

### **MITIGATING RISK IN AUTOMOTIVE SUPPLY CHAIN**

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Page 13



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#### **Editor's Word**



#### On the cover – September/October 2018

Mitigating risk in automotive supply chain page 13

#### **Contents**



Economy Keeping up with the good times

06

News Enhanced logistics streamline service

12

18

EMS An insiders' guide to EMS sourcing

Semiconductor Market Watch Expect longer lead times



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

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# Think of the little ones

Unless you have been holidaying on a remote island over the past 12-months you will understand certain categories of popular components are becoming a little awkward to source regarding volume and timescale. It seems to be a combination of events driven by evolving manufacturing methods, global growth, emerging product technologies and hysteresis in adding more capacity.

Distributors have responded with a universal mantra. The more loyalty, transparency and forward planning a customer can offer, the more likely a distributor will be able to help. Sounds fair to me.

I have a question re forward planning. For large OEMs with an established product range, a stable market share and years of sales data, I would imagine (bar some unexpected natural disaster) projecting components consumption across a 12 to 24-month period would be relatively easy.

However, for one group, startups, the reverse is true. It's likely they will have a new technology that potential customers have never heard of, zero market share and no sales data. At the point of launch everything is guesswork. I'm not too worried if a new consumer gadget is a little late to market but what if the product is an essential, lifesaving medical device.

So, what is a distributor to do? Push the startups to the bottom of the list and miss the potential opportunity to share in the success of a groundbreaking new product or restrict supply to a loyal customer to support a fledgling business.

Maybe I'm imagining a problem that doesn't exist. If it does, I'd be interested to hear buyers' and suppliers' proposed solutions.

Jon Bannett

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# Keeping up with the good times



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

Supply chain services, technology take centre stage as buyers keep pace with the strong economy

#### Economy • By Victoria Kickham

uyers face a different set of challenges as the economy continues its upward climb, particularly when it comes to managing their supply chains. Strong demand across just about every end market has extended lead times for many electronic components and created pricing pressures as well as labor challenges—especially in the manufacturing sector, where employment is expanding and skilled workers are hard to find.

It all adds up to busy times for buyers at organizations of all sizes, who face both fundamental and technological challenges in mid-2018. Fundamentally, today's challenges come down to constraint: Demand is high, and it's placing distributors in a "chief expediter" mode, says Phil Gallagher, global president, electronic components, for Avnet.

"We're doing what we can to feed the lines for our customers," Gallagher says, pointing to the key challenges facing buyers in today's marketplace. "Right now, [this is] one of the top [issues] that may not have been [an issue] two years ago because inventory and parts were plentiful."

Traditional supply chain services such as forecasting and inventory management come into sharp focus in times like these, he adds, as customers concentrate on keeping production lines running smoothly and efficiently.

Still, as business challenges go, Gallagher says these are good ones to have.

"I see them as positive ... because it means things are good," he says, pointing to strength across Avnet's end markets and regions. "Most of our customers are doing well ... There are some exciting things going on. We're seeing it in all regions."

Technology challenges persist during the current good times, as well. Gallagher and others say there continues to be a growing need for electronics expertise among engineering and buying organizations large and small, particularly as customers seek to create increasingly sophisticated products or add Internet connectivity to non-traditional applications. Gallagher points to transportation, medical, and agricultural markets as just a few examples of areas where Avnet is seeing an increase in demand for technical service, from design all the way through to production. The distributor unveiled a suite of IoT services this year aimed at meeting such needs; they include advisory, design and build, cloud and digital, and lifecycle services.

Such capabilities are part of a larger transformation at Avnet over the last 18 months that has included the addition of engineering communities such as element14 (via its acquisition of Premier Farnell) and Hackster.io as well as manufacturing solutions provider Dragon Innovation.

Avnet's transformation underscores a continuing evolution of the distribution sector, as distributors seek to move beyond providing products and services to offering customers complete solutions.

"[We tell customers], 'We want to be your solution provider. If you have an issue, a challenge, call [us]," Gallagher explains. "It's really what we're moving toward."

Other headlines over the summer emphasize the trend as well. Interconnect, passive, and electromechanical specialty distributor TTI announced an expansion of its semiconductor specialty business, TTI Semiconductor Group (TSG), in July with its purchase of California-based distributor RFMW Ltd. The deal is expected to close this fall, and will add RFMW's focus on radio frequency and microwave components, semiconductors and related engineering support to TTI's lineup of specialty services. TTI launched TSG in 2017 with its purchase of Symmetry Electronics as a way to evolve its specialist model to include semiconductor products and services.

"RFMW will be an important addition to the TTI family of companies and our semiconductor distribution group," said Michael Knight, senior vice president, TTI Business Development and TSG President. "The company culture, focus, and reputation for superior customer service and technical expertise complement TTI extremely well and are a perfect fit for our specialty distribution model."

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#### **Enhanced logistics** streamline service

Panasonic Industry Europe has expanded its European logistics centre in Pfaffenhofen, near Munich, to provide enhanced service to customers in the region.

Project head and senior general manager logistic operations at Panasonic, Gerhard Reiprich, said: "This is a decisive step towards an automated, effective and state-of-the-art warehouse. Just one year ago, we had to manually remove small parts from racks., which was a work-intense and inefficient process."

Managing director of Panasonic Industry Europe, Johannes Spatz, added: "The investment of about three million euros will increase our efficiency in the European market. Since we repositioned the company last October, our divisions have been working to provide customers in all areas with new solutions. The latest automation of the European logistics centre will clear the way for further integration, a change that will provide maximum

service delivered at optimal costs."

In the past, the logistics centre was primarily used to store components of Panasonic Electric Works Europe. By the end of the year, it will offer machinery replacement parts from the factory solutions division throughout Europe. industry. panasonic.eu

#### **Enlist smart** support

Arrow Electronics has signed an agreement with RFbeam Microwave to offer its planar radar sensor solutions across Europe, the Middle East and Africa. This will enhance Arrow's support for smart home and city applications and has also facilitated a new solution based on RFbeam's radar modules.

Solutions in the RFbeam portfolio extend from simple Doppler devices through to digital and superhet transceivers. The company, which develops short-range microwave sensors and is a specialist in antenna design and microwave circuit engineering, produces products currently used in applications including movement detection and industrial sensors, traffic supervision and analysis and sport measurement equipment.

Vice president engineering EMEA, Arrow Electronics, David Spragg, said: "Short-range sensor technologies will be fundamental to achieving the functionality and energy efficiency goals of the rapidly developing smart cities and the smart homes within them. RFbeam Microwave brings a new product portfolio and engineering skills that will enable Arrow's customers to create fully customised solutions.

www.arrow.com

#### **Custom connector** capabilities extended

Connector and cable solutions specialist, PEI-Genesis, has been named an authorised distributor for Positronic. This will enhance access to the company's high reliability connector solutions, including its solid machined contacts with low resistance/high conductivity for use in standard and quick-turn custom connectors.

