E&E

FASCINATION OF ELECTRONICS

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ROBUST CONNECTING

Board-to-Board Connectors for the Industry

COVER SPONSOR: PHOENIX CONTACT

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Messe München

Connecting Global Competence

November 13–16, 2018

Connecting everything – smart, safe & secure

Trade fair

- 17 halls
- Full range of technologies, products and solutions

Conferences & forums

- 4 conferences
- 16 forums
- New TechTalk for engineers and developers

Talent meets Industry

- electronica Experience with live demonstrations
- e-ffwd: the start-up platform powered by Elektor
- electronica Careers

SEMICON EUROPA

semi

co-located event

electronica 2018

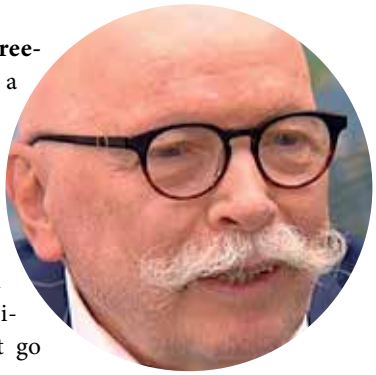
components I systems I applications I solutions

World's leading trade fair and conference for electronics

Messe München I November 13–16, 2018 I electronica.de

Florian Streifinger, Managing Editor E&E: On the Internet, electronics developers can find information on practically all components and parts and how to use them correctly. They can also find everything they need to know about new products, trends and market developments.

"SO WHY IS ELECTRONICA BOOMING AND EVEN GROWING DESPITE THIS POSSIBILITIES?"



Roland Ackermann, freelance author: Well, there is a strong world, steeled by many years of success and failure, beyond algorithms, big data analysis and pure facts and data. And this is dominated by man, with all imponderables and decision-making processes that go beyond the measurable. For example intuition, experience, gut instinct or a feeling for emerging, promising trends. Of course, a bit of luck often plays a decisive role in all these trends, too.

For sure, digital transformation is also on the agenda of the trade fair organisers, who are characterised by an almost incomprehensible diversity. And even though the innovation platform "Trade Fair" itself cannot be digitized, its offerings remain one of the most important information channels for deciders all over the world.

Electronica, as a broadly diversified industry showcase, remains a must even for the top management. Ultimately, the contact with colleagues, suppliers, competitors and their diverse wealth of experience, supported by the physical presence of the products, cannot replace any AI. Nowhere else do you find such a concentrated offering as at the large and small international trade fairs, especially at the German ones, which - like Electronica since 1964 - are in many cases world leaders: CeBIT, Hannover Messe, IFA, Gamescom, Dmexco.

Kick-off

Focus Topic: Electronica

Cover Story

Connection Methods & Wireless

Displays & HMI

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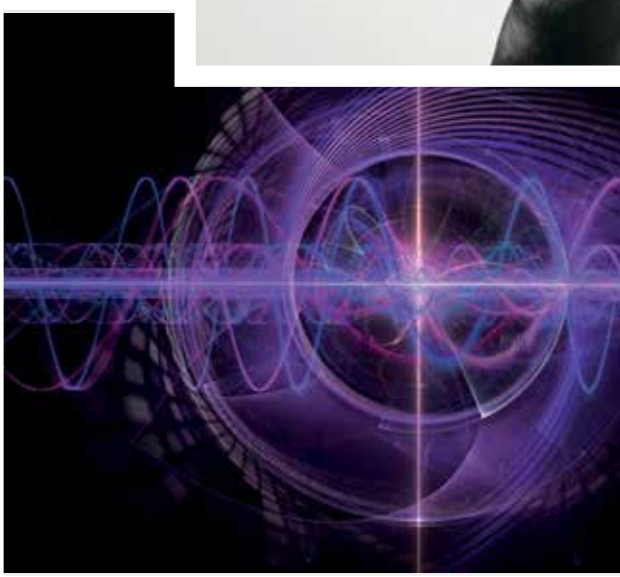
ROBUST CONNECTING

PCB-CONNECTORS FOR THE INDUSTRIAL INTERNET OF THINGS



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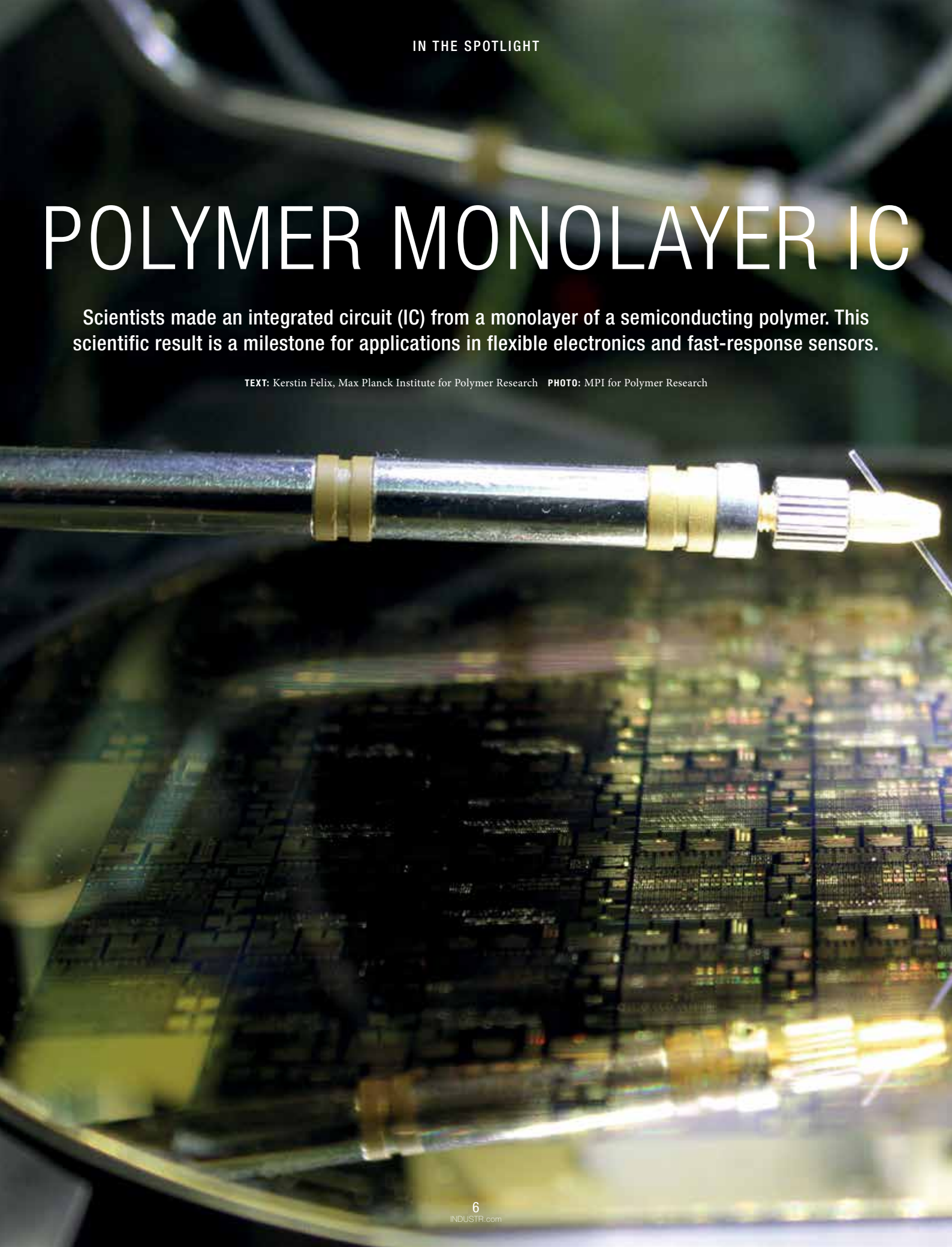
PRACTICAL TIPS

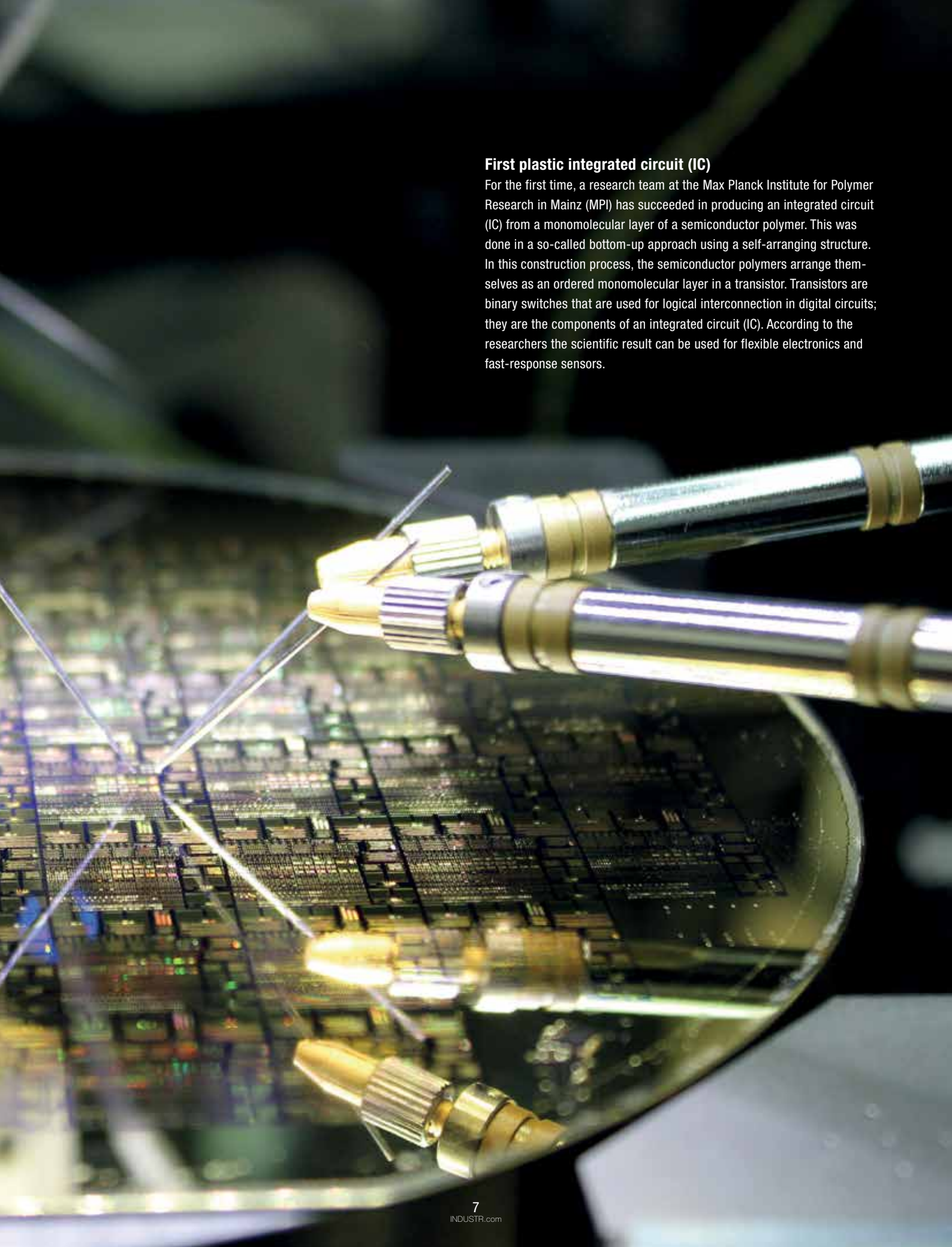
SUCCESSFULLY MANAGE THE TRANSITION FROM CAN TO CAN FD

POLYMER MONOLAYER IC

Scientists made an integrated circuit (IC) from a monolayer of a semiconducting polymer. This scientific result is a milestone for applications in flexible electronics and fast-response sensors.

TEXT: Kerstin Felix, Max Planck Institute for Polymer Research **PHOTO:** MPI for Polymer Research





First plastic integrated circuit (IC)

For the first time, a research team at the Max Planck Institute for Polymer Research in Mainz (MPI) has succeeded in producing an integrated circuit (IC) from a monomolecular layer of a semiconductor polymer. This was done in a so-called bottom-up approach using a self-arranging structure. In this construction process, the semiconductor polymers arrange themselves as an ordered monomolecular layer in a transistor. Transistors are binary switches that are used for logical interconnection in digital circuits; they are the components of an integrated circuit (IC). According to the researchers the scientific result can be used for flexible electronics and fast-response sensors.

Again biggest ever with new Space and Formats added

The World of Electronics in one Place

Smart, reliable and secure networking at all levels is the focus for this year's edition of the world's leading trade fair and conference for electronics, to be held on November 13 to 16, 2018, in Munich. electronica 2018 will be larger than the previous event in 2016, with more than 180,000 square meters of further space spread across four halls, and it will be going way beyond the presentation of relevant components, systems, applications, and solutions. In addition to 17 halls, 13 forums, and four conferences, there will be a wide range of innovations on show.

