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By providing lane-accurate position information, u-blox’ ZED-F9K meets the needs of ADAS and autonomous driving applications, as well as head units and advanced navigation systems. The module’s accuracy and low latency also makes it ideal for automotive OEMs and Tier 1 customers developing V2X (vehicle to everything) communication systems. By continuously sharing their location with other traffic participants, these V2X systems contribute to increasing overall road safety and reducing traffic congestion. See page 16 for more.

For more information contact Andrew Hutton, RF Design, +27 21 555 8400, andrew@rfdesign.co.za

Technical articles covering power supply and filter design, power solutions for lighting, and prolonging UPS battery life.

Enclosures and cooling devices for electronics housings.

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Local developments using solar power

It’s always great to see local developers doing good work, and Dataweek always enjoys getting a chance to feature them. Sadly, people seldom share with us the interesting things they’re working on, whether it’s out of humility or out of fear that somebody else will get wind of their great idea and exploit it for themselves, or just a general mistrust of the media. So when we do hear about something cool someone’s doing, I get a kick out of publishing something about it.

Recently we featured a product called PoolSense, a device that floats in a pool and monitors the quality of the water. Enabled by the Sigfox IoT network, the system transmits measured data to the cloud and supplies the user with instructions via an app on what measures they should take to maintain a healthy pool. We were so impressed with the idea that two of our staff members ended up buying one via the PoolSense Indiegogo page.

In this issue we have another two exciting developments to share with our readers. The first is a solution for tackling malaria, developed by two well-known names to the local industry, Quentin van den Bergh and Kevin Godfrey, in collaboration with the University of Pretoria’s Institute for Sustainable Malaria Control.

In addition to protecting rural villages and homes from mosquitos, the system uses the solar energy it gathers to double as a charging station for mobile phones and other electronic devices.

The second is a bakery that runs on solar energy which is converted into electrical power and used for the baking process. Developed at the University of Johannesburg’s (UJ) School of Electrical and Electronic Engineering Sciences, the concept has given a remote village in Limpopo the ability to not only bake its own bread, but also to create a self-dependent community with a sustainable means of remaining economically active.

What the aforementioned two solutions have in common is power; the necessity of having a source of electricity to power industrial endeavours as well as the devices people use every day. An important facet of this is the use of renewable energy sources such as solar, which is often a necessity in remote areas but is increasingly becoming a critical environmental issue for more developed areas and countries.

Africa stands to benefit greatly from the renewable energy revolution. Many solutions have already been, and are being, developed that make use of solar energy – solutions that can be exported to the rest of the world. The continent is also blessed with an abundance of renewable energy sources, particularly sunshine, and investors are starting to sit up and take notice.

According to the African Development Bank (AfDB), Africa had 168 GW total installed capacity in 2016. 33 GW of that was installed renewable capacity – a figure which is expected to triple by 2025. With an African population that is predicted to double by 2040, that still leaves a long way to go and it’s estimated that around $65-90 billion per year will be needed to achieve universal access to electricity across the continent.

In the South African context, making better use of renewable energy sources would also greatly ease the pressure on Eskom’s strained resources, and reduce our dependence on its failing infrastructure. That is, provided government continues to develop the regulatory framework that will allow and encourage it to happen.
South Africa

• South Africa is looking to take on a leading role in the international space weather monitoring community. Space weather events are capable of seriously disrupting modern technologies such as satellites, GPS, power grids, and navigation and communication systems. Based in Hermanus in the Western Cape, the South African National Space Agency (SANSA) facility is the only such centre on the continent, and has been designated by the International Civil Aviation Organisation (ICAO) as one of two regional centres around the world that will monitor space weather for the global aviation sector, providing crucial safety-related services such as solar storm forecasts and warnings.

Overseas Companies

• A wholly owned subsidiary of NXP Semiconductors has signed an agreement to acquire Marvell’s wireless connectivity portfolio in an all-cash, asset transaction valued at $1.76 billion. The acquisition encompasses Marvell’s Wi-Fi connectivity business unit, Bluetooth technology portfolio and related assets. The acquisition, which includes approximately 550 people worldwide, will enable NXP to deliver complete, scalable processing and connectivity solutions to its customers across its focus end markets. The transaction is expected to close by the first quarter of 2020.

• Infineon Technologies has struck a deal to buy Cypress Semiconductor for $23.85 per share in cash, corresponding to an enterprise value of 9 billion Euros. Cypress has a differentiated portfolio of microcontrollers as well as software and connectivity components that Infineon sees as being highly complementary to its power semiconductors, sensors and security solutions, better positioning the company for high-growth markets. Based on pro forma revenues of 10 billion Euros in 2018, the transaction will make Infineon the eighth biggest chip manufacturer in the world, and the number one supplier to the automotive market.

were down across all regional markets: Europe (-8.0%), Asia Pacific/All Other (-10.7%), China (-10.9%), Japan (-10.9%), and the Americas (-29.5%). WSTS also forecast that the industry’s worldwide sales will be $412.1 billion in 2019, which would be a 12.1% decrease from the 2018 total.

• Intel has regained its place as the number one quarterly semiconductor supplier in the fourth quarter of 2018, after losing the lead spot to Samsung in the second quarter of 2017. While Samsung held the full-year number one ranking in 2017 and 2018, IC Insights has forecast that Intel will easily recapture the number one ranking for the full year of 2019, a position it previously held from 1993 through 2016. With the collapse of the DRAM and NAND Flash markets over the past year, a complete switch has occurred, with Samsung having 23% more total semiconductor sales than Intel in 1Q18 but Intel having 23% more semiconductor sales than Samsung just one year later in 1Q19.

• Based on the premise that Dhrystone and Coremark (which have been the de facto standard microcontroller benchmark suites for the last 30 years) no longer reflect the needs of modern embedded systems, the new EmbBench industry group is touting its offering as an alternative to established EEMBC benchmarks. Free-to-use and open-source, EmBench (www.embench.org) is open for all to join, and will aim to deliver a single performance score based on a suite of about 20 real-world applications.

• In what could well be seen as a consequence of the ongoing US-China trade war, the SEMI industry association reported that worldwide semiconductor manufacturing equipment billings for the first quarter of 2019 dropped 8% from the previous quarter and 19% from the same quarter in 2018 to $13.8 billion. The association expects global semiconductor fabrication equipment spending to rebound in 2020, growing 20% to $58.4 billion after dropping 19% to $48.4 billion in 2019.

Industry

• According to the Semiconductor Industry Association (SIA) and based on numbers compiled by the World Semiconductor Trade Statistics (WSTS) organisation, worldwide sales of semiconductors were $32.1 billion in April 2019, a decrease of 14.6% from the April 2018 total of $37.6 billion and 0.4% less than the March 2019 total of $32.3 billion. On a year-to-year basis, sales
Clearing the Static

Topic 4:

ESD testing and monitoring – Part 2

Once you’ve identified an ESD protected area (EPA) and the combination of ESD (electrostatic discharge) control products your facility requires, continuous testing and monitoring need to be conducted. ESD standard IEC 61340-5-1 requires ESD facilities to conduct regular testing and monitoring in order to remain compliant and safe.

Types of ESD tests include the following:

Personnel testing: the personnel grounding tester is a wrist strap/footwear tester that checks grounding systems before personnel enter the EPA. Check twice daily.

Standing operations: check that the resistance of the person to ground is less than $3.5 \times 10^7 \, \Omega$, using a megohmmeter. Check twice a year.

EPA testing: check workstations, floor mats, ESD ground connections, ionisers and ESD instruments. Check monthly, and check instruments annually.

In-field testing: use a static locator to measure instantly whether static charges are present, how much and in which polarity.

Continuous monitoring methods (check annually):
- Capacitive: affected by noise and capacitive variations associated with personnel and the environment.
- Dual-wire/current loop: accurate but expensive system requiring special wrist straps.
- Wave distortion detection: an effective system that is not affected by interference.

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- Component counters
- In-circuit testers

...Device programming and more . . .
The organisation has recently finalised its new strategy, which aims to leverage its strong science, engineering and technology capabilities to respond to industrial development opportunities and create a more balanced portfolio of scientific and industrial development work, as required by its mandate. The strategy is built around the vision of accelerating socioeconomic prosperity in South Africa, through leading innovation. To achieve this, the organisation will leverage emerging technologies, especially those rooted in the fourth industrial revolution, as well as its current capabilities and those of its partners.

The chairperson of the CSIR Board, Professor Thokozani Majozi, and CSIR chief executive officer, Dr Thulani Dlamini, shared the organisation’s plans and focus areas at a media briefing in Pretoria on Friday, 24 May 2019. Majozi said that there is an urgent need for the CSIR to respond to the needs of the private sector, and that collaboration would strengthen industrial development, thus creating much-needed jobs in the country.

“The technologies that we develop must be aligned with the needs of industry and should assist in improving the lives of our people. The ultimate goal plan is to harness our resources and skills to support government and industry, thereby collectively contributing to the alleviation of unemployment, inequality and poverty in South Africa,” said Majozi.

In 2017, the CSIR embarked on a process to amplify the ‘I’ in CSIR. The vision behind this initiative was to broaden the scope of growth opportunities for the organisation by deepening its relationships with industry in a manner that fosters industrial development. In doing so, we will always ensure that we balance our scientific and technological innovation in accordance with our mandate,” added Majozi.

Dlamini said the strategy provides a clear direction on how the CSIR innovates and localises technologies in collaboration with others, while providing knowledge solutions for the inclusive and sustainable advancement of industry, as well as the broader society.