President and chief executive officer of PEI-Genesis, Steven Fisher, said: "Adding Positronic strengthens our line-up of the industry's top connector brands and enhances our extensive and unmatched high mix, low volume value-added capabilities. Leveraging our engineering services with the breadth and depth of the Positronic offerings will provide our customers with enhanced capabilities." www.peigenesis.com

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#### In Brief

IA support enhanced

Digi-Key Electronics has strengthened its industrial automation offering with 15 new lines in the past year, including products from Altech, Sick, Idec, Carlo Gavazzi and Belden. It also updated its industrial automation landing page to make it more mobile-friendly, with more graphical links and the ability to find related parts.

www.digikey.com

#### **Distributor prevents landfill**

Farnell element14 redirects over 10 tonnes of waste from landfill each year through its recycling scheme. Almost two million reels and over 200,000 waffle trays have been recycled since 2011. The programme is used by over 250 customers who send back empty reels and trays, free of charge, from anywhere in Europe. www.element14.com

#### Connectors target agriculture

RS Components has announced a new series of Amphenol ISOBUS circular connectors targeting agricultural and forestry vehicles. The series meets ISO 11783-2, the serial data network standard for control and communications between tractors and their implements. A key feature of the series is its two size eight power contacts for 6, 10 and 16mm<sup>2</sup> wire gauge. www.rs-online.com

#### Underlining Polish commitment

TE has changed the name of ABB Poland to TE Connectivity Industrial Poland, following its acquisition of ABB's Entrelec terminal block business. The change reflects global efforts to present a unified brand and underlines the importance of this acquisition for customers in Poland, who now have access to a broader product platform. www.te.com



#### **Buying into IoT power**

Available now from Rutronik, Recom's latest 15 and 20W AC/DC power supplies are designed for low power internet of things and household applications. Modules boast high-efficiency over a wide load range and minimal standby power consumption.

minimal standby power consumption. Both the RAC15-K and RAC20-K are PCB-mount AC/DC modules with ultralow energy losses especially in light load conditions. Below 75mW, they have no load power consumption, which makes them ideal for always-on and standby operation in loT and smart home devices. Target applications include building automation, security and communication systems, door access controls, remote sensors and actuators, climate controls and touchscreen interfaces.

Housed in a modular two by one inch case size, the AC/DC converters have a universal input voltage range of 85 to 264V AC for worldwide use, with international safety certifications for industrial, audio video and IT equipment, as well as household standards. www.rutronik.com



# Simplify IIoT development

Mouser Electronics is now stocking Microchip Technology's dsPIC33CH dualcore digital signal controllers for highperformance embedded applications that require sophisticated algorithms, such as motor control, server power supplies, automotive sensors, industrial internet of things, wireless power and industrial automation. The devices combine two dsPIC DSC cores in a single chip and are the first in the dsPIC33 family with optional support for the control area network flexible data rate protocol for robust communication with increased bandwidth.

Microchip dsPIC33CH dual-core DSCs are built to allow independent code development by individual design teams while facilitating integration in a single chip. The master core runs the user interface, communications and system-monitoring functions, while the slave core executes dedicated, time-critical control code. The controllers also boast three low-power management modes for improved energy efficiency. www.mouser.com

# Current sense resistors boxed and ready

TTI can now supply Bourns' CSS series high power current sense resistors, available in both two- and four-terminal options. Designed to meet demand for high measurement accuracy and relatively low cost, these resistors detect and convert current to an easily measured voltage which is proportional to the current through the device. They are ideal for applications such as current sensing, battery management systems, power modules/motor controllers and frequency converters

The two-terminal models are available in three different footprint sizes: 5930, 3920 and 2512. With resistance values as low as 0.2mohm,



each family will have a range of low resistance options and power ratings of up to 15W. The four-terminal design allows for high precision 4 kelvin resistance measurements and is available in size 4026.

Further benefits of the AEC-Q200 compliant CSS range are said to include excellent longterm stability, low inductance, low thermal EMF and custom capability. www.ttieurope.com

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# Resourceful buyers eliminate risks

Taking a flexible approach to sourcing semiconductors can help avoid the risks of the gray market, as microchipDIRECT global sales manager, Martin Warmington, explains

It is a familiar problem: when there is simply no inventory in the secure supply chain, the gray market can appear attractive. But, is this a necessary risk?

Every buyer is aware of some of the issues associated with buying from the gray market, the most important being the high possibility that the parts are counterfeit. Buying from the gray market also means there is no guarantee that parts have been stored in suitable conditions and they will certainly no longer be covered by the manufacturer's warranty.

This lack of a manufacturer warranty can have serious implications if the OEM has a product failure. A gray market or unauthorised source will have limited or no backup from the manufacturer in resolving any faults and is unlikely to reveal their source because component manufacturers act swiftly to close off unauthorised gray market sources. This makes it impossible to know whether a failure is due to a batch fault, or if the parts have deteriorated under unsuitable storage conditions. Loss of traceability could also jeopardise an OEM's certification to quality standards such as ISO 9000-9001, which mandate that parts must be fully traceable to the point of manufacture.

#### Widen the search

A more resourceful option is to check the part on a referral website. These multi-supplier search engines provide a useful tool for an immediate comparison of the latest availability and pricing on parts. Looking at inventory across a range of suppliers can also give the buyer a bigger picture of how much stock is actually in the supply chain. For example, the microchipDIRECT online channel issues inventory updates every 15 minutes, with referral sites typically updating their information at least once a day.

Most referral sites also minimise the risk of buying counterfeit parts because manufacturers and distributors arrange to have their parts listed. Some, however, will include unfranchised sources, so it's best to also visit the component manufacturer's website to confirm that a source is fully franchised and warranted.

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Although referral sites are free to use and don't add to the price of parts, it is worth remembering that the price shown is a guide. The actual price will depend on volume, so contact the component manufacturer via the referral site to check the cost for the actual order volume.

#### Be flexible on quantity

When product is on allocation, buyers can be tempted to increase their order quantity. A more effective route to avoiding a line-stop is to discuss the minimum number of parts required to prevent an



microchipDIRECT global sales manager, Microchip Technology, Martin Warmington

impending line-down. Even though the buyer may have ordered 50,000 devices, the reality could be that 1,000 parts delivered this week, and 2,000 next week, could keep the lines running.

By using referral sites and maintaining dialogue with suppliers, buyers may be able to source enough stock to avoid line-downs, as well as eliminating the risks of gray market sourcing.

www.microchip.com



# Requirements of distributors evolve and get more complicated

OEM and EMS customers want their distributors to help them cut total cost, reduce time to market and help them solve component allocation issues

Distributors, whether they are big or small, know they have to do more than sell parts if they want to increase sales and grow their number of customers.

While distributors obviously have to stock the components customer need, they must also help them compete in the marketplace by aiding their efforts to reduce total cost and get new products to market faster. In addition, over the past year helping customers compete means helping them manage long lead times and shortages.

Such assistance sometimes comes in the form of value added, supply chain, inventory management, and design services. Information is key. Distributors provide technical and market information on their websites crammed with, not only part numbers and market data, but also with spec sheets, tutorials and design tools to make it easier for customers to find the most technically fit, cost-effective solutions.

It's not just brand-name distributors, such as Arrow, Avnet, Future, Mouser and TTI that provide services that help customers reduce their total cost of ownership and reduce time to market. Even small, lesser known, specialised distributors provide value-added, supply chain services and design expertise to customers .



"Some things that we do that traditional distributors don't do is handling die and doing visual inspection of the die," he said. "A customer may want a visual inspection because the part might be going into an environment that can't have any dirt or dust or scratches or things like that. We have a clean room in-house and after visuals" the die is re-plated and serialised, he said.

