferences and 13 forums to facilitate knowledge exchange. Digital support for further networking between exhibitors and visitors, as well as among visitors, will be provided by Electronica Matchmaking and the new Electronica Connect tool.

Opportunities for inspiration and experience can be found in new areas: *Electronica Experience*; and *Impact — Design for a Cause*. Housed in hall C6, *Electronica Experience* will feature live demos, applications and presentations, as well as a job market. *Impact — Design for a Cause* will look at the future influence of electronics on communication, the environment and medicine.

Visionary keynote

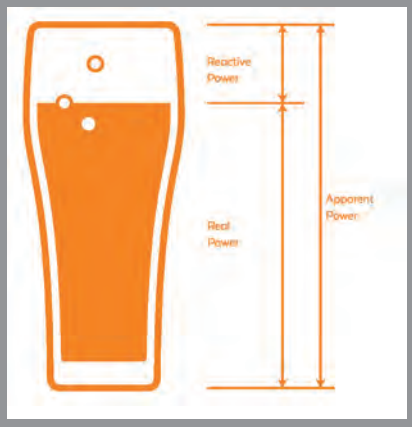
Touching on these themes, US social theorist, Jeremy Rifkin, will open Electronica with a keynote speech on Monday, 12 November.

In his works *The End of Work*, *The Third Industrial Revolution* and *The Zero Marginal Cost Society*, he identifies current developments in the economy and society, as well as touching on the global networking of industrial and social processes in the Supergrid. Jeremy will also open *Electronica Experience* with a talk on Tuesday, 13 November.

electronica.com

The importance of power factor correction

A good power factor is becoming increasingly important as more devices are fitted with switch-mode power supplies, explains Astute Electronics



Power factor correction explained

Equipment fitted with switch-mode power supplies can sometimes present a non-linear load and create harmonics that potentially cause damage, lower efficiency and increase running costs. In an ideal world, the voltage and current would be in phase; resulting in a PF of 1.0. In other words, a device would consume all the power it draws.

Power factor is best explained using this popular analogy. If you pay for a pint of beer (apparent power) you would hope that there would be more beer (real power) than froth (reactive power). If a pint was 75 per cent beer and 25 per cent froth, you would not get value for money. On the other hand, by correcting the flow of beer and gas, you could achieve better than 95 per cent beer, resulting in better value.

The same applies to power. For example, aircraft fuel is not only used to keep the plane flying, but to power all the electronics, so cockpit controls and lights can impact the amount of fuel burned. Simplistically, assume the aircraft needs 100kW of working power, but the PF is 0.8. The engines need to generate 125kW of apparent power just to keep everything working. If the PF is improved to 0.99, only 101kW is required, thereby saving fuel.

There are many regulations regarding power factor. Although equipment manufacturers must meet these requirements by law, it also makes economic sense.

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surface mount



through-hole



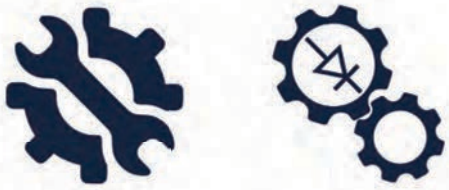
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SINE Systems / Amphenol
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Skyworks Solutions, Inc.
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TE Connectivity ALCOSWITCH Switches
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TE Connectivity Corcom Filters
TE Connectivity DEUTSCH Connectors
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TE Connectivity Potter & Brumfield Relays
TE Connectivity Raychem Cable Protection
TE Connectivity Raychem Circuit Protection / Littelfuse
TE Connectivity's Agastat Relays
TE Connectivity's Axicom Relays
TE Connectivity's Buchanan Terminal Blocks
TE Connectivity's CGS Resistors
TE Connectivity's CII
TE Connectivity's Elcon Connectors
TE Connectivity's Holsworthy Resistors
TE Connectivity's Kilovac Relays
TE Connectivity's Neohm Resistors
TE Connectivity's OEG Relays
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TE Connectivity's Q-Cee's
TE Connectivity's Schrack Relays
TE Connectivity's Sigma Inductors
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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											
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											
AAVID THERMALLOY	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,627	N/A	$0	60.42%	150	3500+	Y
ADVANCED THERMAL SOLUTIONS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	109,878	N/A	$0	100.00%	150	3500+	Y
ALPHA WIRE	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	26,919	N/A	$0	97.04%	150	3500+	Y
ALPS	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
APEM INC.	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	7,226	N/A	$0	100.00%	150	3500+	Y
Apem, Inc.	Mouser Electronics	800-346-6873	www.mouser.com	Y	4,326	N/A	$0	83.00%	50	1,000+	Y
APEX TOOL GROUP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,744	N/A	$0	99.38%	150	3500+	Y
ARTESYN EMBEDDED TECHNOLOGIES	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	10,717	N/A	$0	89.62%	150	3500+	Y
B&K PRECISION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	834	N/A	$0	100.00%	150	3500+	Y
BELDEN INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,157	N/A	$0	99.91%	150	3500+	Y
BUD INDUSTRIES	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	4,224	N/A	$0	100.00%	150	3500+	Y
C&K	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,940	N/A	$0	93.65%	150	3500+	Y
C&K Switches	Mouser Electronics	800-346-6873	www.mouser.com	Y	27,230	N/A	$0	90.00%	50	1,000+	Y
CHEMTRONICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	604	N/A	$0	100.00%	150	3500+	Y
CINCH CONNECTIVITY/Bel	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	31,120	N/A	$0	78.21%	150	3500+	Y
CNC TECH LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	5,702	N/A	$0	100.00%	150	3500+	Y
COMAIR ROTRON	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	696	N/A	$0	100.00%	150	3500+	Y
COTO TECHNOLOGY	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,079	N/A	$0	99.63%	150	3500+	Y
CRYDOM CO	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	5,554	N/A	$0	100.00%	150	3500+	Y
CUI INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	17,410	N/A	$0	92.21%	150	3500+	Y
DELTA PRODUCT GROUPS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,215	N/A	$0	99.95%	150	3500+	Y
DESCO	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,589	N/A	$0	99.83%	150	3500+	Y
EBM-PAPST INC.	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,857	N/A	$0	99.89%	150	3500+	Y
ESSENTRA COMPONENTS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	17,288	N/A	$0	99.99%	150	3500+	Y



