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CHINA IS PROPELLING ITS IT INDUSTRY INTO THE NEXT GENERATION

A critical mass of next-generation IT firms has taken shape in northern China, as forward-thinking policies spearheaded by industrial parks such as the Tianjin Economic-Technological Development Area (TEDA) come to fruition.

In the region, six internet industrial clusters have been established, comprising over 150 enterprises with overall main business revenue of 5.1bn yuan and together employing some 5,600 employees.

TEDA's R&D investment in the so-called "New-Gen" IT industry has reached 7.8bn yuan in terms of R&D investment, already producing over 800 patents.

According to Zou Fang, Deputy Director of TEDA's Investment Promotion Bureau, the park has many advantages in fostering IT innovation, including its mature investment climate, green credentials, government efficiency and a stable infrastructure. But perhaps the most important factor is TEDA's focus on clustering – locating complementary companies and services in hubs.

"The clustering effect, or cross-pollination advantage, here at TEDA is outstanding," says Fang. "The electronic industrial chain and information-service chain rely on each other, making a new generation information technology industry ecosystem and the best digitization development area in China."

Each of the six clusters has its own specific focus and success stories. The cloud computing and big-data cluster, for example, is home to the National Supercomputer Center in Tianjin, HP's Cloud Center and Tencent, developer of WeChat and QQ. The e-commerce cluster has attracted titans such as Alibaba's Tmall shopping platform, as well as iHaveli, China's equivalent of Gilt. The Internet Services Provider cluster houses Sohu's rapidly-growing online video operation and China's online classifieds leader 58TongCheng, which recently listed on the NASDAQ.

TEDA's approach is in line with the key best practices for accelerators, as defined by Duncan Innes-Ker, China Economist at the Economist Intelligence Unit. These are effective collaborations between private and public sector, regulation that responds to developments, and an intensely competitive environment in which companies actively seek both clients and talent.

One example of the benefits of the cluster system at TEDA is IT infrastructure solution provider Teamsun, which benefits from and contributes to the

“ TEDA's Science and Technology Development Group purchases products and services from Teamsun, such as cloud services, server capacity and technical training, which are then given to tenants free of charge

collaborative ideology. TEDA's Science and Technology Development Group purchases products and services from Teamsun, such as cloud services, server capacity and technical training, which are then given to tenants free of charge. Although this accounts for only around 7% of Teamsun's overall operation, General Manager of Teamsun Zhou Peiyong says it has become strategically important to their business, as down the line the firms that benefit often approach Teamsun directly and become clients.

"We have found that this cooperation pattern has secured its own viable business model, which is win-win for all: tenants, our company as a service provider, and the whole region," said Zhou.

All the Next-Gen clusters benefit from TEDA's support strategies, which fall into three areas: talent, financing and operations. Such innovations are attracting industry leaders to the region, according to Wei Kai, Senior Director of the Internet Center, China Academy of Telecommunication Research of Ministry of Industry and Information Technology (MIIT). He says that there are also wider socio-economic factors influencing IT firms to choose TEDA.

"The region has a vast manufacturing base, which in itself poses a big market for the IT industry," says Kai. "Also, the services and support provided, such as schooling, housing and family medical care programs, help attract top talent. As a result, many industry players are flocking into this region."

TEDA is also reaching out to neighbouring areas to strengthen inter-regional cooperation, says Fang. One primary focus is the capital, Beijing, which is only around 30 minutes away by high-speed train, but where rents can be triple that of Tianjin.

The region has developed the Tianjin-Beijing Interconnected Entrepreneurship Promotion Center, with Zhongguancun – the area in Beijing known as the Silicon Valley of China.

By Adam Skuse. Tianjin Economic Development Area (TEDA) is the largest industrial zone in China

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DESIGN: Tania King
PUBLISHER: Wayne Darroch

ISSN: 1365-4675

PRINTER: Buxton Press Ltd

SUBSCRIPTIONS:
Subscription rates:
1 year: £59 (UK);
£85 (worldwide)
Tel/Fax +44 (0)1635 879361/868594
Email: electronicsworld@circdata.com



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BREAKTHROUGH IN SUPERCONDUCTING SPINTRONICS BRINGS CLOSER SUPER-EFFICIENT COMPUTING

University of Cambridge researchers have shown that superconductors could be used as an energy-efficient source for spin-based devices, expecting them to create a “revolution” in computing.

Spin-based electronics, also known as spintronics, promises to create a new generation of super-fast computers, capable of processing vast amounts of data in an energy-efficient way.

“At the moment, high-performance computers used in large-scale data handling facilities – such as e-data centres – waste huge amounts of energy. In Europe, about 3% of the energy that we generate

is consumed by them,” said Dr Jason Robinson, materials scientist and Fellow of St John’s College, Cambridge. “If we could combine spintronics with superconductivity, we would be able to take advantage of the benefits that both areas offer to reduce this. We could create circuits that are highly complex and extremely powerful on the one hand, but very low in terms of their energy demands on the other.”

Spintronics exploits the electron’s angular momentum, or spin, manipulating it to perform logic operations in devices. However, spin currents are

dissipative and a large part of the input energy is wasted as heat.

Superconductors on the other hand are materials that when cooled below a certain temperature conduct current without losing energy. Harnessing such materials in spin-based devices would provide an energy-efficient source for the charge required to create spin currents.

In their work, the St John’s College team made both superconductivity and spin possible simultaneously. It was achieved by adding an intervening magnetic layer – the rare earth element holmium, within which the magnetism rotates and forms a non-collinear interface with the magnetic layers (of permalloy); it is these layers that are used to manipulate the spin. Therefore, the study has shown that the natural spin of electrons can be manipulated and, more importantly, detected within the current flowing from a superconductor. The results could pave the way for the use of superconductors in spintronics, making these devices more energy-efficient.

The team are now working on a memory-element prototype, based on superconducting spin currents, and are also looking into new material combinations that might increase the effectiveness of their method.



Data storage at CERN, Geneva
[Credit Gruntzooki, via Flickr]

ELECTRONICS AT THE HEART OF COMBATING GUN CRIMES AND ACCIDENTS

An RFID-enabled weapons smart system by German military company Armatix promises to reduce gun violence and accidents. Its Armatix iP1 solution comprises a PIN-code-enabled, radio-controlled gun and wristwatch, which signals when to fire. The two have to be within 10 inches of each other for the gun to be armed.

If the gun loses radio contact with the watch, for example if knocked out of the user’s hand or in case of loss or theft, it automatically deactivates itself. In addition, the gun can be tracked online if reported lost or stolen.

Irish company TriggerSmart offers a similar system but one controlled by a ring or wristband. An RFID reader module is embedded in the handle of the gun and the owner is issued a passive HF transponder that sits in that ring or wristband. The instant the reader receives the correct ID number from the HF transponder the gun becomes operational. This technology was developed

at Georgia Tech Ireland’s campus at Athlone in Co. Westmeath.

RFID technologies and others, such as biometrics, are the industry’s latest efforts in preventing gun violence, accidental shootings or suicides. Adding extra safety features to weapons, as well as placing electronics markers within public places, such as schools for example, is expected to prevent such crimes.

Biometric systems are designed to recognize the fingerprint or heartbeat of the person holding the weapon, and then match it to the owner. The New Jersey Institute of Technology is using sensors to recognize users’ grips and grasping behaviour. Kodiak Arms, also from the US, has a version called Intelligun that unlocks with fingerprints. Other companies use voice recognition to enable and disable weapons. Yardarm, a California start-up, uses a smartphone app to notify gun owners of their weapon’s

movement, so they can remotely disable it.

Gun safety is a hot subject in many countries at present. In the US alone there are nearly 100,000 deaths per year linked to guns, in a country with a high level of gun ownership. However, the companies involved in making weapons smart claim it will also help the police force control their own weapons, whilst in use or storage.

PIN-code based and RF-enabled gun and wristwatch weapon system from Armatix promise to reduce gun crimes and shooting accidents



NEW TECHNIQUE MAKES LEDS BRIGHTER AND MORE RESILIENT

Researchers from North Carolina State University have developed a new processing technique that makes light emitting diodes (LEDs) brighter and more resilient by coating the semiconductor material gallium nitride (GaN) with a layer of phosphorus-derived acid.

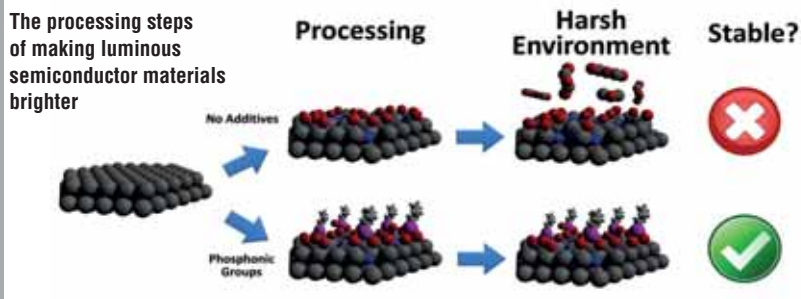
"By coating polar GaN with a self-assembling layer of phosphonic groups, we were able to increase luminescence without increasing energy input," says Stewart Wilkins, a PhD student at NC State and lead author of a paper describing the work. "The phosphonic groups also improve stability, making the GaN less likely to degrade in solution."

"Making the GaN more stable is important," he added, "because that makes it more viable for use in biomedical applications, such as implantable sensors."

The researchers started with polar GaN, composed of alternating layers of gallium and nitrogen. To increase luminescence, they etched the surface of the material with phosphoric acid. At the same time, they added phosphonic groups – organic molecules containing phosphorus – that self-assembled into a monolayer on the surface of the material. This layer further increased luminescence and improved the stability of the GaN by making it less likely to react chemically with its environment.

PROCESSING STEPS

In situ functionalization of polar (c plane) and nonpolar (a plane) gallium nitride (GaN) was performed by adding (3-bromopropyl) phosphonic acid or propyl phosphonic acid to a phosphoric acid etch. The target was to modulate the emission properties and oxide formation of GaN, which was explored through surface characterization with atomic force microscopy, X-ray photoelectron spectroscopy, photoluminescence (PL), inductively coupled plasma–mass spectrometry, and water contact angle. The use of (3-bromopropyl) phosphonic acid and propyl phosphonic acid in phosphoric acid demonstrated lower amounts of gallium oxide formation and greater hydrophobicity for both sample sets, while also improving PL emission of polar GaN samples. In addition to crystal orientation, growth-related factors such as defect density in bulk GaN versus thin GaN films residing on sapphire substrates were investigated as well as their responses to in situ functionalization. Thin nonpolar GaN layers were the most sensitive to etching treatments due in part to higher defect densities (stacking faults and threading dislocations), which accounts for large surface depressions. High-quality GaN (both free-standing bulk polar and bulk nonpolar) demonstrated increased sensitivity to oxide formation. Room-temperature PL stands out as an excellent technique to identify nonradiative recombination as observed in the spectra of heteroepitaxially grown GaN samples. The chemical methods applied to tune optical and physical properties of GaN provide a quantitative framework for future novel chemical and biochemical sensor development.



ARM AND PARTNERS LAUNCH 'LAB-IN-A-BOX' FOR PARTICIPATING UNIVERSITIES WORLDWIDE

The University Program by microprocessor IP supplier ARM has started shipping the flagship 'Lab-in-a-Box' (LiB) kit to higher educational institutions around the globe. The LiB contains ARM-based technology and high quality, rigorous training materials that support electronics and computer engineering courses. It provides a migration package for academics wanting to upgrade their existing curricula to ARM-based technologies and is a key part of the ARM University Program in its mission to make low-power, high-performance ARM-based products accessible to students, as well as spark the next generation of electronics innovation.

The Lab-in-a-Box (LiB) package includes hardware boards from ARM partners, software licenses from ARM and complete teaching materials ready to be immediately used in classes. Current partners supplying hardware boards include Freescale and NXP.

The contents of the LiB box contains 10 ARM-based development boards, 100 ARM Keil MDK-ARM Pro 1-year, renewable software tools licenses, and a complete suite of teaching materials, including lecture note slides, demonstration codes, lab manuals and projects with solutions in source.

"We are pleased to see the very first LiBs start shipping to our partner institutions," said Khaled

Benkrid, manager for the Worldwide University Program at ARM. "This is an important moment for the ARM University Program and for our partners, who are giving us very strong support. Together, we are enabling educators and their students to discover the possibilities of ARM technology. We are committed to equipping tomorrow's engineers with the skills they need to drive the exciting and intelligent products that are transforming how people work and play."

Current program partners include Cypress, Freescale, Nuvoton, NXP, ST and Silicon Labs/Energy Micro.

THE FUNDAMENTAL COMPONENTS OF THE INTERNET OF THINGS

Mark Zack, VP Semiconductors, Digi-Key

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The focus of the internet is set to change over the next five years as systems become smarter. According to networking specialist Cisco, 50 billion devices are likely to be connected to the internet by 2020, helping to sustain a \$14tr market. The systems that dominate the internet today, such as PCs, laptops, tablets and smartphones, will be dwarfed by the tens of billions of machines with network connections that will relay data to each other with the aim of making life more efficient.

The idea of the internet of things (IoT) dates back to the late 1990s when researchers proposed ideas such as ambient intelligence, in which a forest of smart sensors would monitor environmental conditions, alerting control systems to changes. By enacting changes in response, these control systems can improve efficiency in a wide range of systems, from industrial control through home automation to healthcare. For example, a set of smart sensors dotted around the body, can pick up on health problems that alert the user to a problem through their phone.

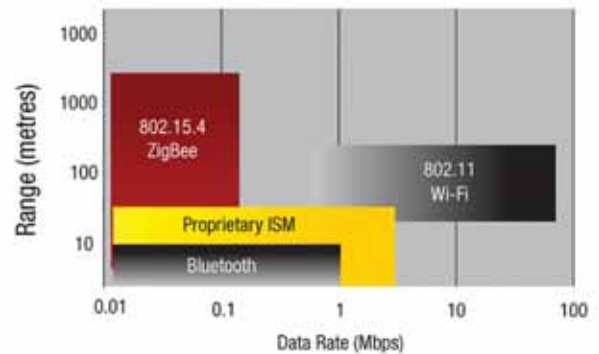
In industrial control, a series of sensors mounted along a production line can detect conditions that may lead to problems such as sudden changes in temperature or excess vibration that may signal a problem in a machine tool or a process going outside its bounds.

There are three fundamental components that combine to form an IoT node: intelligence, sensing, and wireless communications. Wireless connectivity is vital because it will allow sensor nodes to be deployed quickly and easily without the requirement to route network cables to each location.

In order to survive for long periods of time on a single battery charge, an IoT node needs to exhibit low power consumption. Typically, the node will be dormant for long periods of time, waking up for short periods to take a reading and then make a decision on whether to send out an alert based on the change or go back to sleep. A large number of microcontrollers are designed around this core requirement, sporting ultralow-energy sleep modes combined with high-performance instruction pipelines to streamline processing while awake.



The Internet of Things is today's fastest growing technology segment," said Dave Doherty, Executive Vice President of Operations at Digi-Key. "We expect an explosion of product design opportunities as innovative manufacturers look to continue to incorporate connectivity into their designs



A key decision is the type of architecture. A growing number of low-cost microcontrollers from vendors such as Atmel, Freescale, STMicroelectronics and Texas Instruments use 32-bit cores based on architectures such as ARM to deliver high performance at low power and access to a growing range of open-source software that allows applications to be built quickly. However, architectures such as Atmel's AVR demonstrate that the 8-bit platform still provides a great deal of power, using advanced smart peripherals to collect data from sensor interfaces, and delivering high cost-effectiveness.

There are a number of possible approaches for introducing low-power communications to an IoT node, ranging from purpose-designed protocols such as ZigBee to low-power variants of Bluetooth and Wi-Fi. Some of these protocols offer direct compatibility with the internet protocol (IP). Others rely on a gateway to map between IP packets and the leaner protocols used by the IoT sensor nodes.

ZigBee is a low-power wireless network specification based on the IEEE 802.15.4 (2003) standard that was developed by a group of 16 companies involved in industrial and building automation. A novel aspect of ZigBee compared to many other networking protocols lies in its use of mesh networking. This allows IoT nodes far away from a central controller to use nodes in between to carry their communications. This not only extends the range of a central gateway, it also increases robustness as a transmission can use a number of different routes through the mesh.

Originally launched by Nokia as Wibree in 2006, Bluetooth Low-Energy (BLE) or Bluetooth Smart provides a similar range to classic Bluetooth but with reduced power consumption. In place of the 1MHz channels used by the original Bluetooth protocol, BLE uses a smaller set of wider-bandwidth channels of 2MHz but with a lower peak data rate. The channel bandwidth is similar to that of ZigBee but with narrower spacing.

A key advantage of BLE is its lower latency, just 3ms versus the 100ms of classic Bluetooth, as well as lower complexity so that its software stack can easily be incorporated into lower-cost microcontrollers. BLE retains support for frequency hopping from the original Bluetooth protocol, which makes it more robust than ZigBee in the presence of strong interfering signals.

One of the main application areas for BLE is medical instrumentation, where a number of on-body sensors to monitor heart rate, blood pressure, and posture relay their readings at regular intervals to a central controller, which may be a mobile phone or a dedicated medical instrument.