The CSIR strategy is centred on nine clusters to address national priorities, including public good science, potential for socioeconomic impact and the fourth industrial revolution. The clusters are NextGen Health; Advanced Agriculture and Food; Future Production: Chemicals; Future Production: Manufacturing; Future Production: Mining; Defence and Security; Smart Places; NextGen Enterprises and Institutions; and Smart Logistics.

Dlamini added that there is an array of technologies that are ready for commercialisation and need industry partners, citing a smart sensor developed to monitor indoor airborne infection risk, such as the risk of tuberculosis spreading.

The technology is being piloted in public hospitals and peri-urban homes. Together with its online back end, it offers a new platform for indoor environmental quality management and research. “This technology is suitable for high-risk settings – congregate social facilities, such as hospitals, clinic waiting rooms and correctional centres. For us to take these technologies forward, we need partners; we need business and government support,” he said.

The CSIR is developing defence and security capabilities for South Africa’s borders, while fostering cybersecure platforms to conduct business. The ‘Meerkat’ wide area surveillance system was designed to detect and track rhino poachers at poaching hotspots in the Kruger National Park.

The CSIR continues to invest in new infrastructure and pilot scale equipment, enterprise support and skills development.

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There is still no solution which makes it possible to execute and train neural networks on embedded systems, such as microcontrollers. Nevertheless, it can be useful to conduct the training directly in the embedded system, for example, when an implanted sensor is to calibrate itself.

The vision is sensor-related AI that can be directly integrated in a sensor system. A team of researchers at Fraunhofer IMS has made this vision a reality in the form of AIfES (Artificial Intelligence for Embedded Systems), a machine learning library programmed in C that can run on microcontrollers, but also on other platforms such as PCs, Raspberry Pi and Android.

The library currently contains a completely configurable artificial neural network (ANN), which can also generate deep networks for deep learning when necessary. An ANN is an attempt to mathematically simulate the human brain using algorithms in order to make functional contexts learnable for the algorithms. AIfES has been optimised specifically for embedded systems.

“We’ve reduced the source code to a minimum, which means the ANN can be trained directly on the microcontroller or the sensor, i.e. the embedded system. In addition the source code is universally valid and can be compiled for almost any platform. Because the same algorithms are always used, an ANN generated for example on a PC, can easily be ported to a microcontroller. Until now this has been impossible in this form with commercially available software solutions,” says Dr. Pierre Gembaczka, research associate at Fraunhofer IMS.

**AI on a chip**

A wide variety of software solutions currently exist for machine learning, but as a rule they are only available for the PC and are based on the programming language Python.

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**AIfES demonstrator for handwriting recognition. All functions have been integrated on the Arduino UNO, which reads the sensor values of the touchpad, performs number recognition and outputs the result to the display.**
the recognition of handwritten numbers on PS/2 touchpad are identified and output by the microcontroller.

Protection of privacy
Until now, artificial intelligence and neural networks have been used primarily for image processing and speech recognition, sometimes with the data leaving the local systems. For example, voice profiles are processed in the cloud on external servers, since the computing power of the local system is not always adequate.

“IT’s difficult to protect privacy in this process, and enormous amounts of data are transmitted. That’s why we’ve chosen a different approach and are turning away from machine learning processes in the cloud in favour of machine learning directly in the embedded system. Since no sensitive data leave the system, data protection can be guaranteed and the amounts of data to be transferred are significantly reduced,” says Burkhard Heidemann, embedded systems group manager at Fraunhofer IMS.

“Of course it’s not possible to implement giant deep learning models on an embedded system, so we’re increasing our efforts toward making an elegant feature extraction to reduce input signals.” By embedding the AI directly in the microcontroller, the researchers make it possible to equip a device with additional functions without the need for expensive hardware modifications.

Reducing data
AIfES doesn’t focus on processing large amounts of data, instead, transferring only the data needed to build very small neural networks. “We’re not following the trend toward processing big data; we’re sticking with the absolutely necessary data and are creating a kind of micro-intelligence in the embedded system that can resolve the task in question. We develop new feature extractions and new data pre-processing strategies for each problem so that we can realise the smallest possible ANN. This enables subsequent learning on the controller itself,” Gembaczka explains.

The approach has already been put into practice in the form of several demonstrators. For example, the research team implemented the recognition of handwritten numbers on an inexpensive 8-bit microcontroller (Arduino Uno). This was made technically possible by developing an innovative feature extraction method.

Another demonstrator is capable of recognising complex gestures made in the air. Here the IMS scientists have developed a system consisting of a microcontroller and an absolute orientation sensor that recognises numbers written in the air. “One possible application here would be operation of a wearable,” the researchers point out.

“In order for this type of communication to work, various persons write the numbers one through nine several times. The neural network receives this training data, learns from it and in the next step identifies the numbers independently. And almost any figure can be trained, not only numbers.” This eliminates the need to control the device using speech recognition: the wearable can be controlled with gestures and the user’s privacy remains protected.

There is a huge range of potential applications of AIfES. For example, a wristband with integrated gesture recognition could be used to control indoor lighting. And not only can AIfES recognise gestures, it can also monitor how well the gestures have been made. Exercises and movements in physical therapy and fitness can be evaluated without the need for a coach or therapist. Privacy is maintained since no camera or cloud is used. AIfES can be used in a variety of fields such as automotive, medicine, smart home and Industry 4.0.

Decentralised AI
The AIfES library makes it possible to decentralise computing power, for example by allowing small embedded systems to receive data before processing and pass on the results to a superordinate system. This dramatically reduces the amount of data to be transferred. In addition, it’s possible to implement a network of small learning-capable systems which distribute tasks among themselves.

Deep learning
AIfES currently contains a neural network with a feedforward structure that also supports deep neural networks. “We programmed our solution so that we can describe a complete network with one single function,” says Gembaczka. The integration of additional network forms and structures is currently in development. Furthermore the researcher and his colleagues are developing hardware components for neural networks in addition to other learning algorithms and demonstrators.

Fraunhofer IMS is currently working on a RISC-V microprocessor which will have a hardware accelerator specifically for neural networks. A special version of AIfES is being optimised for this hardware in order to optimally exploit the resource.

For more information visit www.fraunhofer.de

www.dataweek.co.za
Better thermal management enabled by advances in semiconductor packaging

By Mark Patrick, Mouser Electronics.

The effective removal of heat from electronic systems has long been a topic that is high on the agenda of engineering professionals – especially those tasked with shrinking designs from a size and weight perspective, while also adding extra functionality. As space for deploying cooling mechanisms reduces and power levels simultaneously increase, the challenge becomes ever greater.

Experienced engineers will say that the best way to deal with heat is to not generate it in the first place. While theoretically speaking that is a valid point, in reality it is difficult to accomplish (despite the best endeavours of semiconductor manufacturers to raise power efficiency benchmarks). The next best approach is to ensure that any excess heat is carried away as quickly and effectively as possible from its source to the ambient air.

This article will step beyond the realm of traditional thermal management solutions (such as fans, blowers and heatsinks) and look at the way that the latest IC packaging technologies are making a significant contribution to satisfying the exacting thermal demands of modern electronic designs.

Semiconductors come in all shapes and sizes, covering a broad range of product types – from complex microcontroller units through to simple, single-function, discrete devices. The discrete devices, such as MOSFETs and IGBTs, used in power applications are a key focus for thermal improvement as they have the potential to generate significant quantities of heat energy if not optimised.

Semiconductor manufacturers have gone to great lengths to improve on-state resistance ($R_{DS(ON)}$), thereby mitigating the static losses of these devices, as well as reducing important output parameters, such as $C_{oss}$, which impact on switching losses. Alongside improvements to semiconductor processes, advances in component packaging are also responsible for enhancing the thermal performance.

Replacing wire bonds

One of the most popular packages for MOSFET devices is the DPAK. This small (6.5 x 9.5 x 2.3 mm) surface-mount device incorporates a metal tab for thermal conduction and mechanical strength. The small size and ability to be auto-placed have made it very appealing, although in the most space-constrained applications, many components used are now of a lower profile.

Another drawback of the DPAK arrangement is that the semiconductor die is connected to the leadframe via wire bonds. These 70 μm bonds limit the current handling capability of the device and create a not insignificant resistance path which leads to sizeable amounts of heat being generated.

To overcome these problems, ON Semiconductor recently announced the ATPAK next-generation package for discrete power devices such as MOSFETs. The ATPAK maintains exactly the same footprint as the DPAK, but reduces the height from 2.3 mm to just 1.5 mm, making it highly suitable for new ultra-thin applications as well as for retrofitting to upgrade existing designs. A unique copper clip structure is used which replaces the thin wire bonds found in DPAK devices, and boosts both the thermal and electrical capabilities as a result.

As the clip has a much larger cross-sectional area, the $R_{DS(ON)}$ figure is substantially lowered, with static losses consequently being a lot less. $I^2R$ losses are also kept in check, thus curbing

Continued on page 12
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heat generation in the device. The strong thermal conduction capabilities of the copper clip are far better than those of conventional wire bonds, so heat generated from the semiconductor junction is rapidly transferred to the package pins, allowing it to be dissipated into the PCB. As an additional benefit the clip’s greater cross-sectional area and reduced resistance also allows heightened current handling.

Testing against a standard DPAK device under identical conditions has seen the ATPAK exhibit case and junction temperatures of 74.8°C and 76.0°C respectively when set with dissipating 1.44 W. By comparison the DPAK’s figures were 80°C and 82.2°C. This translated into ATPAK offering greater long-term device reliability as well as requiring significantly less cooling, despite the 35% reduction in volume when compared to DPAK.