Another specialist distributor, Symmetry Electronics based in Hawthorne, Calif., has inventory programs to help reduce cost for customers. "We have the ability to do all the standard inventory bonds," said Mark Zack, vice president and general manager of Symmetry Electronics, based in Hawthorne, Calif. "We can do proximity warehousing. We can do one-day or two-day shipments," he said. Symmetry is also increasing inventory for customers.





Mark Zack, vice president and general manager of Symmetry Electronics

Shortening lead times Helping customers to reduce cost by carrying inventory for customers is also a focus for Integra Electronics, a small distributor based in Anaheim, Calif.

"We carry the inventory. We try to shorten the lead times so customers always have products on the shelf," said Victor Montez, president of Integra, which carries a range of components including capacitors, connectors, diodes and transistors, frequency control devices and LEDs among other parts. "We have the ability to do all the standard inventory bonds. We can do proximity warehousing"

"If a customer needs a half million pieces and we know that they're using them we are going to have" the parts in stock, he said. "Some of the inventory is bonded, but most of it is dedicated to our customer base."

Montez said Integra's customer base is limited, but it offers a high level of services to its customers. Integra understands customer forecasts and "is in tune with their products" and what parts they will need for new designs that are going into production, he said.





# Widest Selection



Montez said customers are "looking for boutique type of service." When they have a new design, "we understand what they need," he said. If a part being considered for a new design is going end of life, Integra offers alternative solutions.

"We know the strengths and weaknesses of our products and where the technologies are going," he said.

#### **Requirements change**

Distributors say customer requirements have evolved over the years and are more complex than in the past and there is no one-size-fits all solution to satisfy requirements. For instance, some OEM customers want to use the web exclusively to do business with distributors and are not interested in face-to-face meetings with field application engineers, sales reps or account executives. Others insist on inperson meetings with both sales and technical support.

Because of the web, customers have a lot of information but they "don't want to have to hash through hundreds of thousands of pages to understand what's the best technology for their requirements, for their challenges and for the boards" that they are building, said Karim Yasmine, corporate vice president strategic supplier development for Future Electronics based in Montréal.

As a result, Future and other distributors have highly trained field application engineers to help customers find the best solution for a design. "The FAEs are not driving one manufacturer over another. They are driving the best solution for the customer," and helping reduce the time it takes to bring a new product to market, he said.

On the supply chain side, OEM and EMS providers' reliance on distributors has become more acute over the past year because of market conditions. There are shortages and allocations of semiconductors and passives and many buyers are looking to distributors for shortage parts, or alternative components or solutions.

"In this environment you get a lot of face-to-face contact because they are struggling" to find parts, said Yasmine. "We have to support

#### "We know the strengths and weaknesses of our products and where the technologies are going"

- Victor Montez, president of Integra Electronics

those customers that have been good at communicating their MRP requirements." With many customers, "we sit down and we talk to them directly part by part to understand their needs," he said. Future tries to make sure it has the inventory of parts that the customer needs "to keep lines running," he said. "It's a tough situation but we're spending more time than ever on the phone with customers" about shortage parts.

"The mandate from our ownership is, success coming out of this market environment by means of all regular customers being taken care of," said Yasmine. "Number two is if we can pick up additional customers through support with our inventory programs without impacting our loyal customers" then Future will do that. But the priority is regular customers.

The same is true will smaller distributors. Montez said during the current shortage, Integra is getting calls from buyers at many companies that it has not done business with before looking for parts.

"We went from the back of the Rolodex to the front of it," he joked. Buyers seem to say "we haven't called these guys before so let's give him a shot." But Integra focuses on its existing customers. "We want our customers to understand we are going through this with them, we want to be in business with them when everything is said and done," said Montez.

Yasmine said with current tight supply market conditions, "we're

spending more time than ever on the phone with customers" about shortage parts and some customers "are open to second sourcing and alternatives and that requires a lot of conversations."

One particular problem area is multilayer ceramic capacitors. MLCC supply is tight and some manufacturers are not taking orders. Some are discontinuing production of capacitors in larger case sizes in favour of smaller case sizes which are more in demand.

Often distributors have inventory to meet the needs of their regular customers. However, in instances where a part has been discontinued, a board may need to be redesigned and distributors suggest alternate parts for the component that's going end-oflife (EOL).

However, another solution may be just changing suppliers. For example, there are extended lead times for some microcontrollers from certain manufacturers. In some cases, lead times are out to 36 weeks. However, similar parts from other manufacturers have more traditional lead of 8 to 10 weeks, according to Yasmine.

"Everything is not on allocation. You can't say that all technologies of one type or another are on allocation. You need to get down to the vendor, and the package to understand where the issues may be," he said.

Joel Levine, president of RFMW

#### "Some things that we do that traditional distributors don't do is handling die and doing visual inspection of the die"



# No Minimum Order Quantities

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# An insiders guide to EMS sourcing

Supply chain manager at electronics manufacturing services provider, Chemigraphic, Jemma Heath, explains how EMS providers implement successful component sourcing strategy

Understand the requirement When sourcing electronic components for a client's product, it's vital to receive a full brief on exactly what your customer needs. In order to be able to source the right components and meet production deadlines, EMS partners need to understand the product type, timeframes, urgency and quantities required. If a job is urgent, this may call for alternative solutions to be found, or specific processes to be implemented. Additionally, it's essential to know if the products need to meet certain standards, for example, if they have to be built to military grades or other strict regulations.

#### 2 Identify key technology drivers

Understanding exactly what purpose a product will serve and the objectives it needs to achieve will be a huge help for any EMS provider when determining a sourcing strategy. For example, if a product will have internet of things functionality, it may be necessary to locate components in China or other offshore locations where parts are lower cost and more readily available. Looking at market conditions and current component stocks will also affect where and when the sourcing journey begins.

#### Audit streams of supply

With any sourcing task, there will be a variety of options available in terms of locating and procuring suitable components for a product. In terms of choosing reliable, credible and efficient suppliers, there are a number of checks that must be made before embarking upon a deal. From basic financial checks to an audit of the accreditations and certifications each supplier holds, it's essential that research is carried out before any decision is taken. Looking at capital assets will reassure you of a firm's financial stability and it's always useful to ask for references and testimonials from other partners as well.

Create a shortlist When putting together a shortlist of suppliers to tender for a component contract, EMS providers need to look at the fundamentals to see which companies make the best impression. Look at costs, turnaround times, the commercial success each business has enjoyed and its reputation in the industry. Do due diligence on each contender and wean the list down to those who tick the boxes in terms of chemistry, reliability and quality. It's also vital to choose suppliers that will be flexible and resourceful: as an EMS supplier, you will often have to find suitable alternatives for your customers when complexities arise and your suppliers will need to do so as well. Pick partners who are willing to seek out different solutions where necessary.

Select a supplier Put as much effort into establishing and building the foundations of a supplier relationship as you did into finding the supplier in the first place. Draw up thorough contracts or standard operating agreements, carry out comprehensive induction processes and trial the relationship by setting test orders or quantities. If the tests are passed and the results are good, then increase the amounts and progress the partnership.

www.chemigraphic.co.uk



Supply Chain Manager, Chemigraphic, Jemma Heath

# Toyota buyers mitigate risk to avoid managing supply chain crises

For Toyota, two-way communication with suppliers is imperative in order to identify and mitigate supply chain risk By James Carbone

Managing risk in the supply chain is a tough task for purchasers in all industries, but it is especially challenging for buyers at automakers because the auto industry has multiple tiers of suppliers.