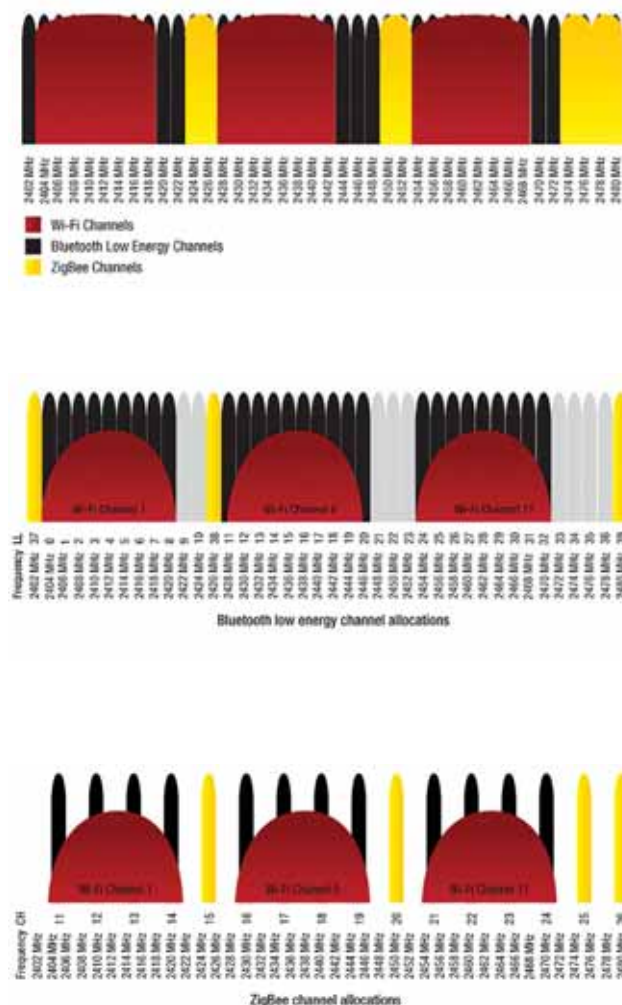
Having been in use in various forms for more than 15 years, Wi-Fi has the benefit of being the most mature wireless-networking radio technology suitable for IoT applications. Through protocols such as WPS, Wi-Fi can offer easy integration into an existing network for devices that have little to no physical user interface.

Of the wireless technologies suitable for IoT applications, Wi-Fi has the best power-per-bit transmission efficiency. Conventional Wi-Fi designs tend to use more energy to maintain a connection while quiescent than protocols such as BLE, which can decrease energy efficiency if the application does not need high bandwidth. However, vendors such as GainSpan have worked on power efficiency in designs such as the GS2000, which combines support for both ZigBee and Wi-Fi on the 2.4GHz and 5GHz band. These designs put the radio into an energy-saving standby mode if the sensor node does not need to transmit any data. It wakes up only to send data or keep-alive connection packets used to assure central controllers that the node has not failed.

In general, Wi-Fi tends to suit applications where compliance with the IP stack is an advantage, there is a requirement to deliver large amounts of data, such as audio or video, or the remote devices can be powered by external energy sources.

An example of Wi-Fi in use is by Mernok Elektronik of South Africa, which used modules from connectBlue to incorporate wireless networking into the locomotive control and safety management systems of railway systems used in mining. The modules are used to collect real-time operation data on each vehicle and provide a robust wireless connection across both 2.4GHz and 5GHz frequency bands with support for over-the-air firmware updates and parameter changes.

BLE and Wi-Fi can be used together efficiently as they both support coexistence protocols designed to reduce interference between the two on their common frequency band of 2.4GHz. This coexistence ability lends itself to implementation in gateway designs where BLE is used for connections to sensor nodes and Wi-Fi for relaying aggregated data to a backbone network. The APx4 from Bluegiga provides an off-the-shelf solution for this, providing support for both Wi-Fi and the full



Bluetooth 4.0 software stack that includes BLE, based around a powerful 450MHz ARM9 processor.

A number of integrated microcontrollers and support chipsets from vendors such as Atmel, CSR, Freescale, STMicroelectronics and Texas Instruments provide support for protocols such as BLE, Wi-Fi and ZigBee. For implementations that need flexibility, the configurable radio transceivers made by Lime Microsystems make it easier to deploy nodes that can be programmed with a specific RF interface personality at the point of manufacture to suit different networking needs in the target system.

As the IoT scales up, we can expect more integrated solutions to arrive on the market. But, even at this early stage of development, there are many choices available to the engineer with which to incorporate the three key components of IoT support.

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r low duty-cycle p/n dithered burst transmission in low-power radio networks!

Numerous short-range data transfer applications now involve a basic architecture that’s considerably more interesting than a basic one-to-one pairing.

In some cases the radio network is as functionally complex as a wired-Ethernet installation, with multiple nodes exchanging large amounts of data on a peer-to-peer basis. In others it can be as simple as a single master controller, periodically broadcasting a handful of command bytes to a constellation of subordinate receivers, with each controlling a physical device.

The system type I intend to examine here is of a common variety, best identified as a “data gathering” network. In this case the system comprises a large number of sensor nodes, which could be sensing anything from complex environmental data to the state of an alarm button, all reporting to a central master station, where the data is gathered and processed.

While there are many possible uses for this network type, such as fire or intruder alarms, agricultural monitoring, perimeter intruder detection and energy efficiency monitoring, they are characterized by a handful of common characteristics:

1. Data flow is one way: from sensor nodes to master.
2. Multiple transmitters share the same channel.
3. Individual transmit duty-cycle is low, to minimise power and meet regulations.
4. Overall data throughput is low; each node sends only a few dozen bytes.
5. Response time is not critical; a ten second delay would not be disastrous.

Experienced users of low-power wireless devices will already be familiar with a number of techniques that address one or more of these requirements, such as traditional sequential polling, or beacon synchronisation, not to mention any number of more sophisticated proprietary mesh-network techniques.

Unfortunately, all these methodologies require the use of a wireless device capable of functioning as a transceiver. While such hardware (in this age of single-chip radio devices) is no

longer prohibitively large or expensive, a transceiver is still more expensive than the equivalent transmitter, and all these synchronous-network methods require a finite power drain – albeit sometimes a small one – at the sensor node, to run the receiver function that maintains network synchronisation from the periodic base transmitted timing-burst.

How Else Can This Sub-Class Of Network Be Organised?

Obviously, if all transmitters are allowed to send continuously, as well as suffering from a prohibitive level of power consumption, they would all block each other and, allowing for capture effect, only the nearest node to the master would have a chance of being heard.

Time-division multiplexing is the obvious solution. Organise the data into a concise burst or packet, with the necessary

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The system type I intend to examine here is of a common variety, best identified as a “data gathering” network

framing, addressing and check-sum sequences, and then transmit it as infrequently as the overall system constraints allow; which could be anywhere from less than once per day, to several times per second. This technique

obviously allows very low duty-cycles and, with some care in design of any periodic wake-up “heartbeat timers”, low-to-negligible average current, all achieved with a very simple transmit-only node. Perfect?

Not quite. All “transmit blind” methods retain the risk of any given transmission colliding (occurring in the same time-slot) with another, resulting in the loss of at least one set of data. This can happen when external events simultaneously trigger two or more nodes at the same time, or when by pure bad luck the periodic transmission “beat” of one node falls into step of another. In these circumstances the only solution is for each node to re-transmit the data enough times that at least one of its messages will reach the master receiver

uncorrupted. For such re-transmissions to avoid simply becoming repeats of an initial collision, it is vitally necessary that no two or more nodes transmit with the same periodicity and pattern.

A pseudo-random number sequence-generator is the key to a very effective method of achieving this: If, instead of sending a single data burst, the node sends a number of identical bursts, each separated from the previous by a (pseudo) random time-period then the likelihood of at least one getting through is greatly increased. The chance of losing an entire data-set to collisions with another transmitting node becomes insignificant if making the number of repeats large enough.

How Many Repeat Transmissions Are Necessary?

This is the critical question. The chance of a collision is related to length of burst, number of nodes transmitting on the system and the frequency of transmission. While direct analysis of the probability is possible, for practical engineering purposes I use a simple software simulation of the network.

The required coding is very simple and can be implemented in any high-level language. The technique I suggest is the following:

- Determine the length of the transmit burst. This is the basic “granularity” or “time slot” of the system timing (there is no point in a time step of 1ms if the bursts are 50ms long; a timing change of less than fifty “ticks” would not avoid collision).
- Write a good software model of the p/n code that your actual system is using (length of shift register, position of taps, initial seeding, transmission rules etc).
- Set up a separate routine for each node on the system, determining if it transmits in a given time-slot (according to the rules set up above).
- In each time slot simulated, record which nodes transmit and so determine how often each node successfully sends a burst without collision.
- Run the simulation over many thousand simulated time-slots, to yield a statistically meaningful result. I have used simple interpreted BASIC as my simulation tool.

Once a valid simulation has been written, it is then possible to vary the number of nodes, the frequency of transmission and the number of repeats, until an acceptable compromise is found. ●

EXAMPLE

A simple transceiver sends an 8-byte burst in 50ms – typical narrowband UHF performance with 10ms tx-on switching, then 8 (payload) + 4 (overhead) bytes at 2400 bit/s. It consumes 20mA in active transmit.

A data-gathering system is built, with 30 of these transceivers communicating with a single master node. Rather than sending short groups of bursts, each node sends a burst at an average – but p/n dithered – rate. This average period of transmission is varied in the simulation to optimise data throughput against number of collisions. In this case, the random element is a tapped shift register p/n (16-bit register with XOR feedback, tapped at bits 15 and 13). The transmit rule is “send if the lowest (n bit) word of the register is equal to zero”; obviously, far more sophisticated rules are possible.

For simulation purposes, assume a 100ms “occupied time-slot” (as the last bit of one transmission must not overlap the first bit of the next).

Results at a simulated time-period of 1000 seconds:

Comparison word length (n)	7 bits	6 bits	5 bits	4 bits	3 bits	2 bits
Average time between bursts	12s	6.2s	3.1s	1.6s	0.8s	0.4s
Average success rate	74%	63%	38%	14%	1%	<1%
Average number of valid bursts	65	97	126	103	24	<1
Usable link?	Yes	yes	yes	yes	barely	no

(“Usable link” is based on sufficient bursts getting through in the time considered)

It can be seen that while (as might be expected) the greater the repetition rate, the greater the chance of a collision occurring, the actual throughput, considered as the overall number of valid bursts reaching the master, peaks in the centre of the test range and falls away to unusability if the nodes are permitted to transmit too often.

In this example, given the burst length, the number of nodes on system and used randomisation rule, I would probably choose the second option (approximately 6s between transmissions) as offering a reasonable throughput for sub-1% duty-cycle:

50ms burst every 6.2s = 0.8% duty cycle

Assuming peak tx current of 20mA, average = 160uA

Simulations of this type are the most certain method for examining the integrity of low duty-cycle systems of this type, as they allow the randomisation methods themselves to be prototyped and examined in (simulated) operation, without needing to run real hardware in real-time over impractically long, experimental sample-periods.

ENERGY-SAVING NETWORK POWER-MANAGEMENT (ES-NP)

TWO NETWORK STANDARDS FOCUSING ON MEETING THE EUROPEAN CO₂ EMISSION GUIDELINES ARE VYING FOR THE DEVELOPER'S ATTENTION: PRETENDED NETWORKING AND PARTIAL NETWORKING. **MICHAEL GRABOWSKI**, FROM THE AUTOMOTIVE BUSINESS GROUP AT RENESAS ELECTRONICS EUROPE ANALYSES EACH ONE AND PRESENTS A SUITABLE SOLUTION



Since 2012 everybody is talking about the European CO₂ tax for cars. Every car manufacturer selling vehicles with CO₂ emissions exceeding the regulation limits in the EU must pay penalties – or CO₂ tax. The intention is to make the industry and consumers aware of the costs of climate change

and environmental damages caused by CO₂ emissions through money.

The CO₂ tax has been a controversial subject: heated debates have ensued over its amount, effectiveness and whether or not it is at all justified. But, the discussion around it has triggered a long overdue debate over the issue of limited resources and climate change. Now work is under way to resolve some of these problems, and car manufacturers are already improving their vehicle models. Each aspect of the car, such as its combustion engine, air drag, road resistance, right up to its electrical loads, has been scrutinised for improvements and the corresponding costs calculated. From this point of view, the CO₂ tax has motivated innovation for economic and efficient use of energy.

Saving CO₂ Through Control Units

This article deals with the role of electronic control units (ECUs) that, assisted by microcontrollers, contribute significantly towards the reduction of energy consumption in cars. In a typical

premium vehicle there are up to 100 control units interconnected in a network to help increase efficiency. Some of these are active even when the car is stationary, such as door control and anti-theft protection. To assess efficiency improvements in this segment, the complete chain of factors impacting it have to be reviewed from the ground up (see Figure 1).

One of the biggest loads in an ECU is the microcontroller, which is powered by a voltage regulator powered by the dynamo, which in turn is driven by the combustion engine; so, the more current a microcontroller draws, the more fuel the car consumes and, consequently, the more CO₂ it outputs. Up to now, a premium model with 100 control units has been discharging up to 5g CO₂/km, purely due to the control electronics' current consumption, and that's without a single other electrical load such as headlights or air conditioning for example.

The CO₂ tax might levy EUR 95 tax per 1g CO₂/km per car if the weight-specific CO₂ emission limit is exceeded. Thus, for an emission of 5g CO₂/km, a car manufacturer would have to pay up to EUR 475 in CO₂ tax.

Such assessments have increased awareness even for the lowest of energy loads. Development teams have been urged to put control units in current-saving modes as often as possible, or even shut them down completely. This idea has been copied from laptops and mobile phones, where displays are switched off and the CPU frequency is reduced when idle. Of course, reduced current-consumption is always goes with reduced functionality and, additionally, the ramp-up time until full functionality is available again is long – just like in laptops. Therefore, engineers have to consider and control precisely when an ECU is not required, so as not to save energy at the expense of functionality.

ECU Networks

In modern cars all control units communicate with each other via a network, so car manufacturers have created standards that define how much current can be saved in an ECU and when. One such software-standard platform is AUTOSAR, and two approaches – Partial Networking and Pretended Networking – are defined within it.

With Partial Networking, groups of ECUs (Partial Network Cluster – PNC) can be shut down and communication re-started

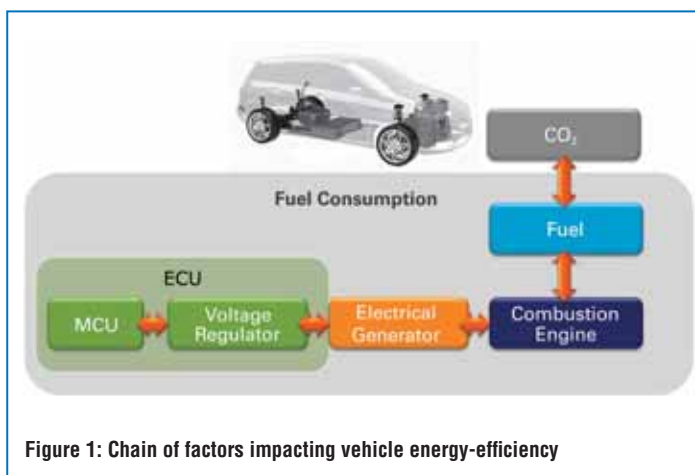


Figure 1: Chain of factors impacting vehicle energy-efficiency

during normal bus communication; but ECUs that need to be shut down require special transceiver hardware. With Pretended Networking, the ECU is in a low-power mode whilst keeping up bus communication, e.g. by using mechanisms of ECU degradation.

Common to both is a specification for a two-current saving level, called Level 1 and Level 2 in the Pretended Networking; and Standby and Sleep in Partial Networking. The higher the current reduction, the longer the wake-up time of an ECU will be until it regains its full functionality (see Figure 2).

With Pretended Networking, under extremely reduced use of resources the currents are below 7mA, with the aim of reducing them to below 2mA in the future. The lower limit of the current is determined by the transceiver, which typically takes the largest portion of the total standby current.

With this standard, volume producers have ensured that the new Pretended Networking ECUs are interoperable with the older units, significantly reducing development risk and guaranteeing

future product continuity. The wake-up time is considerably shorter than in Partial Networking, because the microcontroller is never fully powered off and modern microcontroller current-saving modes allow optimisation.

Partial Networking is the more radical of the two, but is also more expensive. Here, a new type of intelligent network transceiver controls the whole ECU, allowing standby currents

Solution	Additional Hardware Cost	Efforts	Power Saving / Wake-Up Time		Comment
Partial Networking SLEEP	ISO 11898-6 Transceiver	NM redesign New Transceiver Hardware	high	99% Slow	Significant architectural system changes
ES-NP Partial Networking STANDBY	-	NM redesign	↑ ↓	90% Average	-
ES-NP Pretended Networking Level 2	-	No big efforts		90% Average	Best Practice
Pretended Networking Level 1	-	No big efforts		30% Fast	Low efficiency

Figure 2: Potential power savings for different network standards

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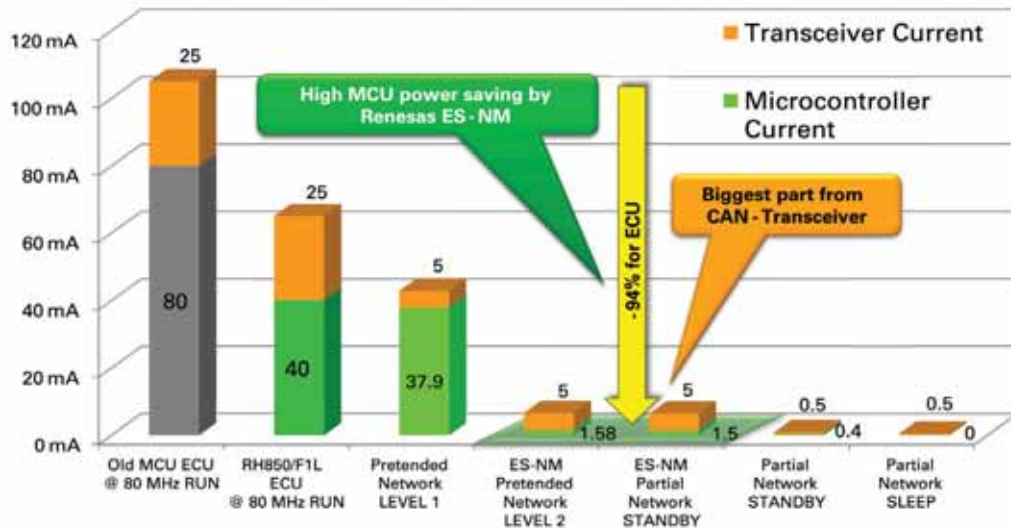


Figure 3: Device current improvements

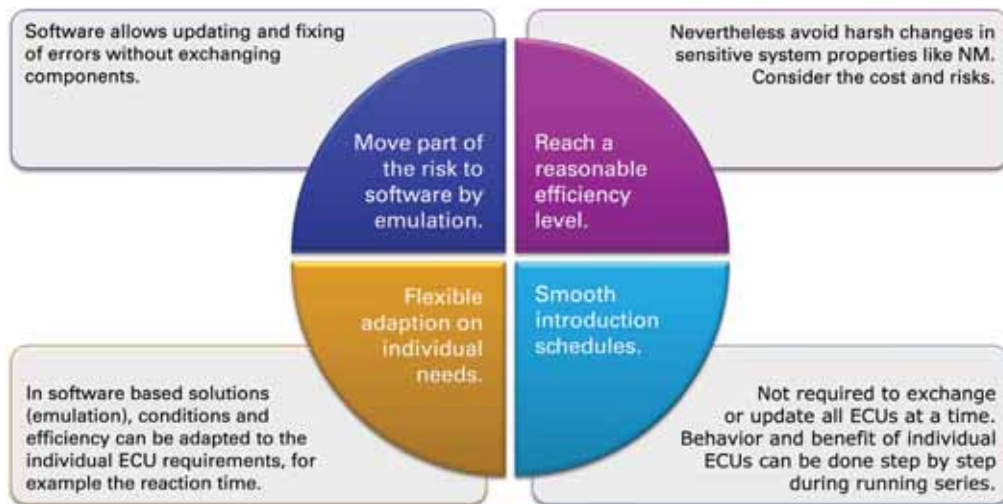


Figure 4: Reduced risks

of below 0.5mA. However, a complete implementation of this standard requires all ECUs in the network to be equipped with intelligent network-transceivers, which makes it a rather expensive solution.