Top-side cooling allows SMD device use in challenging power applications

In high-power application settings it is still relatively common to use through-hole switching MOSFET devices in popular packages, such as TO-220 or TO-247, as they often simplify the task of cooling the design. Since these packages can be fixed directly to heatsinks, they generally provide a more closely-coupled thermal path than SMD devices that most often dissipate heat through the PCB.

However, there are a couple of issues with this approach. The longer leads of conventional packages have relatively large parasitic inductances associated with them, which prevents efficient high-speed switching topologies from being used. Also, as pin-through devices require a different placement and soldering process, they add both cost and complexity to manufacturing of the end product.

While conventional SMD packages rely on dispersing heat through the PCB, the new DDPAK package from Infineon Technologies is a surface-mountable package format for power devices with top-side cooling via a heatsink, thereby benefitting from the natural rising of heat. The packaging concept is optimised for high-power, high-voltage and high-reliability applications and is suitable for MOSFETs and SiC diodes alike – both of which are essential to modern power designs.

Although DDPAK and the associated semiconductor technologies, such as Infineon’s CoolMOS G7 or CoolSiC G6, are very thermally efficient, for almost all practical applications some form of heatsinking will still be required – attached to the top-side of the device.

The package design provides several options for affixing the heatsink, including the use of clips, thermally conductive adhesives or direct soldering. The surface is compatible with the application of gap fillers or gap pads to ensure that the highest levels of thermal conductivity are derived. DDPAK packages offer five connections for the drain current, three source connections and a source sense connection. This multi-pin approach is not possible with standard TO-220 or TO-247 packages and provides cleaner waveforms that reduce losses, and therefore combats heat generation. This format is smaller than a TO-220 package and also has shorter leads, reducing the parasitic lead inductance by 50%, allowing more efficient, higher-frequency topologies to be used.

As semiconductor devices are housed in plastic packages and PCBs are made from a different material (e.g. FR4), they will expand at different rates when they heat up, due to their respective coefficients of thermal expansion (CTE). This can put strain on solder joints and even cause internal package defects to arise, which can result in premature failure.

The leads of the DDPAK are able to absorb the differences in expansion, removing any strain from the solder joints and eliminating potential sources of failure. In thermal cycling tests, DDPAK devices showed no failures after 2000 cycles, indicating the operational robustness levels achievable.

Summary

When engineers think of thermal management, it is generally related to incorporating heat dissipative devices such as heatsinks or fans to an existing design. However, as we have seen, by selecting innovative semiconductor devices at the start of the design cycle, less heat can be generated, allowing for far denser implementations and greatly simplified thermal management. Ultimately this will help increase reliability and decrease size, weight and cost of the final design.

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EXFO launches new category of fibre testing solutions

EXFO has launched what it describes as the first optical fibre multimeter (OFM).

Called Optical Xplorer, it aims to make fibre testing simple for all frontline technicians, whether beginner or expert, and speed up the process while empowering them to do more on site. The device verifies optical links in seconds and if faults are suspected, it finds and identifies them automatically.

Telecom operators are under significant pressure to deploy more high-quality fibre-optic networks faster and at a lower cost to meet skyrocketing demand for bandwidth and prepare for next-generation technologies like 5G. The complexity of testing methods of procedure (MOPs), the necessity to outsource and the shortage in skilled frontline technicians make it difficult for both operators and contractors to attain a good return on investment (ROI) while ensuring networks are deployed right the first time.

Optical Xplorer delivers three key technological innovations:

1. Reduces total cost of ownership (TCO) through lifetime calibration. Hidden costs throughout a product’s life make up a massive, yet sometimes overlooked, part of TCO. Optical Xplorer’s lifetime calibration cuts costly downtime and logistics associated with factory-based updates, maintenance and repairs.
2. Saves time by exploring only faulty links. The Fault Xplorer feature self-launches during the optical link verification process, automatically exploring only those links suspected as faulty, eliminating doubts while saving testing time.
3. Validates link quality in seconds, assigning a 1- to 5-star rating. With the built-in EXFO Advisor feature, technicians get the benefit of EXFO’s 30+ years of fibre expertise and sophisticated algorithms at the push of a button, assigning ratings to links based on industry best practices.

For more information contact Chris Nel, Lambda Test Equipment, +27 12 349 1341, chris@lambdatest.co.za.

Handheld industrial Ethernet tester

Ideal Networks has launched NaviTEK IE, a handheld network tester designed for commissioning, preventative maintenance and troubleshooting of PROFINET industrial Ethernet networks, plus standard Ethernet IP networks.

The rugged copper and fibre troubleshooter has been developed to simplify the process of testing both cabling and networking performance, making it unnecessary to have a laptop with specialist software to identify and test network nodes and configuration, which could prove cumbersome in these typically desk-free environments.

The tester offers all the same features as the NaviTEK NT Pro, but with a range of additional tools specific to the needs of industrial Ethernet, where packet delivery time is critical for operation. For instance, the system health check feature on NaviTEK IE enables frontline technicians to pinpoint potential issues before they become network failures and result in downtime. With an easy-to-understand traffic-light system, the health check provides a quick indication of how each device is performing. Clicking on each device provides further details of the issues discovered so corrective actions can be taken.

Cable faults are another common cause of network downtime. To minimise this, advanced wiremap tools on NaviTEK IE allow users to automatically discover cable, network or device configuration, or faults, at the touch of a button. The tester uses time domain reflectometry (TDR) to provide accurate distance-to-fault data, testing every wire in the data cable (not every pair) to help isolate issues that other testers cannot find. It can be customised to support standard and non-standard cabling configurations.

For copper cabling, using the RJ45 or M12 interfaces included with the NaviTEK IE kit, the tester displays the correct wiring colours for the protocol used, measures the cable length and determines where and what the cable fault is, including split pairs, open circuits, short circuits and miswiring. Those testing fibre data cables can use an optional SFP module to test different wavelengths, measure the optical RX power received and discover cable faults such as dirty connectors, breaks or bends that exceed specification limits.

Additional troubleshooting features include quick and easy discovery of incorrect device names, duplicate IP addresses, network latency issues and packet loss, and the ability to display and validate network node details quickly. The event log feature also helps to find intermittent issues by recording all network errors over a 48-hour period to determine whether the issue lies with the cabling, node, PLC or network configuration.

The NETMAP comparison tool can also perform a scan of the entire network to identify all active devices and save this for comparison to future scans. This enables easy identification of new or removed network devices, incorrectly configured devices or configuration changes, such as those caused by automatic firmware updates.

With the device blink feature, hidden or poorly labelled devices can also be found quickly, even in incorrectly labelled networks, by using the NaviTEK IE to flash a specific device LED. To prove the network has been commissioned successfully, NaviTEK IE also provides professional PDF or CSV reports that can be customised and shared with colleagues and clients using a free mobile app.

For more information contact Coral-i Solutions, +27 11 315 5500, sales@coral-i.com.

Dataweek, 26 June 2019
**eSPI-to-LPC bridge**

Microchip Technology’s new ECE1200 bridge allows developers to implement the eSPI standard in boards with legacy LPC connectors and peripherals.

Product longevity is critical in industrial computing equipment applications because of the significant upfront investment required. The ECE1200 allows developers to maintain long lifecycles while supporting the eSPI bus technology that is required for new computing applications using the next generation of chipsets and CPUs. To reduce risk for developers, the eSPI bus technology has been through intensive validation for industrial computing applications and has been validated with leading processor companies.

For more information contact Shane Padayachee, Avnet South Africa, +27 11 319 8600, shane.padayachee@avnet.eu.

**Library of parts added to Proteus software**

The version 8.9 update to the Proteus EDA software suite sees the integration of a growing online library – currently listing over 1,5 million parts – into its part selection dialog. This follows the partnering of Proteus with a number of online parts library sources, including Ultra Librarian, PCB Library Expert, SnapEDA, SamacSys, DigiKey and RS Components.

While the original partnering enabled users to manually download library parts from online sources and then import them into Proteus, this latest release makes the process entirely integrated. When searching for a part within Proteus, the results from the local library are displayed first; a button is then displayed offering the option to search the online library as well, and if selected, online search results are added to the list.

The initial automatic integration supports the SamacSys online library (componentssearchengine.com), with further integrations planned for future releases.

For more information contact Dizzy Enterprises, +27 72 435 0005, mail@dizzy.co.za.

**Bluetooth LE pass-through module**

The HM-BT4501 from HopeRF is a wireless data pass-through module based on a CMT4501 low-power Bluetooth 5.0 chip. By connecting with a microcontroller, it can be used to realise a connection and data communication between the module and Bluetooth devices such as smartphones and tablets.

The module aims to simplify development without any experience in Bluetooth stack applications, and supports AT instructions for various software, connection and power management functions. It operates from a working voltage in the range of 1,8 V to 3,6 V, across a temperature range of -40°C to 125°C. It supports transmitter power levels between -20 dBm and +8 dBm, and has a receiver sensitivity of 97 dBm.

For more information contact iCorp Technologies, +27 11 781 2029, enquiries@icorptechnologies.co.za.

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With world class factories on your doorstep, why would you look elsewhere?
Positioning module for autonomous driving

The ZED-F9K from u-blox is a high-precision multiband GNSS (global navigation satellite system) module with built-in inertial sensors. The module combines the latest generation of GNSS receiver technology, signal processing algorithms and correction services to deliver down to decimetre-level accuracy within seconds, addressing the evolving needs of ADAS (advanced driver assistance systems) and automated driving markets.