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
ELECTROMECHANICAL (continued)											
E-SWITCH	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	8,181	N/A	$0	98.45%	150	3500+	Y
E-Switch	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
GE CRITICAL POWER	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,905	N/A	$0	75.49%	150	3500+	Y
GENERAL CABLE/CAROL BRAND	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	7,556	N/A	$0	98.28%	150	3500+	Y
GRAYHILL INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	17,836	N/A	$0	97.33%	150	3500+	Y
Grayhill	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
HAMMOND MANUFACTURING	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	13,433	N/A	$0	99.47%	150	3500+	Y
HENKEL	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	456	N/A	$0	67.04%	150	3500+	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	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	6,315	N/A	$0	95.17%	150	3500+	Y
Keystone Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Laird	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	15,187	N/A	$0	97.20%	150	3500+	Y
MEMORY PROTECTION DEVICES	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	861	N/A	$0	99.65%	150	3500+	Y
Murata	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	66,179	N/A	$0	99.79%	150	3500+	Y
NIDEC COPAL ELECTRONICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	5,797	N/A	$0	99.97%	150	3500+	Y
NKK SWITCHES	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	18,564	N/A	$0	95.73%	150	3500+	Y
NKK Switches	Mouser Electronics	800-346-6873	www.mouser.com	Y	13,976	N/A	$0	86.00%	50	1,000+	Y
NMB TECHNOLOGIES CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,057	N/A	$0	98.82%	150	3500+	Y
Omron	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
OMRON ELECTRONICS INC-EMC DIV	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	74,369	N/A	$0	95.47%	150	3500+	Y
ORION FANS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,049	N/A	$0	100.00%	150	3500+	Y
Panasonic	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	154,777	N/A	$0	94.42%	150	3500+	Y
Panasonic	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
PANDUIT CORP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	31,977	N/A	$0	99.92%	150	3500+	Y
PHIHONG USA CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,481	N/A	$0	100.00%	150	3500+	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
PORTESCAP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	99	N/A	$0	98.99%	150	3500+	Y
QUALTEK	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	5,115	N/A	$0	99.98%	150	3500+	Y
RECOM POWER INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	27,153	N/A	$0	100.00%	150	3500+	Y
SANYO DENKI AMERICA INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,816	N/A	$0	100.00%	150	3500+	Y
SCHAFFNER EMC INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,154	N/A	$0	100.00%	150	3500+	Y
SCHURTER INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	12,140	N/A	$0	99.57%	150	3500+	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
SL POWER ELECTRONICS MANUFACTURE OF CONDOR/AULT BRANDS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,733	N/A	$0	84.46%	150	3500+	Y
SUNON FANS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,860	N/A	$0	77.20%	150	3500+	Y
TDK	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	60,769	N/A	$0	99.20%	150	3500+	Y
TE	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	338,106	N/A	$0	79.40%	150	3500+	Y
TE Connectivity	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
TECHFLEX	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,184	N/A	$0	99.54%	150	3500+	Y
Teledyne Relays	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
T-GLOBAL TECHNOLOGY	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,885	N/A	$0	99.95%	150	3500+	Y
THOMAS RESEARCH PRODUCTS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,596	N/A	$0	84.65%	150	3500+	Y
VICOR CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	196,048	N/A	$0	52.13%	150	3500+	Y
XP POWER	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	5,255	N/A	$0	100.00%	150	3500+	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											
ADAFRUIT INDUSTRIES LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,854	N/A	$0	99.51%	150	3500+	Y
AKM SEMICONDUCTOR INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,215	N/A	$0	100.00%	150	3500+	Y
ALLEGRO MICROSYSTEMS, LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,090	N/A	$0	87.22%	150	3500+	Y
ALPHA & OMEGA SEMICONDUCTOR INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,316	N/A	$0	100.00%	150	3500+	Y
ALTERA	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	10,901	N/A	$0	84.86%	150	3500+	Y
AMS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,288	N/A	$0	99.29%	150	3500+	Y
ANALOG DEVICES INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	52,308	N/A	$0	73.79%	150	3500+	Y
Analog Devices, Inc	Mouser Electronics	800-346-6873	www.mouser.com	Y	18,749	N/A	$0	95%	50	1,000+	Y
APEX MICROTECHNOLOGY INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	436	N/A	$0	75.46%	150	3500+	Y
ATP ELECTRONICS, INC.	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	710	N/A	$0	100.00%	150	3500+	Y
AVAGO/Broadcom	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	16,512	N/A	$0	91.38%	150	3500+	Y
BIVAR INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	17,728	N/A	$0	100.00%	150	3500+	Y
BRIDGELUX	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,853	N/A	$0	100.00%	150	3500+	Y
Broadcom Limited	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y