TEXT: Roland Ackermann for E&E **PHOTOS:** iStock, Pony Wang; Alex Schelbert, Messe München

Jeremy Rifkin, US social theorist, will hold the keynote speech on the evening of Monday, November 12, before opening the new electronica Experience with a talk on Tuesday, November 13. In his works he not only identified current developments in the economy and society at an early stage, he also touched on the global networking of industrial and social processes in the "Supergrid." Exhibitors, visitors, established industry players and start-ups, not to mention employers and new talent, will have extensive opportunities for making contacts and networking. Over 3000 companies from more than 50 countries will be present to provide a glimpse of the future with their products and solutions. Visitors will benefit from four additional halls (C2 and C3 now integrated, plus new C5 and C6) resulting in a new hall layout – with semiconductors, the core of electronica, moving to the center: halls A4, B4, C4, B5, C5 and C3. As a co-located event, SEMICON Europa will take up part of hall A4. The automotive and em-

bedded systems segments and, directly adjacent to them, displays and sensors will also move closer to the center. Five entrances (as compared to previous 2), color-coding in the halls, expressways, and the visitor shuttle together with indoor navigation via the electronica app will aid navigation.

Networking, Inspiration, and Experience

As Angela Marten, Exhibition Director for the trade fair, points out, electromechanics/system periphery, relays and casing technology are another segment that takes up more than two halls, "which is why we have chosen a north to south arrangement on the grounds for this as well. From 2018, exhibitors from these areas will be in halls A2, B2 and C2 at electronica. Circuit carriers and EMS will move to halls A1 and B1, and passive components to A6 and B6. As a result, the remaining areas will move too."

There will also be even more opportunities for networking, inspiration, and experience thanks to the new formats, electronica Experience and IMPACT – Design for a Cause. The new hall C6 will give visitors the opportunity to get to grips with electronics, as well as showcasing career opportunities within the electronics branch. electronica Experience will feature live demos, applications, and presentations, as well as a job market, to facilitate networking between exhibitors, students, and school pupils. IMPACT – Design for a Cause will also be taking place as part of electronica Experience. The event, which will feature engineering associations Hackster and Element14 among others, will look at the future influence of electronics on communication, the environment and medicine in pitches, presentations, and discussion panels.

Embedded Systems – Key for a Smart World

The motto of electronica 2018 "Connecting Everything – smart, safe & secure" applies especially to the trade fair focal point "Embedded Systems". As one of the most important interdisciplinary technologies in the 21th century, they are represented in almost all areas: concentrated in the Embedded exhibition area, the Embedded Forum and at the electronica eEPC (Embedded Plat-

Four halls will be added this year to electronica. More than 3,000 companies will be presenting their products in this halls.

forms Conference – see later). Talks and panel discussions will take place on all four exhibition days at the electronica Embedded Forum. Design engineers, specialists and technical management can obtain information in the middle of exhibition Hall B5 about all important trends and discuss current market and technology topics with experts and colleagues. New this year is the "Tech Talk", a format that explicitly addresses engineers and developers with special technical depth.

The automotive industry is undergoing a dramatic transformation. By 2025, a quarter of all cars worldwide are anticipated to be electrically powered. On top of that, manufacturers and suppliers are currently responding to increasing demands for "next-generation" technologies including autonomous and connected vehicles. electronica 2018 will present this complex automotive topic in three ways: Visitor access the exhibition itself, attendance at the Automotive Forum and attendance at the electronica Automotive Conference (eAC).

Digitization of the Energy Industry

Electronics and software already account for more than ninety percent of all "automotive" innovations. And these developments are not only being driven by autonomous and connected driving alone, but also by the electrification of roads for example. In addition, the growing demand for driving performance, safety, comfort and also environmental compatibility can only be achieved using the latest electronically-managed vehicle functions. Until 2022, car production will rise from 99 million to 110 million units, which means, that the worldwide sales of automotive semiconductors will go up from 45.5 Billion US-Dollar in 2017 to 53.4 Billion US-Dollar by 2022. At the electronica Automotive Forum, presentations from expert speakers and panel discussions will be taking place across all four days of the trade fair. Sales engineers, electronics developers, system designers, project leaders, supply chain managers and anyone that works on automotive development projects should make their way to exhibition hall B4 where they can find out more about important trends and speak to experts and colleagues about the latest market and technology news.

The energy system in Europe is undergoing a historic transition. The switch to sustainable generation is bringing about increasing decentralization with huge ramifications for the entire value chain. Smart energy is the umbrella term for a wide range of technologies in this area relating to energy storage, consumption control, and energy conversion.

Power supply from a small number of large, centrally connected power plants will soon be a thing of the past. More and more customers are becoming "prosumers", i.e. consuming and producing electricity at the same time. Many small power plants are also obtaining energy from renewable resources. This increasingly fragmented, bidirectional, and volatile supply structure urgently requires an intelligent load and generation management system – in other words, a smart grid.

The Power Electronics Forum

The first ever Power Electronics Forum will specifically cater to the subject of smart energy. The forum will cover the whole spectrum of power supply units, power stores and power electronics, last of which is among the key technologies for climate-friendly, resource-saving, yet competitive energy supply. This is because innovative power electronics technology minimizes losses through the conversion, distribution, and consumption of electrical energy. For many applications, silicon is no longer the first choice here. Wide-bandgap semiconductors such as silicon carbide (SiC) and gallium nitride (GaN) deliver higher switching capacity and breakdown voltages in a high temperature range.

Passive components such as heat sinks, capacitors, and coils can therefore be smaller in size, which has a positive impact on the form factor of the overall.

Four Conferences Debut

The conferences in the context of electronica are getting new additions this year – the Automotive Conference, Embedded Platforms Conference and Wireless Congress, the Medical Electronics Conference, all dealing with developments and trends in electronics – will take place for the first time.

On Monday November 12, 2018 – the day before the fair opens – prominent speakers at the eAC will address both managers and technicians. Alongside their presentations, they will also be discussing current technology trends and strategies for the worldwide automotive industry. As well as emission-free and autonomous driving up to level 5, a focal point for the conference will be the interesting topic of so-called last-mile vehicles as part of the overall mobility mix.

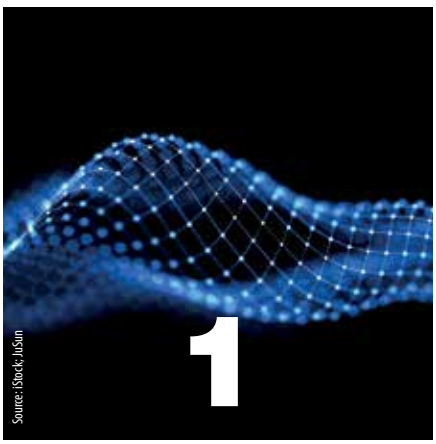
This two-day conference on November 14 and 15 will be dedicated to current buzzwords in the embedded sector. Main focuses include:

- Embedded processors, MCUs, multicore, FPGA and SoCs
- Operating systems, tools and software for safety and security
- Embedded boards and smart modules for short development times
- Embedded vision, machine learning and also adaptive systems

Medical Electronics Conference

In the wake of digitalization of almost all areas of life, the use of high-performance electrical devices in medicine will go far beyond high-resolution imaging methods and digital patient records in the future. To support and promote this development, a separate conference is being dedicated to the highlight topic of medical electronics: the electronica Medical Electronics Conference on November 15 is aimed at all those involved in the digital transformation process in the healthcare sector. The goal is to bring together practitioners from everyday medical treatment with specialists from the electronics industry. Requirements and solutions of digitalization in the healthcare system will be discussed in direct exchanges.

The electronica Embedded Platforms Conference (eEPC) is the ideal communication platform for suppliers of components, tools, software and solutions. In addition to embedded platforms and ecosystems, it also addresses the latest trends to futuristic solutions with high-profile talks at the International Congress Center Munich (ICM) on November 14 to 15, 2018, in parallel to the trade fair. ❐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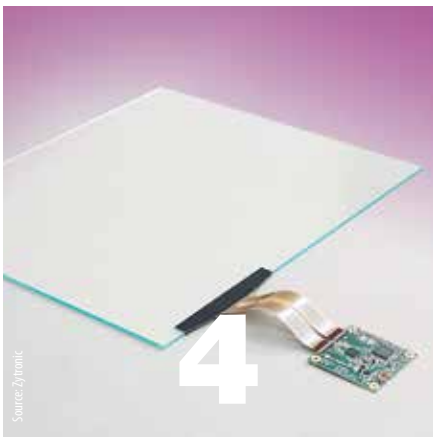
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Mobility
Living Space
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Source: Panasonic


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Source: Emtron Electronic

9 NEUHEITEN

Since its beginnnig, electronica has always presented the most promising trends of the electronic sector. We have highlighted some products you shouldn't miss at this year's trade fair.

Hall C4, Booth 112

BT Mesh Network

How large-scale Bluetooth networks can be made safer and more reliable can be found at **Silicon Labs**. In addition, a demo illustrates the possibilities of Bluetooth Mesh for intelligent lighting. Also visitors have the opportunity to experience the new Bluetooth 5 connectivity to end node designs. The company shows how to add Bluetooth 5 connectivity to end node designs with zero programming and no Bluetooth expertise.

1

Hall C4, Booth 440

Power Management

Saved design time and reduced complexity: The MAX20092 offers that with its flexible current management for matrix and pixel lighting. With its twelve integrated switches, LED string voltages of up to 56 V can be controlled. The resistance of its integrated MOSFETs offers with 70 Ohm the industry's lowest value. **Maxim Integrated** shows the MAX20092 at the tradefair in hall C4 at booth 440.

2

Hall B5, Booth 502

Reference platform

NXP will present a reference platform to visitors at electronica that accelerates the development of electric traction motors for electric vehicles. A highlight of the booth will be autonomous real-time route planning based on the NXP BlueBox development platform. The technology will be presented by means of video simulation, in which visitors to the stand can compete with the machine in a car race.

3

Hall B4, Booth 210

Multi-Touch controllers

Zytronic is presenting its new range of Multi-Touch controllers. The ZXY500 range has been individually designed to operate with a Tx drive voltage of up to 40 V. This improves sensitivity and enables full multi-touch detection in HMI applications even under demanding conditions. The new controllers feature better noise immunity, which reduces optical parallax and improves the view of the display.

4

Hall B6, Booth 272

Avoiding repairs

With the smart predict sensor system, **pk components** shows how wear and tear on machines can be detected in advance and turned around before expensive repairs are required. In addition, an alternative to aluminum electrolytic capacitors and MLCCs is demonstrated on an object. With this, the hybrid polymer aluminum electrolyte can reduce the capacitor bank and extend the service life of the capacitors.

5

Hall B5, Booth 526

Longterm components

Alliance Memory devices eliminate costly rebuilds by providing long-term support for end-of-life components. At the electronica the company will introduce a new family of high-speed CMOS pseudo SRAMs that combine the most desirable features of SRAMs and DRAMs to provide designers with easy-to-use, low-power, and cost-effective memory solutions for wireless, automotive, networking, and industrial applications.

6

Hall B3. Booth 560

Smart Sensors

Omron Electronic Components will be demonstrating at the trade fair its IoT-enabled sensors for digital signage, building and factory automation at its booth. The company will show the possibilities of automating manned and unmanned buildings using sensor components. These include the new USB version of the 2JCIE environmental sensor, which measures seven different parameters in a single housing.

7

Hall B5, Booth 564

Back to the roots

Since its repositioning last year, **Panasonic** has offered a comprehensive product portfolio that ranges from electronic components, devices and modules through complete solutions to manufacturing systems and future-oriented services and training. Visitors to the stand will have the opportunity to take a closer look at the products in the Mobility, Living Space and Business segments.

8

Hall A6, Booth 234

Much more Power

With the introduction of the PSPA-1000 series **Mean Well** has increased the output line of the predecessor model to 1,000 W. The new model does not require more space, but has a higher power output. The AC/DC power supplies are particularly suitable for demanding ambient conditions. They have an output line of one kW and different output voltages of 12 to 18 V. Emtron shows them in hall A6 at booth 234.

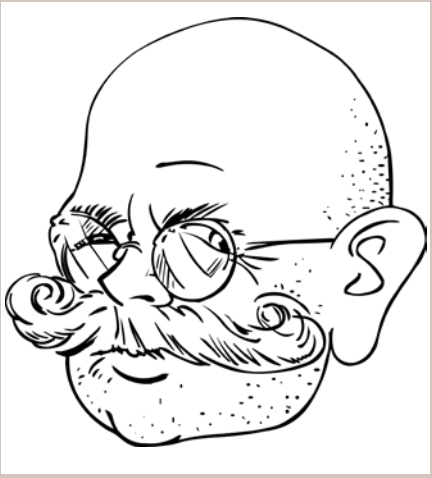
9

ACKERMANN´S SIDEWAYS GLANCES

TRADE FAIRS AND THE INTERNET

With the advent of the Internet, the voices that soon saw the end of trade fairs and exhibitions gained the upper hand. The topicality of online information seemed so important and unbeatable compared to annual or even biennial events that many thought they had irrefutable arguments predicting mass death of the fairs. They were wrong, at least partly.

1964 in the March issue of the former magazine "Elektronik-Entwicklung" – shortly before the opening of the very first Electronica – I commented in my editorial: "The trend towards sales-oriented special fairs – in contrast to the all-round type of the Hanover Fair - is unmistakable for all those who see reason, and the respective realization is only a question of the market strength of the industry concerned. A trade fair for electronic components certainly has its right to exist with us...". At that time there was only the annual Salon des Composants Electroniques in Paris. 70 percent of the visitors were French.