Purchasers at carmakers such as Ford, General Motors, Honda and Toyota often purchase electronics systems or assemblies from tier 1 suppliers such as Denso, Continental, ZF/TRW, Harman, Panasonic, Pioneer and Bosch among others. Tier 1 suppliers build systems such as car computers, anti-lock braking, airbags, infotainment, radios, climate control, advanced driver assistance systems (ADAS), rear backup cameras, Wi-Fi and other systems.

Buyers at automakers don't purchase semiconductors, passives and other components used in those systems. Rather they depend on their tier 1 suppliers to buy the chips, capacitors, resistors and electronic components needed for production and to manage the relationships with those electronic parts suppliers.

However, when it comes to managing supply chain risk that could impact components used in automotive systems, vehicle manufacturer buyers are more involved and have developed risk management strategies that affect not only their tier 1 suppliers, but tier

▶ continued on page 14



6699

#### The earlier we know about a potential problem, the more opportunity we have for risk mitigation

- Blaine Lewis, senior manager of electronics purchasing for Toyota Motor North America



#### **Purchasing**

2 and tier 3 suppliers as well. 

Automaker buyers need to be involved with supply chain risk management to make sure their supply chains maintain continuity of supply if a natural disaster disrupts production of components or other materials, or market conditions result in shortages of needed parts.

Most vehicle manufacturers, as well as OEMs in other industries, beefed up supply chain risk management efforts following the devastating earthquake and tsunami in Japan in March 2011 and the flooding in Thailand later that year. Besides killing thousands of people, those disasters shut down production of many electronic components and other products used by many industries, including automotive.

"Basically, the tsunami in and of itself really kicked



us into this activity of risk management," said Blaine Lewis, senior manager of electronics purchasing for Toyota Motor North America, based in Plano, Texas. "At that point time we did not have an established

countermeasure system for those types of events," said Lewis, who is based at Toyota's Research and Development Center in Saline, Mich. With a lot of effort, "we did fare well" through the disaster, he said. The global market for automotive electronics hardware will rise from \$126.9 billion in 2017 to \$169 billion in 2022

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"We did have some impact and had to do some adjustments to make sure we made it through without completely stalling production," said Lewis.

#### Bridge the gap

After the earthquake and tsunami in Japan, Toyota challenged its first-tier suppliers to look at their supply base and determine if there was another catastrophic event that disrupted production, how long it would take them to recover. The automaker also wanted to know how suppliers could bridge the gap between recovery and the immediate needs of Toyota as an automotive maker buying parts.

"Once they determined that, they also told us what their countermeasures would or should be," said Lewis. When Toyota received those countermeasure ideas from all of its suppliers, the company evaluated them and identified "some fantastic countermeasures" that could help mitigate risk and keep supply of parts flowing, said Lewis. Other supplier ideas "needed some improvements" and Toyota made suggestions on how the ideas could be enhanced.

To reduce risk, it is important to have two-way communication with suppliers, said Lewis. Suppliers need to inform Toyota if they see a potential risk problem occurring and communicate the information as quickly as possible, he said.

"The earlier we know about a potential problem, the more opportunity we have for risk mitigation," said Lewis. Toyota can query other suppliers if they are seeing the same problem in the supply chain. "This will help us determine if it is an issue with one supplier or is it an issue that spans across our supply base," said Lewis.

Jim Holloway, general manager purchasing responsible for electronics, electrical and powertrain procurement for Toyota, said prior to the tsunami "we had strong collaboration with our suppliers for information sharing. But it was more crisis management" than risk management. "The real change for us was shifting from managing crises to mitigating risk," he said.

#### A resilient supply base

After the disaster, the car maker identified some key characteristics of its supply base. Toyota recognised the "resilience of our supply base to be able to recover through a crisis collaboratively with us," said Holloway. Toyota also learned that it did not have good information about its first-tier suppliers' supply chain.

"A lot of tier 1 suppliers view that information as propriety. Their supply chain is confidential to them," said Holloway. But since the tsunami, Toyota has worked with its suppliers to understand their supply base and where some "pinch points might be" if there is another disaster.

"Now we see those pinch points and we can proactively work with our suppliers to mitigate risk rather than manage crisis," said Holloway. Holloway said Toyota expects its tier 1 suppliers to manage their supply chains and provide "continuous supply to us despite multiple avenues of potential interruption."

One way of reducing risk and providing continuous supply is have more than one supplier for a needed part or have multiple manufacturing locations for the

▶ continued on page 16



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#### **Purchasing**

 components. Lewis says Toyota has discussions with its tier 1 suppliers about this issue.

If a component supplier to tier 1 manufacturer has a single manufacturing site for a needed part used in a system that Toyota buys, the automaker wants to know how the tier 1 is going to protect Toyota if something happens to disrupt manufacturing of the part.

"It's a big burden for them if they have a single-source manufacturing facility v ersus a dual source and they recognise that," said Lewis. He said that automotive suppliers including tier 1, 2 and 3 suppliers are doing a much better job "making sure there are multiple manufacturing sites or some manufacturing flexibility."

#### Secondary source needed

Holloway said there are "different scenarios" on how tier 1 suppliers protect the supply-chain and supply flow and collaborate with them to understand what their approach is to guarantee supply. "For example, if their approach is to approve a secondary source, then they need our approval of that," he said. "We will collaborate and cooperate with them on that, but the ownership (of the relationship with the secondary source) is theirs."

Collaboration and cooperation with suppliers

are not just needed to manage risk. Rather it permeates the entire relationship Toyota has with its suppliers including new product development. "We work very closely with suppliers in the very early stages of new product development," said Lewis.

Toyota generates new ideas for future vehicles, but its suppliers also do research and development and make suggestions for new features as well. "In the end it is a combination" of ideas that result in new features in Toyota models, he said.

Because Toyota's supply base is stable and partners with key tier 1 suppliers, the automaker rarely changes suppliers. It may add a supplier if it has a new technology or for competitive reasons.

Toyota has an open-door policy with potential new suppliers because the automaker recognises that there are companies that are developing new and advanced technologies that Toyota needs to know about, said Holloway. "We have an open-door policy to make sure that we understand what the competitive environment in the marketplace is," he said. He added if Toyota's current supply base "can't keep pace with that, in some cases we may have to make a change."

However, Toyota rarely changes suppliers because of performance issues. "Once you are supplier partner, we have long-term relationships and we work diligently with suppliers to make sure that suppliers are successful," said Lewis.

He said Toyota has key performance indicators and "we constantly evaluate our suppliers on safety, quality, and cost," said Lewis. "If we see a supplier is struggling in an area then purchasing may form a new cross functional team that includes various areas of our company such as quality or logistics" or other functions depending what the issue is to support the supplier, he said.

Holloway said Toyota provides clear expectations to suppliers. "If suppliers are struggling with our expectations, we partner with them on identifying ways to meet them. One of our core philosophies is continuous improvement," he said.



The real change for us was shifting from managing crises to mitigating risk

 Jim Holloway, general manager purchasing responsible for electronics electrical and powertrain procurement for Toyota





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# Buyers can expect 30-week lead times and higher tags to continue for MOSFETs

Chipmakers are increasing production, but it won't be enough to reduce lead times until the fourth quarter at the earliest

James Carbone

Semiconductor manufacturers are adding more capacity of metal oxide semiconductor field emitting transistors (MOSFETs), but supply will likely remain tight and prices will rise until the end of the year.