Another disadvantage of this approach is the relatively long ECU wake-up time when coming out of deepest current-saving mode. This is because – for the microcontroller – it is almost a cold-start process that takes up to 10 times longer than a warm start.

Decision: Revolution or Evolution?

Partial Networking and Pretended Networking are both defined parts of AUTOSAR and technically they are integrating (Partial could include Pretended Networking). But in practice, all car manufacturers have to decide if they implement “just” Pretended or with much more effort Partial Networking. Every

car manufacturer must ask itself: revolution or evolution; Partial Networking or Pretended Networking? In other words: how much money and effort have to be spent to achieve the necessary CO₂ reduction goal? Wouldn't the resources for an expensive network transceiver and the efforts needed to convert all of the network's ECUs software, as well as the penalty of ECUs' slow reaction time when waking up from maximum current-saving mode, be better spent elsewhere?

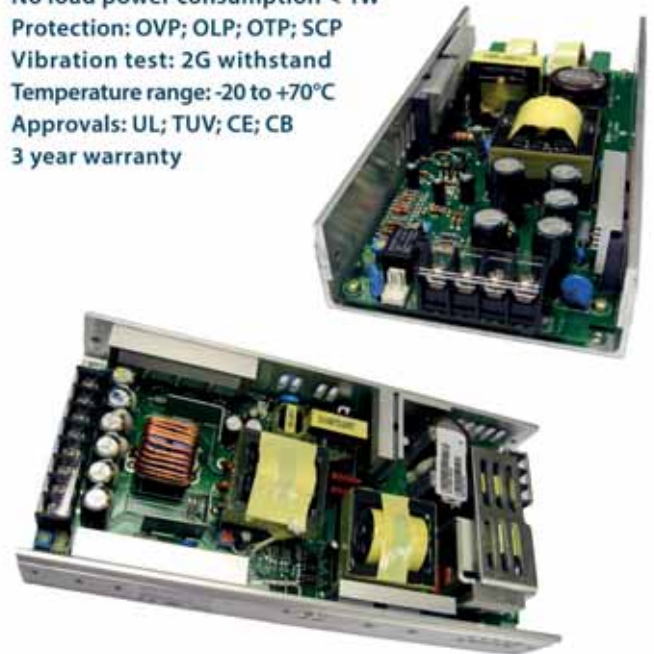
The solution approach of Energy Saving Technologies (EST) may help. Renesas has developed several technologies that reduce the current consumption of microcontrollers:

- ES-FT: “Energy Saving - Flash Technology”
- ES-NP: “Energy Saving - Network Power Management”
- ES-LPS: “Energy Saving - Low Power Sampler”
- ES-PM: “Energy Saving - Power Modes”
- ES-PS: “Energy Saving - Power Scaling”.



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Approvals: UL; TUV; CE; CB
3 year warranty



Housed in a low-profile U-channel the UP series delivers from 150W to 400W (UP350 = 300W, UP500 = 400W) with free air convection, (UP350 = 350W, UP500 = 500W with fan cooling). Built using 105°C electrolytic capacitors for a long service life, these units are designed for a range of telecom and industrial applications requiring low maintenance and noise. All models have universal ac input, and are available with a single output voltage of 12, 15, 24 or 48Vdc. Safeguards include: short-circuit protection; over-voltage protection; overload protection and over-temperature protection. The 350W and 500W units also feature: active inrush current limiting; remote voltage sensing; remote inhibit function; power OK signal.

Relec Electronics Ltd

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Design solutions for design engineers

The company's 32-bit microcontroller transistor (based on the 40nm process with internal Flash) help increase MCU performance and yet reduce current consumption by 50% whilst in operating mode, without having to consider any functional limitation of the ECUs. This implies efficiency growth by a factor of two, a feat which only a few other automotive sectors might be able to duplicate. Renesas achieved these improvements by optimising the transistor.

Transistor Improvements

The total current consumption of a transistor is the sum of its dynamic and static currents: The static currents are determined by leakage currents that flow as soon as power is applied to the transistor; whereas dynamic current flows during transistor switching – that is, when it changes its logic state (1 or 0). These currents are determined by the internal characteristics of the transistors.

Renesas has succeeded in reducing both these currents by modifying the physical structure of the transistor. The internal transistor capacitance was reduced by altering the oxide material and by changing the transistor geometry. This way the leakage current was reduced by a factor of ten and, cumulatively, these changes resulted in higher operating frequencies too.

In addition, Renesas optimised the microcontroller's digital structure in such a way that maximum-current saving modes can be applied (see Figure 3) whilst the microcontroller would still be able to react to external signals. This has been taken care of by intelligent IPs (peripherals) without any CPU interaction.

So, the improvements are partially linked to the clocktree being made highly configurable – what digital part can be clocked on at which clock cycle; the power modes – what part of the MCU can be switched off while others continue to work; and digital IP features, such as the intelligent filter of the CAN-IP.

Although in STOP mode the CPU is sleeping, in this configuration the CAN-IP can participate in the network communication by itself. The integrated intelligent message filters wake up the CPU when a dedicated message type – which is configurable – is detected. As the microcontroller is only in STOP mode, it takes only microseconds to execute a warm start. After wake-up, the CPU can retrieve the message detected by the filter of the CAN-IP and process it.

This configuration is optimal for realising Pretended Networking Level 2. Renesas has tested it in a real application and has thereby achieved an average current consumption of 1.58mA. This means that the current consumption of an ECU that normally consumes 105mA has now been reduced to a mere 6.5mA in current-saving mode, translating into a 94% reduction in current consumption. There are no additional costs, no other ECUs in the network that have to be changed, and the ECUs wake up from their current-saving mode in a very short time.

The same configuration, with similar current consumption reductions, can also be used for the Standby Mode of Partial Networking; although in this case, there are still the associated disadvantages described earlier, which will require adapting all the ECUs.

Outlook

There are many ways to reduce current consumption and with it CO₂ emissions. Renesas believes that an approach combining latest microcontroller technologies with Pretended Networking is the most efficient and least risky to reduce the current consumption of the vehicle's control units at a reasonable cost (see Figure 4). ●

CHARGING FORWARD

REINHOLD MÜHLICH, MANAGING DIRECTOR OF MCS GMBH, EXPLORES THE FUTURE OF ELECTRIC VEHICLE CHARGING STATIONS AND OUTLINES THE TECHNICAL DETAILS OF RWE'S ESTATION COMBI

C

ars should be ideally refuelled within minutes; but does the same apply to electric cars?

The "tank" of an electric car is the battery – an energy storage device that takes time to recharge. However, thanks to the efforts of various companies, ultra-fast charging is on the horizon.

Where Are We Headed?

The end for traditional, internal-combustion-engine vehicles is nearing fast, at least in their present form of use. As producers of CO₂, combustion engines have been blacklisted as climate killers, as cities are full of traffic-related fine-particulate air pollution. Equally, parking in cities is expensive and fast becoming rare too.

Studies suggest that two out of three people will live in megacities by



Figure 1: RWE eStation Combi – a super-fast way to recharge electric vehicle batteries

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2050, but how can such cities sustain a good quality of life and easy traffic movements?

Things are starting to change however. With the advance of electric and hybrid cars, many cities have started to provide specially designated parking spaces with electric charging stations. Drivers of electric cars are often allowed to use bus lanes, enabling them to move through the city faster. In Germany alone it is predicted that some 500,000 electric vehicles will be on the roads by 2017, making this market a leading future sector.

Currently, electric cars are suitable for the modern-day urban environments and a range of them – from the small and nippy city types to racing models – are available from a number of car makers. But, to make electric vehicles prevalent on our roads, an efficient infrastructure is a must, as drivers want their electric cars to achieve similar travel ranges to those of the combustion engine.

Infrastructure For Electromobility

The RWE Group, one of Europe's largest electricity and gas companies, has been working on electric mobility since the 1960s. Its RWE e-mobility business unit is currently developing charging

facilities necessary for mass adoption of electric vehicles, which include efficient charging stations and back-end systems that will allow plugging into the smart grid and automatically identifying vehicles.

Together with its partners, RWE has developed the Type 2 connector which has established itself as the standard charging port in many European countries. The goal is a Europe-wide network of compatible and vendor-independent electric vehicle charging stations.

At first glance, a charging station simply supplies cars with energy. However, every car has its own type of battery that may require a different charging protocol. The charging station exchanges this information with the car and adjusts to the vehicle. Overall, the station communicates with the vehicle, the Internet, the customer and possibly other charging stations to make recharging fast, seamless and payment-transparent. The charging station contains a lot of intelligence and is not just a simple socket. Typically stationed outdoors it also requires robustness and the ability to withstand harsh – and potentially abusive – environments, so legislation prescribes strict technical measures to protect users from harm. ●

ESTATION COMBI

MICRONIC Computer Systeme (MCS) and RWE have jointly developed an electric filling station that provides up to 22 times faster charging than a standard household outlet. It's called the RWE eStation Combi and it will be initially positioned at service stations, motorway rest areas and some parts of the inner cities.

To make this station forward-compatible, especially when it comes to meeting new requirements and legislation, the partners decided to build their computers based on the Computer-on-Module (COM) technology, which by its very nature allows scalability. As such they chose to implement congatec's conga-QA6/E680-1G computer module in their eStation.

The conga-QA6/E680-1G supports extended temperature range of -40°C to +85°C. The Qseven module offers low power consumption and improved graphics performance. The module is based on the Intel Atom processor E600, with speeds from 600MHz to 1.6GHz.

In the eStation Combi, the COM module is mounted on a baseboard that contains all application-specific features, as well as the necessary peripherals and power supply.

The combination of COM module and carrier board yields an application-specific device with the latest in computing power: whenever a new application requires higher computing power, the device manufacturer can simply replace the COM module with a more powerful one. The drivers and integration into the operating system software usually remain unchanged, or can be easily modified with the help of the module manufacturer; the device manufacturer can just develop the application's functions directly on the baseboard.



Figure 2: Qseven Computer-on-Module concept with carrier board and computer module

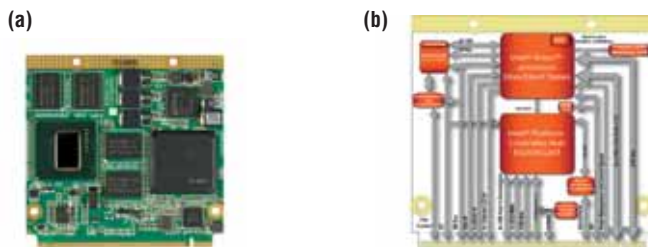


Figure 3: (a) conga-QA6 Qseven COM with Intel Atom processor E600; and (b) its block diagram

The eStation Combi's direct payment system allows payments via debit card, credit card or SMS, and the process is particularly easy for RWE vehicle electricity customers who are automatically identified at the AC charging point via the plug-and-charge standard. An intelligent charging cable shares all relevant data between vehicle and charging station. For other customers there's an intuitive, self-explanatory menu on the 10-inch touchscreen.

The station is water-proof in accordance with the IP 54 code.

ADVANCED LED DRIVERS

FOR AUTOMOTIVE INSTRUMENT CLUSTERS

RAIMUND WAGNER, EMEA PRODUCT MARKETING MANAGER AT ROHM SEMICONDUCTOR, DESCRIBES ROHM'S APPROACH TO A 12-CHANNEL LED DRIVER SOLUTION THAT PROVIDES AN ANSWER TO THE NEW, CHALLENGING AUTOMOTIVE REQUIREMENTS

U

sing LEDs in automotive applications is on the rise for a variety of reasons, including the LEDs longer service life and lower power consumption. Equally, the size, diversity and complexity of integrated, state-of-the-art instrument-cluster displays call for LED technologies.

It is no longer enough to just “drive” the LED with discrete components; we are seeing a need for constant and precise light output from different LEDs whilst varying their brightness to respond to various ambient conditions.

The demanding automotive environment also requires diagnostic functions and protection circuits to prevent complete lights failure if a single component becomes faulty. All this is in addition to the ongoing expectations of greater performance in smaller spaces.

LED Drivers

LED drivers can provide a combination of serial and parallel LED control to address specific instrument-cluster displays, such as for air-conditioning or radio, for example. Components with this feature offer developers the flexibility to drive LEDs in various applications with a single driver and, as such, save development and qualification time. These highly-integrated LED drivers have many advantages over simple current limiting circuits, as they reduce the need for external components and take up less space on the PCB.

The first requirement for LED power management is to provide constant current with high accuracy at the outputs to avoid fluctuating supply voltage and different LED V_f (forward voltage) values, as well as avoid different influences on the LED current and, thus, unwanted brightness variations.

Rohm has addressed this via a three-channel serial input (serial-in, clock, latch-in) that controls a total of twelve driver channels to drive multiple LEDs with an output current of 15 to 50mA per channel. The regulation of maximum current is done via an external resistor. If additional power is needed, multiple channels can be activated in parallel.

Settings can be read via the serial interface register to verify them at any time and address the built-in diagnostics functions, among them an open or shorted connections (faulty LEDs), and chip temperature, especially when it rises above 125°C. The high temperature detection is particularly useful, since measures can be taken (such as reducing the brightness of the global PWM dimming) to prevent it from rising further. In such a case, multiple LED drivers can communicate with each other via a proprietary communication line to reduce the performance. If the temperature continues to rise above 150°C, then a power-on reset is carried out, protecting the chip from irreparable destruction.

Advanced Dimming

Latest panel specifications define a brightness range that starts at very low light intensities with wide scalability. Moreover, in order to implement different RGB colour combinations, each LED must receive a dedicated dimming signal that can be set separately.

Figure 1 shows the calibration and dimming of the output current and the ratio of these two settings. The maximum current I_{Dmax} is adjusted via an external resistor R_{ext} . The adjustment of the calibration bit changes the current value of the associated channel while the duty cycle in all active channels is simultaneously regulated through the PWM input. The PWM input is completely independent of the clock signal.

The use of a “PWM Control CR timer” block in addition to the switching regulator enables the adjustment of the modulation frequency and the duty ratio for a given product at a fixed resistor capacitor

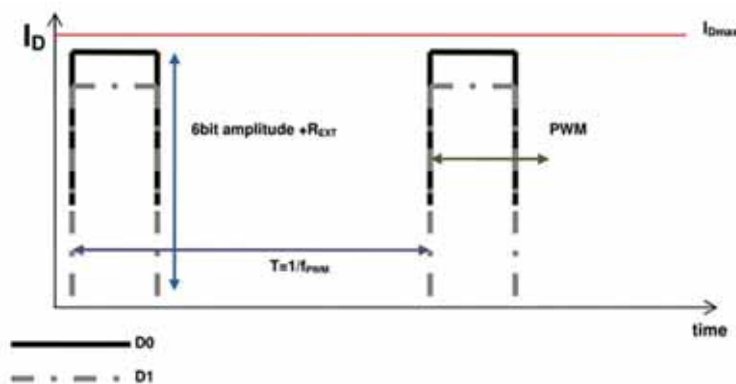


Figure 1: Calibration and dimming of the output current

combination. The time required for the design is in this case reduced by the ability to use a single product platform. This way, less expensive and fewer devices can be used for the design.

In the given example, D_o and D_i are calibrated at a value below the maximum current, and D_i has a lower current than D_o . As indicated, the brightness of both channels can be simultaneously influenced by the PWM signal. The defined current value and duty cycle are independent of each other, ensuring that the calibration of each of the channels does not affect the dimming curve and that no delay occurs. Propagation delay during rise and fall time is the same, which guarantees linearity between input and output.

A number of protection circuits are used to provide high reliability in automotive applications, including circuits against

overvoltage, undervoltage, polarity, overcurrent, short circuit and heat. Overheating is particularly challenging, especially in the case of excessive system voltage.