Roland Ackermann accompanies the electronics industry as long as it exists. As editor-in-chief, publishing director and creator of the „Technischen Report“ for the Bayerischen Rundfunk, he has been shaping the industry since the late 1950s.

Of course, the success proved me right, despite the initial ban on visits for example by Siemens employees and other cross-cuts from the European industry, who wanted to resist the inevitable intrusion of the Americans and Japanese. Behind said success stood endlessly diligent and laborious efforts at all levels of Messe München and their supporters. Amongst them me, too, inter alia as co-initiator, organiser and moderator of the opening panel discussion of the respective leading company directors that still exists today. My colleagues and I have written full books on Electronica. And we still do. And we carried the reputation of its leading position all the way around the whole world. With the result that at times the waiting list overflowed and hundreds could not be assigned a stand.

One can certainly not claim that the Internet had no effect on the trade fair landscape. For sure it did, even in a sustainable way. If, however, you consider this year's Electronica figures and the exhibition space occupied with additional halls once again, now totalling 17, you must curb the pessimism and ultimately speak of a sensible expansion and supplementation of market events. This is connected with the change not to show only products, but solutions and innovative solution approaches.

Despite all search engines, there is nothing like personal discussions among colleagues, the exchange ideas and prospects, of failed and of promising approaches, of market demand and expectations as a basis for continued and deeper cooperation. Early information and topicality are one thing, and this point is perfectly covered by the internet, whereas long-term struggle for the best possible solution with individual assistance is the other one. And let's be honest: a handshake is and will continue to be warmer and more sustainable than a bingo on Google and the like.

Anyhow, coexistence of trade fairs and the internet will continue for a long time to come – and this is especially true at the German trade fairs, which resemble diverse, turbulent and well-attended businesses, where visitors are courted and often even entertained, in contrast to many other countries, where trade fair stands are more reminiscent of sales boxes for collecting leads.

However, in the final analysis, it is all about conquering as large a piece of the market cake as possible and about increasing sales. We – Electronica, the internet just like us journalists and their magazines – are only the necessary instruments for future economic success and ultimately general well-being. ☐

Board-to-Board Connectors for the Industry

ROBUST CONNECTION

In the past five years, hardly any other buzzword has driven the industrial production and automation sector like "the intelligent factory". Otherwise diverse markets as the USA, Europe and China agree on the implications: Industrial production must become more networked, more efficient, more intelligent and thus more internationally competitive. Robust board-to-board connectors are an important step along this path.

TEXT: Markus Sonderer, Phoenix Contact **PHOTOS:** Phoenix Contact; iStock, SvetaZi

Maximum freedom: Horizontal and vertical female connectors allow mezzanine, orthogonal and coplanar PCB arrangements.

One of the drivers of a increased competitiveness should be enhanced versions of production resources that lead to higher performance, more flexible production lines and lower manufacturing costs. For the year 2020, various analyses forecast almost 20 billion (IDC, 2016), almost 30 billion (Gartner, 2017) or even up to 50 billion (CISCO IBSG, 2011) IT-networked "things". So even the most cautious forecast means that in just two years there will be almost three times more things communicating with each other than people.

In addition to the ubiquitous smart devices, these things also include the intelligent devices of the industrial production: controllers, power supplies, I/Os, HMIs and many more. These devices themselves have become more intelligent in recent years. Their electronic components, such as processors, could be produced at substantially lower cost and thus became more powerful and numerous. Together with their components, industrial electronic devices themselves became ever smaller, more powerful and more numerous. As a result, more intelligence from a formerly central and strictly hierarchical unit moved decentrally into the field.

Stringent requirements

As the number of participants in the field increases, so does the need to network them using information technology, equip them with appropriate electronics and interfaces for signal, data and power transmission, and shield them from harsh environmental conditions. Electromechanical interfaces play an important role here: they are the key to exploiting further miniaturization potential and making devices more reliable and flexible in industrial applications. However, dirt, vibrations, high temperatures and electromagnetic radiation place high demands on passive components.

Phoenix Contact responds to these requirements with a newly developed series of board-to-board connectors with 0.8 and 1.27 mm pitch. Both product families are ideally suited for the device-internal connection of several printed circuit boards. Thanks to horizontal and vertical variants, device manufacturers can implement mezzanine, orthogonal or coplanar PCB arrangements and thus offer flexible electronic layouts for different device applications.

Full flexibility

All board-to-board connectors are designed for currents up to 1.4 A and voltages up to 500 V_{AC}; and they offer solutions for 12 to 80 connection poles. Reverse polarity protection is particularly important in the compact pitches to prevent damage to the contact metals when they are mated and to ensure long-term stable connections inside the device. All board-to-board connectors are therefore polarized accordingly – the special geometry of the insulating housing reliably prevents female and male connectors from being mismatched.

Up to 500 mating and withdrawal cycles

The double-sided contacts of both product families make contact on the gold-plated rolled surfaces of the metals and thus guarantee an optimum contact force at all times, even under high shock effects of up to 50 g. Another advantage of the robust design: up to 500 mating and withdrawal cycles are possible without impairing electromechanical stability.

The unshielded Finepitch 1.27 series is suitable for stacking heights from 8 to 13.8 mm and, thanks to pre-assembled female connectors with flat ribbon cable, also enables wire-to-board applications, for example for larger PCB spacings.

INTERVIEW

"There is no PCB-Connector this Size, that is more robust"

Most existing PCB connectors are not suitable for harsh industrial conditions. The industry requires robust and ever smaller components. Phoenix Contact has therefore developed a sturdy PCB-connector with a 0.8 mm pitch. In the interview with E&E Volker Koppert, Vice President of Phoenix Contact, and Markus Sonderer, Senior Director at Phoenix Contact, explain what makes him special and when he will be available.

TEXT: Florian Streifinger, E&E **PHOTO:** Phoenix Contact

E&E: What is the key feature of the Finepitch FP 0.8 PCB connector?
Markus Sonderer: There is already a great variety of board-to-board connectors in the market. However, many of these do not necessarily address the industrial sector. The industry requires very robust and very resistant components for its devices. Currently there is still a lack of a broader selection. With a grid size of 0.8 mm, there is no PCB connector that is more robust than the Finepitch FP 0.8. We have integrated several features into it that ensure exactly this.

What are these?
Sonderer: More specifically, the Finepitch FP 0.8 has, among other things, a double contact with a gold surface and a shielding that enables secure data rates, as currently required. Because in Industrie 4.0 and the Industrial Internet of Things (IIoT) the processes are highly networked and run via fast controllers. As a result, the data rates are immense, too.

So with the Finepitch you´re specifically targeting Industrie 4.0 applications?
Sonderer: In any case. Four points are particularly decisive for us. Industrie 4.0 will lead to a strong decentralization. Devices are no longer located centrally in the control room but will be implemented at the very end of the chain. Secondly, the number of sensors will increase exponentially. Sensors almost cost nothing more and can be accommodated anywhere. Thirdly, the modularity of the devices will increase considerably. Additional functions can be plugged in or snapped on. Our customers want their devices to be modular. This

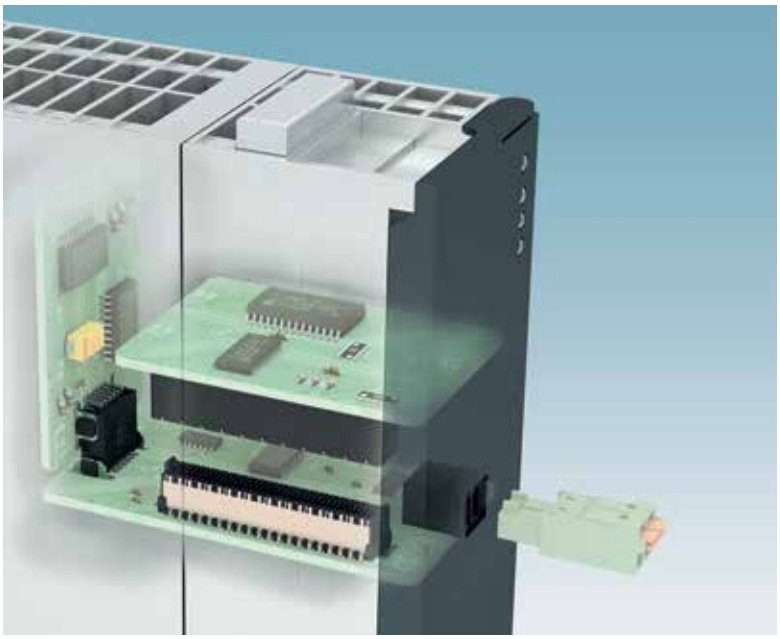
Markus Sonderer (to the left) and Volker Koppert, Phoenix Contact

works particularly well with connectors you can rely on. Fourthly, the performance of the control and regulation system increases significantly. Due to this, real-time monitoring over long distances, including over the Internet, will be possible. This will result in even stronger networking.
Volker Koppert: These developments will lead to an immense increase in the market potential for such products. This is also the reason why we developed the Finepitch FP 0.8 right now. The increase in data and sensor technology as well as the desire for more modular devices means that exactly such a connector is needed.

The Finepitch uses the ScaleX contact system to prevent damage to the connector due to mismating. How does this exactly work?
Sonderer: This is a real unique selling point that we have created with the Finepitch FP 0.8. Many connectors have a kind of trough in which the blade contacts are individually located. If the connectors are not inserted correctly into each other during assembly, individual pins may bend. This does not happen with ScaleX technology. The plastic bodies are designed in such a way that it is not possible to generate any form of destruction through improper handling. This did not exist before and makes handling much easier for the customer.

When will the Finepitch be available?
Koppert: We'll be presenting it at Electronica. It will then be available from January 1, 2019. But of course we are already in a position to provide customers with samples or to assemble prototypes from our customers in small series.

Meanwhile there is a shortage of connectors, too. Will the Finepitch be available in sufficient quantities right from the start?
Sonderer: We have explicitly attached importance to this. We know the problems from other areas and we therefore make sure that there are for example no bottlenecks by purchasing raw materials. ☐



Miniaturized and reliable: Board-to-board connectors are used for the internal connection of printed circuit boards.

The Finepitch 0.8 mm series offers particularly compact solutions for high-speed data transmission at up to 16 Gbps. Depending on the application and the required degree of protection, unshielded versions and versions with lateral shielding metals are available for maximum data integrity.

Mechanically robust thanks to the ScaleX technology

The hermaphroditically designed contacts of the more compact product series allow stacking heights from 6 to 12 mm. The newly developed ScaleX contact system not only guarantees particularly high mechanical stability. It also permits high tolerances for male and female connectors positioned differently for production or assembly reasons. The catch range of the Finepitch 0.8 series is ±0.7 mm per axis, the angle tolerances for mating are up to ±4 degree in longitudinal direction and ±2 degree in transverse direction. These high tolerances compensate the mechanical offset between the printed circuit boards.

FINEPITCH - TECHNICAL DATA

Pitch: 0.8 mm and 1.27 mm
Currents: up to 1.4 A
Voltages: up to 500 V_{AC}
Data rates (FP 0.8): up to 16 Gbps
Number of poles: 12 to 80 poles
Stacking heights: 6 to 12 mm (FP 0.8) or 8 to 13.8 mm (FP 1.27)
Shielded and unshielded versions

The new board-to-board connectors of the Finepitch series are ideally suited for integration into the fully automated SMT process. Specially shaped and tin-plated gullwing surfaces offer a high contact area on the solder pads and improve mechanical stability between the connector and PCB surface. The soldering surfaces are designed in such a way that they still allow "overhead" soldering. This is always necessary when the printed circuit board is assembled on both sides. The unshielded versions also permit automatic optical inspection (AOI) and are delivered in a taped package for the appropriate process.

Simple solution for SMT processes

Connectors of the Finepitch 0.8 mm and 1.27 mm series offer ideal solutions for flexible connection of several printed circuit boards in industrial electronic devices. The particularly robust contact systems allow different PCB arrangements and stacking heights and support flexible and modular device designs. Phoenix Contact is thus following the trend towards miniaturization and modularization of intelligence in the field. The great advantage for device manufacturers is that they can obtain tested and reliable device interfaces for the transmission of signals, data and power from a single source and can thus offer highly adaptive devices for the intelligent factory – regardless of location and local market conditions. ❐

9 Tips & Tricks

Easy Migration from CAN to CAN FD

CAN (Controller Area Network) is a fast and solid bus system that has proven effective in many industries. Three years ago the more powerful CAN FD protocol (CAN with a flexible data rate) was standardized. It allows an easy migration of existing CAN applications to CAN FD or can be used as the base for new applications. Why the transition is worthwile and how it should be done, is shown here.

TEXT: Oliver Thimm, Esd Electronics **PHOTO:** iStock, Artur

1 **Compatibility is key**

CAN was originally developed for the automotive sector. The car manufacturers aimed to improve the performance of the CAN bus while ensuring the downward compatible CAN communication. CAN FD, which is based on the powerful characteristics of CAN, has emerged from this process: real-time enabled bus arbitration, event-triggered, 11 and 29 bit identifier, multimaster capability, low power consumption, high robustness against interferences and the possibility of using existing CAN installations unchanged. Thanks to the downward compatible design existing CAN applications can easily be migrated to the more powerful CAN FD communication, or the new standard can be used as the base for future applications.