The addition of more capacity likely won't be felt for several more months because of continuing strong demand across a wide range of customer segments, especially automotive and industrial.

"Demand for MOSFETs in 2018 is pretty strong across all segments, but it's the highest in automotive, industrial, and communications systems," said Rob Lineback, senior market research analyst for IC Insights, based in Scottsdale, Ariz. He added MOSFET demand is weakest from computer manufacturers while "military/ government and consumer apps are in the middle," he said. MOSFETs are used to switch and amplify electronic signals in electronics equipment. They provide a very high input impedance and are able to be used in very low current circuits. They are widely used in switch mode power supplies, variable frequency drives, lighting intensity controls, motor controls, and home and automobile sound systems among other applications.

Strong demand and limited capacity for MOSFETs means that prices are increasing and lead times have stretched to 30-40 weeks depending on the product and the manufacturer. Dave Valletta, executive vice president worldwide sales for Vishay Intertechnology, based in Malvern, Penn., said Vishay's average lead times for MOSFETs were about 35 weeks in July. He said MOSFET supply began tightening in the second half of last year. Vishay and other chipmakers are adding capacity, but so far demand continues to outpace supply.

"We added capacity and expected that in Q2 (2018) we would be back to normal, but it did not happen," said Valletta.

Lineback said Vishay and several other companies "are working to increase capacity because they don't want MOSFET business and revenue to move to someone else." He said MOSFETs are commodity products and there are second sources.

One reason supply remains tight is because MOSFETs are built on 150mm and 200mm wafer production lines. Other chips, such as display drivers, microcontrollers and mixedsignal semiconductors, are also built on 150mm and 200mm wafer production lines and there's not enough capacity to go around, said Lineback.

"Some companies that might have had some capacity earmarked for MOSFETs" but decided to use some of that capacity for other products such as display drivers or mixed signal chips, he said.

#### Move to 300mm

At least one manufacturer— Infineon—is producing MOSFETs on 300mm wafers instead of 200mm or 150mm wafers. The company has been making chips on 300m wafers for several years at its facility in Dresden, Germany and plans to start construction of a new 300mm facility in 2019 in Austria. However, production won't begin until 2021, according to the chipmaker.

With larger size wafers chipmakers can produce more chips per wafer effectively increasing supply. Over the next five years, other chipmakers will likely follow suit and also produce MOSFETs on 300mm wafers, said Lineback.

However, in the short term MOSFET makers are depending

### By the Numbers

**\$9.6 billion** 



**4.4**%

8%

The compound annual growth rate for MOSFETS through 2022



The percentage increase of MOSFET unit shipments in 2018

The forecast size of the global MOSFET market in 2022



**17.1 CENTS**The average selling price for a MOSFET in 2018

14% The percentage increase of global MOSFET sales in 2018

Source: IC Insights



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on 200mm wafer production for MOSFETs. The problem is chipmakers are having trouble ramping up additional production capacity because lead times for wafer fab equipment are long.

"Some lead times for new equipment are out past one year," said Valletta. "It makes it harder to get capacity on line. Supply is even tight for used fab equipment," he said. As a result, it will be a while before lead times return to normal, which is about 12 weeks.

In the meantime, Valletta said Vishay is "trying to protect customers that have long-term agreements with Vishay and who are providing us forecasts." For customers who are trying to make spot buys, lead times are about 35 weeks, he said.

Supply may start to loosen in the fourth quarter, but it "won't be a dramatic turn because demand is increasing across all geographies markets," said Lineback.

Demand is strong across the board especially with automotive and telecommunications. Valletta said that demand will stay healthy for a long time because there are growing and emerging applications for MOSFETs.

"I think we are in for a long-

term period of growth," said Valletta. "Automotive has been the biggest driver in the past year or so." MOSFET demand from automotive will continue to grow because more automotive systems are electronic and more electric vehicles (EVs) are shipping. EVs typically have a higher semiconductor content than gasoline-powered cars and many of those chips are MOSFETs.

In addition, 5G networks are starting to be built which will require a variety of semiconductors including MOSFETS. Emerging applications involving artificial intelligence, augmented reality and graphics processing are emerging which will further drive demand for MOSFETs, said Lineback.

#### Tags, revenue increase

As a result, industry analysts are bullish about MOSFET growth. The global power MOSFET market will rise about 14 per cent to \$8.8 billion in 2018, according to IC Insights. MOSFET revenue will increase at compound annual growth rate of 4.4 per cent until 2022 when the global MOSFET market will reach \$9.6 billion.

Strong demand and limited capacity have resulted in higher average selling prices and overall higher revenue for MOSFET manufacturers. Prices, which have The global MOSFET market will post mostly steady growth through 2022 when sales revenue surpasses \$9.6 billion *Source: IC Insights* 

#### MOSFET revenue to top \$9.6 billion



increased the last two years, will end 2018 increasing by about 5 per cent to 17.1 cents.

Strong economic growth in many regions is helping drive demand for electronics equipment and semiconductors, including MOSFETs. "The global economy controls so much of what goes on in the semiconductor industry these days, especially in commodity type products such as MOSFETs," said Lineback. "We see the economy as being the biggest factor in semiconductor growth."

The global economy will continue to grow in 2019, but at a slower pace and MOSFET revenue will slow as well. For instance, gross domestic product (GDP) in the United States increased 4.1 per cent in the second quarter and is expected to grow 2.9 per cent for the year and decline to 2.7 per cent in 2019, according to International Monetary Fund (IMF). GDP in Europe in 2019 is forecast to fall to 1.9 percent from 2.2 per cent in 2018 and economic growth in China will fall from 6.6 per cent in 2018 to 6.4 per cent in 2019, the IMF said.

#### MOSFET growth will slow

Less economic growth will mean less growth for semiconductors including MOSFETs, said Lineback. MOSFET revenue will rise 2 percent in 2019 and then decline 1 per cent in 2020 before increasing 3 percent in 2021 and 5 per cent in 2022 when the market will total \$9.6 billion. Unit shipments will rise 5 per cent in 2019 but drop 2 per cent in 2020 before climbing 4 per cent in 2021 and 5 per cent in 2022, the researcher said.

The good news for semiconductor buyers is that while the average price for MOSFETs will grow 5 per cent in 2018, tags will drop 3 per cent in 2019 and 2 per cent in 2020. From 2017 to 2022, the average price of a MOSFET will rise only .2 per cent. However, for 2018, higher prices are welcome news for MOSFET manufacturers.

"MOSFET suppliers are having good sales this year because of higher average selling prices (ASPs), resulting from robust demand and tight supply. However, there is concern that once more capacity is added, demand will slow down.

"That's what typically happens in our industry," said Valletta. "We add capacity then all of a sudden demand goes away. We want capacity in be in balance with demand without overshooting it," he said.