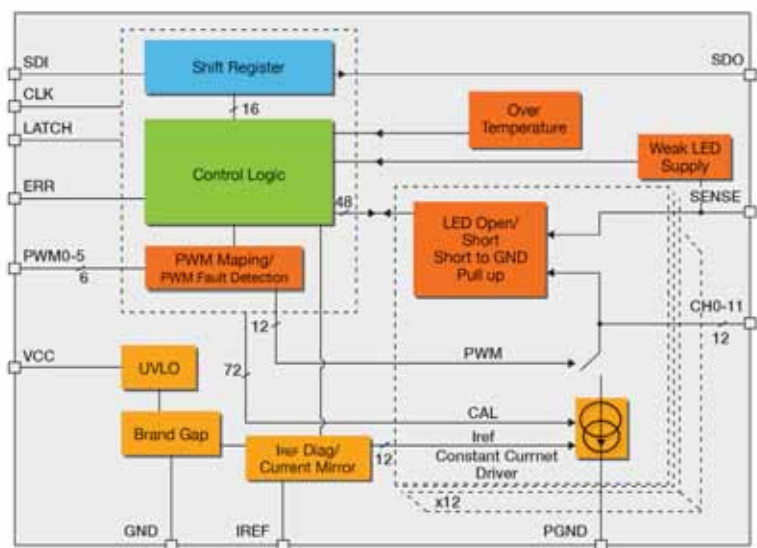
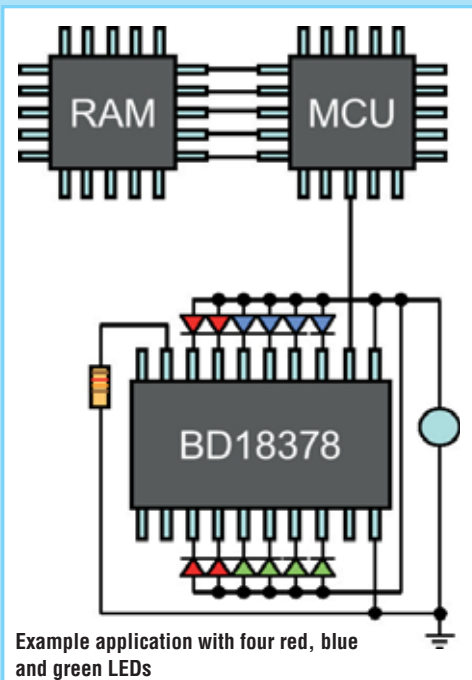
The voltage in cars ranges from 9-16V, and extreme conditions have to be accommodated, such as inverse polarity protection up to 12V, jump-start aid conditions with continuous double battery voltage (+24V) and failures such as the load dump/overvoltage which occurs when the battery is disconnected from the generator while the engine is running, as well as other power transitions. An undamped load drop may take several hundred milliseconds and easily exceed 80V but, nowadays, many manufacturers have centralized their limiting circuits for load drop and, as such, require components to resist transient voltages of 40-60V. ●

THE NEW BD18378 DEVICE

ROHM has developed an LED driver – the BD18378 – that includes twelve constant current drivers in a single chip to control a large number of LEDs; 6-bit per channel current calibration and a 6-channel PWM brightness control (0.1-99.2%); diagnostic functionality; an emergency warning pin; and a limp-home function for additional reliability. Combined with the ultra-flat RGB LEDs of the SRGB series, the AEC-Q100-qualified device in a compact HTSSOP20 packaging offers a complete solution for automotive clusters.

At 30mA, the BD18378 provides output current accuracy of $\pm 2.5\%$ from channel to channel of a single device, or $\pm 1.7\%$ between two devices. The brightness of each LED can be individually adjusted via current control, calibrating from 1.6-100% (6-bit). Additionally, global calibration of 0.1-100% is possible via PWM. Thus, LEDs with different brightness from different batches can be used without having to adjust them to different resistor values; only the register settings must be adjusted for the LEDs used, so subjective differences between LEDs of different colours can be regulated as well.

In order to meet the car manufacturers' warranty specifications, which may be over ten years, the BD18378 offers several system-protection features. Shorted and open circuits are easily detected, preventing high currents and voltages at the LED output. Its extensive diagnostic functions can identify errors (read by the microcontroller), allowing corrective actions to be taken to prevent any component's destruction. This significantly increases the cluster's reliability, avoiding any expensive complete-system replacements.



EXTENDING THE LIFE OF A VEHICLE'S ELECTRONIC COMPONENTS

ROBERT CHAMBERLAIN, SALES MANAGER FOR AUTOMOTIVE ELECTRONICS AT W. L. GORE & ASSOCIATES DISCUSSES VENTING SOLUTIONS FOR ELECTRONIC PARTS, ESPECIALLY WHEN HAVING TO PROVIDE AN EFFECTIVE GUARD AGAINST DIRT AND FAILURE IN THE VEHICLE'S ENVIRONMENT

The number of electronic components being built into vehicles is growing rapidly as many mechanical parts are being replaced with electrically-powered ones and various autonomous systems, such as driver assistance for example, become increasingly common.

These trends are placing more pressure on car makers and their suppliers to find effective ways to guard in-vehicle electronics against dirt and failure. Making sure these electronic components function reliably throughout the car's entire lifetime is a top priority, not only for cost-effectiveness, but also to promote the premium quality and reliability of their brand.

All electronic components – whether part of compressors, pumps, motors, control units or sensors – are subjected to huge temperature fluctuations throughout their service life. These can arise when the component's housing heats up in operation and then comes into contact with cold spray from the environment. Such temperature fluctuations can

cause a significant vacuum to develop inside the electronics housing. The resulting pressure differential can be so strong that the seals and sealing components protecting the sensitive electronics can be seriously compromised, letting in dirt particles and liquids that can corrode the component and shorten its service life. Damaged or defective components usually have to be replaced, leading to high warranty and repair costs for the car makers and their suppliers.

Challenge: Electronics And Batteries In Electric Vehicles

One major challenge facing the automotive industry is the thermal management of high-performance electronics and batteries in electric vehicles, since they need to operate in a certain temperature range to achieve optimum performance. They get very hot when running and need to be cooled using fluids. This can cause such huge temperature differentials within the electronic unit itself that condensate can form at the coldest point in the

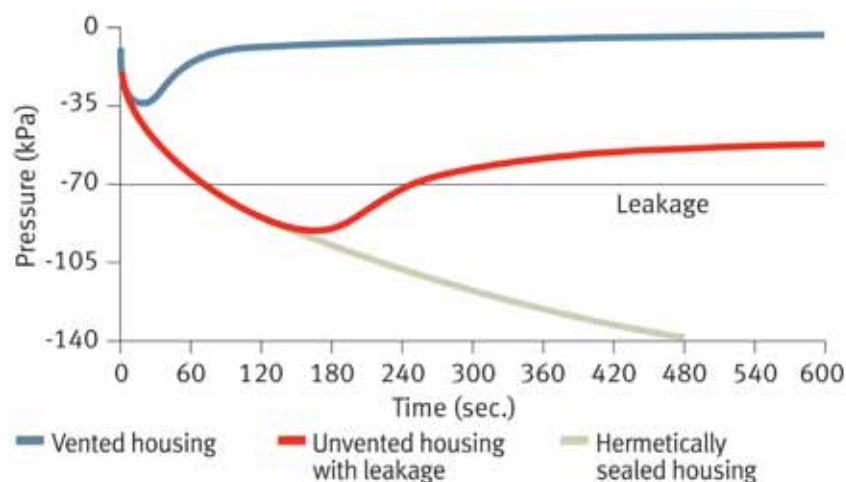


Figure 1: Continuous buildup of negative pressure within a hermetically sealed housing. In unvented housings, as little as 7kPa of pressure can cause seals to fail after several temperature cycles; vented housings equalize pressure and avoid seal leakage

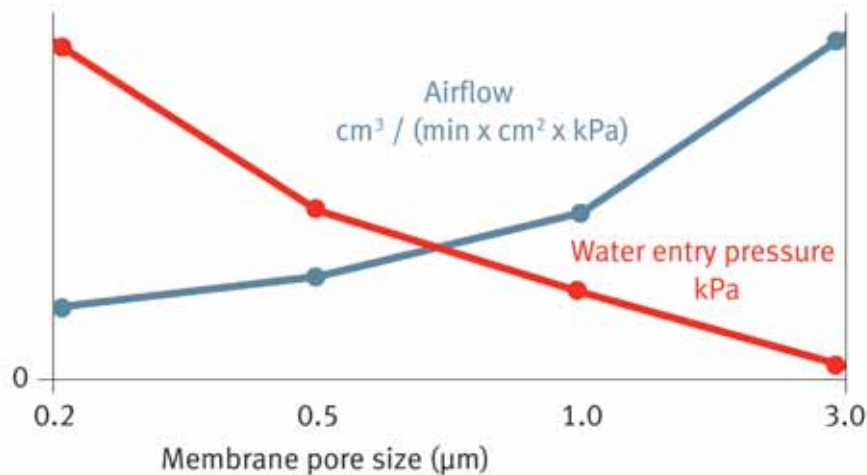


Figure 2: Even though venting components have to become smaller, housings still have to provide greater airflow per membrane surface area, resulting in a lower water entry pressure

housing, which can lead to corrosion or cause a short circuit.

For large battery housings, this problem can be so extensive that it is difficult to solve without effective measures to equalize temperature and pressure. Given the housing's size, even minor temperature differentials can put

enough pressure on it to cause deformation. In certain circumstances, driving a car out of a warm garage into the cold winter air can produce an interior vacuum that exerts a negative pressure of 500kg/m². Lightweight housings are scarcely able to withstand such pressure.

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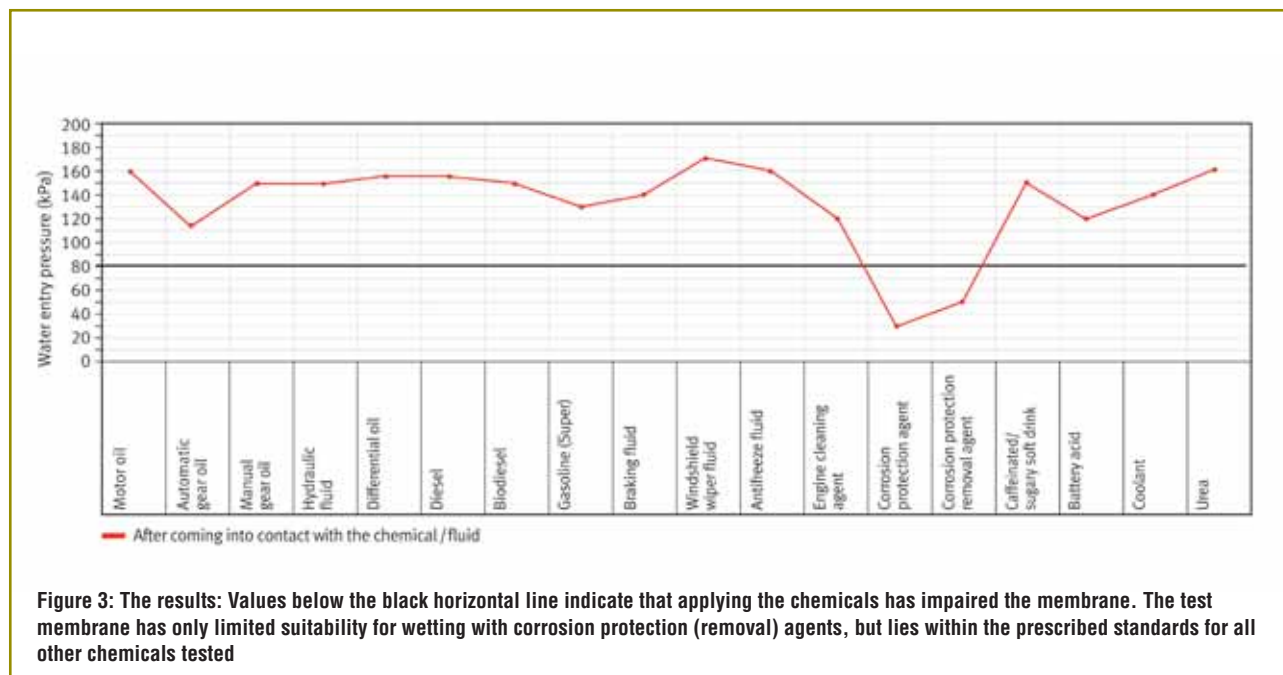
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Guaranteeing Air And Pressure Equalization

OEMs generally deal with these problems in one of three ways. The first option is to pot the electronic components: While this solution creates a perfectly sealed system, the unit ends up significantly heavier and cannot be re-opened and repaired if it fails. Another way to achieve a hermetically-sealed system is to use high-quality seals and thicker housing walls. The drawback of this system, however, is that it makes components more expensive and unnecessarily heavy.

A common and much more sensible solution is to incorporate a membrane that equalizes the air inside the housing while at the same time preventing the ingress of liquids and dirt particles (see Figure 1).

Important Characteristics For Membrane Solutions

Airflow and water entry pressure are the two fundamental characteristics that determine a membrane's performance. Airflow describes how much air can pass through the membrane in a given period, at a given differential pressure. This defines how long it would take to equalize a pressure differential. Water entry pressure is the minimum hydrostatic pressure that the membrane must be able to withstand before it leaks. Both parameters are influenced by the pore size of the membrane, among other factors. It is the membrane supplier's job to provide the ideal combination of airflow and water entry pressure for each individual application.

A major challenge in the automotive industry is the trend toward increasingly compact electronic components. This means venting components must also become smaller if they

are to be integrated into smaller housings as effectively as possible. This in turn requires greater airflow per membrane surface area, resulting in a lower water entry pressure, (see Figure 2).

Typically, a system's imperviousness is determined by ascertaining its IP protection rating (according to DIN 40050-9). The IP test determines the electronics housing's protection level against solid objects and liquids. The IP protection rating is defined by two digits: IPXY. The first digit (X) indicates the protection rating against ingress of solid foreign objects; the second digit (Y) indicates the level of protection against ingress of liquids. IPX9K shows how well the housing with integrated membrane is able to remain watertight when exposed to steam jets.

The IPX9K test is carried out in a testing chamber in which the housing, including its integrated membrane, is exposed to a steam jet from a distance of 100 to 150mm, at angles of 0, 30, 60 and 90 degrees. The airflow rate is kept between 14 and 16 l/min, water pressure maintained

at between 8,000 to 10,000kPa and temperature at 80°C.

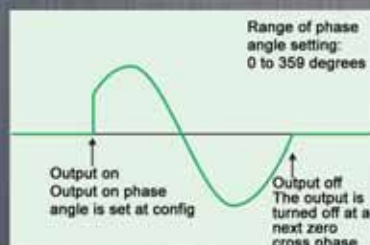
The IP protection rating is defined by two digits: IPXY. The first digit (X) indicates the protection rating against ingress of solid foreign objects; the second digit (Y) indicates the level of protection against ingress of liquids

Chemical Resistance Of ePTFE Membranes

Gore uses PTFE (polytetrafluoroethylene), a material that is ideally suited to venting applications because of its unique microstructure.

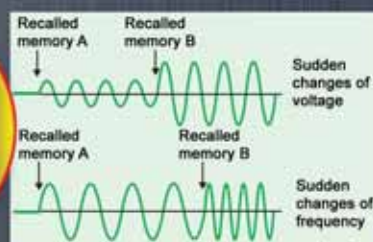
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The PTFE raw material is stretched in a specially designed process to create a membrane with very fine pores and in which the nodes are interconnected by fibrils. This material, called expanded polytetrafluoroethylene or ePTFE, is extremely hydrophobic (water resistant) thanks to its low surface tension. This means that any water droplets on the surface are unable to penetrate the membrane structure. The membrane is also oleophobic (oil resistant) and repels liquids with low surface tensions, such as oils.

ePTFE's oil-repelling properties are particularly important for applications in the automotive industry, as the likelihood is very high that vehicle components will come into contact with motor oil, cleaning agents or other automotive fluids.

Gore tests how well its venting solutions are able to withstand up to 20 different chemicals (in accordance with the ISO 16750-5 standard). This is done by exposing the vents to each test liquid and then leaving it for 24 hours at room temperature (21-23°C) or heating it for 96 hours in an oven. Airflow and water entry pressure are measured before and after the test. Both results must lie within prescribed specifications, see Figure 3.

Temperature Resistance Of ePTFE

Another advantage of PTFE is its extremely high resistance to extreme temperatures. Its ability to withstand temperatures ranging from -150°C to 240°C is a property that is important, given the current trend toward reducing engine size while maintaining or even improving performance. Shrinking the size of engines in this way usually pushes temperatures above the 125°C threshold that electronic housings have been designed to cope with until now. It is no longer uncommon for temperatures to reach 150°C and above.

Gore puts its vents through numerous tests to determine their ability to withstand extreme temperatures (ISO 16750-4). In the temperature resistance test, the vent is exposed to a maximum temperature of up to 150°C for 2,000 hours, or a minimum of -40°C for 1,000 hours. In the ice dunk test, the vent is placed in a sealed housing and heated at a temperature between 80 and 120°C in an oven for 40 to 60 minutes. The housing is then rapidly cooled to between 0 and 4°C by placing it in iced water containing 5% sodium chloride, a solution designed to simulate the salt water that electronic housings are likely to come into

contact with in winter. This procedure is repeated ten to twenty times, with venting properties measured before and after the test.

Membrane Solutions In Different Configurations

Choosing the right membrane to suit each particular application and its requirements is vitally important. Gore offers adhesive and weldable vents as well as molded parts. GORE Adhesive Vents are coated with a high-performance adhesive that adheres strongly to various kinds of metal and plastic. They are supplied on a lightly adhesive backing for manual or automated installation. The adhesive is long-lasting and capable of withstanding harsh conditions. However, as the adhesive has only limited resistance to extremely high temperatures and strong chemicals, these vents are less suitable for under-the-hood use. They are designed to be used with vehicle components that are less likely to come into contact with liquid chemicals, such as automotive lamps.

Weldable vents can be made of different material combinations and in different sizes to suit the specific requirements of the intended application. They are mainly used in applications with plastic housings, and are attached by the customer using ultrasonic welding. At the weld seam a small section of the housing material melts and flows into the porous structure of the membrane, thereby guaranteeing that the join is sealed and solid. Since the melting point of PTFE is much higher than the welding temperature, this process does not compromise the membrane. These vents provide a long-lasting, reliable solution even when exposed to high temperatures and strong chemicals. However, the welding process is very complex and requires specialized welding tools and qualified experts to complete the process. In addition, protective walls have to be integrated into the housing design to protect the vent from steam jets and mechanical loads, which can be an expensive and complicated process.

Molded parts represent a solution that is able to withstand the most challenging environmental conditions, as well as being easy to integrate. Gore achieves this by adding a step to the manufacturing process. For example, insert molding is a process that integrates the membrane directly as part of the plastic injection molding process. The molded parts can then be attached by simply snapping them into place in an opening in the housing. This protects the membrane from mechanical loads without the need to integrate expensive and complex protective walls into the housing. Furthermore, integrating the vent does not call for special machines or qualified experts: the vent is simply fitted in the housing via the "plug & play" method. ●



RS TOOLBOX – THE HANDY REFERENCE MOBILE APP FOR ELECTRONICS ENGINEERS

By Mike Brojak, Applications Manager, RS Components

Launched at the end of last year, RS Toolbox is a brand new mobile device app for iOS based devices that is available completely free and combines electronic reference materials with calculation and conversion tools in an easy-to-use app for electronics design engineers.

Electronics design engineers are forever under increasing time pressures and are always on the lookout for design shortcuts. Therefore online calculation, converters and lookup tables – usually to be found via leading Internet search engines – have become highly popular. Consequently, to meet this demand and in line with the company's strategy to deliver software tools that are not only free, but also are high performance and highly useful tools that allow engineers to exploit innovation, RS has now launched its first design-support app for mobile devices – the RS Toolbox. An equivalent App, called Allied Toolbox, has also been launched in the US, where the Company operates as Allied Electronics.