The dead reckoning module builds on the u-blox F9 technology platform featuring compatibility with modern GNSS correction services to further improve positioning accuracy by compensating for ionospheric and other errors. The multi-constellation RTK (real-time kinematics) receiver module receives GNSS signals from all orbiting GNSS constellations. A greater number of visible satellites improves positioning performance in partially obstructed conditions, while increased satellite signal diversity delivers faster convergence times when signals are interrupted.

Inertial sensors integrated into the module constantly monitor changes in the moving vehicle’s trajectory and continue to deliver lane-accurate positioning when satellite signals are partially or completely obstructed, as is the case when the vehicle is in parking garages, tunnels, urban canyons or forested areas. When satellite signals become available again, the module combines inertial sensor data with GNSS signals to deliver fast convergence times and high availability.

By providing lane-accurate position information, the ZED-F9K meets the needs of ADAS and autonomous driving applications, as well as head units and advanced navigation systems. The module’s accuracy and low latency also makes it ideal for automotive OEMs and Tier 1 customers developing V2X (vehicle to everything) communication systems. By continuously sharing their location with other traffic participants, these V2X systems contribute to increasing overall road safety and reducing traffic congestion.

For more information contact Andrew Hutton, RF Design, +27 21 555 8400, andrew@rfdesign.co.za

Impedance and potentiostat front end

A new electrochemical and impedance measurement front end has been developed by Analog Devices to enable the next generation of vital sign monitoring devices and intelligent electrochemical sensors.

The AD5940 incorporates both potentiostat and electrochemical impedance spectroscopy (EIS) functionality on a single chip, allowing for sensor measurement in both time and frequency domains.

The device features integrated hardware accelerators for advanced sensor diagnostics, ultra low noise for accurate sensor measurements, and is designed for wearable ‘always-on’ applications. Supporting the measurement of 2-lead, 3-lead and 4-lead electrochemical sensors, it is suitable for applications where high-precision biological and chemical sensing is mission-critical, such as industrial gas sensing, liquid analysis, material sensing, vital signs monitoring, impedance spectroscopy and disease management.

The on-chip potentiostat allows for a host of standard electrochemical-based measurement techniques, such as amperometric, voltametric or impedance measurements.

The AD5940 is designed to be used in healthcare-related bio-impedance systems for both skin impedance and body impedance measurements, and also to work with the AD8233 AFE in a complete bioelectric/biopotential measurement system.

The analog front end chip can measure voltage, current and impedance. The device consists of two potentiostat loops: a low bandwidth loop with the ability to generate AC signals up to 200 Hz, and a high bandwidth loop with the ability to generate AC signals up to 200 kHz. The ultra-low power potentiostat consumes 6.5 µA in biased mode.

The AD5940 measurement channel features a 16-bit, 800 kSps, multichannel successive approximation register (SAR) analog-to-digital converter (ADC) with input buffers, a built in anti-alias filter (AAF), and a programmable gain amplifier (PGA).

The ADC features an input voltage range of ±1.35 V, an input mux before the ADC allows the user to select an input channel for measurement. These input channels include multiple external current and voltage inputs, and internal voltage channels. The internal channels enable on-chip diagnostic measurements of the internal supply voltages, die temperature and reference voltages.

The AD5940 measurement blocks can be controlled via direct register writes through the serial peripheral interface (SPI), or alternatively, by using a pre-programmable sequencer, which provides autonomous control of the AFE chip. 6 KB of static random access memory (SRAM) is partitioned for a deep data first in, first out (FIFO) and command memory. Measurement commands are stored in the command memory and measurement results are stored in the data FIFO. A number of FIFO related interrupts are available to indicate the state of the FIFO.

For more information contact Conrad Coetzee, Altron Arrow, +27 11 923 9600, ccoetzee@arrow.altech.co.za.
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Dataweek South Africa’s leading electronics and communications publication
Solar-powered bakery developed at UJ

Despite being ranked as the eighth most developed country in Africa in the United Nations Development Programme’s annual report in 2018, several challenges still plague South Africa.

The need for employment, access to energy, economic activity, community development and access to affordable essential foods is still very prominent in both rural and urban areas.

While working on a project to empower a remote village in the northern part of South Africa through locally available renewable energy sources, Profs Johan Meyer and Sune von Solms of the University of Johannesburg’s (UJ) School of Electrical and Electronic Engineering Sciences conceptualised the Solar Bread Box – a first for commercial sized photovoltaic solar bakeries.

Boasting the same equipment and baking cycle as a standard grid tied commercial bakery, the Solar Bread Box eliminates the dependence, purchase and monthly bills associated with grid tied electricity. Not only that, but the bakery is also an instantaneous employment and skills development opportunity for youths, a tool for economic stimuli and an avenue for an essential product.

Low income households in rural and urban communities where there is no grid connection; communities where the residents cannot afford electricity; or communities where there are underlying social issues regarding the access and distribution of electrical power consider bread an everyday staple. The affordability and access of wholesome, fresh bread is essential in such areas.

Prof Meyer clarifies that the Solar Bread Box should not be confused with other solar solutions such as concentrated solar power or solar thermal technologies that are used for heating and cooling. He explains that this solution uses a photovoltaic system, which converts solar energy into electrical power used for the baking process.

Prof von Solms says that the idea is for the bakery to function on the conversion of solar energy as much as possible – minimising the cost of solar energy storage solutions. This means that baking will be seasonally dependent, and bakers will have to adjust their baking times in accordance with the sun to harness maximum power during baking cycles.

The UJ School of Electrical Engineering, in collaboration with Bakery and Food Technology Incubator of South Africa (BICSA), offers training on how to bake, how to run a bakery as a business and how to maintain a solar PV system, enabling communities to thrive independently.

So far, the Solar Bread Box has sparked economic activity, created jobs for eight individuals, created an enterprise that now serves neighbouring villages, enabled access to wholesome foods and the production of at least 100 loaves of bread a day, and boosted skills development in Gwakwani – a small, remote village in Limpopo that initially had no grid connection.

When used as a tool for community development, the Solar Bread Box becomes a self-sustaining, economy stimulating, job creating and skills development platform – creating communities that have access to healthy, wholesome baked goods, are self-dependent and economically active.

For more information contact Cornay Keefer, University of Johannesburg, cornayk@uj.ac.za
Passive filter design for an ultra-low noise buck regulator

Switched-mode power supplies (SMPS) have the advantage of high efficiency compared to traditional low-dropout (LDO) regulators. Due to its switching nature, an SMPS emits noise at its switching frequency and its harmonics.

This article illustrates the procedure of designing filtering to achieve ultra-low output voltage noise with SMPS regulators.

Single-stage capacitive filtering is commonly used for DC-DC converter applications, and low-ESR ceramic capacitors are utilized to meet output voltage ripple specifications. The single-stage capacitive filter is sufficient for applications that require no less than 1 to 2 mV of output voltage ripple, but for applications such as RF analog-to-digital and digital-to-analog conversion, where it is necessary to meet less than 1 mV ripple, a second-stage LC filter should be used to effectively suppress the switching noise.

**Single-stage filter design**

A synchronous buck converter consists of an input capacitor (C\text{IN}), two switches (S1 and S2) with their body diodes, an energy storage power inductor (L), and output capacitor (C\text{OUT}). The input source provides energy to the power inductor (L) and the load when S1 is turned on and S2 is turned off. During this period, the inductor current rises. The energy stored in the inductor is transferred to the output capacitor and load when S2 is on and S1 is off, causing the inductor current to drop.

The switching behaviour of the buck regulator causes the output voltage to fluctuate. The output capacitor (C\text{OUT}) is placed at the output to smooth the output voltage under steady state. The output capacitor reduces the output voltage ripple by providing a low-impedance path for the high-frequency voltage components to return to ground.

In the subsequent development, it is assumed the buck converter operates under continuous conduction mode (CCM) for output voltage ripple minimization. The inductance of L is designed to meet inductor current ripple requirements. The minimum inductance of L is determined as:

\[
L_{\text{Min}} = \frac{(V_{\text{IN}} - V_{\text{OUT}}) D}{I_{\text{L,p–p}} f_{SW}} \quad [1]
\]

Where \(V_{\text{IN}}\) and \(V_{\text{OUT}}\) represent the input and output voltage, respectively, \(D = \frac{V_{\text{OUT}}}{V_{\text{IN}}}\) represents the duty ratio, \(I_{\text{L,p–p}}\) is the peak-to-peak current ripple of the inductor, and \(f_{SW}\) represents the switching frequency of the converter. Typically, the peak-to-peak inductor current ripple is selected as 20-40% of the output DC current.

The output capacitance is selected to ensure that the output ripple is below the specified peak-to-peak value. For a single-stage capacitive filter, a minimum output voltage ripple of 1 mV to 2 mV can be achieved. Under steady state, the net electric charge delivered to the capacitor is zero within one switching period. The capacitor charge of the shaded area in Figure 1 is calculated as:

\[
C_{\text{Min}} = \frac{T I_{\text{L,p–p}}}{4 f_{SW} \Delta V_{\text{C,p–p}}} \quad [4]
\]

Equating Equation 2 and Equation 3, the minimum capacitance to achieve the required output peak-to-peak voltage ripple \((\Delta V_{\text{OUT,p–p}})\) is determined as:

\[
C_{\text{Min}} = \frac{I_{\text{L,p–p}}}{8 f_{SW} \Delta V_{\text{L,p–p}}} \quad [4]
\]

Ideally, the noise shunt capability can be increased by paralleling more output capacitors. Practically, the output capacitors are laterally placed on a printed circuit board (PCB). Adding more output capacitors on a PCB would introduce additional parasitic inductance and AC resistance to the shunt path and thus reduce the effectiveness of bypassing the switching noise.
shown in Figure 4a where the output voltage capacitors is 1 nH. The parasitic inductance involved with the new placed further away from the power module, at the output. Since the new capacitor has to be one additional 22 µF output capacitor is placed 2 A load.