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
ICs & SEMICONDUCTORS (continued)											
CEL CALIFORNIA EASTERN LABS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,529	N/A	$0	85.80%	150	3500+	Y
CENTRAL SEMICONDUCTOR CORP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	6,054	N/A	$0	91.92%	150	3500+	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
Central Semiconductor	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
CIRRUS LOGIC INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,187	N/A	$0	84.82%	150	3500+	Y
COMCHIP TECHNOLOGY	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	6,890	N/A	$0	100.00%	150	3500+	Y
CREE INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	28,807	N/A	$0	100.00%	150	3500+	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
CYPRESS SEMICONDUCTOR CORP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	27,423	N/A	$0	92.54%	150	3500+	Y
DECAWAVE LIMITED	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	15	N/A	$0	100.00%	150	3500+	Y
DIALIGHT	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	12,426	N/A	$0	78.05%	150	3500+	Y
DIGI INTERNATIONAL	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	4,355	N/A	$0	95.30%	150	3500+	Y
Digi International	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
DIGILENT, INC.	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	406	N/A	$0	100.00%	150	3500+	Y
DIODES INCORPORATED	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	38,292	N/A	$0	90.02%	150	3500+	Y
Diodes Incorporated	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
EPC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	483	N/A	$0	90.68%	150	3500+	Y
FINISAR CORP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,327	N/A	$0	98.84%	150	3500+	Y
FOXCONN OPTICAL INTERCONNECT TECHNOLOGIES, INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	304	N/A	$0	99.67%	150	3500+	Y
FTDI	Mouser Electronics	800-346-6873	www.mouser.com	Y	94	N/A	$0	100%	50	1,000+	Y
FTDI	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	569	N/A	$0	100.00%	150	3500+	Y
IDT	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	51,696	N/A	$0	87.69%	150	3500+	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
INFINEON TECHNOLOGIES	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	28,850	N/A	$0	93.70%	150	3500+	Y
Intel	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
INTERSIL	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	21,865	N/A	$0	72.31%	150	3500+	Y
ISSI	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	5,006	N/A	$0	85.36%	150	3500+	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
IXYS INTEGRATED CIRCUITS DIVISION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	7,377	N/A	$0	99.60%	150	3500+	Y
KINGBRIGHT COMPANY LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,803	N/A	$0	100.00%	150	3500+	Y
KYOCERA INTERNATIONAL, INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	757	N/A	$0	97.09%	150	3500+	Y
Laird	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	15,187	N/A	$0	97.20%	150	3500+	Y
Lattice	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
LATTICE SEMICONDUCTOR CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	7,245	N/A	$0	65.92%	150	3500+	Y
LINEAR TECHNOLOGY	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	37,479	N/A	$0	77.62%	150	3500+	Y
LINX TECHNOLOGIES INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	928	N/A	$0	92.67%	150	3500+	Y
LITE-ON INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,759	N/A	$0	99.49%	150	3500+	Y
LUMEX OPTO/COMPONENTS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	8,181	N/A	$0	96.61%	150	3500+	Y
M/A-COM TECHNOLOGY SOLUTIONS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,822	N/A	$0	86.17%	150	3500+	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
MAXIM INTEGRATED	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	68,021	N/A	$0	78.22%	150	3500+	Y
MELEXIS TECHNOLOGIES NV	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,652	N/A	$0	95.16%	150	3500+	Y
MICRO COMMERCIAL CO	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	9,873	N/A	$0	97.15%	150	3500+	Y
Microchip	Mouser Electronics	800-346-6873	www.mouser.com	Y	5,800	N/A	$0	100%	50	1,000+	Y
MICROCHIP TECHNOLOGY	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	86,517	N/A	$0	86.12%	150	3500+	Y
MICRON TECHNOLOGY INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	11,216	N/A	$0	89.77%	150	3500+	Y
Microsemi	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
MICROSEMI COMMERCIAL COMPONENTS GROUP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	59,698	N/A	$0	54.44%	150	3500+	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
MULTI-TECH SYSTEMS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,322	N/A	$0	99.64%	150	3500+	Y
NEWHAVEN DISPLAY INTL	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	758	N/A	$0	100.00%	150	3500+	Y
Nexperia	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
NEXPERIA USA INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	23,513	N/A	$0	99.29%	150	3500+	Y
NORDIC SEMICONDUCTOR ASA	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	219	N/A	$0	99.54%	150	3500+	Y
NXP	Mouser Electronics	800-346-6873	www.mouser.com	Y	7,205	N/A	$0	100%	50	1,000+	Y
NXP USA INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	36,258	N/A	$0	93.55%	150	3500+	Y
ON Semiconductor	Mouser Electronics	800-346-6873	www.mouser.com	Y	7,486	N/A	$0	96%	50	1,000+	Y
ON SEMICONDUCTOR	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	87,298	N/A	$0	85.61%	150	3500+	Y
OSRAM OPTO SEMICONDUCTORS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	6,707	N/A	$0	98.48%	150	3500+	Y
PEREGRINE SEMICONDUCTOR	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	498	N/A	$0	99.60%	150	3500+	Y
POWER INTEGRATIONS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,751	N/A	$0	94.76%	150	3500+	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
QUALCOMM TECHNOLOGIES INTERNATIONAL, LTD.	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,763	N/A	$0	99.88%	150	3500+	Y
QUATECH-DIVISION OF B&B ELECTRONICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	210	N/A	$0	92.86%	150	3500+	Y
Renesas Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
RENESAS ELECTRONICS AMERICA	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	13,028	N/A	$0	85.07%	150	3500+	Y
Rohm	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	55,139	N/A	$0	99.85%	150	3500+	Y
ROHM Semiconductor	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Samsung	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	37,336	N/A	$0	100.00%	150	3500+	Y
SanDisk	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
SEEED TECHNOLOGY CO., LTD	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,444	N/A	$0	100.00%	150	3500+	Y
SEGGER MICROCONTROLLER SYSTEMS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	71	N/A	$0	100.00%	150	3500+	Y
SEMTECH CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	4,532	N/A	$0	89.94%	150	3500+	Y