**MOSFET unit demand rises** 

OEMS and electronics manufacturing services providers will buy more than 58 billion MOSFETs by 2022 Source: IC Insights



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Manufacturer	Distributor	Telephone	Website	Locat	Franc Distri	No. o' Princ	Stock Princ	Minir Value	% Le: Princ	No. o' Supp	Total	Buffe Facili
	_		CABLE ASSEM	BLY								
FTDI	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	100	N/A	0€		50	1,500+	Y
Molex	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		300	N/A	0€	97%	50	1,500+	
			CIRCUIT PROTEC	CTION	_					_		
Bourns	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	5,000	N/A	0€	58%	50	1,500+	Y
EPCOS/TDK	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		5,000	N/A	0€	58%	50	1,500+	
Littelfuse	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		35,000	N/A	0€	67%	50	1,500+	
			ELECTROMECHA	NICAL								
ALPHA WIRE	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU	Y	26,919	N/A	0€	97.04%	150	3500+	Y
CINCH CONNECTIVITY/Bel	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		31,120	N/A	0€	78.21%	150	3500+	
CUI INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		17,410	N/A	0€	92.21%	150	3500+	
DELTA PRODUCT GROUPS	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		3,215	N/A	0€	99.95%	150	3500+	
KEYSTONE ELECTRONICS	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		6,315	N/A	0€	95.17%	150	3500+	
Laird	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU	Y	15,187	N/A	0€	97.20%	150	3500+	Y
	Digi-Key Electronics	+51 (0)55 484 9584	www.digikey.com/europe	EU	ř V	74 740	N/A	0€	99./9%	150	3500+	ř V
Panasonic	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	FII		154 777	N/A	0€ 0€	94.47%	150	3500+	
ТОК	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		60,769	N/A	0€	99.20%	150	3500+	
TE	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		338,106	N/A	0€	79.40%	150	3500+	
Bud	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	2.500	N/A	0€	80%	50	1.500+	Y
Hammond	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		12,500	N/A	0€	100%	50	1,500+	
Metcase Enclosures	OKW Enclosures	+44 (0) 1489 583858	www.metcase.com	EU	N/A	288	£40K	0€	100%		22	
			FREQUENC	Y								
ABRACON	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	1,000	N/A	0€	91%	50	1,500+	Y
ECS	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	FII		500	N/A N/A	0€	59%	50	1,500+	
		0017 (0)07 520 102 110		20		500					2,500	
			HEAT SINK	S		700			(70)	50	4 500	
Aavid	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	/00	N/A	0€	6/%	50	1,500+	Y
			ICs & SEMICONDU	JCTORS								
ALLEGRO MICROSYSTEMS, LLC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		3,090	N/A	0€	87.22%	150	3500+	
Altera	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,600	N/A	0€	60%	50	1,500+	
ALTERA	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		10,901	N/A	0€	84.86%	150	3500+	
ANALUG DEVICES INC	Digi-Key Electronics	+51 (U)55 484 9584	www.digikey.com/europe	EU	Y	52,508	N/A	U€ 	/5./9%	150	1 500+	Y
Attalog Devices Inc.	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	FII	v	1 700	N/A	0€	58%	50	1,500+	v
Avago Technologies	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		400	N/A	0€	84%	50	1.500+	
AVAGO TECHNOLOGIES US INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		16,512	N/A	0€	91.38%	150	3500+	
Broadcom	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			100	N/A	0€	69%	50	1,500+	
Central Semiconductor Corp.	Future Electronics	0049 40 547 277 000	www.futureelectronics.com	EU, UK		N/A	N/A	N/A	N/A	N/A	N/A	
Cirrus Logic	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		300	N/A	0€	80%	50	1,500+	
Cypress Semiconductor	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,400	N/A	0€	63%	50	1,500+	
CYPRESS SEMICONDUCTOR CORP	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		27,423	N/A	0€	92.54%	150	3500+	
DIGI INTERNATIONAL	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		4,355	N/A	0€	95.30%	150	3500+	
Diodes Incorporated	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,600	N/A	0€	98%	50	1,500+	
DIODES INCORPORATED	Digi-Key Electronics	+51 (0)55 484 9584	www.digikey.com/europe	EU	Y V	38,292	N/A	0€	90.02%	150	1 500+	Y V
LAU	Mouser Lietti onits	0047 (0)87 520 402 110	www.mousei.com			1,100	- N/A	- 00			1,500+	



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Fairchild Semiconductor	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,500	N/A	0€	90%	50	1,500+	
Freescale Semiconductor	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,500	N/A	0€	42%	50	1,500+	
FTDI	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	97%	50	1,500+	
FTDI	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		569	N/A	0€	100.00%	150	3500+	
IDT (Integrated Device Technology)	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,100	N/A	0€	97%	50	1,500+	
Infineon	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		800	N/A	0€	66%	50	1,500+	
INFINEON TECHNOLOGIES	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		28,850	N/A	0€	93.70%	150	3500+	
Intel	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		500	N/A	0€	78%	50	1,500+	
International Rectifier	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		600	N/A	0€	87%	50	1,500+	
Intersil	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,900	N/A	0€	50%	50	1,500+	
ISSI	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		700	N/A	0€	98%	50	1,500+	
Laird	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		15,187	N/A	0€	97.20%	150	3500+	
Lattice	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		700	N/A	0€	69%	50	1,500+	
LINEAR TECHNOLOGY	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		37,479	N/A	0€	77.62%	150	3500+	
Maxim Integrated	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		11,200	N/A	0€	67%	50	1,500+	
MAXIM INTEGRATED	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		68,021	N/A	0€	78.22%	150	3500+	
Microchip	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		12,600	N/A	0€	91%	50	1,500+	
MICROCHIP TECHNOLOGY	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		86,517	N/A	0€	86.12%	150	3500+	
Microsemi	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		400	N/A	0€	90%	50	1,500+	
Monolithic Power Systems (MPS)	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			600	N/A	0€	40%	50	1,500+	
NEXPERIA USA INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		23,513	N/A	0€	99.29%	150	3500+	
NXP	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		3,900	N/A	0€	91%	50	1,500+	
NXP USA INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		36,258	N/A	0€	93.55%	150	3500+	
ON Semiconductor	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		5,100	N/A	0€	87%	50	1,500+	
ON SEMICONDUCTOR	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		87,298	N/A	0€	85.61%	150	3500+	
Power Integrations	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		600	N/A	0€	59%	50	1,500+	
Qorvo	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		300	N/A	0€	90%	50	1,500+	
Rohm	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe			55,139	N/A	0€	99.85%	150	3500+	
ROHM Semiconductor	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			1,400	N/A	0€	55%	50	1,500+	
Samsung	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		37,336	N/A	0€	100.00%	150	3500+	
Silicon Laboratories	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,500	N/A	0€	96%	50	1,500+	
SILICON LABORATORIES INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		19,667	N/A	0€	96.54%	150	3500+	
Skyworks	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		300	N/A	0€	91%	50	1,500+	
Spansion Inc.	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		600	N/A	0€	93%	50	1,500+	
STMicroelectronics	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		4,500	N/A	0€	99%	50	1,500+	
STMICROELECTRONICS	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe			39,201	N/A	0€	97.79%	150	3500+	
TDK	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe			60,769	N/A	0€	99.20%	150	3500+	
Texas Instruments	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			36,900	N/A	0€	41%	50	1,500+	
TEXAS INSTRUMENTS	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe			180,012	N/A	0€	91.94%	150	3500+	
Toshiba	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			500	N/A	0€	100%	50	1,500+	
Vishay	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe			581,798	N/A	0€	87.71%	150	3500+	
XILINX INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		8,213	N/A	0€	51.46%	150	3500+	
			INTERCONNEC	TION								
3M	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	3,100	N/A	0€	16%	50	1,500+	Y
3M	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		62,421	N/A	0€	93.42%	150	3500+	
Amphenol	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		25,600	N/A	0€	53%	50	1,500+	
Amphenol	PEI Genesis	+44 8716060	www.peigenesis.com	EU		N/A	£1.3m	10€	N/A	N/A	85	
AMPHENOL RF DIVISION	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		443,368	N/A	0€	75.92%	150	3500+	
Anderson Power Products	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		800	N/A	0€	50%	50	1,500+	
Cinch Connectivity Solutions	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,900	N/A	0€	82%	50	1,500+	
CINCH CONNECTIVITY/Bel	Digi-Key Electronics	+31 (0)53 484 9584	www.digikev.com/europe	EU	γ	31.120	N/A	0€	78.21%	150	3500+	Y
Delphi Connection Systems	Mouser Flectronics	0049 (0)89 520 462 110	www.mouser.com	EU	y	3,300	N/A	0.€	67%	50	1.500+	Y
commetter systems		0013 (0)03 320 102 110				3,500	- AyA				2,500**	