Aimed at electronics engineers, hobbyists and students, the new RS Toolbox mobile app is a collection of popular electronic reference materials and calculation and conversion tools that can now be available at their fingertips and in one handy place. RS Toolbox runs on mobile devices that use the iOS operating system, which includes iPads, iPhones and iPod Touch devices from Apple. In addition, RS is also planning to introduce the App to run on Windows 8 devices. The new app is based upon the 'Electronic Toolbox Pro' app, which was developed by Marcus Roskosch, the author of a range of highly successful Apps for engineers. Electronic Toolbox Pro has already enjoyed a high level of acceptance from engineers with in excess of 200,000 downloads.



Functionality

RS Toolbox offers a very wide range of functions, which are grouped as icons on the main screen for the app, including a multitude of engineering calculators, converters and lookup tables. As an example, included in the functions are filter frequency calculators, 555 timer configurator, calculators for a variety of voltage regulators and op-amps, or essential tools such as numbering systems converters, Ohm's Law calculator and lookup tables for battery types and sizes.

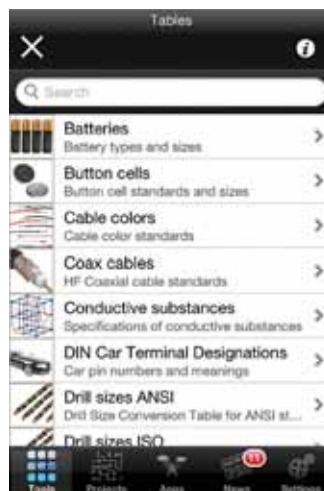
Also included are type listings with colour coding for resistors and capacitor including surface-mount types among many other devices or components. Calculator tools in the app include those for calculating values of many electronic circuit devices including inductors, capacitors, resistors and op-amps. In terms of the App's user interface, a high level of customisation is also available including a choice of 16 different languages.

In one place and on the move

The app means the easy availability of popular reference information in one place, ensuring that the exact same tools are available for the future. It is sometimes hard to keep track of which web sources of reference information were used in a project and when. Web links will often go missing or perhaps are no longer available when a project undergoes a new revision several months later for example.

A second important point is accommodating the increasingly peripatetic role for professional engineers. Engineers will often have ideas when they're not at the workplace, but are on the move or at home, and it is not always the best place and time to pull out the laptop. RS Toolbox empowers engineers to capture design ideas at anytime and anywhere, as the mobile device becomes an ideal way to record moments of sudden inspiration. Ideas can even be grouped into a user-definable project: the app's project function can be used to store and collect information, calculation

results and diagrams from other tools, for example. The app can become an even more valuable tool to engineers working in the field, for example those fixing equipment or a machine on customer premises and need to quickly look up a colour code for cables.



RS Toolbox can be downloaded via <http://uk.rs-online.com/web/generalDisplay.html?id=RSToolbox>

INDUSTRY TURNS TO MEMS FOR ACCURATE REAL-TIME CLOCKS

PAUL NUNN, FORMERLY A SENIOR BUSINESS MANAGER AT MAXIM INTEGRATED, EXPLAINS THE IMPORTANCE OF ACCURACY IN REAL-TIME CLOCKS

Many argue that there is no better way to improve industrial control and automation than with accurate timekeeping, as it will enhance complex control systems in many ways, starting with the simple scheduling of tasks and maintenance. More importantly, accurate timekeeping with real-time clocks (RTCs) allows an industrial system to operate more autonomously, ensuring systems meet operational goals, focus on predetermined outcomes and, as such, minimize costs.

Timeless Need

However sophisticated an application may be, good timing is still of critical importance; highly accurate RTCs will allow system designers to implement semi-autonomous system control without requiring all related system resources to be networked to time.

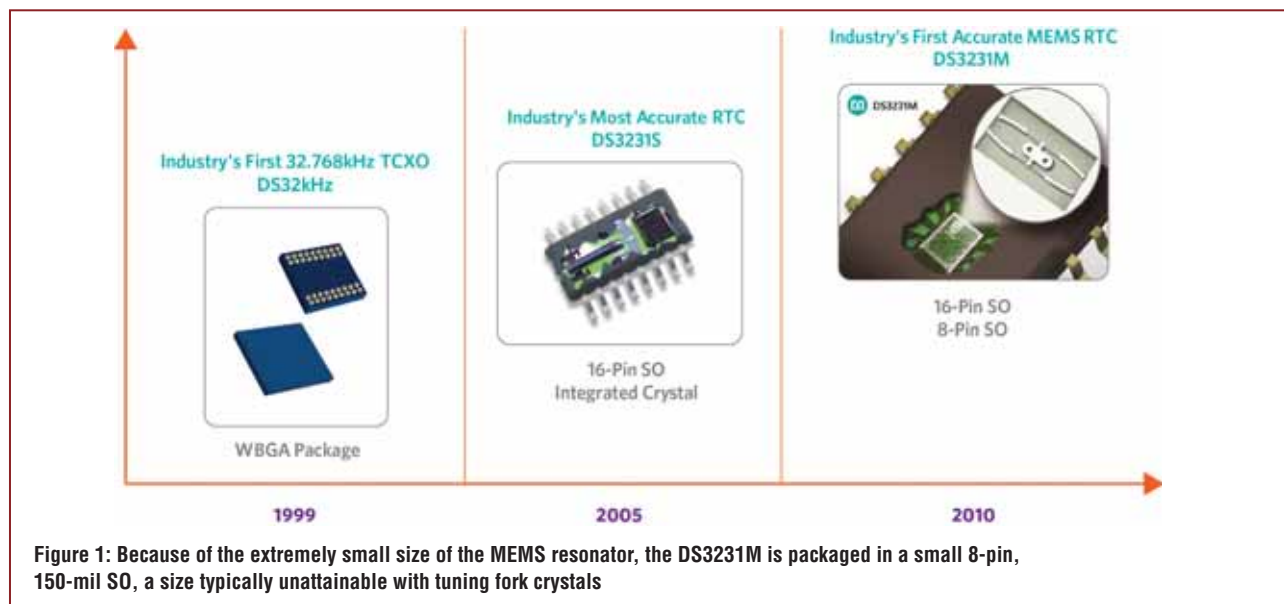
Imagine lighting control systems where lights need to be turned on or off at specific times of the day throughout a busy industrial complex. Accurate timekeeping with programmable RTCs is an easy solution because these clocks eliminate the need to connect each lighting fixture to a single network

timing resource. The RTCs simplify wiring network resources throughout a building; they can replace complex wireless networks that typically require initial customization to ensure proper operation and connectivity, and then long-term maintenance for sustained operation.

Whilst the need for accurate timing is straightforward, the design challenges are not. The best RTCs now typically provide highly accurate solutions ($< 0.5\text{s/day}$) that work over a wide operating temperature range (-40°C to $+85^{\circ}\text{C}$), are low power, at cost-effective prices and in small packages. And today, microelectromechanical system (MEMS) technology is the one that enables the smallest, most accurate, rugged clocks.

The Evolution of Highly Accurate RTCs

The industry's first 32.768kHz temperature-compensated crystal oscillator (TCXO) was introduced in 1999 and it provided timekeeping accuracy of ± 2 minutes per year over the -20°C to $+70^{\circ}\text{C}$ range. By 2005, with a combination of innovative packaging technology and improved temperature-sensor capability, an extremely accurate I²C-integrated RTC/TCXO/crystal was introduced – the DS3231S (see Figure 1). At the time considered the industry's most accurate RTC,



“While the need for accurate timing is straightforward, the design challenges to meet these demands are not

the DS3231S incorporated a 32kHz tuning fork crystal into a highly reliable 16-pin, 300-mil SO package. This highly integrated RTC provided a frequency accuracy of less than $\pm 3.5\text{ppm}$ over the -40°C to $+85^{\circ}\text{C}$ temperature range – accuracy equivalent to less than ± 0.3 seconds/day. It set a new standard for clock accuracy.

Just four years ago, only two corporations offered RTCs with accuracy $> 0.5\text{s/day}$. Applications were demanding smaller packages with lower cost, higher accuracy standards and substantially more ruggedness. The culmination of that design work was a new generation of RTCs based on MEMS technology. Introduced in 2010, the DS3231M integrates a TCXO with a MEMS resonator and provides accuracy of $\pm 5\text{ppm}$. That has changed the entire approach to evaluating accurate timekeeping.

Beyond the issue of accuracy, today's RTCs include independent time-of-day alarms; user-configurable memory for storage of system information; accurate temperature sensing to advise on thermal environmental conditions; the ability to time-stamp critical system events; and simple time-of-day information. Potentially any industrial control or automation operation can use some form of accurate timekeeping.

Today, at least six corporations manufacture accurate RTCs.

The MEMS Evolution

MEMS technology has challenged the conventional limitations of crystal-based designs (Figure 2). This type technology enables significant space savings when compared to cylindrical crystals. A single MEMS resonator occupies 47 times less area and 182 times less volume than a cylindrical crystal. Consequently, the approximate area of an RTC drops by more than half. This dramatic reduction in size is possible because of the transition from the standard barrel, cylindrical crystal to the small ceramic 32.768kHz crystal and the extremely small size of a Maxim MEMS resonator.

Aging is negligible ($< 1\text{ppm}$ lifetime) in MEMS resonators. Crystal-based clocks have typical aging characteristics of $\pm 1\text{ppm}$ per year. Shock and vibration characteristics are significantly more robust in MEMS resonators. Demonstrable performance with mechanical shock (up to 2900g; 5 shocks

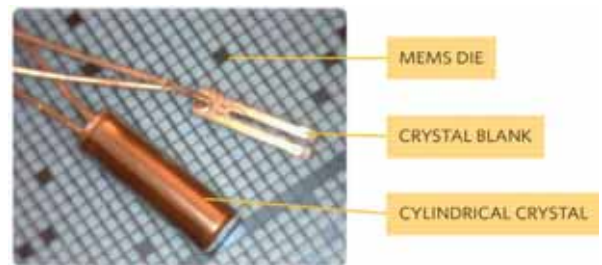


Figure 2: A single MEMS resonator occupies 47 times less area and 182 times less volume than a cylindrical crystal

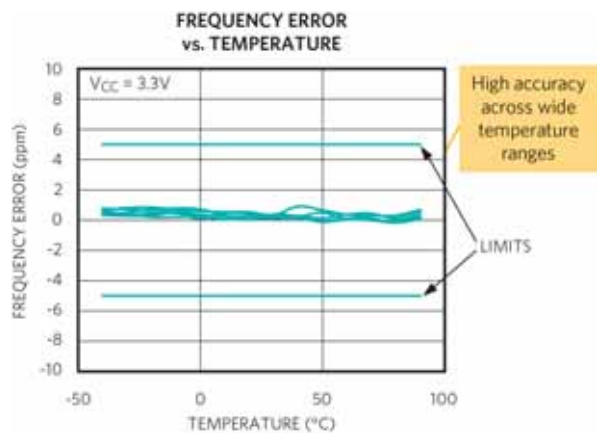


Figure 3: Temperature performance is extremely important for industrial applications. The standard device provides a wide (-40°C to $+85^{\circ}\text{C}$) operating temperature range by keeping accurate time across this band of temperatures

x 6 axes, JESD22-B104C Condition H) and vibration (with variable frequency of 20g; 20/2000Hz, JESD22-B103B Condition 1) has been recorded for MEMS resonators. This rugged performance comes with no discernible frequency perturbations greater than $\pm 1\text{ppm}$. Lastly, overall accuracy for MEMS-based RTCs is specified with lifetime accuracy and stability figures of $< \pm 5\text{ppm}$.

The Future of Clocks Is In MEMS

Longer term, clocks will need to have their size and cost reduced even further and accuracy boosted much higher (Figure 3). It will be MEMS technology that will enable these improvements for RTCs that will be adopted in larger segments of the industrial, automotive, smart grid and medical markets. ●

DESIGN OF THE ELECTRONICS AND CONTROL ARCHITECTURE FOR A MINE RESCUE ROBOT

W.L. LIU, BINHAI YANG, YONGTAO ZHAO AND XIAOYANG LI OF THE SCHOOL OF MECHANICAL AND ELECTRICAL ENGINEERING AT THE CHINA UNIVERSITY OF MINING AND TECHNOLOGY IN XUZHOU PRESENT THE DESIGN OF THE ELECTRONICS AND CONTROL ARCHITECTURE FOR A MINE RESCUE ROBOT

Underground mines are highly dangerous places in which various factors can affect miners' lives. When blasts occur in a mine, it is difficult to immediately assess the exact situation, making the immediate rescuing of survivors rather dangerous.

To solve this problem, current trend is to develop mine rescue robots to search for survivors. However, one major challenge in designing such a robot is the electronic architecture for the integration and control of its complex system.

Mine Rescue Robot Electronics Architecture

Our robot comprises the mechanical structure, electronics and control architecture, a communications system and a power supply.

The electronics architecture is shown in Figure 1: it mainly includes infrared sensors, gas, humidity and temperature sensors, an ultrasonic sensor, an electronic compass, a laser range finder and a camera. Equipped with these sensors, rescuers can quickly obtain the mine's environmental information, and the robot can avoid any collisions with obstacles and adjust its positioning.

The robot remotely communicates with the control system in three ways: via an RS485 radio transceiver, optical fibre and cameras using wireless Ethernet. Its DC motors are powered by two 24V DC batteries, whereas its other systems via 12V or 5V DC converters. Video images can be sent wirelessly with a transmitter whose working frequency is 1.2GHz and communication distance 1km.

We chose the GX-ARM9 embedded ARM development board as the robot's control system, shown in Figure 2.

The ARM microprocessor has three UART serial ports, the highest baud rate being 115200. All three serial ports are used to communicate with the remote control system (RCS). COM1 is connected to the radio transceiver; COM2 to the optical fibre, for which an RS485 converter is also needed, and COM3 is used to communicate with the wireless sensor net (WSN) node.

There are other devices that need a serial port to communicate with the core board too, so a serial port expansion IC GM8142 was selected to provide four standard duplex serial ports. The GM8142 communicates with the ARM9 microprocessor S3C2410 by an SPI bus, and works in interrupt mode. When serial data from any of the four ports is received, a low active interrupt signal is triggered; the data stored in the GM8142's FIFO buffer is then read by the microprocessor.

The servo drivers (MCD3006S) of the two main DC motors are also controlled by the ARM board through the extended COM1 port. They are identified by their respective addresses while sharing the same TX, RX and GND signals.

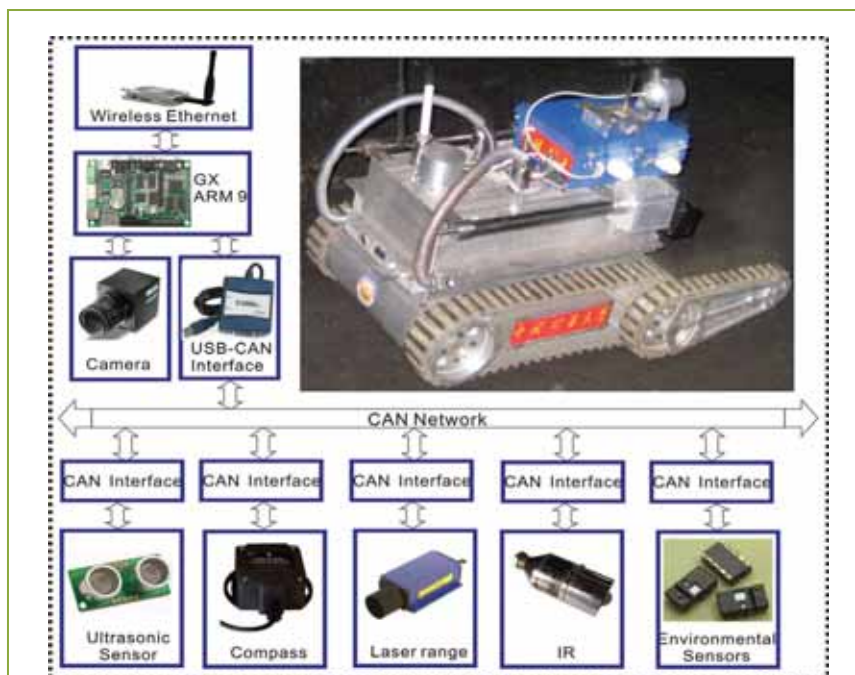


Figure 1: The architecture of the mine rescue robot

Two MAXON DC motor motion controllers (EPOS24/5) are connected together via the CAN open bus (with highest speed of communication at 1Mbps), while one of them is also connected to the extended COM2 of GM8142 and considered the gate node. The extended COM3 is used to read the data from the ultrasonic sensors.

The SRFOI ultrasonic range finder has a single pin serial interface and its data is a TTL signal. As such, an RS485-to-TTL converter should be used between the sensors and GM8142, otherwise connecting the SRFOI directly to the RS485 port will destroy the module.

Information from the electronic compass XW-EC1700, from which we obtain the robot's orientation, roll degree and pitch degree, is read by COM4.

Signal Communication

Every EPOS24/5 motion controller is allocated a unique address through eight DIP switches. All the motion control commands from the control board arrive at the gate node first. The command frame is processed by the gate node, which then sends back a responding data frame; if the command frame is sent for itself, the gate node will send back the responding data frame, otherwise the command frame will be sent to the corresponding node.