2 **What's the idea behind the CAN FD concept?**

CAN data transmission can be roughly divided into three stages: bus arbitration, data transfer and confirmation. During all of these phases bits are being transferred with an identical bit rate. At the same time all nodes are continuously resynchronized in order to

compensate phase noise and phase drift of the independent CAN nodes oscillators. This is especially important during the arbitration and confirmation phases, since all nodes are simultaneously transmitting data to the bus and each node must be able to compare its transmitted bit with the received one. This CAN protocol detail determines the physical limits of the possible maximum bit rate on the CAN bus as well as the cable length.
The idea behind the CAN FD protocol is to send data with a second, usually much higher bit rate during the data transfer phase. The synchronization is suspended during this phase, since there should be only one transmitter on the bus. This enhancement allows a protocol with a flexible and a higher maximum data rate, which can be used without changing the existing wiring cables.

3 Net data rate up to nine times higher

The protocol's name suffix "FD" was derived from the flexible data rate during the data transfer phase, which allows bit rates of up to 10 Mbit/s depending on the network topology and other physical factors. Furthermore the payload of a message was increased from 8 to 64 bytes ensuring a considerable improvement in the ratio between protocol data to user data. Bit rates with a ratio of 1:8 between arbitration phase and data transfer phase result in an increased net data rate by the factor of two up to even nine depending on the payload size. With this improvement in performance an existing CAN application does not necessarily need to change its communication layer to an Industrial Ethernet protocol in case of higher bandwidth demands. Thus, the level of investment in new infrastructure, products and technology can be kept as low as possible. The decisive factor is to determine the long-term requirements of the respective application.

4 CAN FD controller still support the CAN protocol

The CAN FD protocol is designed in such a way that classical CAN concepts are maintained during arbitration and confirmation phase as well as for the fault confinement. In order to achieve the same degree of robustness against communication faults with prolonged payload sizes, a 17-bit checksum (messages of up to 16 bytes user data) or a 21-bit checksum (messages of more than 16 bytes user data) instead of the CAN 15-bit checksum is used to verify the data integrity. However, the RTR (Remote Transmission Requests) feature is no longer supported within the CAN FD protocol. In order to ensure downward compatibility, any CAN FD controller also supports the CAN protocol so existing applications using RTRs need not to be changed. As CAN FD hardware as state-of-the-art technology is nowadays only slightly more expensive than CAN, an early migration to a compatible CAN FD solution is recommended as well as supporting CAN FD in hardware redesigns.

5 Keep on using existing CAN installations

CAN FD scores top marks when it comes to the transmission of larger volumes of data or to the reduction of download time during firmware update using a higher bitrate in the data phase. At the same time the real-time behavior is improved, since overall latency is being reduced while the application protocol can remain unchanged. In conclusion this performance improvement makes it possible to extend existing installations which operate already close to their physical limit with additional CAN nodes.

6 Desired performance gain defines migration effort

Besides the use of CAN FD enabled hardware, switching an existing CAN system to a higher performance level without changing the protocol only requires using a higher bit rate during the data transfer phase. With a ratio of 1:4 between arbitration bit rate and data bit rate and a protocol which is based upon eight-byte messages the throughput is already more than doubled or rather the latency is more than halved. If, on the other hand, a large performance increase is desired, the migration to CAN FD requires also a change in application protocol. It is modified in such a way that more than eight data bytes are utilized. Making full use of the data capacity of 64 bytes increases data throughput by five times at least. A more than nine times growth can be reached by an increased bit rate ratio of 1:8 depending on the topology and wiring quality.

7 Enhanced transceivers not just for CAN FD

Thanks to the fact that more and more of the latest MCUs replace their inter-

nal CAN interfaces, with CAN FD new hardware designs can easily support the improved protocol standard. CAN FD accepts the same oscillator tolerance as CAN until a certain ratio between the bit rates of the arbitration phase and the data phase. For CAN FD it is recommended to use a transceiver specified according to ISO 11898-2:2016, the improved physical characteristics of which also deliver benefits to CAN. Existing designs can easily be upgraded to CAN FD by either using stand-alone controller or integrating a FPGA IP core, such as the esd ACC, if possible.

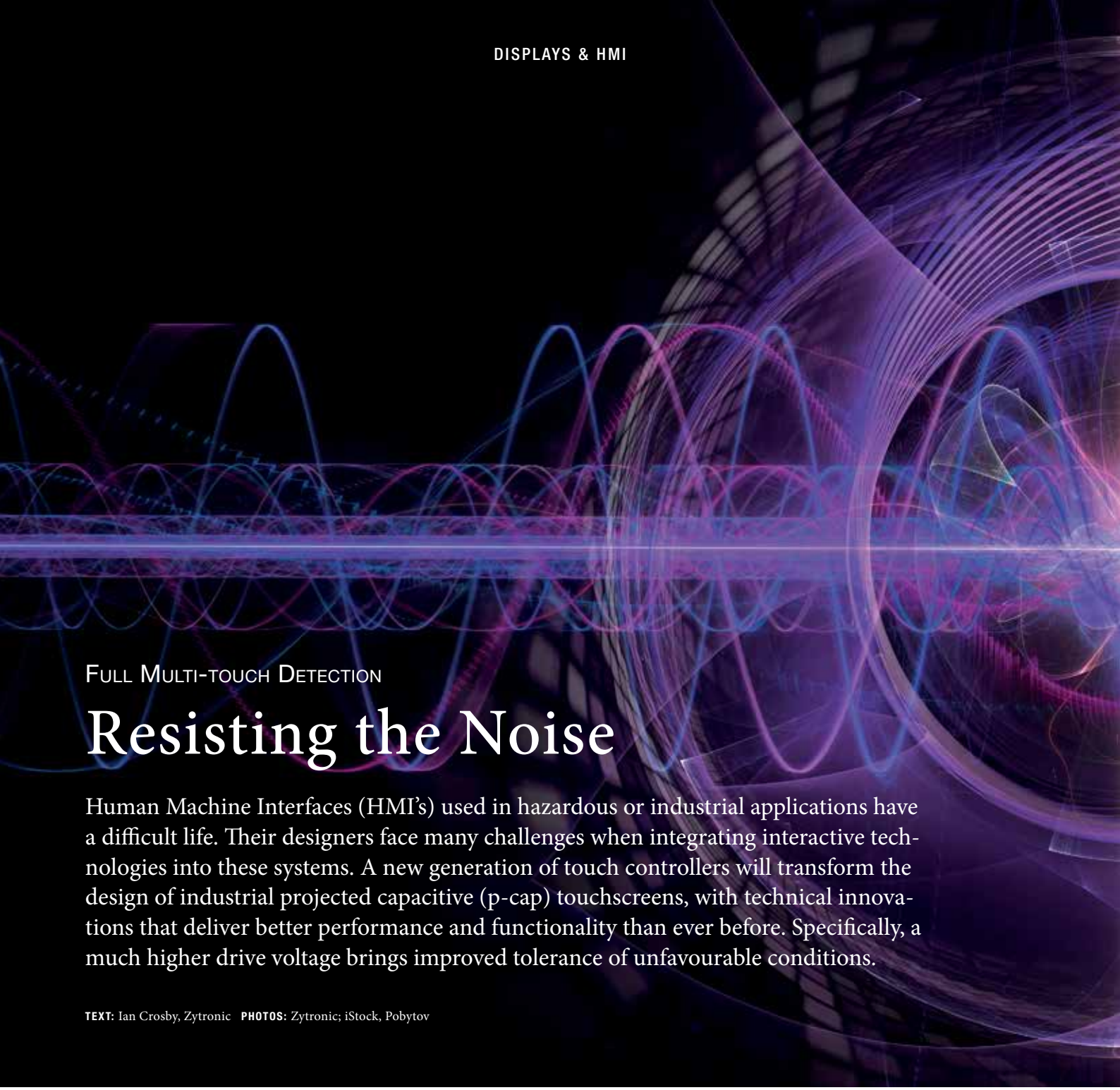
8 Gradual hardware migration

If system integrators are to migrate a CAN network to CAN FD they can gradually replace each CAN node with a CAN FD one. Thanks to the downward compatibility the CAN protocol can still be used until all nodes are updated. If later on – after the complete migration – the need arises to realize a higher communication performance and/or a lower latency the application can be adapted to CAN FD according to the steps described below. There is always a chance to switch back to the original application with classical CAN, since wiring remains unchanged. A migration of all nodes to CAN FD is required before the application can profit from the performance improvements, as otherwise the remaining CAN controller would handle CAN FD messages as protocol faults.

9 Gradual software migration

The migration effort from the application programmer's point of view is heavily depending on the CAN API which is been used. If the integration of CAN FD does not affect the original CAN API, the migration can take place in three steps: The first and initial step would be migrating all the node's hardware to CAN FD. This process has already been described above. In a second step, all nodes can be configured to use a higher bit rate in the data phase while at the same time maintaining the application protocol. This approach immediately reduces the latency and also the bus load or increases the throughput respectively.

In a final and more effortful step the throughput can be increased further by modifying the application protocol to utilize the increased payload size. This procedure opens up as well new application fields which require a larger process data consistency. That's the case for example for the implementation of present safety and security protocols. ❐



Full Multi-touch Detection

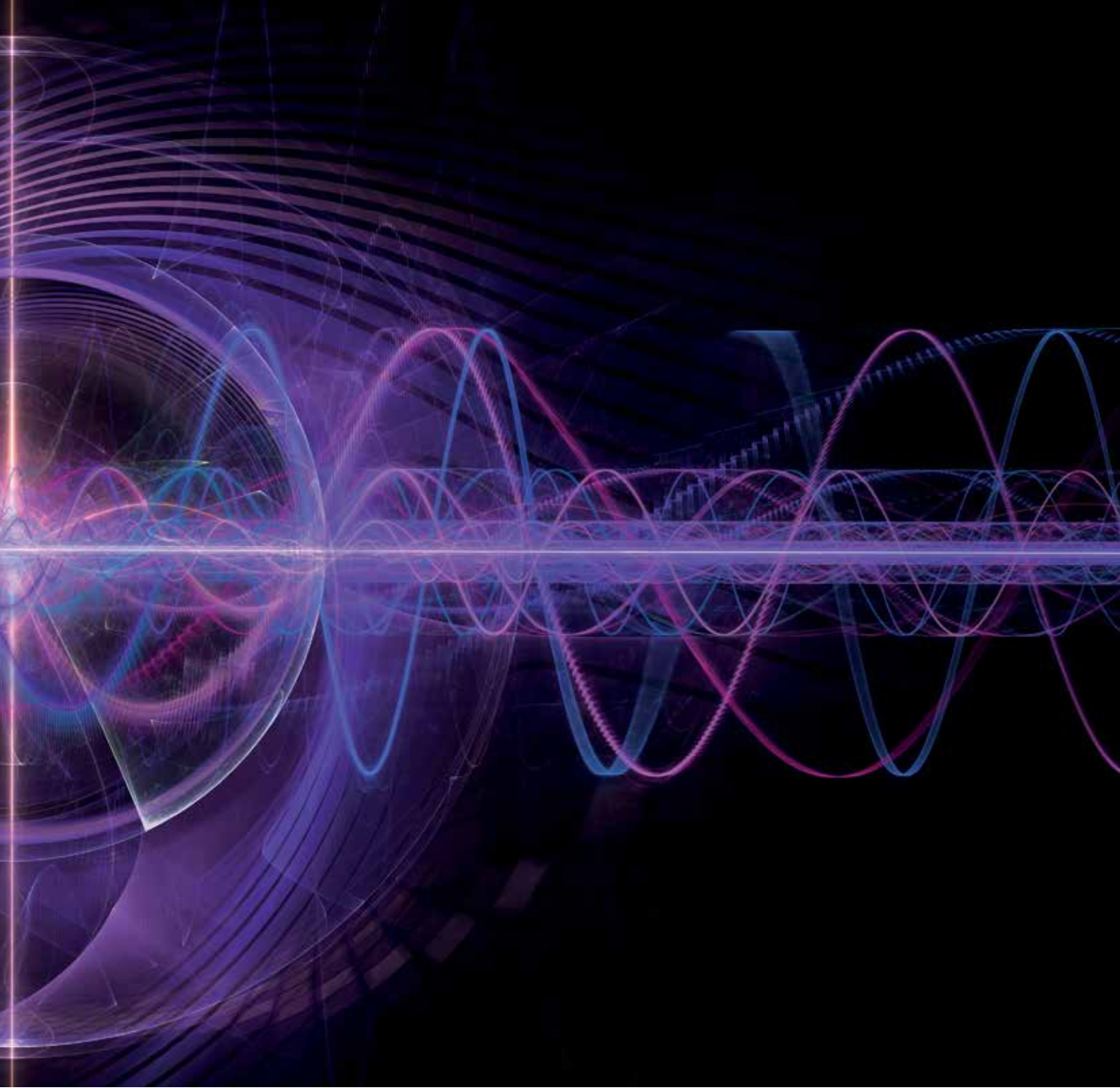
Resisting the Noise

Human Machine Interfaces (HMI's) used in hazardous or industrial applications have a difficult life. Their designers face many challenges when integrating interactive technologies into these systems. A new generation of touch controllers will transform the design of industrial projected capacitive (p-cap) touchscreens, with technical innovations that deliver better performance and functionality than ever before. Specifically, a much higher drive voltage brings improved tolerance of unfavourable conditions.