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Glenair	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,900	N/A	0€	76%	50	1,500+	
HARTING	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		4,700	N/A	0€	31%	50	1,500+	
Harwin	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,200	N/A	0€	79%	50	1,500+	
Hirose Electric	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		6,100	N/A	0€	99%	50	1,500+	
HIROSE ELECTRIC CO LTD	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		37,215	N/A	0€	90.98%	150	3500+	
Hirose Electric Europe B.V		0031-(0)2 655 7460	www.hirose.com/eu	EU		50,000	N/A	0€	N/A	N/A	4,190	
ITT Cannon	PEI Genesis	+44 8716060	www.peigenesis.com	EU		N/A	£1.3m	10€	N/A	N/A	85	
JAE Electronics	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,200	N/A	0€	32%	50	1,500+	
JST SALES AMERICA INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		5,109	N/A	0€	84.32%	150	3500+	
Кусоп	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		700	N/A	0€	99%	50	1,500+	
LEMO	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,900	N/A	0€	65%	50	1,500+	
Molex	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		16,900	N/A	0€	75%	50	1,500+	
MOLEX, LLC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		120,034	N/A	0€	97.98%	150	3500+	
Neutrik	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,000	N/A	0€	86%	50	1,500+	
ODU		+49 8631 6156-0	www.odu.de	EU, USA, ASIA			N/A	0€	N/A	50	1,650	
Phoenix Contact	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		12,000	N/A	0€	99%	50	1,500+	
PHOENIX CONTACT	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		54,845	N/A	0€	99.99%	150	3500+	
SAMTEC INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		427,448	N/A	0€	99.99%	150	3500+	
Switchcraft	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,200	N/A	0€	69%	50	1,500+	
TE	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		338,106	N/A	0€	79.40%	150	3500+	
TE Connectivity	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		30,900	N/A	0€	40%	50	1,500+	
	America II Electronics	01462 707070	OBSOLESCENCE / HA	<b>RD TO FIND</b> EU, G, UK	N	1,900	\$1B	0€	75%	59	550+	Y
			OPTO ELECTR	DNICS								
Avago Technologies	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	8,200	N/A	0€	89%	50	1,500+	Y
Cree, Inc.	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		22,500	N/A	0€	74%	50	1,500+	
Dialight	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		9,800	N/A	0€	99%	50	1,500+	
Kingbright	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		3,100	N/A	0€	100%	50	1,500+	
Lumileds	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,100	N/A	0€	99%	50	1,500+	
Newhaven Display	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		700	N/A	0€	65%	50	1,500+	
Osram Opto Semiconductor	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,800	N/A	0€	99%	50	1,500+	
VCC	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		5,000	N/A	0€	92%	50	1,500+	
Vishay	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		3,100	N/A	0€	99%	50	1,500+	
			PASSIVE	5								
ABRACON LLC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		41,991	N/A	0€	100.00%	150	3500+	
AVX	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		70,700	N/A	0€	58.00%	50	1,500+	
AVX CORPORATION	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		70,131	N/A	0€	89.28%	150	3500+	
Bourns	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		49,500	N/A	0€	98%	50	1,500+	
BOURNS INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		59,314	N/A	0€	82.47%	150	3500+	
CINCH CONNECTIVITY/Bel	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		31,120	N/A	0€	78.21%	150	3500+	
Coilcraft	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		10,400	N/A	0€	98%	50	1,500+	
Cornell Dubilier	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		33,000	N/A	0€	65.00%	50	1,500+	
EPCOS / TDK	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		31,000	N/A	0€	74%	50	1,500+	
Fair-Rite	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,000	N/A	0€	94%	50	1,500+	
HONEYWELL MICROELECTRONICS & PRECISION SENSORS	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe			28,560	N/A	0€	89.87%	150	3500+	
Kemet												
	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		135,800	N/A	0€	93%	50	1,500+	Y
Kemet	Mouser Electronics RS Components	0049 (0)89 520 462 110 08457 201201	www.mouser.com www.rs-components.com	EU EU		135,800 N/A	N/A £161m	0€ 0€	93% N/A	50 50+	1,500+ 2,500	Y Y
Kemet	Mouser Electronics RS Components Digi-Key Electronics	0049 (0)89 520 462 110 08457 201201 +31 (0)53 484 9584	www.mouser.com www.rs-components.com www.digikey.com/europe	EU EU EU		135,800 N/A 101,257	N/A £161m N/A	0€ 0€ 0€	93% N/A 91.57%	50 50+ 150	1,500+ 2,500 3500+	Y Y Y