The simulated output voltage ripple is 

\[ V_{1,p-p} \text{, the additional one 22 µF capacitor is less effective.} \]

The second-stage filter design

Typically, the shunt output capacitor can effectively reduce the output voltage ripple to 1 mV. Beyond this point, a second-stage output filter is required to achieve smaller output voltage ripple (-1 mV voltage ripple can be achieved).

Figure 5 (page 21) illustrates a second-stage LC filter which is cascaded to the first-stage output capacitors. The second-stage filter consists of one filter inductor and its series resistor (DCR), a bypassing capacitor branch, and a damping branch. The LC filter works by creating a high impedance to the output. The filtering inductor \( L_p \) is resistive at the intended high frequency range and dissipates the noise energy in the form of heat. The inductor combines with additional shunt capacitors to form a low-pass LC filter network. The second-stage filter is very effective for reducing the output voltage noise when properly designed. It is crucial to size the component of the second-stage LC filter for the intended frequency band. The first step of the design procedure involves choosing the first-stage output capacitor based on Equation 4.

A 5 mV to 10 mV output voltage ripple is typical for the first-stage design. Usually a 10 – 22 µF capacitor is sufficient. The capacitor \( C_{OUT} \) of the first stage must be smaller than the bypassing capacitor \( C_s \) of the second stage to ensure system stability.

Once the first-stage capacitor is determined and the specified output voltage ripple (at a given frequency) is given, the required attenuation of the second-stage LC filter can be determined as:

\[ A_{0,db} = 20 \log \left( \frac{V_{0,p-p}}{V_{1,p-p}} \right) \]  

Where \( V_{1,p-p} \) represents peak-to-peak voltage ripple at the output capacitor, and \( V_{0,p-p} \) represents the peak-to-peak of the output voltage (after the second-stage filter).

Using phasor analysis, the amplitude of the gain of the LC filter is determined as:

\[ H(f) = \frac{1}{\sqrt{1 - \left( \frac{2\pi f f_0}{L_p C_s} \right)^2 + \left( \frac{\omega_{DC} C_s}{2} \right)^2}} \]  

Note that the impedance of the damping branch, which consists of a large series resistor, is much larger than the bypassing branch at the switching frequency. Thus, the filter shown in Figure 5 is approximated as a second-order RLC filter.

The cut-off frequency of the filter is determined as:

\[ f_0 = \frac{1}{2\pi \sqrt{L_p C_s}} \]

Typically, an inductor with 0.22 µH to 1 µH of inductance can be selected to achieve the required output ripple. The inductor should be selected to have minimal DCR, as the serious resistance increases power dissipation and reduces the output voltage regulation. It should be noted that as the DC current increases, the core material of the inductor becomes saturated, which reduces the inductance of the inductor. Care should be taken to ensure that the inductance is high enough at the rated DC current.

Once the filtering inductor is selected, its DCR can be extracted from the datasheet. The second-stage LC filter, which is a second-order filter, provides 40 dB per decade roll-off after the cut-off frequency. The attenuation at a given frequency can be estimated as:

\[ A(f) = -40 \log \left( \frac{f}{f_0} \right) \text{ dB} \]  

Using the attenuation calculated in Equation 5, the required cut-off frequency is determined as:
Figure 5. Second-stage LC filter with parallel damping branch.

Ceramic capacitors should be used as the bypassing capacitor for their low ESR and ESL. It should be noted that the capacitance of ceramic capacitors experiences significant derating at DC bias voltage. Figure 6 illustrates the DC derating curve of a particular manufacturer’s ceramic capacitor which is rated at 6.3 V. As shown, at the full-rated DC bias voltage, the capacitance drops to 20% of the nominal value. The bypassing capacitor should be selected at the nominal DC bias voltage to factor in the derating.

Damping
The second-stage LC filter may introduce resonance peaking if not properly damped. The resonance between the filtering inductor and bypassing capacitor may amplify the output ripple and create undesired ringing at load transient.

\[
f_0 = \frac{f}{10^{-40}}\quad \text{[9]}
\]

Subsequently, the required bypassing capacitance \( C_1 \) is determined as:

\[
C_1 = \frac{1}{4\pi^2 f_0^2 L_r} \quad \text{[10]}
\]

Figure 7a (page 22) shows the output voltage of an underdamped converter system with the second-stage LC filter. Initially, the system operates under steady state. At \( t = 200 \mu s \), a load transient from 1 A to 2 A is initiated which causes the output voltage to ring.

Figure 7b illustrates the output voltage and current under load transient of an overdamped second-stage filter. To avoid undesired ringing at load transient, the second-stage LC filter resonance must be properly damped. In most

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designs, the second-stage filter will be placed outside of the control loop to avoid control stability issues. Consequently, the damping must be achieved by passive components (additional damping resistors).

The filtering inductor usually includes a parasitic DC resistance in series with the inductor. This DCR provides damping to the network. However, to provide enough damping for a series RLC circuit, the series resistance must satisfy $R_{DC} > 2 \times \sqrt{L_f/C_1}$. In most cases, the DCR alone cannot provide sufficient damping. To this end, an RC damping network is inserted in parallel with the bypassing capacitors to damp the resonant circuit along with the series DCR resistor.

**Design example**
The EVREF0102A is the analog power module developed for the ZCU1275 Zynq UltraScale+ RFSoC characterisation kit. The power module provides ultra-low noise power supply for the high-speed data converters on the ZCU1275 development kit.

The EVREF0102A employs five high-efficiency, step-down, switch-mode power modules with integrated inductors. The MPM3833C is a 6 V, 3 A, ultra-small step-down power module, and the MPM3683-7 is a 16 V, 8 A power module. Both power modules feature integrated protection functions including over-current, over-voltage, under-voltage, and over-temperature.

Compared to the traditional LDO solution, the EVREF0102A can achieve up to 80% efficiency improvement. It also achieves an ultra-low noise level to meet the specifications of the Xilinx high-speed data converter by leveraging the forced continuous conduction mode (CCM) operation and implementing post passive filters. CLC passive filters are utilised for the two most sensitive ADC and DAC rails, and capacitive filters are utilised for the rest of the power rails.

The design procedure is illustrated on the ADC_AVCC rail where the MPM3833C power module is employed to power the rail. The MPM3833C integrates a 1 µH power inductor, whose current ripple at 5 V input and 0.925 V output is determined as 0.63 A by applying Equation 1. Subsequently, the first-stage output capacitor is selected based on Equation 4 as 22 µF to provide 3 mV voltage ripple to the second-stage filter.

The required gain of the second-stage LC filter is determined by Equation 5 as -30 dB to achieve 120 µV output voltage ripple at the switching frequency. Considering the size and current rating availability, a 0.24 µH Murata chip inductor DFE201612E-R24 is selected with sufficient current rating. The ADC and DAC rails require ultra-low noise across the frequency range up to 15 MHz. To provide attenuation with enough margin, the cut-off frequency of the second-stage filter is selected as 25 kHz.

Finally, the filtering capacitors are selected as 150 µF. This design is conservative to provide enough margin. The cut-off frequency is selected to compensate for the high-frequency gain increase due to the parasitic inductive impedance involved in the filter loop increases at high frequency (up to 15 MHz). An SP-Cap with 100 mΩ ESR is selected as the damping capacitor. Since the series resistor of the SP-Cap is high enough for damping, there is no need to add an external resistor.

The FFT results of the output noise measurement of the EVREF0102A are shown in Figure 9. As shown, the peak noise at the switching frequency is reduced to 14 µV.

For more information contact NuVision Electronics, +27 11 608 0144, gdeklerk@nuvisionelec.co.za.
There are many things that impact the life of a power supply, overstressed components being the main one. All components have a life that is affected by temperature; some components are more strongly affected than others. The design life of modern power supplies is therefore limited by those components and the electromechanical parts, such as fans and relays, all of which have different wear-out rates.

In a typical power supply, it is the electrolytic capacitors that dominate the design life. In most cases, there are three different uses for electrolytic capacitors in a power supply – in the start-up circuit, as an input bulk capacitor, and for output smoothing – each having a different impact on power supply performance as it wears out and eventually fails.

Start-up capacitor
Looking at each of these locations, we first focus on the start-up capacitor: on initial power up, this capacitor is charged and the energy stored in it is used to power the control ICs, whilst the power supply output is established. Once the power supply is running, the control circuit is powered by the power supply, so this capacitor then serves no useful function.

As the capacitor wears out, it stores less and less energy until eventually getting to a point where it stores insufficient energy for the power supply to start up – this is a common failure mechanism in server applications where the power supply is running warm all of the time. As the start-up capacitor dries out, it no longer functions properly, but this isn’t apparent since the power supply is already running. If, however, the power supply is turned off for routine maintenance, it may not turn back on.

Bulk capacitor
For the bulk capacitor (which is the output capacitor of the power factor correction circuit in a typical power supply), the consequence of wear-out is reduced power supply hold-up. A typical power supply will have around 20 ms of hold-up time when new, but as the bulk capacitor’s electrolyte gradually evaporates over time the capacitance is reduced and hold-up time falls. This generally manifests itself as intolerance to brownouts, causing ‘soft errors’ in electronic equipment.

Good designs will take account of this and select capacitors with a higher value to take account of long-term ageing. Although this increases the cost of the power supply it is usually justifiable in applications requiring hold-up for saving critical data, or to ride through line disturbances or where a long service life is expected by the end equipment user.