TEXT: Ian Crosby, Zytronic **PHOTOS:** Zytronic; iStock, Pobytov

The biggest constraint on p-cap touchscreen performance is noise immunity. When the touch controller receives a signal from the sensor, it must distinguish between genuine and false touches (created by electromagnetic interference, or EMI). A finger pressed firmly onto the screen will give a clear signal – but that signal will be weaker if the user is wearing gloves, is touching lightly, or if the screen is behind thick cover glass, and/or the surface is contaminated. The key to improving sensitivity is the drive signal applied to the sensors Transmit (Tx) array of electrodes by the touch controller. The level of this signal is a classic trade-off, a low voltage signal can be overwhelmed by EMI from the environment, a high drive voltage can create interference in the sensor itself, which can potentially degrade performance.

Most p-cap touchscreen manufacturers are forced to use a Tx signal with a DC current of between 20 to 30 V, due to limitations in available "off-the-shelf" touch control compo-



nents and ASICs. However, Zytronic's new ZXY500 range of controllers have been purpose designed to operate at an industry leading Tx drive voltage of up to 40 V, enabling full multi-touch detection in extremely challenging industrial applications.

The results of this innovation are dramatic. The higher drive voltages reduce the influence of noise on the data captured. A significant source of this noise is the proximity of the display itself. With all projected capacitive touchscreens, it is necessary to have a gap (air or resin filled) between the front of the display and the rear of the touch sensor, and the new ZXY500 controller now allows this gap to be substantially reduced, depending on the size and type of display selected for the system. This not only allows the whole interface to become slimmer and more compact, it also reduces optical parallax between the display and the overlaying sensor, improving the user experience and accuracy of touch.

The Zytronic ZXY500 controllers also allow the design of "soft keys" around the edge of the dynamic active area of the projected capacitive touchscreen.

Each Zytronic projected capacitive touch sensor is manufactured with a conductive matrix laminated within the rear surface of the screen. This matrix consists of an array of ultra-low resistance, microfine electrodes, which are near invisible to the human eye on a powered display. These electrodes are connected to the remotely mounted touch controller, which applies a small charge to the sensing array. When a finger, conductive stylus or known object approaches the front surface of the sensor, a change in the charge applied to the conductive matrix is detected at the crossing points within the sensing array. This induced change is largest immediately beneath the touch points, and the touch controller's firmware algorithms filters interference, calculates the applied touch positions and rapidly conveys this data to the host computer in a stream of X-Y positional co-ordinates.

Touchscreen design

In addition to directly improving performance, this new generation of ZXY500 touch controllers combined with Zytronic's flexible p-cap manufacturing process, provides system designers with limitless opportunities to customise the appearance of the user interface irrespective of quantity, optimising it for the application and helping to differentiate the overall hardware from competitive products.

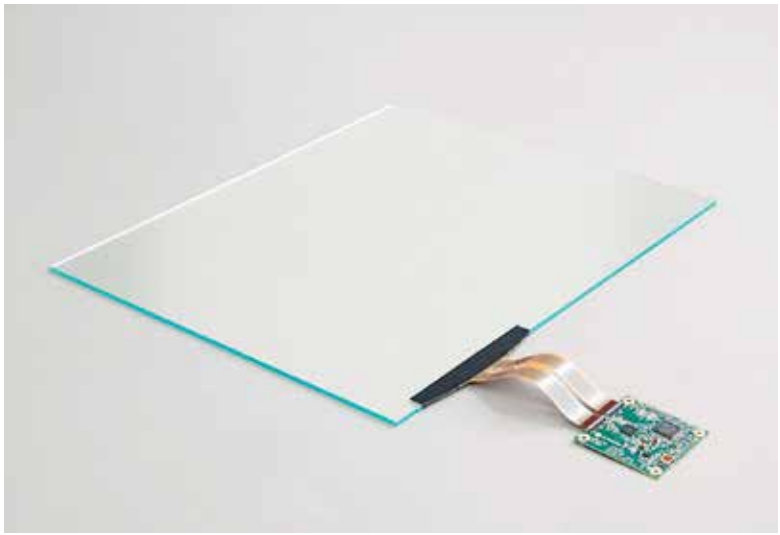
The new controllers allow the border around the perimeter of the touch active areas of the screen to be substantially reduced – for example a touch sensor designed for a 55 inch display can now be designed with sub 10 mm borders, helping to reduce the user interface "footprint" – useful, in applications where space is limited. Zytronic has been able to achieve this border reduction through proprietary new touch detection algorithms in firmware which allow the transmit and receive electrodes in the sensor borders to be located far closer together without creating interference or "cross-talk.

The ZXY500 controllers also now make it possible to design "soft keys" around the edge of the dynamic active area of the projected capacitive touchscreen. These fixed touch "buttons" are managed by the same controller and their function can be defined by the system designer – for example keys for dimming/increasing brightness or raising and lowering volume. This is useful in applications where sealing and water ingress via mechanical controls could be an issue. It also enables designers to use smaller, cheaper displays, while still retaining touch interactivity around the perimeter of the screen in a single, unbroken surface.

The new p-cap controllers support up to 80 simultaneous touches, enabling true multi-user interactivity and improved "palm" rejection capability, that means detecting and ignoring anomalous touches, such as an arm resting on the screen. The Zytronic proprietary ASIC (Figure 4) within the ZXY500 controllers also increases the speed of touch detection, updating touch co-ordinates in just 1ms at the controller output – reducing touch latency by a third compared to the previous generation controllers, and improving the overall user experience. They can also reliably detect touches through more than 8mm of overlaying glass – even with gloved hands, and are unaffected by rain, salt water, oil or ice on the surface of the touch sensor.

Tactile feedback

A common objection to all types of touchscreen is that they don't provide tactile feedback in the way mechanical controls do. This can be a drawback, for example, if a user is looking



The smallest p-cap Controller in the ZXY500 range has been significantly reduced in size to just 61 mm x 64 mm to support Zytronic touch sensor sizes up to around 19 inches.

away when operating the screen, which can result in accidental touches. A feature within the ZXY500 projected capacitive touch controllers which addresses this issue is "force" sensing. Zytronic has developed custom touch detection firmware which responds to the increased surface area of a fingertip when pressed more firmly onto the screen and differentiates its output accordingly. Software developers can then use the graduated information from the controller to activate different functions depending on the applied pressure, such as issuing an audible message alerting the user to the option selected when the screen is touched lightly, and then confirming the choice when pressed harder. So, for example an instrument can say "temperature", "pressure" or "time" as the user's finger moves across the screen. Once the finger is over the correct option, a firm press makes the selection, without the risk of an incorrect touch.

System integration and communications

A key factor in the success of a user interface design is how easy it is to integrate the controller into the rest of the system. USB is an extremely popular interface, but there are some applications that require RS232, I2C or SPI interfaces. Size is also an important consideration, and the smallest p-cap controller in the new ZXY500 range has been significantly reduced in size to just 61 mm x 64mm to support Zytronic touch sensor sizes up to about 19 inch. The flexible printed circuits (FPC) connecting the touch sensors to the new controllers have also been reduced to just 120 mm in length, further simplifying integration. Finally, the new controllers have been designed to be HID (Human Interface Device) compliant and offer "plug-and-play" operation with later Windows operating systems, also supporting Linux and Android builds suitable for multi-touch input.

The latest Zytronic projected capacitive touch controllers provide a very high performance. Even in demanding conditions with high levels of EMI and exposure to contaminants, the touchscreens provide a responsive user interface. They are ideal for outdoor applications where it can be protected from physical damage and environmental factors without compromising performance. ☐

Because the rechargeable and SMT compatible CeraCharge is a solid-state battery, it is very safe.

Ceramic Multilayer Technology meets IoT Power Supply Demands

RECHARGEABLE SOLID-STATE SMD BATTERY

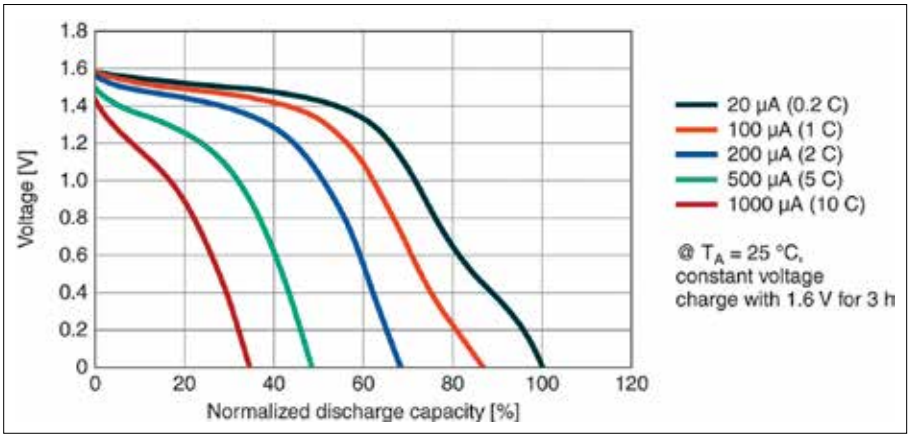
From simple gadgets to complex devices for the industrial IoT – they all require compact, reliable and safe power supplies. The CeraCharge from TDK, the world's first rechargeable solid-state SMD battery, is a new technology that meets these demands.

TEXT: Masahiro Oishi, Markus Puff, beide TDK **PHOTOS:** TDK, Christian Jungwirth

Life today would be unimaginable without batteries and accumulators using a wide variety of technologies and with widely differing capacities. The Internet of Things in all its facets will in future require billions of special power supplies tailored to the requirements of new ultra-low-power semiconductors and sensors. These devices must function for years, independently of external power supplies, by using energy-harvesting technologies.

The demands made on energy storage media are as follows: small dimensions, rechargeability, intrinsically safe, easy to assemble, low cost and long service life. Not all of these requirements can be met simultaneously using currently available technologies. For many applications, the TDK CeraCharge now offers a way out of this dilemma. Unlike most common technologies, this involves a solid-state rechargeable battery with no liquid electrolyte through which the lithium ions move during charging or discharging. CeraCharge is based on a multilayer technology, similar to MLCCs.

Thanks to this technology, a relatively high energy density and smallest volume are combined with the safety and high volume manufacturing benefits of ceramic multilayer components. In addition, the use of a solid ceramic electrolyte rules out the risks of fire, explosion, or the leakage of liquid electrolyte.



Typical discharge characteristics of CeraCharge

CeraCharge is the world's first rechargeable battery to be designed as an SMT-compatible component. Accordingly, this results in further advantages such as easy placement of components and the use of conventional reflow soldering processes, which in turn reduces the production costs of the devices. Initially, the CeraCharge is available in an EIA 1812 package (4.5 mm x 3.2 mm x 1.1 mm). This component offers a capacity of 100 µAh at a rated voltage of 1.4 V and an initial internal resistance of smaller than 200 Ω.

Simple process thanks to SMT-compatible design

The nominal discharge current for CeraCharge is 20 µA, but one CeraCharge is also able to support a continuous discharge of 1 mA (10 °C). Compared to conventional batteries, rechargeable or otherwise, CeraCharge offers a very wide temperature range of between -20 °C and 80 °C, making it suitable for outdoor use, for example in weather stations.

Depending on the requirements, the number of charge/discharge cycles that CeraCharge is able to perform ranges from several dozens of to up to 1000 without any significant losses in terms of electrical parameters (up to 80 percent of the initial values). For short periods or in pulsed operation – when supplying a Bluetooth beacon module during transmission, for example – one CeraCharge can cupply currents with magnitude of about 3 mA/s.