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ICs & SEMICONDUCTORS (continued)											
Silicon Laboratories Inc	Mouser Electronics	800-346-6873	www.mouser.com	Y	1,141	N/A	$0	100.00%	50	1,000+	Y
SILICON LABORATORIES INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	19,667	N/A	$0	96.54%	150	3500+	Y
Skyworks	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
SKYWORKS SOLUTIONS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,621	N/A	$0	99.66%	150	3500+	Y
SPARKFUN ELECTRONICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,696	N/A	$0	96.58%	150	3500+	Y
ST Microelectronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	8,145	N/A	$0	96.00%	50	1,000+	Y
STMICROELECTRONICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	39,201	N/A	$0	97.79%	150	3500+	Y
Swissbit	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
SWISSBIT NA INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,233	N/A	$0	100.00%	150	3500+	Y
TAOGLAS LIMITED	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	628	N/A	$0	100.00%	150	3500+	Y
TDK	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	60,769	N/A	$0	99.20%	150	3500+	Y
Texas Instruments	Mouser Electronics	800-346-6873	www.mouser.com	Y	29,676	N/A	$0	94%	50	1,000+	Y
TEXAS INSTRUMENTS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	180,012	N/A	$0	91.94%	150	3500+	Y
Toshiba	Mouser Electronics	800-346-6873	www.mouser.com	Y	800	N/A	N/A	N/A	N/A	N/A	Y
TOSHIBA SEMICONDUCTOR AND STORAGE	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	14,145	N/A	$0	75.25%	150	3500+	Y
TRINAMIC MOTION CONTROL GMBH	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	333	N/A	$0	100.00%	150	3500+	Y
TT ELECTRONICS/OPTEK TECHNOLOGY	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	12,399	N/A	$0	96.55%	150	3500+	Y
U-BLOX AMERICA INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	165	N/A	$0	100.00%	150	3500+	Y
VERSALOGIC CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	623	N/A	$0	96.79%	150	3500+	Y
Vishay	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	581,798	N/A	$0	87.71%	150	3500+	Y
Vishay	Mouser Electronics	800-346-6873	www.mouser.com	Y	53,781	N/A	$0	77%	50	1,000+	Y
VISUAL COMMUNICATIONS COMPANY, LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	6,422	N/A	$0	96.61%	150	3500+	Y
WINBOND ELECTRONICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,233	N/A	$0	99.84%	150	3500+	Y
WOLFSPEED	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	303	N/A	$0	97.69%	150	3500+	Y
XILINX INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	8,213	N/A	$0	51.46%	150	3500+	Y
INTERCONNECTION											
3M	Mouser Electronics	800-346-6873	www.mouser.com	Y	23,235	N/A	$0	46.00%	50	1,000+	Y
3M	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	62,421	N/A	$0	93.42%	150	3500+	Y
AMPHENOL	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	443,368	N/A	$0	75.92%	150	3500+	Y
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
ASSMANN WSW COMPONENTS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	11,669	N/A	$0	92.37%	150	3500+	Y
BULGIN	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	4,059	N/A	$0	100.00%	150	3500+	Y
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	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	31,120	N/A	$0	78.21%	150	3500+	Y
Cinch Connectivity/Bel	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
CONEC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	8,202	N/A	$0	99.98%	150	3500+	Y
CW INDUSTRIES	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,989	N/A	$0	94.87%	150	3500+	Y
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
Glenair	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
Harting	Mouser Electronics	800-346-6873	www.mouser.com	Y	2,160	N/A	$0	51.00%	50	1,000+	Y
HARTING	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	16,742	N/A	$0	99.96%	150	3500+	Y
Harwin	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
HARWIN INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	11,191	N/A	$0	89.61%	150	3500+	Y
Hirose Electric	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
HIROSE ELECTRIC CO LTD	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	37,215	N/A	$0	90.98%	150	3500+	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
ITT CANNON, LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	151,353	N/A	$0	39.47%	150	3500+	Y
JAE Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	6,02	N/A	$0	100%	N/A	N/A	Y
JAE ELECTRONICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	6,788	N/A	$0	95.58%	150	3500+	Y
JST	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
JST SALES AMERICA INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	5,109	N/A	$0	84.32%	150	3500+	Y
LEMO	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
Mill-Max	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
MILL-MAX MANUFACTURING CORP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	60,434	N/A	$0	64.55%	150	3500+	Y
Molex	Mouser Electronics	800-346-6873	www.mouser.com	Y	85,634	N/A	$0	89%	50	1,000+	Y
MOLEX CONNECTOR CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	305	N/A	$0	100.00%	150	3500+	Y
MOLEX, LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	120,034	N/A	$0	97.98%	150	3500+	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
NORCOMP INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	7,185	N/A	$0	57.87%	150	3500+	Y
ON SHORE TECHNOLOGY INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	13,026	N/A	$0	99.99%	150	3500+	Y
PARLEX USA LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	790	N/A	$0	98.35%	150	3500+	Y
Phoenix Contact	Mouser Electronics	800-346-6873	www.mouser.com	Y	30,044	N/A	$0	77.00%	50	1,000+	Y
PHOENIX CONTACT	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	54,845	N/A	$0	99.99%	150	3500+	Y
Radiall	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
SAMTEC INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	427,448	N/A	$0	99.99%	150	3500+	Y
Souriau	Mouser Electronics	800-346-6873	www.mouser.com	Y	10,744	N/A	$0	27%	50	1,000+	Y
SOURIAU USA	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	65,743	N/A	$0	64.34%	150	3500+	Y
SULLINS CONNECTOR SOLUTIONS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	204,991	N/A	$0	97.59%	150	3500+	Y
Switchcraft Corporation	Mouser Electronics	800-346-6873	www.mouser.com	Y	300	N/A	$0	55%	50	1,000+	Y