Output capacitors
Looking at the output capacitors, wear-out of these typically results in higher levels of ripple and noise, and reduced stability of the control loop. In imaging or test and measurement applications, where very small signals are often measured, a low-noise environment is essential. As the output capacitors age, the ripple and noise increase and the signal-to-noise ratio increases, affecting the performance of the end equipment over time.

In each of these cases, the power supply may not have suffered a hard failure but it has ceased to function correctly, causing host equipment malfunction.

Design margins
Considering the above points, for the start-up continued on page 24
Prolonging the life of UPS batteries

The battery is one of the most important parts of an uninterrupted power supply (UPS) system, and is directly related to the reliability of the entire UPS system. Even the most advanced UPS system is unable to provide uninterrupted power if the battery fails, so it is not advisable to take any risks by using an inferior battery to save costs. Doing this will ultimately affect the reliability of the UPS system and can cause even greater losses.

The battery has the shortest mean time between failure (MTBF) in the entire UPS system. If the battery pack is correctly used and well maintained, its service life can be extended. However, if the battery pack is not correctly used or maintained, it will shorten the battery life. This article presents some basic principles of a UPS battery and the precautions to take when using it.

Popular battery chemistries

There are several types of batteries that are often used for power storage, but considering the load conditions, operating environment, service life and costs, valve regulated lead acid (VRLA) batteries are the most commonly used batteries for UPS systems. The main feature of lead-acid batteries is that oxygen is generated on the positive plate during charging, and is reduced to water on the negative plate by a chemical reaction.

Compared to traditional lead-acid batteries, a VRLA battery does not need to be refilled with water or have its electrolyte levels adjusted, and is therefore referred to as being ‘maintenance-free’. That does not mean, however, that no maintenance is required for VRLA batteries – in fact, all batteries need to be properly used and maintained.

Ambient temperature

The ambient temperature has a significant impact on the battery. If the ambient temperature is too high, more gas will be generated during the battery charging process and may cause thermal runaway. If the ambient temperature is too low, it will cause poor charging efficiency, resulting in the battery not being fully charged and eventually affecting the battery life.

It is therefore recommended that the battery be installed in an ambient temperature of around 20°C to 25°C. As the battery performance will be affected by the ambient temperature, it should not be used at an ambient temperature of below 5°C or above 35°C, as doing so will reduce the battery capacity and greatly shorten its life.

Temperature effects must be considered when the ambient temperatures are

Continued from page 23

To maximise operational life it is vital that end equipment designers pay careful attention to the power supply manufacturer’s installation instructions, in particular ensuring that critical component temperatures are not exceeded. Good power supply vendors will be able to provide technical support and their own design validation measurements to help ensure that the OEM meets its customer’s expectations for field service life.

For more information contact Tobie Muller, Accutronics, +27 11 782 8728, tmuller@accutronics.co.za
below 5°C or above 35°C, as the charge settings can be adjusted for temperature compensation. The temperature coefficient for cycle service is -5 mV/°C per cell and for standby use (trickle charge or float charge) is -3.3 mV/°C per cell.

Depth of discharge
The depth of discharge is also an important factor affecting battery life. The deeper the discharge, the fewer the number of cycles the battery can provide. Therefore, avoiding deep discharge will be a good way to protect the battery. Most UPS systems have protection built in to shut the UPS down when the battery is discharged to about 10.5 V. However, if the UPS is under light load or no-load discharge mode, it might still cause deep discharge of the battery.

During transportation and shelf storage, the battery will inevitably lose some of its power, which is called self-discharge. Therefore, before installing and using the battery, the battery voltage should be checked to determine the remaining power. If the voltage is too low, supplementary charging is required. For batteries that are not being used or are being stored for an extended period of time, they should be recharged every three months.

A quick way of determining the remaining battery power is by measuring the open circuit voltage of the battery. Using a 12V VRLA battery as an example, if the open circuit voltage is above 12.5 V, the battery may still have more than 80% power. However, if the voltage is lower than 12.5 V, the battery should be recharged. If it is lower than 12 V, the battery’s power delivery may be less than 20% and it needs to be recharged immediately. If the voltage cannot be recovered after it has been charged several times, it means the battery is unusable.

Charging voltage
A UPS is a continual power system that provides emergency power to a load when the main input power fails. The battery is in standby mode under normal conditions but plays the role of a power bank to provide the necessary power when the mains power is off. This ensures continuity of power supply.

To prolong the service life of the battery, UPS chargers are often designed with a constant-voltage current limiting mode. This means that when the battery is fully charged, the equipment will switch into floating mode, and each floating charge voltage is set to about 13.6 V. If the charging voltage is too high, the battery will be overcharged. Conversely, if the charging voltage is too low, the battery will not be fully charged.

An abnormal charging voltage may be caused by an error in the battery configuration or due to a charger failure. Therefore, when installing the batteries, be sure to pay attention to the correctness of the specifications and quantity of the batteries. Do not mix batteries of different specifications, brands and batch numbers, and do not use a poor-quality charger. The heat dissipation issue also needs to be noted.

Advanced battery management systems
Many high-end UPS systems now use ABM (advanced battery management) three-stage intelligent battery management solutions, which divide the charging process into three phases: initial charging, float charging and resting:
1. Constant voltage equalisation charging of the battery to 90% capacity.
2. Float charging mode to fully charge the battery to 100%, and then stop charging.
3. Natural discharge, in which the battery discharges via its own leakage current until the low-voltage limit is reached, and then repeats the above three stages.

This method changes the traditional charging design in such a way that the battery is not always kept in a floating state, thereby prolonging the life of the battery.

General considerations
It is important to monitor the following conditions of the battery pack or individual battery during use: the terminal voltage and floating charge current of the battery pack; the voltage of each battery cell; and the ground resistance and insulation of the battery pack and the DC bus.

Do not increase or decrease the load on any single battery cells in the battery pack. It will result in an unbalanced battery capacity, uneven charging and reduced battery life. The battery should be installed in a clean, cool, ventilated, dry place and away from heaters or other sources of radiant heat. The battery should be placed upright and not tilted, and the terminal connections between each battery should be firm.

Faulty procedures or inadequate charging, over-discharge, over-charge and insufficient charging time will result in the failure of the battery to recover normal capacity, reduced capacity, or shortened battery service life. It is necessary to perform periodic maintenance for assurance of the optimum battery reliability. It is recommended that these inspections should be performed at least every three months.

In general, periodic maintenance will include visual inspection of the battery, ambient temperature checking, capacity test, voltage measurement, float voltage inspection, high-rate load test, resistance and that the connections are properly secured.

These maintenance tasks are designed to determine the gradual decrease of capacity of the system and to detect any abnormal error or individual battery condition that may impact on system reliability. It is also suggested to discharge/recharge the batteries periodically to keep them active, and to do so at least every three months.

For more information contact Forbatt SA, +27 11 469 3598, sales@forbatt.co

www.dataweek.co.za
Designing certified power solutions for LED lighting

By Phillip Lechner, technical specialist, Avnet Abacus.

LED lighting has become the product of choice in all types of environments, from domestic to industrial through to specialist areas such as stage lighting. The combination of efficiency in terms of lumens per Watt, long life and controllability of LEDs make them better than incandescentst in just about every way.

There are many differences, though, in how to provide power to them; specific electronic LED drivers are needed which have their own characteristics and specifications and it’s easy to get it wrong. A cheap light bulb will just fail early but a low-cost LED driver from a dubious source can be at best unreliable and at worst a shock and fire hazard. It may even actively generate electrical noise, risking interference with other equipment.

**Look for the certification mark**
A vital starting point when selecting an LED driver is to find one with the ‘ENEC’ mark (Figure 1). This signifies that the product meets the relevant safety standard, EN 61347-1 in Europe, broadly equivalent to the South African Bureau of Standards’ (SABS) SANS 61347-1 standard in South Africa, and UL 8750 in the US.

The ENEC mark also shows compliance with EN 62384, a standard for LED driver performance. In fact, in Europe it is mandatory for luminaires to show the ENEC mark, and also for LED drivers if they are not inside fixtures. Even if an LED driver module is fitted inside a luminaire, in practice it needs the mark otherwise the builder or importer would need to have the driver certified separately, which would be at prohibitive cost and impractical without the close support of the original manufacturer.

Certification must be done by an accredited test facility and the manufacturer must have a quality system based on ISO 9000 standards. The mark also confirms that the manufacturer’s facilities are inspected annually and the product and its production process are monitored going forward.

It’s sometimes thought that a ‘CE’ mark is sufficient to guarantee safety of products but this is not the case; the CE mark is placed by the manufacturer to signify that they think the part meets relevant European directives, and they might think only the Machinery Directive applies, for example. The ENEC mark gives specific guarantees of safety standards applied to the design and manufacture of the driver.

While the ENEC mark can be applied to any electrical appliance against the relevant standards, an interesting development for LED lighting is the formation of the ENEC+ mark, which is a tie between ENEC certification and LightingEurope, the voice of the European lighting industry. The ENEC+ mark is a flexible scheme that is intended to evolve as technology advances, providing independently verified confirmation of a manufacturer’s claims for safety and performance.

**What the certification tells you**
We all believe that the right mark on a product makes it ‘safe’ but the certification is more than a simple guarantee against electric shock. EN 61347-1, for example, covers marking, insulation, moisture resistance, electric strength, thermal endurance, performance under fault conditions, resistance to heat, fire, tracking, corrosion and much more. Internal construction is specified to ensure correct creepage and clearance distances across safety barriers as well as appropriate protection against accidental contact with live parts.