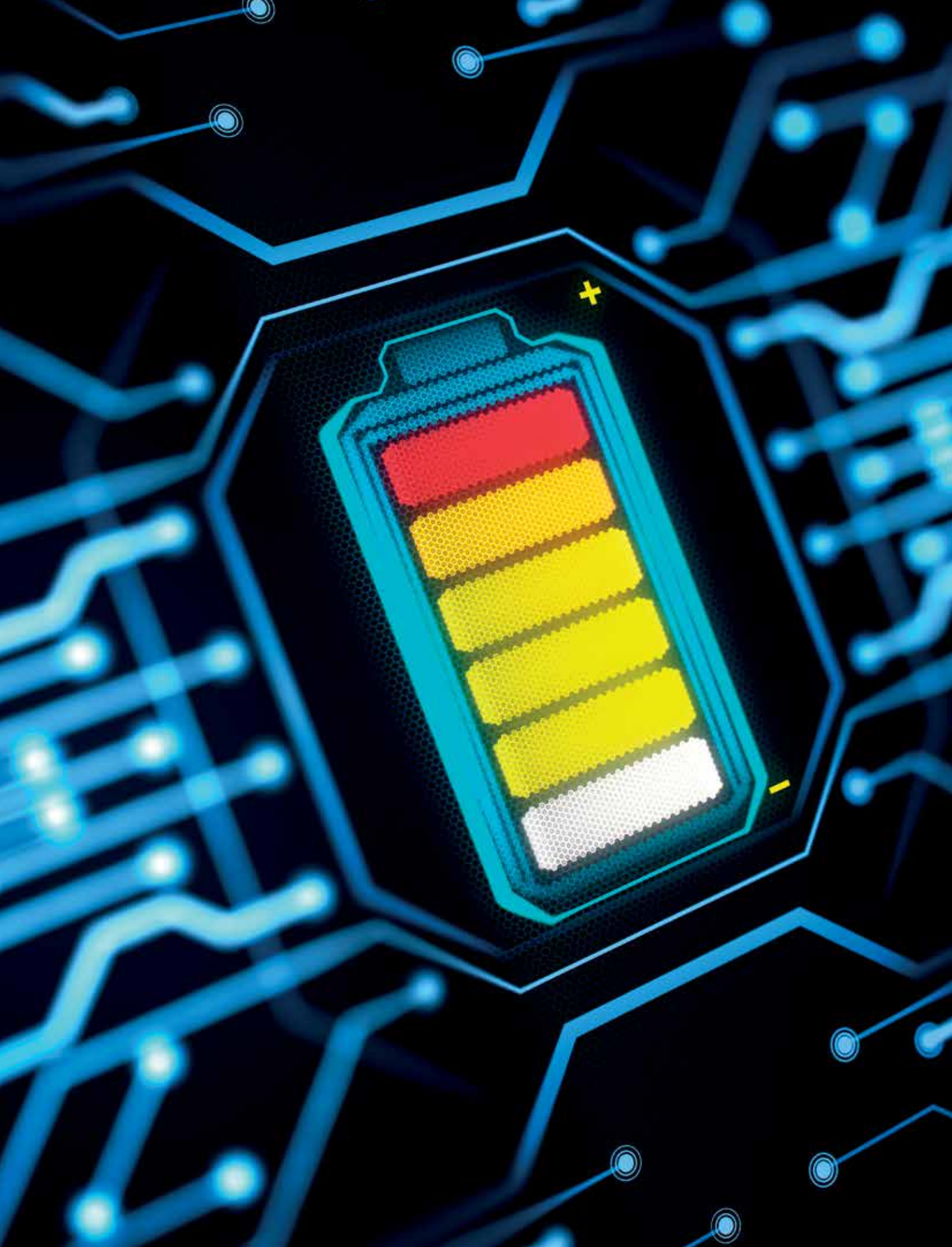
Wide range of applications

To increase the capacity and the voltage, any number of individual CeraCharge components can by connected in series and parallel. This opens up a wide range of possible applications, for example, as the backup battery for real-time clocks (RTC) or energy storage for Bluetooth beacon transmission. In most cases primary cells (coin cells) are used as the battery for RTCs. The major disadvantage of this conventional solution is that users must eventually change the battery. Because a VSB (supply voltage to battery) exists in an RTC, replacing the primary cell the RTC module with a rechargeable battery such as CeraCharge overcomes this problem. The RTC generally needs power from the backup battery for less than one hour at a time, and one CeraCharge can back up the RTC function for 1 to 2 weeks without recharging.

The prerequisite for the IoT is the ability to connect all kinds of appliances and devices with the Internet. Solar powered Bluetooth Low Energy (BLE) beacon technology is emerging as the connectivity solution of choice because of its miniature space requirements and low power consumption. Figure 7 shows a driving model for a solar powered BLE beacon. In this circuit, the solar cell first charges a capacitor (either an MLCC or EDLC), which provides the primary power for the BLE module. CeraCharge serves to store energy in order to charge the capacitor, when the solar cell is not active. It is charged with a surplus energy after the capacitor is fully charged, and discharges to the capacitor when it's empty. This enables the solar powered beacon to operate continuously. The number of parallel CeraCharge units needed in the circuit depends on the maximum the BLE module must be powered without the solar cell.

Solar powered beacon with CeraCharge

Apart from the SMD type currently available in EIA size 1812, TDK will in future also develop CeraCharge types in other sizes such as EIA 0603 and with other capacities, in order to cover an even wider range of applications. Some examples include energy storage for energy harvesting or as a sub-battery in wearables to smooth current and voltage levels during momentary periods of high demand. ❐



Buck-Boost Converter Solutions simplify Design

Managing Batteries properly

Batteries are commonly used these days. They are virtually ubiquitous in a myriad of products and applications, like cell phones, notebook computers or medical devices. When using batteries, it's also important to combine them with the right power management solution.

TEXT: Tony Armstrong, Analog Devices **PHOTOS:** Analog Devices; iStock, MF3d

The global market for portable battery-powered products was valued at an estimated of 480 Billion US-Dollar in 2011 and is expected to reach more than 611 Billion US-Dollar in 2016. Furthermore, this market is expected to continue its growth expansion through to 2020.

It is clear that this market is significant and growing but what about the battery chemistry used inside them? Well, the predominant battery chemistry being utilized in this diverse product offering is Lithium-based, which was according to Frost & Sullivan estimated to be valued at 22.5 Billion US-Dollar in 2016. North America and China have more than half the global revenues for Lithium batteries. What's more, going forward, this demand will be further fueled by key end-users from the consumer device vendors, industrial goods manufacturers, the grid and renewable energy storage segment and automobile manufacturers. Within the industrial segment, healthcare, power tools and military applications represent the leading usage for Lithium-Ion batteries.

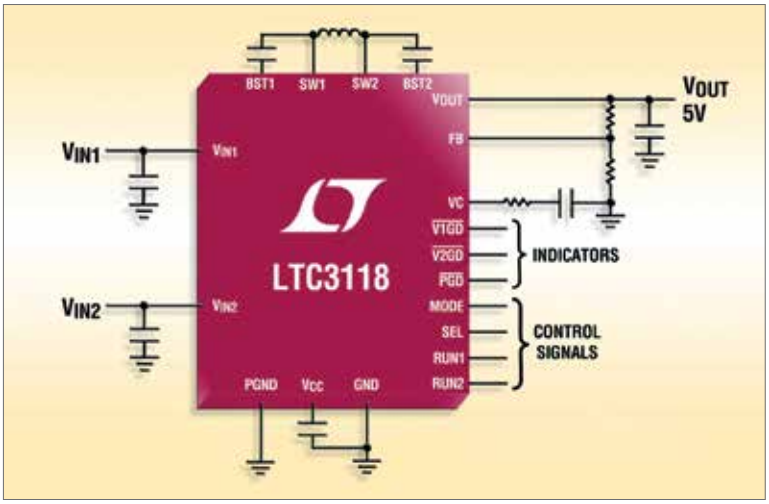
A typical Lithium-Ion battery has a discharge profile from a high of 4.2 V when fully charged, down to as low as 2.7 V when fully discharged. While this is an excellent choice for smart phones and MP3 players, it may not be suitable for portable scientific instruments, power tools and medical healthcare devices. In these instances, multiple cells may be required in order to supply the necessary run-time to be of practical use. This means that 2 to 4 cells will have to be utilized, either in series or in parallel, or a combination of both. As a result, the voltage range of these battery configurations could vary from a high of 16.8 V to 10.8 V (4 Lithium cells in series), to 8.4 V to 5.4 V (2 Lithium cells in series).

High power density has become a primary requirement for DC/DC converters, as they must keep up with ever increasing functional density of electronics. Likewise, power dissipation is a major concern for today's feature rich, tightly packed devices pushing the need for highly efficient solutions to minimize temperature rise. For applications where the input voltage source can be above or below the regulated output voltage, finding an efficient compact solution can be a challenge, especially at elevated power levels. Conventional design approaches, such as using a dual inductor SEPIC converter, produce relatively low efficiencies and a relatively large solution size.

Battery voltage conversion

As already discussed, power-hungry handheld devices, medical products and industrial instruments often need multicell or high capacity batteries to support their ever-increasing processing needs. Many loads require a regulated output that sits within the battery voltage range which necessitates the use of a converter that can both step-up and step-down. Although a SEPIC converter is a viable solution, its large size and modest conversion efficacy are suboptimum for use in portable or luggable products. Thus, a wide voltage range, high efficiency buck-boost DC/DC converter is the ideal solution for longer battery run times and handling multiple input sources.

From the power supply designer's perspective, it would be great if every time they powered up a prototype supply board for the very first time, it not only works, but also runs quiet and cool. Unfortunately, this does not always happen. A common problem of switching power supplies is "unstable" switching waveforms. Sometimes, waveform jitter is so pronounced that



LTC3118 schematic with Power-path section between two inputs

audible noise can be heard from the magnetic components. If the problem is related to the printed circuit board (PCB) layout, identifying the cause can be difficult. As a result, proper PCB layout at the early stage of a switching supply design is very critical and its importance cannot be overstated.

Of course, power supply designers understand the technical details and functional requirements of the supply within the final product. They usually work closely with the PCB layout designer on the critical supply layout from the beginning. A good layout design optimizes supply efficiency, alleviates thermal stress, and most importantly, minimizes the noise and interactions among traces and components. To achieve these, it is important for the designer to understand the current conduction paths and signal flows in the switching power supply.

In a design without external heat sinks for surface mounted power MOSFETs and inductors, it is necessary to have sufficient copper area as a heat sink. For a DC voltage node, such as input/output voltage and power ground, it is desirable to make the copper area as large as possible. Multiple vias are helpful in further reducing thermal stress. For the high dv/dt switch nodes, the proper size of the switch node copper area is a design trade-off between minimizing the dv/dt related noises and providing good heat sinking capability for the MOSFETs.

Finally, the control circuitry should be located away from the noisy switching copper areas. It is preferable to have the control circuitry located close to the Vout+ side for a buck converter and close to the Vin+ side for a boost converter, where the power traces carry continuous current. If space allows, the control IC should be populated a small distance (0.5 to 1 inches) from the power MOSFETs and inductors, which are noisy and hot. However, if the space constraint forces the controller to be located close to power MOSFETs and inductors, special care must be taken to isolate the control circuitry from power components with ground planes.

Optimized power converter solutions

Clearly, a power supply designer's job is not an easy task. Having solutions that mitigate the risk involved with optimizing a cumbersome solution like a SEPIC converter to generate a fixed output voltage when the input can be above, below, or even equal to the input are of great benefit. Optimizing and integrating the power MOSFETs to facilitate a compact, highly efficient solution simplifies the design task. Fortunately, Linear Technology has some new converter solutions that do just that.

The LTC3119 is a synchronous current mode monolithic buck-boost converter that delivers up to 5 A of continuous output current in buck mode from a wide variety of input sources, including single- or multiple-cell batteries, unregulated wall adapters as well as solar panels and supercapacitors. Even higher output currents can be supported for pulsed load applications. The device's 2.5 V to 18 V input voltage range extends down to 250 mV once started. The output voltage is regulated with inputs above, below or equal to the output and is programmable from 0.8 V to 18 V. User-selectable Burst Mode operation lowers quiescent current to only 31 µA, improving light load efficiency while extending battery run time. The proprietary 4-switch PWM buck-boost topology incorporated in the LTC3119 provides low noise, jitter-free switching through all operating modes, making it ideal for RF and precision analog applications that are sensitive to power supply noise. The device also includes

programmable maximum power point control (MPPC) capability, ensuring maximum power delivery from power sources with higher output impedance including photovoltaic cells.

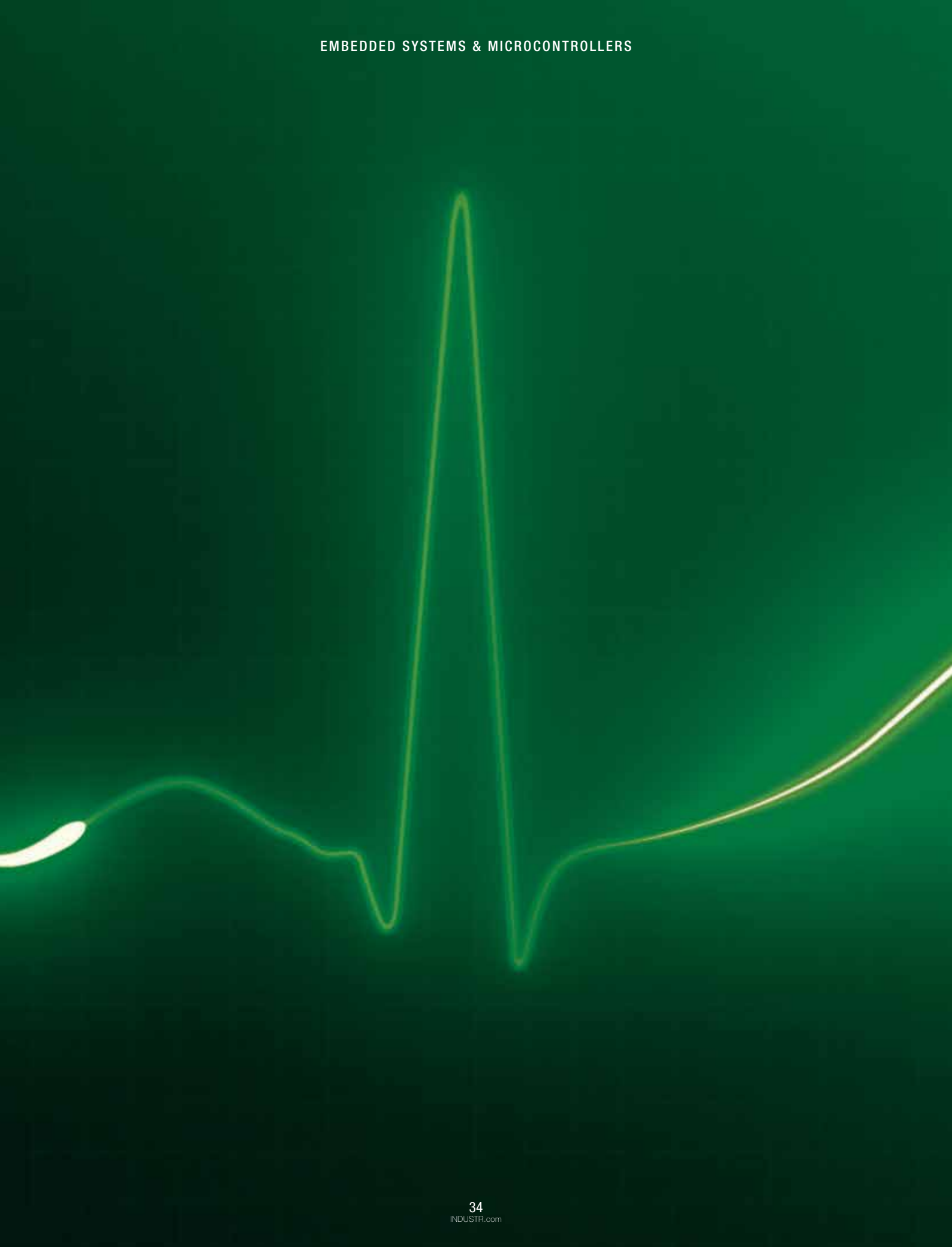
The LTC3119 includes four internal low RDSON N-channel MOSFETs to deliver efficiencies of up to 95 percent. Burst Mode operation can be disabled, offering low noise continuous switching. External frequency programming or synchronization using an internal PLL enables operation over a wide switching frequency range of 400 kHz to 2 MHz, which allows for the tradeoff between conversion efficiency and solution size. Other features include short-circuit protection, thermal overload protection, less than 3 µA shutdown current, and a power good indicator. The device's combination of tiny externals, wide operating voltage range, compact packaging, plus low quiescent current makes the LTC3119 well suited for RF power supplies, high current pulsed load applications, system backup power supplies and even lead-acid battery to 12 V conversion systems.