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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
INTERCONNECTION (continued)											
SWITCHCRAFT INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	4,392	N/A	$0	80.56%	150	3500+	Y
TE	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	338,106	N/A	$0	79.40%	150	3500+	Y
TE Connectivity	Mouser Electronics	800-346-6873	www.mouser.com	Y	123,613	N/A	$0	69%	50	1,000+	Y
TENSILITY INTERNATIONAL CORP	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,292	N/A	$0	100.00%	150	3500+	Y
WEIDMULLER	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	42,913	N/A	$0	96.55%	150	3500+	Y
OBSOLESCENCE / HARD TO FIND											
	America II Electronics	800-767-2637	www.americaii.com	M	1,900	$1B	$0	75.00%	59	550+	Y
	Lantek Corp.	973-579-8100	www.lantekcorp.com	M	186,000	$22M	$0	75.00%	5	62	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
ABRACON LLC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	41,991	N/A	$0	100.00%	150	3500+	Y
AMERICAN TECHNICAL CERAMICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,978	N/A	$0	88.78%	150	3500+	Y
API DELEVAN INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	31,481	N/A	$0	44.15%	150	3500+	Y
AVX	Mouser Electronics	800-346-6873	www.mouser.com	Y	42,454	N/A	$0	72%	50	1,000+	Y
AVX CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	70,131	N/A	$0	89.28%	150	3500+	Y
Bourns	Mouser Electronics	800-346-6873	www.mouser.com	Y	38	N/A	$0	78%	50	1,000+	Y
BOURNS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	59,314	N/A	$0	82.47%	150	3500+	Y
CADDOCK ELECTRONICS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	531	N/A	$0	98.87%	150	3500+	Y
CINCH CONNECTIVITY/Bel	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	31,120	N/A	$0	78.21%	150	3500+	Y
Cornell Dubilier	Mouser Electronics	800-346-6873	www.mouser.com	Y	24,145	N/A	$0	71%	50	1,000+	Y
CORNELL DUBILIER ELECTRONICS (CDE)	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	26,367	N/A	$0	77.48%	150	3500+	Y
Coilcraft	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
CRYSTEK CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,728	N/A	$0	100.00%	150	3500+	Y
CTS RESISTOR PRODUCTS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	9,604	N/A	$0	64.89%	150	3500+	Y
EATON	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	29,997	N/A	$0	86.82%	150	3500+	Y
ECS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	9,122	N/A	$0	86.46%	150	3500+	Y
ENERGIZER BATTERY COMPANY	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	528	N/A	$0	97.73%	150	3500+	Y
EPCOS	Mouser Electronics	800-346-6873	www.mouser.com	Y	26,533	N/A	$0	98.00%	50	1,000+	Y
EPSON	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	21,166	N/A	$0	93.14%	150	3500+	Y
Fair-Rite	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
HONEYWELL MICROELECTRONICS & PRECISION SENSORS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	28,560	N/A	$0	89.87%	150	3500+	Y
JOHANSON DIELECTRICS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,234	N/A	$0	95.79%	150	3500+	Y
Kemet	Mouser Electronics	800-346-6873	www.mouser.com	Y	77,568	N/A	$0	66%	50	1,000+	Y
KEMET	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	101,257	N/A	$0	91.57%	150	3500+	Y
KNOWLES	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	271,696	N/A	$0	87.06%	150	3500+	Y
KOA Speer	Mouser Electronics	800-346-6873	www.mouser.com	Y	34,078	N/A	$0	58%	50	1,000+	Y
Laird	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	15,187	N/A	$0	97.20%	150	3500+	Y
LEM USA INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	401	N/A	$0	98.50%	150	3500+	Y
LITTELFUSE INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	59,517	N/A	$0	91.54%	150	3500+	Y
Murata	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	66,179	N/A	$0	99.79%	150	3500+	Y
Murata	Mouser Electronics	800-346-6873	www.mouser.com	Y	33,780	N/A	$0	99%	50	1,000+	Y
NDK AMERICA, INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,035	N/A	$0	100.00%	150	3500+	Y