The result is a product that does not just happen to protect against high voltages and temperatures but is shown to be designed and built to do so reliably over many years in service in all reasonably expected environmental and fault conditions. The standards evolve over time and the latest version of IEC 61347-1:2015 A1:2017, for example, has additional requirements for marking, creepage and clearance, and includes consideration of systems that must have high availability in harsh conditions, both electrical and environmental.

We mentioned that the ENEC marking also includes a guarantee of functional performance according to EN 62384 (SANS 62384 in South Africa); this standard covers LED drivers operating on supplies up to 250 V d.c. or 1000 V a.c. supplying constant current or voltage.

The tests applied are for marking to correspond with actual performance, for power rating, power factor, output voltage and current. Start-up into capacitive load is checked along with temperature endurance and input voltage cycling. Fault conditions are simulated such as LED disconnection, LED reduced resistance and output short circuits. In all cases, the driver should be undamaged after replacement of any ‘protecting device’ such as a fuse.

A particular requirement of some LED ‘control gear’ or drivers is that they should present an inductive load to the supply at audio frequencies between 250 Hz and 2 kHz. A specialised network is used for the test, which generates an audio signal on the supply line at 3.5% of the voltage input. When the driver complies, it is marked with a special ‘Z’ symbol.

It’s reassuring that EN 62384 gives guidance on quoting product life and failure rate in product specifications. This is often confused by manufacturers of dubious origin who sometimes even wrongly define MTBF (inverse of failure rate) as lifetime. The standard specifies that life and failure rate are identified separately in hours and FITs (failures in time) respectively.

**Driver classification**
The standards cover different types of LED drivers, referred to as ‘lamp control gear’ with corresponding constructional requirements. The drivers can be Class I, Class II or Class III, respectively, with a protection earth, earth-free and devices with no voltages higher than SELV (Safety Extra Low Voltage) present.

The system designer should be aware of what the installation requires and use an appropriate part. A Class I rated driver used in an earth-free Class II installation would function, for example, but would be potentially dangerous as driver single-fault protection would be lost, and if the casing is metallic an operator or installer might experience a high ‘touch’ current.

**IP rating**
According to EN 61347-1 ‘lamp control gear’ must be moisture resistant as a minimum, with 90% humidity tests performed for 48 hours after which insulation resistance is checked. Parts available on the market have differing IP or ‘ingress protection’ ratings (Figure 2) and generally range from IP20 for indoor use to IP67 or IP68 for an outdoor installation where complete sealing is required.

**Dimming**
Being able to dim an LED through its driver is a key feature that can give significant energy savings, prolonged life and user comfort benefits. In little-used areas, deep dimming when no traffic is sensed can have surprisingly little effect on perceived illumination, with just 10% of LED power being perceived as 32% of maximum illumination (Figure 3). In fact, a 15-20% reduction has been shown to be imperceptible by a majority of users.

Dimming can be achieved in a ‘linear’ way with the LED current varied smoothly or in a PWM (pulse width modulated) way. In either case, at deep dimming levels, there is a risk of ‘flicker’ with poorly designed drivers. The standards test for acceptable levels of flicker as well as residual AC supply ripple, typically at 100 or 120 Hz which is highly visible and uncomfortable.

**DALI and DMX**
Many LED drivers will have a Digital Addressable Lighting Interface (DALI). This enables remote control and monitoring of the attached LED.
through a two-wire communications link. A central controller is used which can connect to a maximum of 64 devices, which can be addressed individually or in groups.

The DALI standard, defined in IEC 62386 and IEC 60929, allows for some intelligent features such as 254 levels of brightness control translated to a logarithmic curve that matches the steps in LED power with consistent steps in perceived brightness by the human eye.

DMX512 is a standard for a more general unidirectional control and communication system that is extensively used in stage and theatre environments, where lighting and other equipment such as fog machines can be controlled. The electrical interface is the familiar RS-485 arrangement.

Products available

There are some major players in the market for the supply of LED drivers, such as Fulham. Its range includes DC and low inrush current AC inputs with power levels up to 165 W. Constant current and constant voltage types are available in cases rated from IP20 to IP68. Its LUMO and Workhorse series with ENEC marking are particularly popular with power ratings up to 200 W and currents from 200 mA to 4 A, some with a DALI interface. The parts are suitable for standalone or built-in applications and feature strain relief on their slide-in terminal connectors.

Delta, the largest power supply manufacturer worldwide, has introduced its new LNP series, which is targeted at the cost sensitive, non-dimmable downlight LED market. Rated at 15 W up to 50 W and in an IP20 case with strain reliefs, they are Class II, earth-free.

Mean Well has a large range of LED driver modules suitable for all applications, some with DALI interfaces, and casing styles varying from leaded and board-mount to slide-in terminal types. IP ratings include open-frame boards up to rectangular and circular IP67, and electrical ratings are up to 320 W/ 5 A.

For more information contact Avnet South Africa, +27 11 319 8600, sales@avnet.co.za
Sealed enclosures for industrial electronics

Hammond Manufacturing has added 36 new configurations to its 1554 and 1555 sealed enclosure families for Industry 4.0. Available in ABS or polycarbonate with styled, opaque, clear or smoked lids, the six new sizes are 105 x 105 x 60 and 90, 140 x 140 x 60 and 90, and 180 x 180 x 60 and 90, giving a grand total of 150 sizes and lid options available as standard.

In addition to the new sizes, the polycarbonate versions have cUL and UL 508A listing and are tested to IP68 (NEMA Type 4, 4X, 6, 6P, 12 and 13). Sealing is achieved with a tongue and groove construction and a one-piece, UL-listed silicone gasket.

All versions have a RAL7035 grey base. The polycarbonate range is available with a plain or styled opaque lid, a clear lid or a smoked lid; the ABS units have a plain or styled opaque grey lid. The lid is secured with self-captivated M4 stainless steel machine screws, located outside the sealed area and threaded into integral stainless-steel bushings to preserve the sealing integrity after repetitive assembly and disassembly.

The internal features vary with size. M3 threaded brass inserts and/or standoffs for PCB or inner panel mounting and vertical PCB guides are provided in all but the smallest B size. DIN rail mounting tabs are moulded into most sizes.

The polycarbonate versions are UV stabilised for outdoor use. The grey material has a UL94-SVA flammability rating, the clear and smoked lids are rated UL94V-0, and the ABS versions are rated UL94-HB.

For more information contact Electrocomp, +27 11 458 9000, andrew@electrocomp.co.za

ebm-papst expands AxiBlade fan range

Axial fans, which are used in air-conditioning and refrigeration systems such as evaporators, condensers and heat pumps, must fulfil high requirements with regard to air flow, energy efficiency and noise. The motor and fan specialist ebm-papst, has thus expanded its AxiBlade product range to include additional fans in smaller sizes.

With the AxiBlade fans, which were developed in the sizes 630 and 710, the impellers are made of a composite material with profiled blade geometry and winglets for maximum efficiency. The impellers are designed for different motors with which they can be combined. The sturdy guard grills are optimised according to aerodynamic criteria. The robust sheet metal ring with corrosion-resistant paint contributes to the fans’ greater overall stability.

The first variants of the AxiBlade fans, with impeller diameters 630 and 710, are already available, and will soon be joined by additional motor variants in both EC technology and AC technology. The new fans can handle air flows up to 25 000 m³/h, with a maximum pressure range of up to 450 Pa.

Thanks to their plug-and-play design, these fans can be connected easily and their identical installation dimensions enable a like-for-like replacement of previous fans in the customer’s device. The flat design of the AxiBlade fans can prove beneficial when transporting customer devices.

AxiBlade axial fans operate in a wide variety of applications with a static efficiency of up to 53%. Depending on how they are installed, the noise level can also be reduced by up to 4 dB(A), as compared to the previous product range. With regard to efficiency, all AxiBlade fans exceed the current ErP requirements.

For more information contact Nadia Speranza, ebm-papst South Africa, +27 11 794 3434, nadia.speranza@za.ebmpapst.com
Verotec supplies turnkey enclosure for NMR monitoring

TgK Scientific’s InsightXpress new stop-flow delivery pumps enable the screening of reaction conditions by nuclear magnetic resonance (NMR) at an unprecedented speed for industrial and academic scientists studying or optimising reactions, with extremely low sample volumes and a dead time of less than 150 ms. Variable ratios of reagents to explore different reaction conditions and fast flow-rate injection of 0.2 – 2 ml/s offer great versatility in use.

Verotec was selected as the enclosure supplier for several reasons. Low to medium volumes are expected, so using modified standard products did away with up-front expensive tooling, and time to market was minimised. Verotec supplied 3D files of the standard products, and then imported the required modifications back into its CAD system to create manufacturing and assembly drawings, simplifying the design cycle. Verotec’s in-house capabilities, which include mechanical assembly, screen printing, a mix of soldered and crimped cabling and electrical test, enabled a complete solution to be provided.

Vent panels for increased airflow and EMI protection

Vent panels made by Laird Technologies offer effective ventilation within electronic equipment, while upholding signal integrity of the enclosure. Its MaxAir and ElectroVent solutions consist of layered, woven and crimped wire mesh for effective component cooling, combined with filtering media to help capture any contaminants that may disrupt ventilation and airflow to the application.

Each panel features EMI gaskets designed to prevent RF leakage and prevent signal migration to sensitive electronic equipment. They can be used for small enclosures, large housings, high-traffic areas and room-size facilities. A variety of plating and materials includes Monel, tin, copper, aluminium, brass and steel.

MaxAir is ideal for telecommunications hardware equipment such as fans, server racks and shielded rooms. Nickel and copper-plated polycarbonate honeycomb material and a frameless design allow for greater airflow through the entire honeycomb surface and greater EMI protection. It features easy press-to-fit assembly and increases useable airflow area by 10% to 20% compared to framed aluminium vent panels.