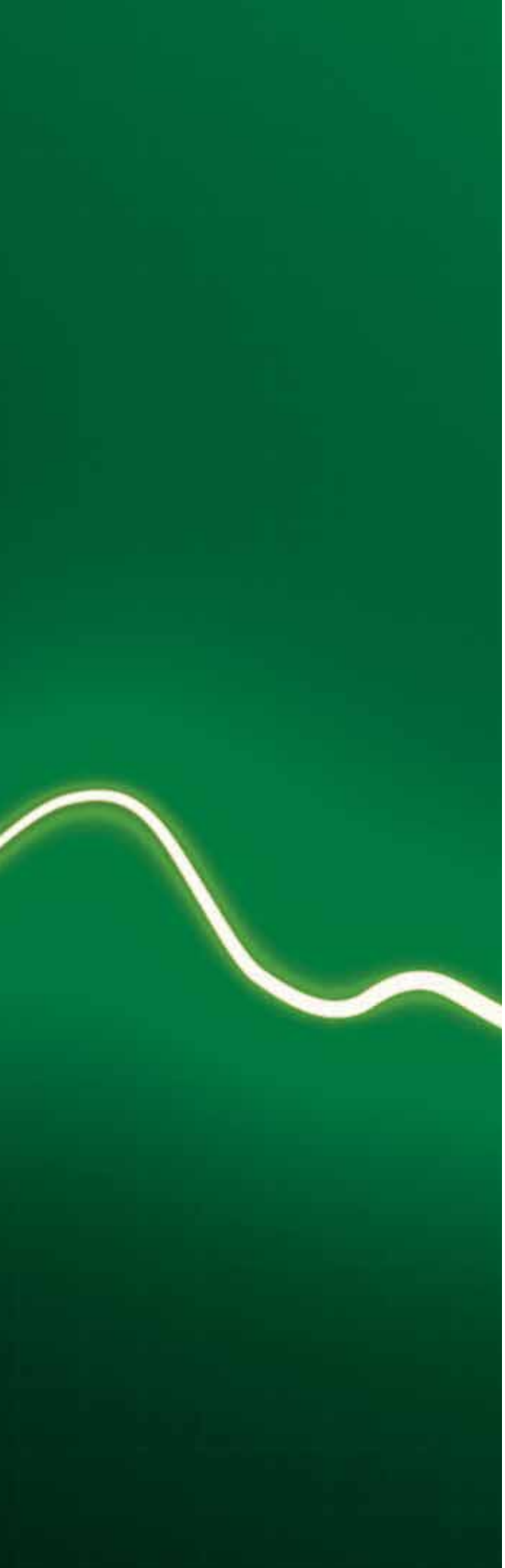
Many portable systems require being powered from multiple input sources including single or multi-call battery configurations, wall adapters and supercapacitor stacks. Another device within the same family as the LTC3119 is the LTC3118, a dual input, monolithic buck-boost with integrated lossless PowerPath which is capable of delivering up to 2 A of continuous output current. The LTC3118 integrates the intelligence to automatically transition to the proper input source to seamlessly maintain a regulated output. Each input can operate from 2.2 V to 18 V, while the output can be programmed between 2 V and 18 V making the part suitable for a wide variety of applications. The LTC3118 employs a low noise, current mode buck-boost topology architecture with a fixed 1.2 MHz switching frequency. Its unique design provides a continuous, jitter-free transition between buck and boost modes, making it ideal for RF and other noise-sensitive applications. The combination of tiny externals and a 4 mm x 5 mm QFN or TSSOP-28E package provides a compact solution footprint.

The LTC3118 includes four internal low RDS(ON) N-channel MOSFETs to deliver efficiencies of up to 94 percent from either input. User-selectable Burst Mode operation lowers input quiescent current to only 50 µA, improving light load efficiency and extending battery run time. For noise-sensitive applications, Burst Mode operation can be disabled resulting in fixed frequency, low-noise operation independent of load current. Other features include soft-start, overvoltage protection, short-circuit protection, thermal shutdown and output disconnect.

A large opportunity has presented itself for designing a wide range of battery powered portable products to meet the growing appetite for communications, medical and computer related products. System designers have faced some challenges in selecting the right power conversion solution that meets the key design objectives, including spanning the input-to-output voltage constraints, power levels and ease of design, without compromising efficiency, run time and solution size.

Designing a solution that meets the system goals without a performance impact can be a daunting task. Fortunately, there are a growing number of buck-boost converter solutions from Linear Technology, which simplify the design, offer best-in-class features and have the ability to maximize run times in-between battery recharging cycles due to their high efficiency operation across a wide range of loads. ❐





Wearable Devices

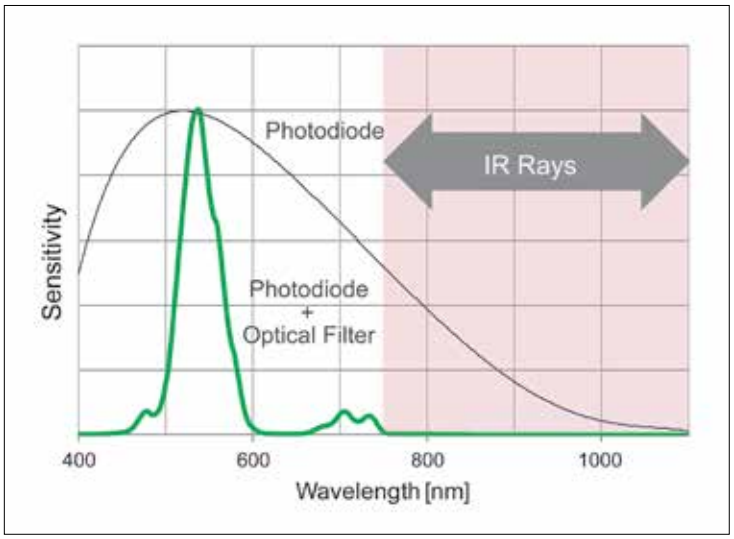
Modern Heart Rate Measurement

Wearable Devices are often used for measuring vital parameter like the the heart rate. But before they can work properly, there are some technical challenges to solve. Their power consumption has to be low and they need specialised sensors.

TEXT: Raimund Wagner, Rohm Semiconductor
PHOTOS: Rohm Semiconductor; iStock, Teekid

In recent years, after taking into account load and mountability on the skin, reflector-type sensors using green light have become mainstream in smart bands and watches equipped with optical heart rate monitors. Green light features a small penetration depth that affects only blood not tissue. This, combined with the large absorption coefficient of hemoglobin, enables easy measurement of heart rate signals with a large pulsation component.

Wearable devices are inherently limited by size and weight to ensure portability, making it difficult to increase battery capacity. This makes low power operation an extremely important consideration. In conventional sensors, both the LED drive block and analog front end (AFE) consume a considerable amount of current. In contrast, Rohm's BH1790GLC increases the sensitivity of the receiver block to reduce LED drive current consumption by enabling detection of heart rate signals even at low LED brightness levels and integrates the AFE block directly into the chip itself, reducing current consumption significantly.



Spectral characteristics of the light receiving block of the BH1790GLC

Here we will discuss specific methods for increasing the sensitivity of the light receiving block. With conventional technology, current generated by the photodiode is converted into voltage using a transimpedance amplifier (TIA) circuit comprised of an amplifier and resistor. However, since the current generated when the light hits the photodiode is very small, it is necessary to increase the resistance in order to improve sensitivity, giving rise to amplifier noise and thermal noise from the resistance.

The BH1790GLC, on the other hand, utilizes a charge integrator amp to achieve high sensitivity. The charge integrator amp converts current into voltage by charging a capacitor from photodiode current for a certain period of time, reducing noise by smoothing it during the charging period. This enables low-noise light detection and increases the sensitivity of the light receiving block. As a result, light can be sufficiently detected even with a smaller light receiving element, making it easy to configure a photodiode and AFE on a single chip. The ability to measure heart rate (pulse waves) even at low brightness reduces current consumption of the drive block. So adopting a charge integrator amp allows the BH1790GLC to decrease current consumption by 85 percent compared to conventional solutions.

IR removal characteristics

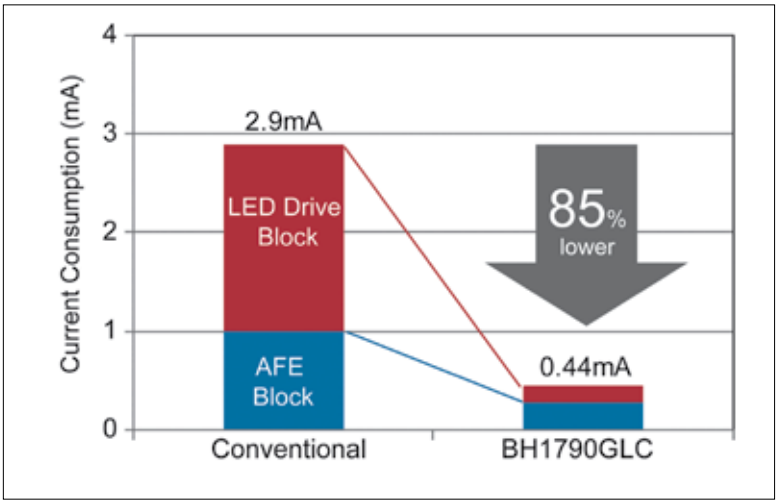
Because wearables are often used outdoors, a light sensor is needed to remove ambient light noise such as IR rays that are easily transmitted through the body. Photodiodes using common Si substrates feature a sensitivity in the vicinity of the IR spectrum (850 nm), making it susceptible to external light noise.

The BH1790GLC, however, integrates a photodiode with a peak wavelength in the green band of 530 nm. This diode is achieved using a photodiode formed on the shallow part of the Si surface, utilizing the property that the peak sensitivity shifts towards the shorter wavelength side as the distance from the Si surface to the PN junction becomes more shallow. Furthermore, the BH-1790GLC incorporates 2 optical filters – a color resist and multilayer filter – on an Si substrate to remove red and IR light components, respectively, allowing only green wavelengths to pass through.

In the case of heart rate measurement in an environment with ambient noise, the ambient light components overlap with the pulse signal, increasing the noise in a general photodiode, whereas in the BH1790GLC the effects of ambient light are minimized, enabling stable detection of pulse signals. This allows for stable acquisition of high quality pulse signals, even outdoors in sunlight, making it ideal for heart rate monitors in wearables.

Heart rate sensor system

This time, we created a heart rate monitor band that measures the pulse rate using the BH1790GLC. The pulse sensor block consists of a heart rate sensor (Rohm's BH1790GLC), LED (Rohm's SMLE13EC8T), accelerometer (Kionix's KX-022), and MCU (LAPIS Semiconductor's ML630Q791). External communication is performed using a Bluetooth LE module (LAPIS Semiconductor's MK71050-03) mounted on a separate board.