NESSCAP CO LTD	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	34	N/A	$0	100.00%	150	3500+	Y
Nichicon	Mouser Electronics	800-346-6873	www.mouser.com	Y	20,389	N/A	$0	84.00%	50	1,000+	Y
NICHICON	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	39,747	N/A	$0	96.70%	150	3500+	Y
NVE CORP/ISOLATION PRODUCTS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	270	N/A	$0	67.41%	150	3500+	Y
Ohmite	Mouser Electronics	800-346-6873	www.mouser.com	Y	14,293	N/A	$0	55.00%	50	1,000+	Y
OHMITE	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	17,487	N/A	$0	65.22%	150	3500+	Y
Panasonic	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	154,777	N/A	$0	94.42%	150	3500+	Y
Panasonic Electronic Components	Mouser Electronics	800-346-6873	www.mouser.com	Y	14,948	N/A	$0	100.00%	50	1,000+	Y
PUI AUDIO, INC.	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	1,155	N/A	$0	71.69%	150	3500+	Y
PULSE ELECTRONICS POWER	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	10,065	N/A	$0	93.11%	150	3500+	Y
RIEDON	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	3,756	N/A	$0	99.87%	150	3500+	Y
Rohm	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	55,139	N/A	$0	99.85%	150	3500+	Y
RUBYCON	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	13,950	N/A	$0	94.54%	150	3500+	Y
Samsung	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	37,336	N/A	$0	100.00%	150	3500+	Y
SOBERTON INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	256	N/A	$0	100.00%	150	3500+	Y
STACKPOLE ELECTRONICS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	94,176	N/A	$0	99.55%	150	3500+	Y
STANDEX-MEDER ELECTRONICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	656	N/A	$0	99.85%	150	3500+	Y
SUMIDA AMERICA COMPONENTS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	7,201	N/A	$0	86.64%	150	3500+	Y
SUSUMU	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	43,346	N/A	$0	99.98%	150	3500+	Y
Taiyo Yuden	Mouser Electronics	800-346-6873	www.mouser.com	Y	4,620	N/A	$0	98.00%	50	1,000+	Y
TAIYO YUDEN	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	21,540	N/A	$0	99.97%	150	3500+	Y
TDK	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	60,769	N/A	$0	99.20%	150	3500+	Y
TDK	Mouser Electronics	800-346-6873	www.mouser.com	Y	6,663	N/A	$0	100.00%	50	1,000+	Y
TE	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	338,106	N/A	$0	79.40%	150	3500+	Y
TRIAD MAGNETICS	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	2,144	N/A	$0	99.11%	150	3500+	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)											
TRIPP LITE	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	4,484	N/A	$0	90.83%	150	3500+	Y
TT Electronics	Mouser Electronics	800-346-6873	www.mouser.com	Y	N/A	N/A	$0	N/A	50	1,000+	Y
TXC CORPORATION	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	10,542	N/A	$0	100.00%	150	3500+	Y
UNITED CHEMI-CON	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	16,382	N/A	$0	87.60%	150	3500+	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	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	581,798	N/A	$0	87.71%	150	3500+	Y
Vishay	Mouser Electronics	800-346-6873	www.mouser.com	Y	102,917	N/A	$0	64.00%	50	1,000+	Y
VISHAY FOIL RESISTORS (DIVISION OF VISHAY PRECISION GROUP)	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	28,346	N/A	$0	52.45%	150	3500+	Y
Wurth	Mouser Electronics	800-346-6873	www.mouser.com	Y	934	N/A	$0	99.00%	50	1,000+	Y
WURTH ELECTRONICS INC	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	23,733	N/A	$0	100.00%	150	3500+	Y
YAGEO	Digi-Key Electronics	1-800-344-4539	www.digikey.com	Y	147,833	N/A	$0	84.31%	150	3500+	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
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
THERMAL MANAGEMENT											
STEGO, Inc		770-984-0858	www.stegousa.com	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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