There are several gas sensors, a temperature sensor and a humidity sensor that need to be sampled by the

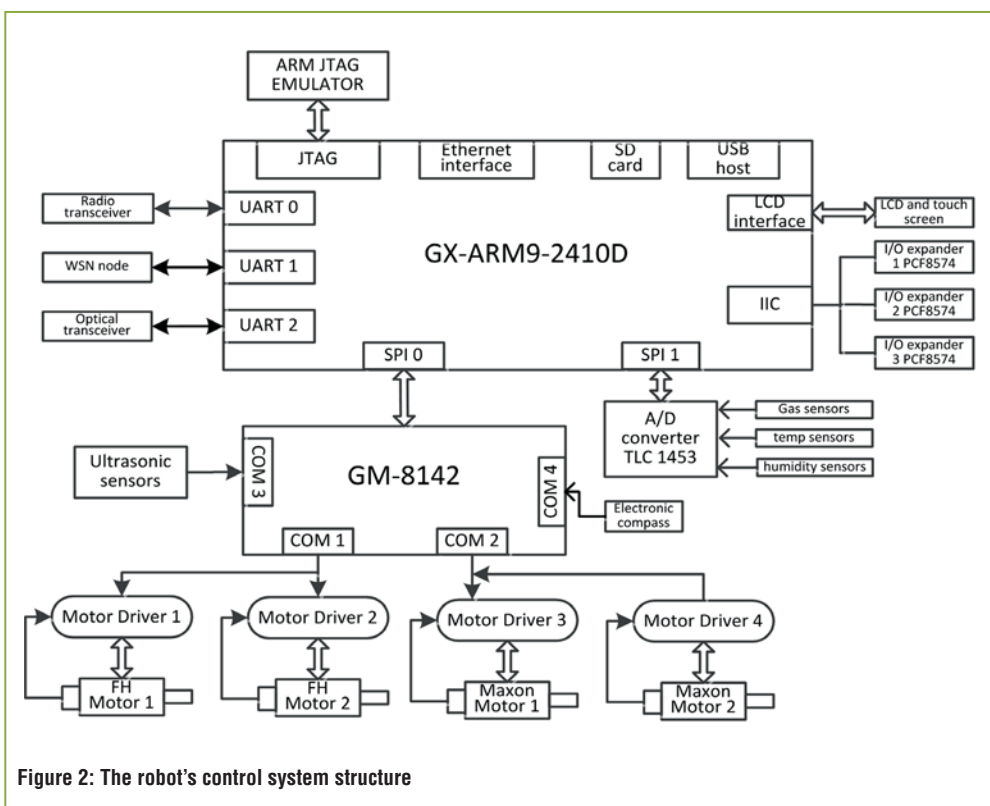


Figure 2: The robot's control system structure

microprocessor. An analog-to-digital converter (ADC) with eleven analog input channels is used (TLC1543) to gather information from these sensors. This is a CMOS-based 10-bit switched-capacitor successive-approximation ADC with three digital inputs and a 3-state digital output (chip select, input-output clock, address input and data output). The SPI 1 interface of S3C2410 is used to read the analog inputs' converted results.

When the operation arm is used, several I/O ports are needed to control the joints' DC motors by bridge circuits.

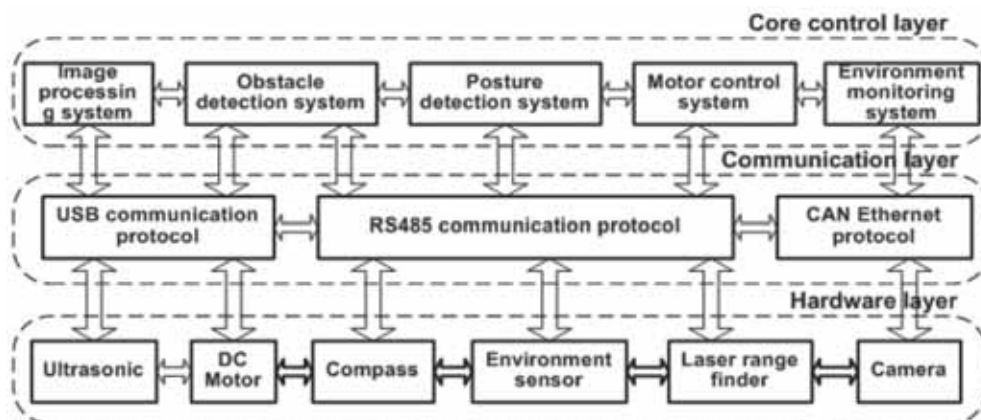


Figure 3: Control architecture of the mine rescue robot

Figure 4: The control process of the mine rescue robot

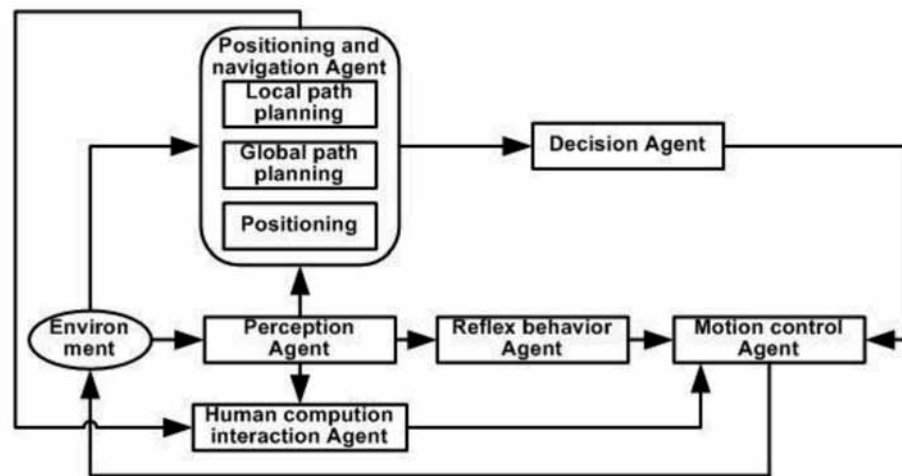
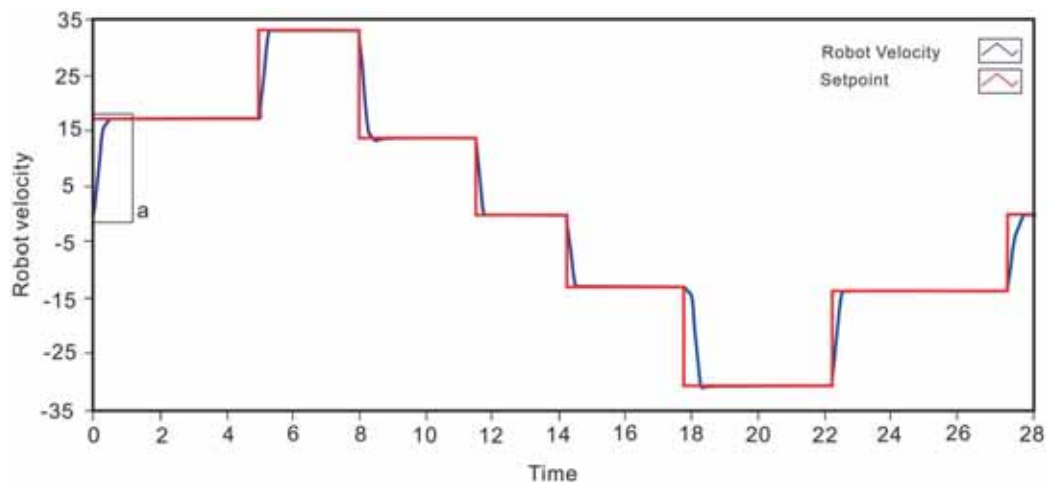


Figure 5: Step responses of the traction motors



Because the I/O ports provided by the extended interface of the development board are not enough, three I/O expanders (PCF8574) are used to add another port through the line bidirectional bus (IIC bus). PCF8574 is a silicon CMOS circuit that can provide general purpose, remote, 8-bit I/O ports for the microcontroller via the two-line bidirectional bus. It can be addressed by three hardware address pins so that as many as eight devices can be extended through the two-line bus if needed.

Furthermore, the LCD and touchscreen can be used to display status information of the robot and diagnose faults. Information such as running speed, arm angles, orientation, gas concentration, ambient temperature, humidity, obstacles distance and communication status are updated regularly and can be accessed at any time.

The Robot's Control Architecture

The control architecture of our robot is shown in Figure 3. It mainly includes three layers: hardware, communication protocol and control layer. The robot's internal state and external environment conditions are monitored by the hardware layer, which includes the various sensors, circuits, motors and drives.

The communication protocol layer is the interactive bridge between hardware and software, which relies on the USB communication protocol, RS485 serial communication protocol and CAN protocol to interact with the system.

Taking the CAN open communication protocol as an example: the control computer and motor drives communicate via the CAN bus, where it takes the CAN node number as a physical address of the device to identify it. Each CAN drive

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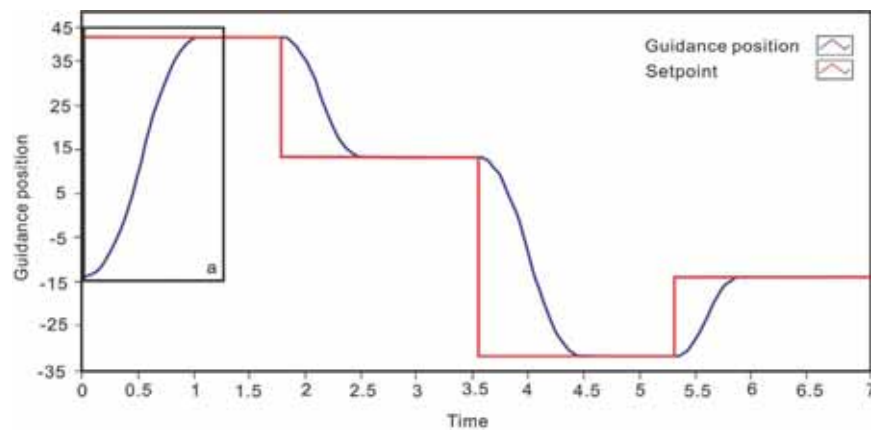


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Figure 6: Step responses of the guidance motors



controller is assigned a unique node number that ranges from 1 to 127, with the 0 node being the broadcast address.

The control layer's primary function is to process the data picked up by the sensors and to send commands to the execution control layer regarding the robot's movements. It is composed of a perception agent, reflex behaviour agent, positioning and navigation agent, human-computer interaction agent, decision agent and motion control agent, of which only the perception agent is associated with these sensors and the rest with the software. The control process of the software system for the robot is shown in Figure 4.

The main task of the perception agent is to gather the external environmental information, as well as the robot's own internal state status. The perception agent transfers information to the positioning and navigation agent and the human-computer interaction agent, so they can perform operations such as path planning accordingly. When the robot meets unexpected or urgent situations, the perception agent sends information to the reflex behaviour agent which then controls the robot directly.

The positioning and navigation agent receives information from the perception agent and sends the current location and posture of the robot to the decision agent. After handling the received data, the decision agent generates motor control commands and sends them to the motion control agent, thus adjusting the position and actions of the robot. This same agent also sends the information from the perception agent to the human-computer interaction agent, when human operators need to interfere in the robot's positioning or when they need to assign it a certain task.

The decision agent is the core software agent and 'brain' of the entire system. It receives information from the positioning

and navigation agent and perception agent; comprehensively handles and fuses that information and outputs consistent results, with the robot moving towards its target in safe conditions and obstacle-free.

The moving motion control agent receives information from three different sources: the reflex behaviour agent, decision agent and human-computer interaction agent, in order to drive the motors. Sometimes there will be conflict between the three agents when sending information, so the reflex behaviour agent is assigned the highest priority and, as such, it can interrupt the other two agents' instructions in the event of emergencies.

Experiments

To verify the robot's reliability, a series of experiments were carried out, including field tests. Robot navigation and feedback were analyzed for movement accuracy, but also for any time delays between command transmission and feedback. Figure 5 shows the step responses of the robot's motors.

The robot's maximum velocity is 1.5m/s. Figure 5 shows no steady state error, and motor velocity increased in a ramp-like fashion, indicating the correct design of the PID controllers for the robot's traction. All four traction motors show the same response, since the CAN network allows transmission of messages in a diffused manner. The robot's arm controller needs to transmit just one message to the CAN network and all ECUs will receive it and control the motors at the same time. This strategy prevents any time delays or lack of synchronism in receiving the control commands.

Figure 6 shows the accuracy of the guidance motors' response in relation to the required set-point. No steady state error and overshoot can be seen, and an appropriate low speed was achieved for the guidance movement. As seen in Figure 6, a guidance position change of 90° takes approximately 1s to occur, resulting in a movement speed of less than the 0.525m/s, as defined in the design guide for navigating the robot. ●

The robot's arm controller needs to transmit just one message to the CAN network and all ECUs will receive it and control the motors at the same time

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How to Assemble the RTC Module For An Arduino Clock Project

BY BROCK CRAFT

A

sssembling the real-time clock (RTC) module for an Arduino clock project is fairly simple. After the kit is assembled, the battery is added and connected to the Arduino, followed by setting the time on the clock IC with an Arduino sketch.

There are nine parts in the kit:

- Real-time clock PCB
- Dallas Semiconductor real-time clock chip (DS1307)
- Crystal (32.768kHz)
- Two resistors (2.2kohm)
- Header (male 5-pin)
- Battery (CR1220)
- Battery holder.

The printed circuit board (PCB) is labelled with the locations where all the components should be placed. They should be soldered in the following order:

1. Solder a little bead of solder onto the battery solder pad, so there is good contact between the button cell and the pad on the PCB.
2. Solder the resistors (R1 and R2) in place; the orientation of the leads does not matter.
3. Add the capacitor (C1) and the crystal (Q1); the orientation of the leads does not matter.
4. Add the DS1307 IC.

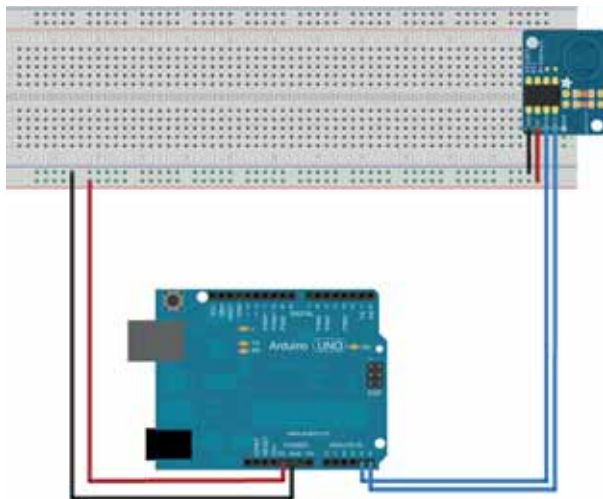


Figure 1: Wiring up the RTC module

Ensure that the little notch in the IC is pointing downward and matches the printed outline on the PCB, as if soldered the wrong way, it won't work at all and will be a pain to remove.

1. Solder the chrome battery holder in position.
2. Insert the header pins into a breadboard and solder the RTC module on top of them.

The header pins should be on the underside of the board, with their short ends are sticking up through the printed side of the PCB.

With the soldering completed, insert the battery, with the positive side facing up. When it is in place, wire up the RTC to the Arduino to be programmed with the correct time. Make the following connections:

1. Create a ground rail and a power rail on the breadboard by connecting the Arduino's +5V and GND pins to the long columns of pins on the sides of the breadboard.
2. Connect the ground pin (GND) to the ground rail.
3. Connect the 5V pin on the RTC to the +5V power rail.
4. Connect the pin labelled SDA to analog Pin 4.
5. Connect the pin labelled SCL to analog Pin 5.

The last pin is labeled SQW and can be used to get a square wave from the RTC chip. As it is not used on the clock, it can be ignored.

After the module is connected, it's time to program it with the correct time. This is done with an Arduino library called RTCLib, provided by Adafruit Industries. The library may also be downloaded from the Adafruit website.

After installing the RTC library, in the examples menu there will be a new item called RTCLib. Load the one called Examples→RTCLib→ds1307. This sketch conveniently sets the time on the RTC module. The important part of this code is in setup():

```
RTC.adjust(DateTime(__DATE__, __TIME__));
```

In this line, the RTC.adjust() function requests the system time from the computer at the time the program is compiled, just before it is sent to Arduino; this is what sets the time on your RTC module. If you ever want to change the time of the module, for example because of Daylight Saving Time, or if the module drifts a bit too much, remove the battery for three seconds, replace it and then re-run this sketch.

If you haven't already done so, upload this code to the Arduino and click the Serial Monitor button in the Arduino IDE. Make sure

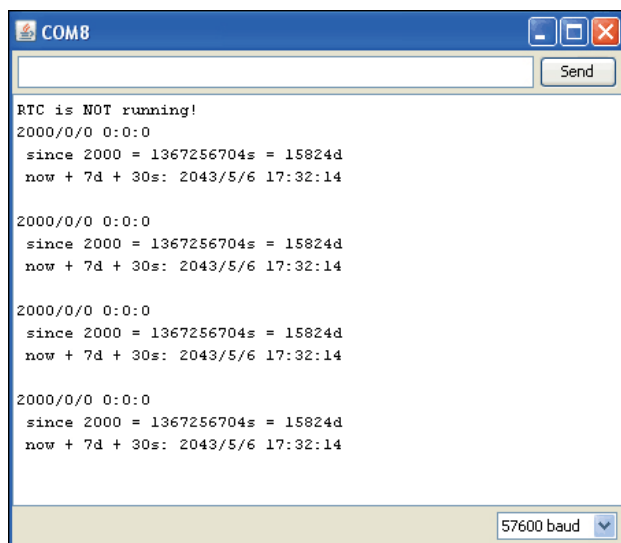


Figure 2: Programming the RTC time and checking it with the serial monitor

your serial monitor is set to 57600 baud in the lower-right corner, otherwise you'll just see gibberish.

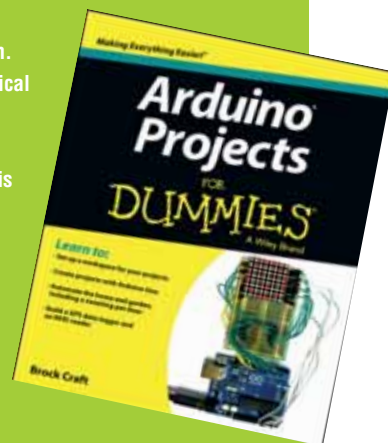
You can also arbitrarily set the time of the RTC module. This is a little trickier, because the time is set to UNIX system time, which is simply the number of seconds since midnight on January 1, 1970. For example, the following code sets the time to February 27, 2012, at 8:50pm:

```
RTC.adjust(DateTime(1330375800));
```

WIN THE 'ARDUINO PROJECTS FOR DUMMIES' BOOK

Brock Craft is a Lecturer in the Department of Computing at Goldsmiths, University of London. He drew extensively on his practical experience with Arduino to write 'Arduino Projects For Dummies'. We have a couple of copies of this book to give away.

To enter please supply your name, address and email to the Editor at svetlanaj@sjpbusinessmedia.com. The winner will be drawn at random and announced at the end of the series.



There's a convenient website for looking up UNIX time, should you need it: www.onlineconversion.com/unix_time.htm.