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Laird	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU	Y	15,187	N/A	0€	97.20%	150	3500+	Y
Laird Technologies	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,800	N/A	0€	50%	50	1,500+	
LITTELFUSE INC	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		59,517	N/A	0€	91.54%	150	3500+	
Murata	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		66,179	N/A	0€	99.79%	150	3500+	
Murata	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			67,300	N/A	0€	99%	50	1,500+	
Nichicon	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			21,600	N/A	0€	47%	50	1,500+	
NICHICON	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe			39,747	N/A	0€	96.70%	150	3500+	
Ohmite	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		17,300	N/A	0€	99%	50	1,500+	
Panasonic	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		154,777	N/A	0€	94.42%	150	3500+	
Panasonic	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		67,900	N/A	0€	69%	50	1,500+	
Rohm	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		55,139	N/A	0€	99.85%	150	3500+	
Samsung	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU		37,336	N/A	0€	100.00%	150	3500+	
Taiyo Yuden	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		6,400	N/A	0€	82%	50	1,500+	
TAIYO YUDEN	Digi-Key Electronics	+31 (0)53 484 9584	www.diaikev.com/europe	EU		21.540	N/A	0€	99.97%	150	3500+	
ТДК	Digi-Key Flectronics	+31 (0)53 484 9584	www.diaikev.com/europe	FU		60.769	N/A	0€	99.20%	150	3500+	
трк	Mouser Flectronics	0049 (0)89 520 462 110	www.mouser.com	FII		25 300	N/A	0€	85%	50	1 500+	
TF	Dini-Key Electronics	+31 (0)53 484 9584	www.dinikev.com/europe	FII		338 106	N/A	0€	79 40%	150	3500+	
TT Electronics	Mouser Flectronics	0049 (0)89 520 462 110	www.mouser.com	FII		32 800	N/A	0€	55%	50	1 500+	
United Chemi-Con (UCC)	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	FII		13,900	N/A	0.6	99.00%	50	1 500+	
Vichay	Digi-Key Electronics	+31 (0)53 484 9584	www.digikev.com/europe	FII	v	581 798	N/A	0.6	8771%	150	3500+	v
Vishay	Mouser Electropics	0049 (0)89 520 462 110	www.mouser.com	EU	v	119 800	N/A	0.6	76%	50	1 500+	
Wurth Electronics	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	v	4 500	N/A	0.6	63%	50	1 500+	
	Digi-Key Electronics	+31 (0)53 484 9584	www.digikey.com/europe	EU	v	72 722	N/A	0€	100.00%	150	3500+	v
Würth Elektropik	Würth Elektronik	+40 (0) 7042 045 0	www.ulgikey.com/eutope		v	23,733 N/A	N/A	06	100.00%	250	4 000	v v
Veree	Maurar Electronice	+++ (0) 7 5+2 5+3 0	www.we-ontine.com		1 V	AF 700	N/A	06	100/0	230 F0	4,000	ı v
rageo	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		45,500	N/A	0€	99.00%	50	1,500+	
TAGEU	Digi-Key Electronics	+51 (U)55 484 9584	www.aigikey.com/europe	EU		147,855	N/A	UE	84.51%	150	5500+	
			POWER & BATT	ERIES								
Bel Power Solutions	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,400	N/A	0€	94%	50	1,500+	
Cincon	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		5,500	N/A	0€	60%	50	1,500+	
Cosel	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		11,800	N/A	0€	99%	50	1,500+	
CUI Inc.	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		3,900	N/A	0€	100%	50	1,500+	
Mean Well	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		4,500	N/A	0€	75%	50	1,500+	
Murata	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		5,200	N/A	0€	93%	50	1,500+	
RECOM	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		23,300	N/A	0€	92%	50	1,500+	
Sanyo Electronic Industries Co., Ltd.	Sanyo Electronic Industries Co., Ltd.	+81 36699 8080	www.eta.co.jp	JP	N	1,000	€3000k	20€	90%	10	100	
Schaffner	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		900	N/A	0€	98%	50	1,500+	
SL Power	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,100	N/A	0€	87%	50	1,500+	
TDK-Lambda	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		4,600	N/A	0€	99%	50	1,500+	
TRACO Power	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		3,400	N/A	0€	95%	50	1,500+	
			SENSORS									
All Sensors	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,300	N/A	0€	70%	50	1,500+	
ams	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			400	N/A	0€	77%	50	1,500+	
Analog Devices Inc.	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			500	N/A	0€	78%	50	1,500+	
Bosch	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			100	N/A	0€	94%	50	1,500+	
Freescale Semiconductor	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			1,000	N/A	0€	66%	50	1,500+	
Honeywell	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		15,500	N/A	0€	80%	50	1,500+	
Maxim Integrated	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		900	N/A	0€		50	1,500+	
Melexis	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		700	N/A	0€		50	1,500+	
Omron	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		5.700	N/A	0€		50	1.500+	
Sensirion	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	FU		100	N/A	0€		50	1,500+	
TE Connectivity	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	FU		1 100	N/A	0€		50	1 500+	
TE connectivity	mouser-Electronics	0047 (0)07 520 402 110	www.inousei.com			1,100	IN/A				1,500*	





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			SWITCHES &	KEYBOARDS								
ALPS	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	400	N/A	0€	70%	50	1,500+	Y
Apem	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		700	N/A	0€	96%	50	1,500+	
C&K Components	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,500	N/A	0€	84%	50	1,500+	
Carling Technologies	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		300	N/A	0€	87%	50	1,500+	
CHERRY	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		200	N/A	0€	77%	50	1,500+	
CHERRY	RS Components	08457 201201	www.rs-components.com	m EU		600	N/A	0€	N/A	50+	3,500+	
E-Switch	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		700	N/A	0€	94%	50	1,500+	
Grayhill	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		400	N/A	0€	84%	50	1,500+	
Honeywell	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		700	N/A	0€	98%	50	1,500+	
NKK Switches	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		1,100	N/A	0€	94%	50	1,500+	
Omron	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		900	N/A	0€	68%	50	1,500+	
Rubbertech 2000	Rubbertech 2000	+44 1594 826019	www.rubbertech2000.co	.uk EU	N/A	N/A	£40k	100€	N/A	N/A	25	
TE Connectivity	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		400	N/A	0€	98%	50	1,500+	
			THERMAL MA	ANAGEMENT								
ADDA	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU	Y	800	N/A	0€	59%	50	1,500+	Y
Delta Electronics	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		500	N/A	0€	28%	50	1,500+	
ebm-papst	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com			2,200	N/A	0€	99%	50	1,500+	
Sanyo Denki	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		2,900	N/A	0€		50	1,500+	
Anaren	Mouser Electronics	0049 (0)89 520 462 110	WIRE www.mouser.com	EU	Y	100	N/A	0€	86%	50	1.500+	Y
B&B Electronics	Mouser Flectronics	0049 (0)89 520 462 110	www.mouser.com	FU	Y	100	N/A	0€	87%	50	1.500+	Y
Bluegiga Technologies	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	93%	50	1.500+	
Digi International	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		200	N/A	0€	92%	50	1,500+	
Laird Technologies	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	76%	50	1,500+	
Linx Technologies	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	99%	50	1,500+	
Microchip	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	85%	50	1,500+	
Murata	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	100%	50	1,500+	
Panasonic	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	91%	50	1,500+	
Redpine Signals	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	94%	50	1,500+	
RF Digital	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	100%	50	1,500+	
Texas Instruments	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	75%	50	1,500+	
Wi2Wi	Mouser Electronics	0049 (0)89 520 462 110	www.mouser.com	EU		100	N/A	0€	36%	50	1,500+	
PCB Buyers' (	Guide Telephone	Service Provided (Le Brovier, Manufacture ∨ Repair)	Location		Appro	vals		Volume - Small, Medium, Large Domhla-sidad	Double-shoeu Multi-layer 4-10/10-20-30	Metal PCBs Flexi / Flexi-Rigid	Obsolescence Solutions	Modifications Prototyping
Elvia PCB Groun	+33 233 763 200 v	www.gench.com M/B F	rance Tunisia China AS91	00 PRI-NADCAP	SO-TS16949		01 15014001	S/M/I Y	/ 1-30	Y FF/R	Y	Y Y
Graphic Plc	00441363 774874 wv	ww.graphic.plc.uk M	UK/China AS910	), NADCAP, ISO 9001, Al	6014001,0HSAS	18001, Mil 31032, Mi	il 55110,Mil 50884	S/M/L N	N 4-10	Y Y	N	
Contract Man	Telephone	<b>Iyers' Guide</b> Website Turnover	Location						Number of Surface Mount Lines BGA Capacity	Lead Free Manufacturer Prototyvning		Full Turnkey Cables and Harnessing
AWS Electronics Group	+44 (0)1782 753200 www.a	awselectronicsgroup.com £40m	UK & Slovakia	AS9100, ISO 9001	13485,14001,TS	16949, IPC-A-610 Clas	is 3, NADCAP	430	11 Y	Y Y		

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