MOUSER MANUFACTURERS

0 - 9

3M
3M Touch Systems
4D Systems

A

AAEON
Aavid Thermalloy
Abracon
aconno
Adafruit
Adaptive Interconnect Electronics
Adesto Technologies
ADI Engineering
ADLINK Technology
Advanced Energy
Advanced Linear Devices
Advanced Thermal Solutions
Advantech
AIM
Alliance Memory
All Sensors
Alorium Technology
Alpha Wire
ALPS
Altech
Altera / Intel
Altitude Technology
AME
American Technical Ceramics
Ametherm
Amphenol
Amprobe
ams
AMSECO / Potier
Amulet Technologies
Analog Devices Inc.
AnalogicTech
Anaren
Anderson Power Products
Antenna Factor
Antenova
Apacer Technology Inc.
APC by Schneider Electric
APEM
Apex Tool Group
API Delevan
APM HEXSEAL
Applied Motion
Aptiv
Arbor Technology
Arcol / Ohmite
Arduino
Aries
Artesyn Embedded Technologies
Astrodyne TDI
Atollic
Ault / SL Power
Auvidea
Avago Technologies
Avery Dennison
AVX
Axiomtek
Azoteq

B

B&B Smart Worx
B&K Precision
Basler, Inc.
BeagleBoard
BEI Sensors
Bel
Bel Fuse
Bel Power Solutions
Belden
Bellin Dynamic Systems
Bergquist
Bias Power
BI Technologies / TT Electronics
BIVAR
Blackhawk
Bluegiga / Silicon Labs
Bluetechnix
Bomar Interconnect
Bosch Sensortec
Bosch Connected Devices
Boundary Devices
Bourns
BPS
Bridgetek
Broadcom
Bud Industries
Bulgin

C

C&K
Caddock
Cal Test
Califia Lighting
California Eastern Labs / CEL
Carling Technologies
Carclo Technical Plastics
CCS
Central Semiconductor
Chemtronics
CHERRY
Chip Quik
Cinch Connectivity Solutions
Cincon
Cirrus Logic
Cirque Corporation
Citizen Finetech Miyota
Clare
Coilcraft
Comchip Technology
Condor / SL Power
CONEC
congatec
Connect One
Conxall
Cornell Dubilier
Cosel
Coto Technology
Cree
Critical Link
Crocus Technology
Crouzet
Crowd Supply
Crydom
CRYSTEK CRYSTALS
CSB
CTS Electronic Components
CUI Inc.
CW Industries
Cypress Semiconductor

D

D3 Semiconductor
DAVE Embedded Systems
Davies Molding
DBM Optix
DB Unlimited
Dell
Delta Electronics
Deltron
Desco
Design Gateway
DFRobot
Dialight
Dialog Semiconductor
Dielectric Laboratories
Digi International
Digilent
Digital View
Diode Laser Concepts
Diodes Incorporated
DIOO Microcircuits
Displaytech Ltd.
DLP Design
DMC Tools (Daniels Manufacturing Corp)
Doodle Labs

E

Eagle-Picher
EAO
EasySync
Eaton
ebm-papst
Ecliptek
ECS
EDAC
EE Tools
eInfochips
Electronic Assembly
Electroswitch
Elna
Elprotronic Inc.
Embedded Artists
Energy Micro
enmo
Enterpoint, Ltd.
EPCOS / TDK
Epson
ERP Power
ERNI Electronics
E-Switch
Esquilo
ETA-USA
E-T-A Circuit Breakers
ETI Systems
Eupec
Eurotech
Everspin Technologies
Everlight
EXAR
Extech

F

Fair-Rite
Fascomp
Fastron
FCI / Amphenol
FCT Electronics
Finisar
Flamar
Flambeau
Flir
FlexiPanel
Fluke
Fox
FTDI
Fujitsu
Future Designs, Inc. (FDI)

G

GeneSiC Semiconductor
GE Critical Power
GHI Electronics
Glenair
Global Specialties
Gravitech
Grayhill
Greenlee
Greenliant
GSI Technology
Guerrilla RF
Gumstix
GWconnect

H

Hammond Enclosures
Hantronix
HARTING
Harwin
Heatron
Helium
Heyco
Hirose Electric
Honeywell
HUBER+SUHNER

I

IAR Systems
iBASE Technology
ICE Components
iEi Technology
IET Labs
ilumi
Illumitex
Imagination Technologies
Industruino
Infineon
Inolux
Insight SiP
Inspired LED
Intel
Integrated Device Technology
International Power
Intersil
Inventus Power
Ioxus
IPDiA / Murata
IQD Frequency Products
IRC / TT Electronics
Iso-Tip
ISSI
ITT Cannon
ITW Switches
IXYS Colorado
IXYS Integrated Circuits

J

J.W. Miller
Jadak
JAE Electronics
Jewell Modutec
JKL Components
Johanson
Johnson / Cinch
JST Automotive Connectors

K

Kamaya
Ka-Ro Electronics
Kavlico
Keil (Arm®)
Keithley
KEMET
Kester
Keterex
Keysight Technologies
Keystone Electronics
Kionix / ROHM Semiconductor
Kingbright
Knowles Acoustics
KOA Speer
Kostal
Kycon
KYOCERA / AVX