After you've set the RTC with your system time, you are ready to get the display wired up and fired up. ●

More on this project, as well as other Arduino-related projects, can be found in the book 'Arduino Projects For Dummies' by Brock Craft.

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Feedback Control

MAURIZIO DI PAOLO EMILIO, PHD IN PHYSICS AND A TELECOMMUNICATIONS ENGINEER, PRESENTS THIS SERIES OF ARTICLES ON THE FUNDAMENTALS OF MICROELECTRONICS

A

mplifiers can't be considered perfectly linear, as the gain (or amplification) changes with the power supply or temperature due to variations of the working point of the transistors. These and other real limitations of the amplifiers can be minimized with the use of negative feedback.

Negative Feedback Amplifier

A good functionality of an amplifier is sometimes limited by the presence of extraneous signals, such as the hum of a power supply, coupling with other, neighbouring amplifiers and so on.

In some cases, negative feedback can reduce these effects. One example is amplifiers and hi-fi audio systems, which are powered with DC voltage from a rectifying AC power supply.

Figure 1 shows a possible feedback outline. The output signal of the amplifier is always smaller than the power supply voltages, and its shape can be a clear demonstration that the output is not linear. The result of this non-linearity is manifested as distortion of the output signal.

The use of negative feedback improves amplifier performance. The main effects of a feedback loop are the following:

- Greater gain stability;
- Less distortion;
- Greater bandwidth;
- Noise reduction.

In general, the behaviour of the negative feedback loop (Figure 2) can be described by a transfer function. The G block is called forward path (open-loop gains of the system), the block H is the feedback network: the output signal $V_{out}(t)$ is sent back, through H , to the input, and is controlled by a comparator. The difference signal represents the error of the system, acting as an input signal to block G to output the corrected signal.

If the system is sufficiently fast, any change in the G block does not affect the output signal. Generally, however, if the input signal changes in time, the negative feedback system corrects it to ensure that the output signal is a faithful representation (with amplification) of the input.

Positive feedback (Figure 3) is used to design oscillators, like the feedback when a public address microphone is too close to its loudspeakers. When the loop gain is positive and greater than 1, the oscillations increase exponentially, until the loop is broken by interrupting the feedback circuit path.

Feedback Effects

A disturbance or noise is an unwanted signal superimposed on the input or output of a circuit. Disruptions can occur in various parts of the system; their effect is greater at the input. Considerations about noise effects in the loop systems include:

- Open loop systems are not able to compensate for the disturbance, but if noise is present at the output, its effect is smaller because the useful signal on which it is superimposed is larger.
- Closed loop systems are able to limit the effect of the disturbance when it is present at the output but not at the input.

The effect of the disorder can be evaluated through the signal-to-noise (S/N) ratio, or SNR.

The time that elapses between the moment when the effect

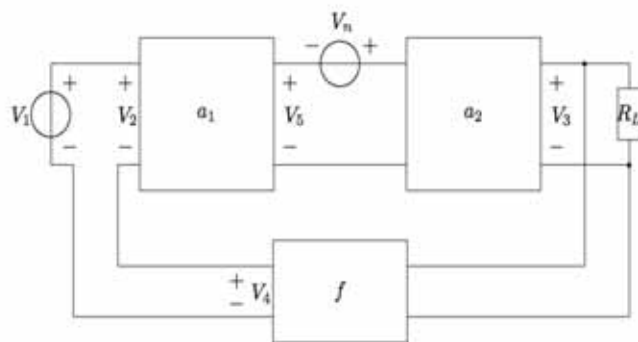
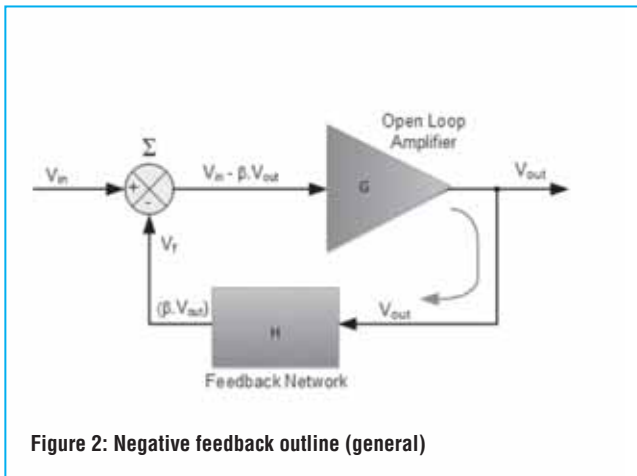


Figure 1: Feedback outline



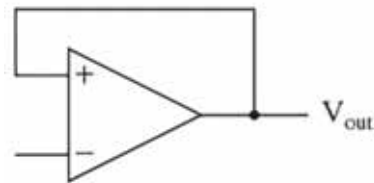
kicks in and the moment it is taken into account to modify the system is called “delay in the feedback loop”. When this delay is high, there may be stability problems.

The Nyquist criterion is a graphical technique for determining the stability of a feedback control system. The Nyquist plot of a closed system in feedback is a representation in the polar plane of the open loop transfer function in terms of frequency, $G(j\omega)$, real part and imaginary part, as a function of the pulsation ω .

PID Controller

The PID controller is probably the most-used feedback control design. PID is an acronym for Proportional Integral Derivative, referring to the three terms operating on the error signal to produce a control signal.

The desired closed loop dynamics are obtained by adjusting the three parameters: proportional, derivative and integral, often iteratively by “tuning” and without specific knowledge of the model. Stability can be ensured using the proportional term only. ●



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IAN DARNEY PRESENTS A SERIES OF ARTICLES ON CIRCUIT MODELLING FOR ELECTROMAGNETIC COMPATIBILITY

Transmission Lines and Antennae

This is the third article in the series. The first introduced the underlying concepts. The second defined a method of creating a triple-T circuit model which can simulate low-frequency cross-coupling.

Circuit components are assigned to the model using data on the geometry of the cable assembly or data from results of electrical testing. These components are described as 'lumped parameters' since they do not cater for the fact that currents and voltages vary along the length of any

conductor. This article shows how a 'distributed parameter' model can be created to simulate the coupling mechanisms up to, and beyond, those frequencies at which interference reaches its highest peak.

Transformation Formulae

It is an observed fact that the current and voltage vary along a twin-conductor cable. Transmission line theory takes this into account, assumes that the waveform of the voltage source at the sending end is sinusoidal and derives a pair of hybrid equations that relate current and voltage at the receiving end to the voltage and current at the sending end.

Figure 1 can be used to define a pair of mesh equations. These can be manipulated to create a pair of hybrid equations that mirror the relationships of the hybrid equations derived from electromagnetic theory. Correlating the passive parameters of these two sets of hybrid equations allows the Z-parameters of Figure 1 to be defined in terms of the inductance, capacitance, resistance and conductance of the line.

Figure 2 shows a corresponding model which uses discrete components. Its relationship with Figure 1 is quite simple. Impedance values can be transformed from lumped parameters to distributed parameters and the transformations are:

$$\begin{aligned} \frac{1}{2} \cdot (Rc + j \cdot \omega \cdot Lc) &\rightarrow Z1 \\ \frac{1}{Gc + j \cdot \omega \cdot Cc} &\rightarrow Z2 \end{aligned} \quad (1)$$

The distributed impedances are defined as:

$$\begin{aligned} Z1 &= Z0 \cdot \tanh\left(\frac{\theta}{2}\right) \Omega \\ Z2 &= Z0 \cdot \operatorname{cosech}(\theta) \Omega \end{aligned} \quad (2)$$

where

$$\begin{aligned} Z0 &= \sqrt{\frac{Rc + j \cdot \omega \cdot Lc}{Gc + j \cdot \omega \cdot Cc}} \Omega \\ \theta &= \sqrt{(Rc + j \cdot \omega \cdot Lc) \cdot (Gc + j \cdot \omega \cdot Cc)} \text{ radian} \end{aligned} \quad (3)$$

and Gc is the conductance.

Figure 3 provides a comparison between the responses of these two models. It is assumed that the model is of a twin-conductor cable, 7.5 metres long, that the far end is open-circuit and the near end is driven by a variable-frequency

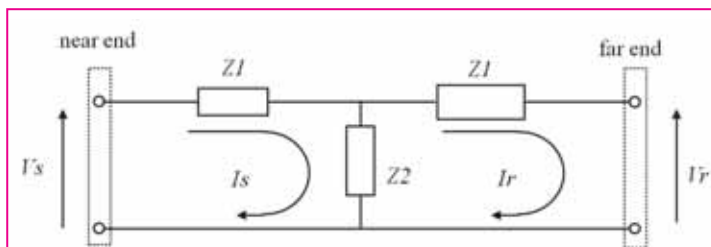


Figure 1: Distributed parameter model of a transmission line

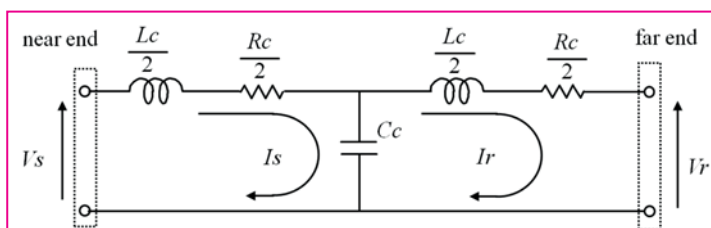


Figure 2: Lumped-parameter model of a transmission line

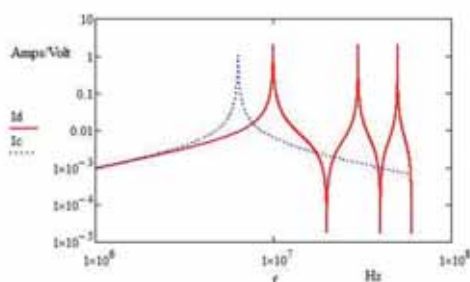


Figure 3: Responses of lumped-parameter and distributed-parameter models

voltage source of 1V via a 1-ohm resistor. The simulation is of the input current. The response of the lumped-parameter model is the dotted blue curve, whilst the distributed-parameter model creates the solid red curve. It is quite clear that the simulation of the distributed-parameter model is more realistic, since the quarter-wave frequency of a 7.5m line is 10MHz. At the quarter-wave frequency, an open-circuit line 'looks' like a short circuit at the sending end.

The fact that one-to-one correlation exists between the branches of the two models means that the cable characteristics can be defined in terms of the familiar components of Figure 2, but analysed using the distributed-parameters of Figure 1. The engineer at the bench can retain visibility of the component values, yet carry out simulations at frequencies well beyond the capability of conventional models.



At resonance, the dipole behaves as a series tuned circuit; since the characteristic impedance of the co-axial cable matches the load resistor, the cable is effectively transparent

Cross-coupling

This technique can be used to simulate the cross-coupling between the signal loop and the ground loop of the signal link illustrated by Figure 4. Using the technique described in the

article on lumped parameters, values can be assigned to the components of the triple-T network of Figure 5.

Replacing each T-network of lumped parameters with a corresponding network of distributed parameters and adding components to simulate the interface circuitry results in the model of Figure 6. This model can be analysed using the analytical tools of Circuit Theory. Mesh analysis results in four simultaneous equations. These can be written down in a Mathcad worksheet (or a Matlab m-file) and processed by the software. At each spot frequency, values can be assigned to all the impedances. Given knowledge of the source voltage V_1 , the magnitude of all four currents can be calculated.

The definitive measure of conducted emission is the ratio of the current created in the ground loop to the source voltage in the signal loop: that is, the transfer admittance YT .

$$YT = \frac{I_{c2}}{V_{c1}} \text{ A/V} \quad (4)$$

If it is assumed that the radii of the conductors are 0.5mm, the separation between the centres is 2mm, the spacing between the conductors and the ground plane is 10mm, the length of the assembly is 7.5m and that the terminals at the far end are shorted together, then the value of the transfer admittance over the range 0-40MHz would be as shown by the dotted blue curve of Figure 7. If the terminals at the far end were open-circuit, the response would be as shown by the red

curve. If the conductors were terminated by the characteristic impedances of the conductors, then the link would be critically damped, giving the response shown by the green curve.

The frequency scale is linear, to illustrate the symmetry between the responses of the grounded and floating configurations. At low frequencies, the transfer admittance of the floating configuration (the red curve) is extremely small. As would be expected, common-mode rejection is excellent.

However, at the quarter-wave frequency of the signal link (10MHz), the transfer admittance reaches a peak. Common-mode rejection is virtually zero. Conversely, at 10MHz, the transfer admittance of the grounded configuration is virtually zero; and so is the level of interference due to cross-coupling.

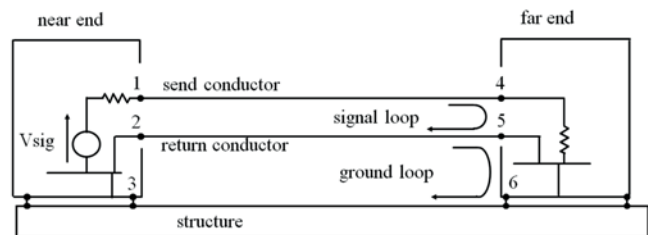


Figure 4: The signal link

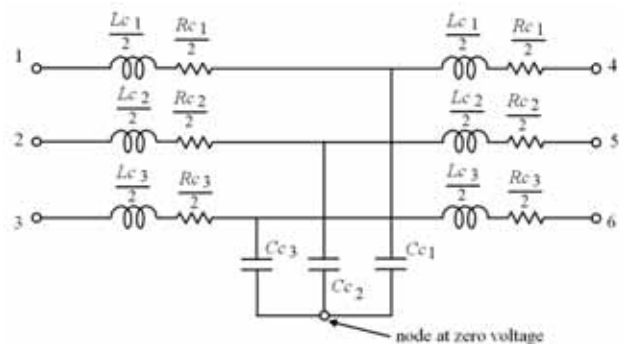


Figure 5: Lumped-parameter model of conductor assembly

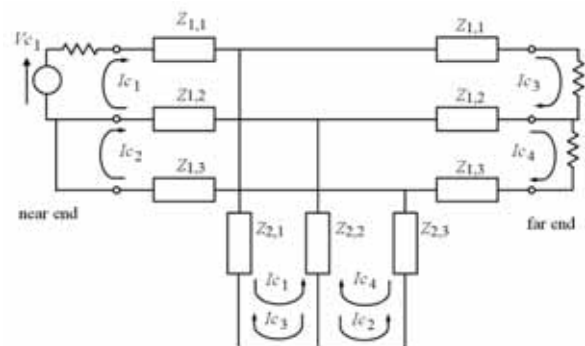


Figure 6: Distributed-parameter model of a signal link

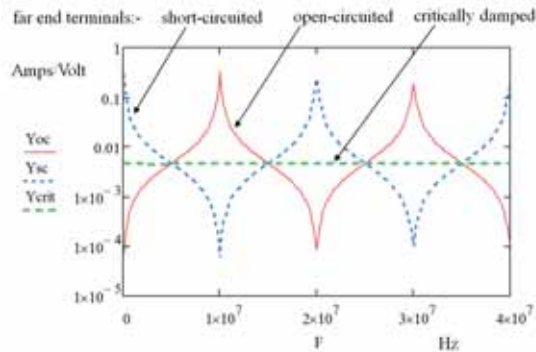


Figure 7: Cross-coupling between signal and ground loops

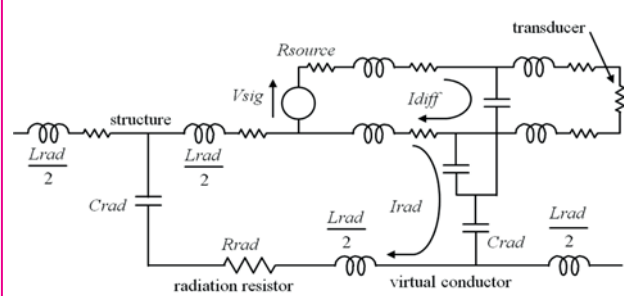


Figure 10: Circuit model – radiated emission from a twin conductor cable

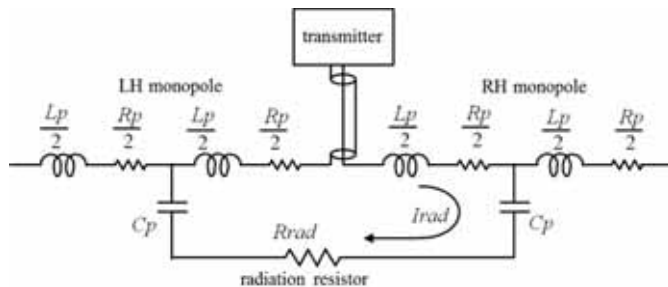


Figure 8: Circuit model of a transmitting dipole

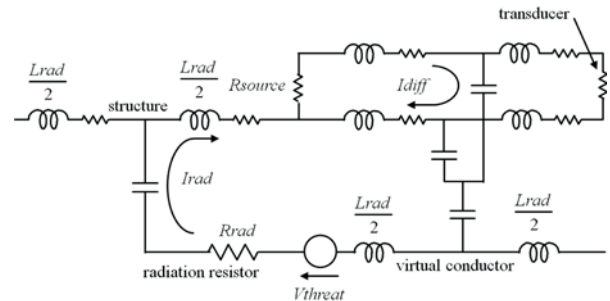


Figure 11: Circuit model – radiation susceptibility of a signal link

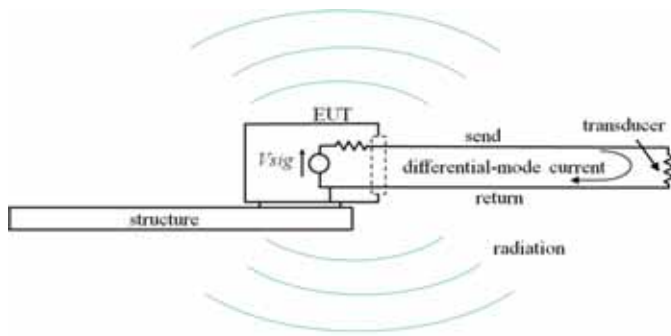


Figure 9: Twin conductor cable connected to remote transducer

The Half-Wave Dipole

Analysis of the half-wave dipole antenna reveals that it behaves as a resistor when delivering peak output. This is called the radiation resistor, and its value has been calculated to be 73 ohms. The article on lumped parameters in the last issue of Electronics World introduced the concepts of the primitive capacitor and the primitive inductor to define the reactive properties of any conductor when it is acting as an antenna. Combining these concepts together leads to the model of Figure 8. Each monopole is represented as a T-network. At resonance, the dipole behaves as a series tuned circuit.