Heart rate sensor current consumption breakdown

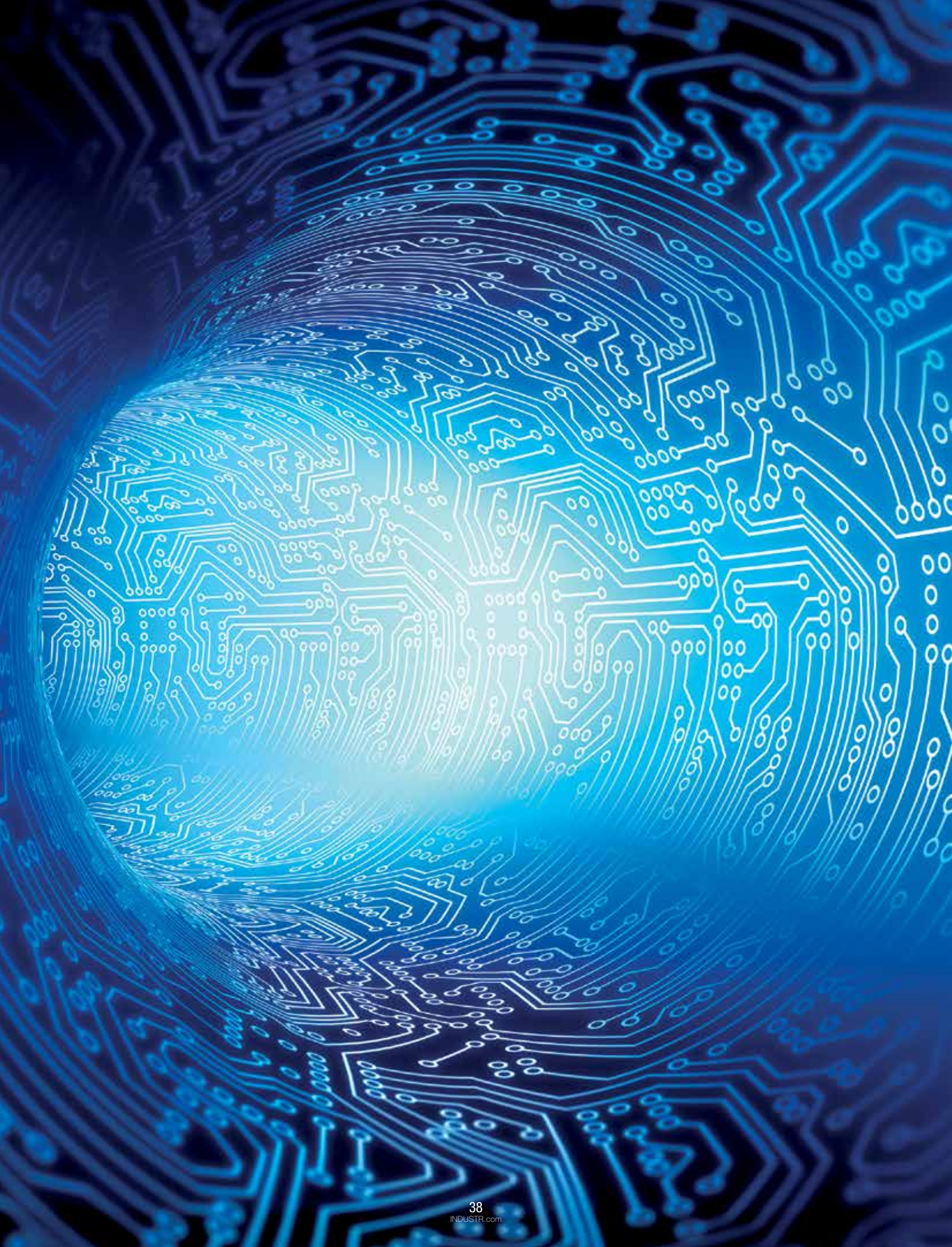
The pulse wave signal can vary greatly depending on the measurement location due to the differences in blood vessel density. The pulse signal is relatively large at a fingertip or earlobe, but tends to be small at the wrist where smart bands and other monitors are worn. Also, since the wrist moves significantly while performing everyday activities, the influence of body movement is quite large. For these reasons it is difficult to continuously calculate the heart rate from pulse waves measured at the wrist.

Calculation algorithm

In response, Rohm developed a heart rate calculation algorithm that can accurately cancel noise due to body motion using an accelerometer. Since body noise is created from changes in blood flow and positional deviation caused by body movement, the noise component can be correlated with the accelerometer signal. Taking advantage of this phenomenon allowed Rohm to create an algorithm that extracts the body movement noise component using the accelerometer and remove noise included in the heart rate signal.

Pulsimeters are typically used for devices using pulse signals, but applications that measure stress by analyzing pulse fluctuations and blood pressure information obtained by performing waveform analysis are currently being developed. Integrating these functions in wearables is expected to make it possible to detect signs of illness at an early stage based on daily changes in the body through regulator monitoring. At present, Rohm is also working on the development of a heart rate sensor that supports measurement of biological (vital) information.

In order to acquire stress measurement and blood pressure information from a pulse wave, it is necessary to increase the temporal resolution of the pulse wave signal. In response, Rohm prototyped a heart rate sensor that increases the sampling frequency to 1024 Hz. High accuracy as well as high resolution detection of pulse signals have been verified for this sensor. Going forward Rohm will work on developing algorithms for calculating the stress and the blood pressure using this heart rate sensor. ❐



Overcoming the Shortcoming of Embedding and De-embedding

CONNECTING VNAS TO TEST OBJECTS

The use of ever higher frequencies in today's communication systems introduces new challenges for the design and verification of devices, PCBs and circuits. In particular, the use of test instruments such as vector network analysers (VNAs) requires the development of new ways of interfacing the instrument with the devices being tested.

TEXT: Christian Sattler, Anritsu **PHOTOS:** Anritsu; iStock, Henrik5000

All VNAs are equipped with coaxial connectors, but the transmission media used in the latest generation of high-frequency communication devices can include transmission-line devices such as stripline, coplanar or microstrip waveguides as well as new types of coaxial connectors. The interfaces needed to integrate such a variety of components into a compatible test environment inevitably lead to significant measurement errors which cannot be ignored.

In some coaxial cases, non-insertable devices can be handled with a special class of adapter removal calibration; but this is usually not the case for PCBs and on-wafer structures. More generally, de-embedding can be used to remove the effects of the fixtures, adapters, launchers and probes required to execute the measurement.

A number of functions are available beyond the basic calibration and display tools to help post-process the available data in a way that is useful:

- Embedding/de-embedding, including the virtual removal or insertion of networks or circuits around a device under test which may represent fixtures, launching structures, tuning elements et cetera.
- Reference plane control, which can be thought of as a simpler subset of de-embedding in which transmission-line lengths and losses are removed from the measured data.
- Impedance transformation, whereby the data is viewed as if the VNA had been calibrated in impedances other than the standard 50 ohms.

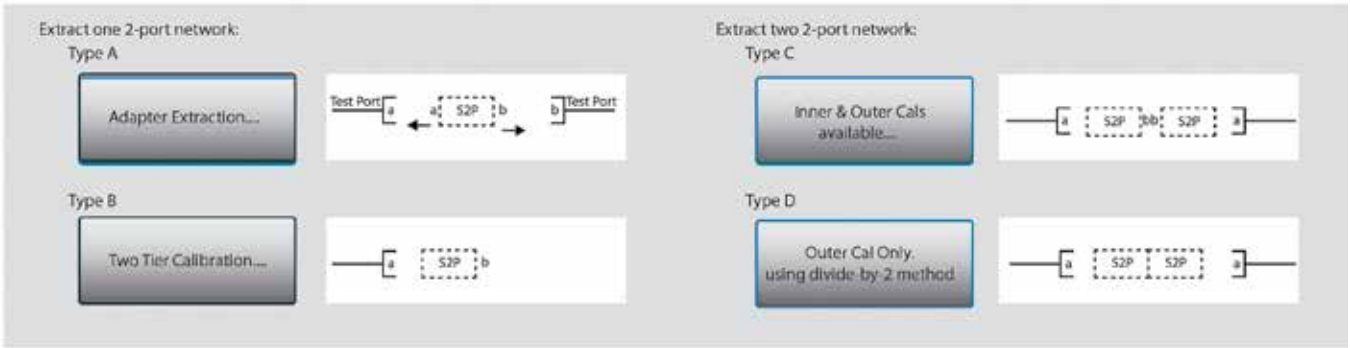
The key concepts for embedding and de-embedding are:

- Networks are set up on a per-port basis
- Networks used on the two ports are entirely independent
- Any number of networks can be cascaded at a given port.

Common embedding tasks are: viewing the results as if a different launch structure were present; viewing the results as if a new matching circuit were being used; and viewing the results as if an added cable length or transmission-line length were used. Common de-embedding tasks are removing the effects of a test fixture; removing the effects of a launch or launching transmission line; and removing the effects of a test matching circuit that will later be physically removed. The latest generation of VNAs incorporate an embedding and de-embedding engine to carry out these tasks.

There are five different types of networks that can be used in these operations: inductive elements, capacitive elements, resistive elements, transmission lines and .S2P-defined, file-based networks.

Dozens of different network extraction and de-embedding methods exist for different measurement environments. One approach is model-based, where it is assumed that a portion of the fixture has a specific circuit configuration (for example, a transmission line, a series impedance, et cetera). However, this approach does not always describe the required network for de-embedding with the necessary accuracy. Because of the complex and incompatible media that may be involved,



Different types of network extraction methods

techniques using multiple calibrations (in different connectors or different media) or techniques using a pair of adapters and fixtures back-to-back are sometimes employed.

For a standard two-port VNA, four types of extraction techniques are available:

Type A - Adapter extraction: Two full 2-port calibrations are performed; one each with the adapter/fixture attached to one port. A single S2P file describing the adapter/fixture is generated.

Type B – Two-tier calibration with full standards: A one-port calibration is performed, followed by additional standards being measured with the adapter/fixture in place. A through connection is not required, and a single .S2p file is generated.

Type C - Inner and outer calibrations: Full 2-port calibrations are performed at the outer plane (often coaxial or waveguide) and at the inner plane (often a fixtured environment). Two S2P files are generated in this case.

Type D - Outer calibrations using the divide-by-two method: Two adapter/fixture "halves" are connected back-to-back and the combination measured using a single outer calibration. With good matching between the halves, S-parameters can be extracted. Two S2P files are generated.

These four methods of network extraction all require one or even more sets of full calibrations, which is sometimes not practical. As a result, a novel approach for network extraction known as Option UFX (Universal Fixture Extraction) has been developed by Anritsu. This approach adds two more useful methods to the list: Type B two-tier calibration with flexible standards, and Type D network extraction with multiple standards.

Phase-localised network extraction

This technique belongs to a class of approaches that have been termed "partial information techniques" since they make additional assumptions about the fixture to avoid the necessity of a full calibration at the inner plane. As such, these techniques are particularly attractive when the inner plane has a complex structure or geometry that makes it difficult to create many standards for that plane or difficult to accurately model those standards.

COMPANIES AND ORGANIZATIONS IN THIS ISSUE

The four standard methods of network extraction all require one or more sets of full calibrations. Sometimes this is not practical. That's where the new approach for network extraction, Option UFX, comes into play.

There are a number of different ways to use Type D. At least one through interconnect between halves is needed. An additional (different length) interconnect can be used or high reflection standards can be used at the inner plane. As more standards are added, additional information is obtained and accuracy generally improves.

A variation of Option UFX type D known as phase-localised network extraction makes use of knowledge of fixture length (through user entry or model fitting) to better localise mismatches and to enable a more accurate extraction if the fixture is electrically long enough. A single standard (either a line or a reflect/reflect pair) is used along with the assumption that

Seven different types of extraction are available in the current version of the Vectorstar MS4640B vector network analyser of Anritsu.

the fixture is electrically long enough (based on the frequency range being used) and the bulk of the fixture mismatch is not too close to the inner plane. If the assumptions are met, this method can outperform the previously discussed Type D variations. Central to this method is the concept of the fixture length as transmission-line like. If the fixture length entry is set to zero, an automatic process (much like auto reference plane delay) will estimate the length.

Sequential extraction – peeling (Option UFX)

Another method of network extraction known as "peeling" involves modelling the network as a collection of lumped elements. This is particularly popular for electrically small structures (such as on-wafer) or those with runs of transmission line punctuated by electrically small structures (PC boards with isolated vias in transmission lines).

Procedurally, this method works on one lumped element at a time. For each element, a .S2p file is generated that can be de-embedded to allow one to get at the next element. Also, transmission line segments can be separately de-embedded to get between lumped defect areas. The process is based on reflection measurements only and a full calibration incorporating that port must be in force. The basic method accepts as input the location (in time from the reference plane) of the defect area of interest and the type of element to model the structure: shunt admittance (Y) or series impedance (Z).

The premise behind a measurement/modelling approach like sequential peeling is that the fixture can be broken down into simple lumped elements, possibly separated by transmission lines, and that these elements can be found through measurement. The lumped elements might physically be vias, abrupt transitions, line bends, close approaches of nearby metallisation or other structures. The important requirements are that they are electrically small (compared to the frequency range being analysed) and that one can assign a shunt or series nature to them. The sequential peeling approach does not require a net list and is not trying to solve for circuit elements explicitly: rather, it is attempting to come up with a simple model that does a reasonable job of describing fixture behaviour while being able to extract those model elements with sufficiently simple measurements.

Seven different types of extraction available

This article has described a series of techniques for handling and studying the problem of non-insertable devices. Adapter removal is a 2-calibration technique for removing the effects of an adapter from a given calibration setup. Network extraction is somewhat more separable in that it tries to extract the S-parameters of the complicating adapter/fixture so that it can be de-embedded later.

Seven different types of extraction are available in the current version of the Anritsu VectorStar MS4640B vector network analyser. A modelling-based extraction technique using sequential localisation or peeling is also available as an alternative for special cases to overcome the shortcoming of traditional embedding and de-embedding functions. All these methods are also applicable for multiport systems. ☐