L

Laird Technologies
Lantronix
Lattice Semiconductor
LedEngin
Ledil
LedLink
LEMO
Leopard Imaging
Leviton
Linear Technology / Analog Devices
LinkSprite
Linx Technologies
Lite-On
Littelfuse
LMB/Heeger
Lorlin
LPRS
LS Research (Laird Technologies)
Lumberg Automation
Lumberg Automation / Hirschman
Lumex
Lumileds
Luminus Devices
Luxo Corporation

M

MACOM
Macraigor Systems
Maestro Wireless
Magnecraft
Mallory
Mallory Sonalert
Marquardt Switches
Matrix Orbital
Maxim Integrated
Maxwell Technologies
MCC
MCS Electronics
MEAN WELL
Measurement Specialties
Meder
Melexis
Memsic
Menda
Merit Sensor
Metcal
MG Chemicals
Micrel
Micro Crystal
Microchip
Micron Technology
Micronas
Microsemi
Microtips
Mide Technology
MikroElektronika
Mill-Max
Mitsubishi Electric
Molex
Monolithic Power Systems (MPS)
Mpression
MSI Sensors
Mueller Electric
Murata
Murata Power Solutions

N

National Instruments
NEC Relays
NetBurner
Netduino
Neutrik
NewAE Technology
New Age Enclosures
Newhaven Display
Nexperia
Nichicon
NJR
NKK Switches
NMB
NorComp
Nordic Semiconductor
Noritake
NOVACAP
NovaSensor / GE Sensing
NovTech
Nutaq
NXP Semiconductors

O

Octavo Systems
Ohmite
OK Industries
Olimex Ltd.
Olmatic
Omron
ON Semiconductor
Onion
Oplink
Optek Technologies
Optrex-Kyocera
Opulent Americas
Orion Fans
OSEPP
OSRAM Opto Semiconductors
OTTO

P

Pacific Silicon Sensor
PacTec
Panasonic
PanaVise
PandaBoard
Panduit
Parallax
Particle
Pericom (Diodes Inc.)
Phihong
Phoenix Contact
Piher
Plato
Plessey Semiconductors
PLX Technology
Pomona
Powercast
Power Dynamics
Power Integrations
Power-Sonic
Preci-Dip
Precision Technology
Protek
Protektive Pak
PUI Audio
Pulse Electronics
Pycom

Q, R

Q-Cee's / TE Connectivity
Qualcomm RF360
Qualtek
Quatech
Radiall
RAF Electronic Hardware
RAFI
Ramtron
Raspberry Pi
RECOM
Rectron
Red Pitaya
Redpine Signals
ReFLEX CES
Renata
Renesas
RF Digital
Ricoh Electronic Devices
Rigado
ROBOTIS
ROHM Semiconductor
Rosenberger
Rowley Associates
RushUP

S

Sagrad, Inc.
Samsung ARTIK
SanDisk
Sanyo Denki
Sargent Tools
Schaffner
SchmartBoard
Schneider Electric
Schurter
SEEED STUDIO
SEGGER Microcontroller
Seiko Printers
Sensata Technologies
SensiEDGE
Seoul Semiconductor
Semelab
Semflex / Cinch
Semitec USA
Semtech
Sensyst
Serpac
Sferalabs
Sharp Microelectronics
Shindengen
Sierra Monitor
Signal Transformer
Silex Technology
Silicon Microstructures
Silicon Labs
Simpson
SiTime
Skyworks Solutions Inc.
Smiths Interconnect
SMSC / Microchip
SolaHD
SolderCore
Song Chuan
Souriau
SL Power
Spansion
SparkFun Electronics
Spectra Symbol
Spectrum Control
Spectrum Digital
SPI Westek
Sprague Goodman
Stadium Group
Staco
Standex-Meder
Steute Wireless
STMicroelectronics
Stratos / Cinch
Sumida
Sunon
Susumu
Sutronics
Swissbit
Switchcraft
Syfer
Symmetry Electronics

T

Tadiran
Taica
Taiwan Semiconductor
Taiyo Yuden
Tamura
Taoglas
TDK
TDK InvenSense
TDK-Lambda
TE Connectivity
TechNexion
Techspray
Tektronix
Teledyne LeCroy
Teledyne Relays
Temp-Flex Cable
Terasic Technologies
Texas Instruments
TinyCircuits
THAT Corporation
Thermometrics
Torex Semiconductor
Toshiba
Toshiba Memory
TRACO Power
Triad Magnetics
Tripp Lite
TriQuint Semiconductor
Triune Systems
Trompeter / Cinch
Tronics
TT Electronics
Tusonix
Twin Industries
TXC
Tyco Electronics

U

UDOO
Ultralife
United Chemi-Con
United Silicon Carbide
UrsaLeo
US Sensor

V

Vacuumschmelze (VAC)
Varitronix
VCC
Vector
Vectron International
Versarion Technologies
VIA Embedded
Vicor
VISATON
Vishay
Vishay Precision Group
Vision Engineering
Visionox
Vitelec / Cinch
Virtium
Volex
Voltronics
VORAGO Technologies

W

W.L. Gore
Wakefield-Vette
Walsin
Wandboard
WeEn Semiconductor
Welwyn / TT Electronics
White-Rodgers
Wi2Wi
WIMA
Wiremold
WIZnet
Wolfson/Cirrus Logic
Wolfspeed
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