InsightXpress is housed in an application-specific Verotec 6U, half-width, 320 mm deep, EMC screened Diplomat enclosure. The unit is fully wired and fitted with three interface control boards, one for each of the three pumps that enable the reagent mixture to be varied. Verotec also manufactures and fits custom machined piece parts into which the high-precision pumps are mounted. An optional fourth pump is housed in another Verotec product, the LBX enclosure, which, when extending the core system capability, is mounted to the standard front to rear heavy-duty extrusion on one side of the Diplomat.

For more information contact Actum Electronics, +27 11 608 3001, sales@actum.co.za

ElectroVent offers the designer versatility to meet EMI, environmental and mechanical requirements. For high-traffic areas, all EMI ventilation panels are available with a protective grille installed. Over 30 compounds available to ensure galvanic compatibility, and the materials are highly corrosion-resistant.

A variety of design specifications and mounting configurations are offered, with module construction available in assorted standard sizes from 19,35 to 111,13 cm². Pre-drilled holes or captive fasteners allow for quick mounting and removal. The panels are designed for an extended service life that exceeds the equipment they protect.

For more information contact Vepac Electronics, +27 11 454 8053, sales@vepac.co.za

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The pins of the STL190 through-hole pin strips were designed by PTR specifically for KNX applications in home, building and system technology. Positioned by means of a carrier pad at a spacing clearance of 5.75 mm, the parts are available in pin lengths of 10.5 mm, 12.0 mm, 14.4 mm, 16.6 mm (plus other lengths on request).

As the carrier pad is made of high-temperature-proof material and is designed as a pick-and-place pad, the STL190 can be used in the reflow soldering process. After soldering, the carrier pad is removed from the pins so that only the optimally aligned pins remain on the circuit board. By using these SMT pins, there is no need for drill holes on the circuit board, so the back of the circuit board can be used for other components.

The pins are designed for an input terminal voltage of 29 V (30 V) so there is no need for approvals, and they can be combined with KNX connectors of various manufacturers.

For more information contact Wiltron Agencies, +27 12 940 9475, wiltron@global.co.za

The Verinas system from PBT Works is a dedicated piece of AOI (automatic optical inspection) equipment for evaluating remaining flux residues on PBT glass test boards.

The system can be used by electronics manufacturers to perform statistical cleaning process control over their printed circuit board (PCB) assembly processes, as well as verification of the cleaning process after changes, and cleaning process capability studies.

The transparent glass base allows for precise measurement of the cleaning progress under components, and the situation after cleaning is scanned through the glass. Precise colour filters are applied to determine the boundary between cleaned and not yet cleaned areas under chips. Areas with remaining flux residues are measured by dedicated software, and a test report is automatically generated using 400 values of flux residues under each chip.

For more information contact Electronic Industry Supplies, +27 11 726 6758, hreispty@iafrica.com

The range of terminal pins available from Vero Technologies provide an easily usable fitting on a through-hole printed circuit board (PCB) for the attachment of oscilloscope probes, multimeter leads and test equipment, saving time and money during the manufacture and test process.

Versions are available to fit both 1,02 and 1,32 mm diameter holes and are manufactured with two tail lengths to suit 1,6 and 2,4 mm thick PCBs. All sizes are available with a range of different bead colours for identification purposes. They self-retain during hand and automated assembly and are suitable for wave, reflow or hand soldering.

By providing a convenient anchor point for one of the leads from a piece of test equipment, the terminal pins act as a convenient ‘third hand’, making it a far easier and quicker process to undertake functional testing, fault finding and setup.

The terminal pins are available ex-stock in packs of 100 from Vepac Electronics.

For more information contact Vepac Electronics, +27 11 454 8053, sales@vepac.co.za

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For more information contact Wiltron Agencies, +27 12 940 9475, wiltron@global.co.za
RGB LEDs for decorative lighting

Würth Elektronik’s new WL-SFTW and WL-SFTD series of RGB LEDs are targeted at accent and decorative lighting, optical displays as well as industrial applications. Thanks to their PLCC contacting design, the two series of individually controllable LEDs are well suited for SMT assembly and reflow soldering.

The WL-SFTW series offers three standard packaging designs: 3528 with four pins, and 3528 and 5050, each with six pins. The WL-SFTD series, in the 3335 package, may be of particular relevance to lighting designers as it is characterised by its IPX6 protection class.

RGB LEDs can be used to create any colour by additive colour mixing, which is appealing for a variety of decorative applications. With the WL-SFTW series LEDs, Würth offers compact components with high light intensity. The 5050 package, in particular, is ideal for applications in areas with bright ambient light.

The IPX6 protection class of the WL-SFTD series makes it suitable for outdoor applications and insensitivity to water. The encapsulation resin of the RGB LED with diffuse lens also contains UV inhibitors to minimise the effects of long-term exposure to direct sunlight. This supports stable light yield throughout the service life of the LED. A wide beam angle and high intensities make these LEDs ideal for outdoor and indoor full-colour displays.

For more information contact Jason Page, Würth Elektronik eSos, +27 71 259 9381, jason.page@we-online.com

Multi-axis joystick

New from APEM is the JC series multi-axis, Hall-effect joystick. Designed specifically for keyboard integration, the JC series measures just 26 mm below the panel, making it ideal where space is limited and precision control is required.

Well suited applications include security and surveillance cameras, medical devices and measurement systems. The JC series utilises Hall-effect technology to provide up to five million lifecycles of control. With over a dozen handle options, it may be configured with up to three axes and two pushbuttons. The JC series features a precision spring centring mechanism that provides an optimal return-to-centre voltage of 80 mV. The product is intended for clean environment, indoor applications with an operating temperature ranging from -25°C to +80°C.

The JC series replaces APEM’s HFX Side Plate series, and has identical mounting cut-out dimensions and is backwards compatible to all HFX Side Plate series’ applications. Legacy HFX Side Plate series part numbers will be supported with no plans of obsolescence.

For more information contact Brabek, +27 21 706 3162, info@brabek.co.za

Compression lugs and splices

Panduit Pan-Lug compression connectors provide permanent terminations for a variety of power and grounding applications.

The connectors are designed for use with many different code and flex conductor types, and are available in a broad range of styles and sizes including copper one-hole, two-hole, and blank tongue lugs and splices; aluminium one-hole and two-hole lugs and splices; and copper in-line reducing splices.

The copper compression lugs and splices meet Network Equipment Building Systems (NEBS) Level 3 requirements as tested by Telcordia Technologies. NEBS Level 3 assures that product performance is suitable for equipment applications that demand minimal service interruptions over the lifespan of the equipment.

For more information contact TRX Electronics, +27 12 997 0509, info@trxe.com
Microchip Technology has added new single-port USB smart hub ICs to its family of USB automotive products. The USB4912 and the USB4712 can be used to add a single port under the radio, in the centre console or together with wireless charging implementations. By using native USB drivers and mechanisms such as Microchip’s patented role-swapping technologies, multi-host reflector and FlexConnect, the ICs easily integrate with infotainment head units, allowing a seamless connection with the smartphone ecosystem of software and applications. Each device includes an embedded 32-bit microcontroller (MCU) for the implementation of USB I/O bridging. Both devices support USB 2.0 Low Speed, Full Speed and Hi-Speed with a single USB 2.0 Hi-Speed upstream port for host connection. As a low-power, configurable USB 2.0 hub controller, the USB4912 allows connectivity to be extended to GPIO, I2C, SPI and UART.

For more information contact Shane Padayachee, Avnet South Africa, +27 11 319 8600, shane.padayachee@avnet.eu

MACOM Technology Solutions announced a new wideband distributed amplifier with the introduction of the MAAM-011275-DIE. Offered as a bare die, this amplifier is well suited for use in test and measurement and communications equipment with broadband frequency coverage from sub-6 GHz to mmW (millimetre-wave). The MAAM-011275-DIE amplifier supports wideband operation from 30 kHz up to 40 GHz with typical gain of 15 dB and flatness of +/- 0.75 dB. The input and output are fully matched at 50 Ω with typical return loss of 13 dB across the band. Operating from a 3 - 8 V supply and drawing 200 mA, the device features a P1dB of 21 dBm, P3dB of 24 dBm and OIP3 of 33 dBm.

For more information contact Andrew Hannay, RFiber Solutions, +27 82 494 5466, sales@rfibersolutions.com
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<tbody>
<tr>
<td>Accutronics</td>
<td>+27 11 782 8728</td>
<td><a href="mailto:sales@accutronics.co.za">sales@accutronics.co.za</a></td>
<td><a href="http://www.accutronics.co.za">www.accutronics.co.za</a></td>
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<tr>
<td>Actum Electronics</td>
<td>+27 11 608 3001</td>
<td><a href="mailto:sales@actum.co.za">sales@actum.co.za</a></td>
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<tr>
<td>Altico Static Control Solutions</td>
<td>+27 11 608 3001</td>
<td><a href="mailto:sales@actum.co.za">sales@actum.co.za</a></td>
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<td>+27 11 923 9600</td>
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<td><a href="http://www.altronarrow.com">www.altronarrow.com</a></td>
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<tr>
<td>AREI</td>
<td>+27 11 462 3256</td>
<td><a href="mailto:arei@icon.co.za">arei@icon.co.za</a></td>
<td><a href="http://www.arei.co.za">www.arei.co.za</a></td>
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<tr>
<td>Avnet South Africa</td>
<td>+27 11 319 8600</td>
<td><a href="mailto:sales@avnet.co.za">sales@avnet.co.za</a></td>
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