Radiated Emissions

The dipole model can be developed to simulate the coupling between a twin-conductor cable and the environment, as illustrated by Figure 9. The cable is routed well away from any structural conductors.

In the model of Figure 10, the structure behaves as the left-hand monopole whilst the cable and the remote transducer behave as the right-hand monopole. Each conductor is represented by a T-network, whilst the effect of the environment is represented by a virtual conductor.

The inductance and capacitance of the virtual conductor can be defined as:

$$L_{rad} = \frac{\mu_0 \cdot \mu_r \cdot l}{2 \cdot \pi} \cdot \ln \left(\frac{l}{r_{1,2}} \right) \text{ H} \quad (5)$$

$$C_{rad} = \frac{2 \cdot \pi \cdot \epsilon_0 \cdot \epsilon_r \cdot l}{\ln \left(\frac{l}{r_{1,2}} \right)} \text{ F} \quad (6)$$

where $r_{1,2}$ is the radial spacing between the centres of the twin conductors and l is the length of the cable.

The signal source creates a differential-mode current in the twin-conductor cable. Current in the send conductor creates an electromagnetic field, most of which couples with the return conductor, creating a current of the opposite polarity in that conductor. The rest of the energy radiates out into the environment. The current loss is represented by I_{rad} .

As far as EMC analysis is concerned, worst-case conditions arise when the assembly acts as a tuned dipole. That is, when the reactive components assigned to the structure are identical to those of the virtual conductor. As with the analysis of cross-coupling, the circuit components are defined in terms of lumped parameters, but transformed into distributed parameters during the computation process.

The strength of the magnetic field at a radial distance s from the cable can be estimated using:

$$H = \frac{I_{rad}}{2 \cdot \pi \cdot s} \text{ A/m} \quad (7)$$

It may or may not be a coincidence that this is also the formula for the magnetic field strength at a radial distance s from an infinitely long straight wire carrying constant current.

The electric field strength at this point is:

$$E = Z_i \cdot H \text{ V/m} \quad (8)$$

where Z_i is the intrinsic impedance of free space:

$$Z_i = 377 \, \Omega \text{ approximately} \quad (9)$$

Radiation Susceptibility

The same circuit model can be used to estimate the susceptibility of the signal link. In this case, the source of interference is the electromagnetic field of the environment. This induces a threat voltage V_{threat} in the antenna-mode loop as shown by Figure 11. This voltage is:

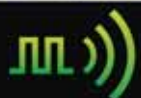
$$V_{threat} = \frac{\lambda}{\pi} \cdot E \text{ Volt} \quad (10)$$

where E is the maximum amplitude of the electric field strength of the threat environment and λ is the wavelength. Given knowledge of these parameters, it is possible to calculate the value of the currents I_{rad} and I_{diff} at any particular frequency and assess the effect this has on the normal response of the system. ●

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features: 'The Global Components Market – A Brief Update' by Aubrey Dunford, Managing Partner of Europartners Consultants; 'Around The World With 17 Cords' by Bob Wersen, President of Interpower Corporation; counterfeiting covered by Mark Rinehart, Managing Director of White Horse Laboratories; and obsolescence and reshoring.

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umt-h.schurter.com

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Intelliconnect Connectors And Cable Assemblies Lead The Way On Quality

Intelliconnect (Europe) Ltd offers one of the widest ranges of connectors available to designers and buyers. Standard connectors include N, C, TNC, 7/16, SMA, SMB, MCX, triax, 3.5mm, 2.92mm,



2.4mm, 1.85mm millimetre-wave ("mmwave") products and quadax types.

Intelliconnect can also provide waterproof versions, proven to IP68 when connectors are unmated.

Most custom connectors, adapters and cable assembly solutions are available within a maximum of 6 to 8 weeks with quotations and drawings confirmed within 24 hours of enquiry.

www.intelliconnect.co.uk

Euroquartz To Show Crystals And Oscillators At ES Live

Frequency control specialist Euroquartz is showing its latest crystals and oscillators for use in embedded applications at the ES Live show (stadiummk, Milton Keynes, 15 May 2014).

Euroquartz produces a wide range of frequency control products for embedded designs including quartz crystals, oscillators, VCXOs and TCXOs. Invariably



a small footprint package is required with specification parameters including low current consumption and custom supply voltages.

Another increasingly

popular choice of embedded designers is the Euroquartz XOE32 range of small footprint SMD clock oscillators.

www.euroquartz.co.uk

New M12 T-pieces Improve Connector Options

Binder has enhanced its range of connecting cables and distributors with the range of M12 T-pieces suitable for connecting two sensors, actuators or active components to the bus line for CANbus or DeviceNet. Versions are offered with either five-pole male M12 to two female M12, four-pole female M12 to one male one female M12 or five-pole female M12 to one male and one female M12.

These A-coded M12 interface connections have a connector body of nickel-plated brass, gold-plated contacts,



a rated current of 4A and 100 mating cycles, and are protected to IP65

when mated. They are highly suited for use in all types of control, automation and sensing equipment.

www.binder-connector.co.uk

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embedded world Exhibition & Conference

Nürnberg, Germany. 25–27 February 2014

www.embedded-world.de

The Embedded World Exhibition & Conference was once again the biggest knowledge-packed workroom, opening its doors for three days in February. Over 850 exhibitors from 35 countries presented all aspects of embedded systems.

“Embedded World guarantees healthy development: It is growing continuously; it was successful right from the start; and has been the major meeting place for the embedded community since 2003,” said Richard Krowoza, Member of the Management Board at NürnbergMesse. “Embedded World stands out more than almost any other event, for its dynamic and its innovative power and speed. Professionals meet each other technically and thematically on an equal footing. At least 24,000 embedded experts from all over the world were expected, making this the

most important and biggest event of its kind.”

The Internet of Things (IoT) and security were the key themes at the embedded world Exhibition & Conference 2014. This was seen throughout the exhibition halls and at the conferences. David Kleidermacher, CTO at Green Hills Software and an expert in system software and the security sector, kicked off the themes with his keynote address “Securing the Internet of Things”.

IoT and security also permeated the three areas on which this year's embedded world conference was focused on: Smart Systems, Smart Software and Smart Connections, taking an in-depth look at the current and future challenges for embedded developers of such systems. The three-day programme consisted of ten parallel sessions and workshops for each theme.

First congatec COM Express Mini Module with Single-Chip, Quad-Core Intel Processor

Congatec has announced its first COM Express Mini Type 10 module with a size of 55 x 84mm and based on the Intel Atom E3800 series of processors. The conga-MA3 comes in four different Intel Atom processor-based versions for high scalability. It ranges from the entry-level single-core Intel Atom E3815 with 1.46GHz and a low power consumption



of 5W, up to the quad-core Intel Atom E3845 with 1.91GHz and 10W maximum power consumption.

The Type 10 module pinout is a refresh of Type 1 and uses the single 220-pin A-B connector. Type 10 COMs take advantage of modern display interfaces.

www.congatec.com

Microcomputer-Compensated Crystal Oscillator Delivers ±50ppb Stability

Launched at Embedded World 2014, IQD's new IQMT-100 series Microcomputer Compensated Crystal Oscillator (MCXO) offers customers OCXO performance in a standard clock oscillator sized package. The design enables a frequency stability of ±50ppb (parts per billion) over the full industrial operating temperature range of -40degC to 85degC whilst maintaining an extremely good typical short term stability of 2E-10/s. The IQMT-100 is housed in an industry standard sized ceramic package measuring just 7 x 5mm with both 8 and 10 pad options available over a frequency range from 10 to 50MHz.

www.iqdfrequencyproducts.com



Microchip Expands Low Pin-Count, General-Purpose 8-Bit PIC Microcontroller Family

Microchip announces, from Embedded World, an expansion of its 8-bit PIC microcontroller (MCU) portfolio, with the peripheral-rich, low pin-count PIC16(L) F161X family. These new MCUs expand the offering of Microchip's Core Independent Peripherals

(CIP), which off-load timing-critical and core-intensive tasks from

the CPU, allowing it to focus on other application tasks. In addition, this family integrates fault-detecting hardware features to assist engineers in developing safety-critical applications.

www.microchip.com/get/VDLM



Microchip Adds Three High-Resolution 16-Bit PWMs

Microchip announces, from Embedded World, an expansion of its 8-bit PIC microcontroller (MCU) portfolio with the PIC12(L)F157X family, which features multiple 16-bit PWMs with an assortment of analogue peripherals and serial communications in an 8-pin package.

These MCUs deliver three full-featured 16-bit PWMs with

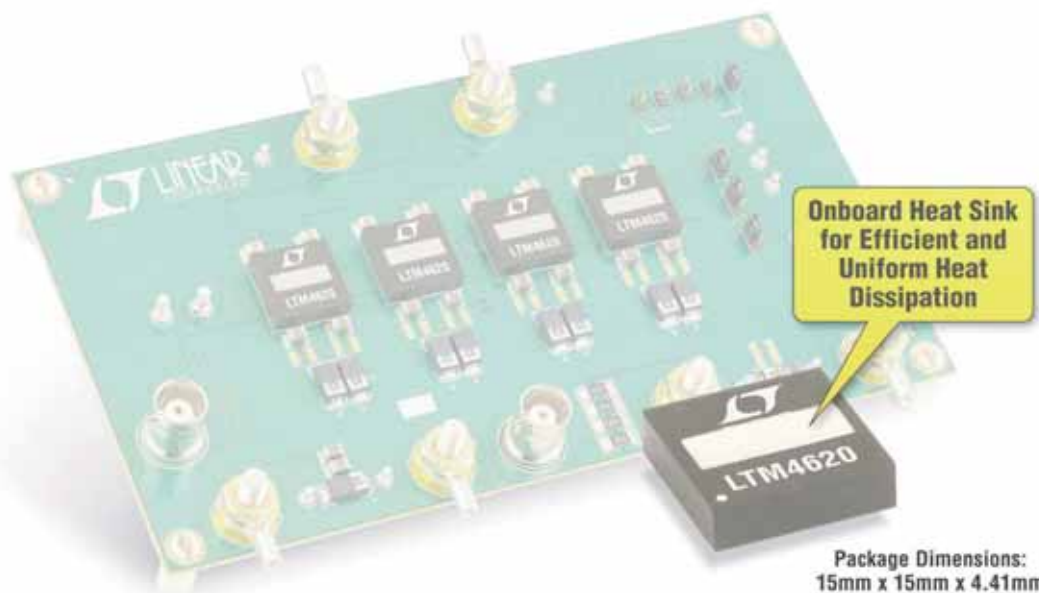
independent timers, for applications where high resolution is needed, such as LED lighting, stepper motors, battery charging and other general-purpose applications. In addition to standard and centre-aligned PWM output modes, the peripheral also has four compare modes and can serve as an additional 16-bit timer.

www.microchip.com/get/G6RB



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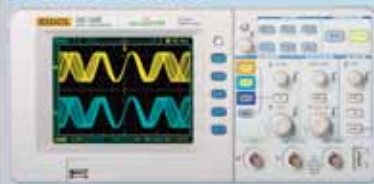
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PIC18F26K22-I/SS	1.28	PIC16F876A-I/SO	2.35
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PIC18F44J10-I/PT	0.95	PIC16F886-I/SO	0.91
PIC18F44J11-I/PT	0.92	PIC16F1827-I/SO	0.61
PIC18F45K20-I/PT	0.96	PIC16F1828-I/SO	0.63
PIC18F45K22-I/PT	1.03	PIC16F873A-I/SP	2.15
PIC18F46K22-I/PT	1.31	PIC16F876A-I/SP	2.25
PIC18F64J11-I/PT	1.17	PIC16F886-I/SP	1.09
PIC18F65J10-I/PT	1.19	PIC18F887-I/PT	1.16
PIC18F65J11-I/PT	1.32	PIC18F4520-I/PT	2.22
PIC18F65J15-I/PT	1.33	PIC18F6585-I/PT	4.55
PIC18F65K22-I/PT	1.48	PIC18F6621-I/PT	4.45
PIC18F66J10-I/PT	1.37	PIC18F6622-I/PT	3.35
PIC18F67J11-I/PT	1.19	PIC18F8722-I/PT	4.35
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PIC18F87K22-I/PT	2.04	M27C1001-10F1	2.44
PIC12F629-I/SN	0.36	M27C512-10F1	1.95
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HIGH EFFICIENCY BUCK-BOOST/BOOST SWITCHING REGULATORS INCREASE BATTERY LIFE

Intersil announced the industry's first high-current buck-boost and boost switching regulator family in a tiny, integrated CSP package, enabling improved efficiency for high-current designs in a small form-factor. Its ISL91110, ISL91108 and ISL91117 power management solutions are based on an innovative, proprietary, fully synchronous four-switch architecture that enables efficiency of up to 96%.

This advanced architecture enables the seamless transition from buck to boost, delivering of up to 2.5A output current at the lowest single-cell Li battery voltages to significantly improve power efficiency, increase battery life and prevent overheating of mobile devices. The ISL91117 boost converter is ideal for USB on-the-go implementations in handheld devices that require high current and high efficiency.

These switching regulators are used in mobile devices to supply the system power management IC (PMIC), the Wi-Fi or radio frequency (RF) power amplifier, as well as other system peripherals such as the camera and memory interfaces.

www.intersil.com



SLIMLINE M12 CONNECTOR FOR GIGABIT ETHERNET APPLICATIONS

Harting has added a slimline M12 connector to its *har*-speed product family for the 8-wire Gigabit Ethernet applications. This is a slim design with crimp connection technology and is significantly smaller in both diameter and length than standard versions. The external diameter has been cut back to 16.5mm, allowing designers to achieve high integration density when the connector is used on devices such as industrial Ethernet switches. The design also has a considerably more robust housing than the standard product, being capable of resisting torques greater than 1.5Nm.

The connector is designed to conform to IEC 61076-2-109, and meets Cat.6A and performance class EA.

The Harting Group develops, manufactures and distributes electrical and electronic connectors, network components, pre-assembled system cables and backplane assemblies. These products are capable of withstanding the harshest demands in industrial environments and provide high data rates for electronic applications.

www.harting.co.uk



CURRENT SENSOR IC COMBINES LOW NOISE, HIGH PRECISION AND DIGITAL OUTPUT

The new ACS764 from Allegro MicroSystems Europe is a low-noise precision digital current sensor IC targeted at server, telecom and power monitoring IC applications at up to 100V within the industrial, consumer and computer markets.



The new fully integrated Hall-effect current sensor IC is the first digital current sensor IC released by Allegro, designed for applications that require digital current sensing and reporting through an I²C bus.

Factory programming of the offset and gain, including the temperature coefficients, stabilises the offset and gain over the operating temperature range. This programming greatly reduces the device total error, typically less than 2% over the operating temperature range.

An integrated low-resistance conductor means that external shunt resistors are not required and, by employing Hall-effect sensing technology, eliminates the error normally associated with the sensor resistance varying with temperature. The device allows 16 unique I²C bus addresses, selectable via external pins.

www.allegromicro.com

NEW VALUES OF RATED CURRENT FOR THE UMT-H, THE SMD FUSE WITH THE HIGH BREAKING CAPACITY

Schurter has expanded its successful UMT-H series of SMD fuses with 13 additional rated currents. The expanded series – which covers rated currents between 160mA and 10A – protecting an even broader range of applications. This means that Schurter now offers the UMT-H in a total of 19 rated currents at voltages up to 277 VAC and 250 VDC. With a rated breaking capacity of 1500A, this compact SMD fuse is capable of protecting against short circuits, while providing reliable over-current protection.



Besides a wide range of applications in power circuits and sensors, the UMT-H is particularly well suited for the primary protection of power supply units rated up to 277 VAC, as well as for the protection of single phase industrial appliances. The spacing between the end caps of > 10mm and the ability to be potted also make these devices useful in applications according to IEC 60079-11 that involve explosion protection.

www.schurter.co.uk

CUSTOM OVERMOULDED CABLE HARNESSES

Durability and consistent performance are two aspects of cable harness design that are critical to the lifetime of a product, especially when used in demanding environments where vibration, impact and corrosion can all greatly reduce the long-term performance of cable harnesses.



SIC can provide overmoulding on products that require it via the dedicated moulding section of its UK manufacturing facility.

Benefits of overmoulding include resistance to shock and vibration, restricts fluid ingress, defending the harness against abrasion and corrosion, and performance in extreme temperatures.

SIC has moulding presses in its ISO9001:2008 certified manufacturing facility and in-house manufacture can be completed to specification and on-time, regardless of the requirements. SIC has 50 years of industry experience, and the engineering and technology resources to take customers' cable assembly design and manufacture it to meet the demands of the application.

www.sicltd.com

"INTERNET OF THINGS" OPENS DOORS FOR ELECTRONIC COMPONENT MANUFACTURERS

Global electronic components distributor Digi-Key Corporation has added several new suppliers in response to customer demand for Internet of Things (IoT) solutions. As device connectivity becomes more prevalent, embedded and wireless suppliers offering machine-to-machine M2M solutions are choosing Digi-Key to expand their customer reach on a global scale.

According to Gartner, IoT is defined as a network of physical objects that contain embedded technology to communicate sense or interact with internal or external environments. The analyst firm predicts that IoT growth in 2014 will far exceed that of other connected devices. Shipments are expected to reach an estimated 26 billion units, nearly a 30-fold increase from 0.9 billion in 2009.

Seeking a competitive edge with the go-to-market strategies, many innovative suppliers have turned to Digi-Key for the company's highly trafficked website and a unique next-generation distribution model, centred on product fulfilment and service excellence.

www.digikey.com



NEW LOAD SWITCH WITH CONTROLLED TURN-ON

Advanced Power Electronics Corp (USA) launched a small load switch with controlled turn-on and very low on-resistance.

The APE8937-HF-3 load switch contains one N-channel MOSFET that can operate over a wide input voltage range from 0.8V to 5.5V and support a maximum continuous current of up to 4A. On-resistance is very low with only 22mΩ from VIN = 1.8V to VIN = 5.0V. The switch is controlled by an on/off input and is capable of interfacing directly with control signals as low as 0.8V. Additional features



include a 300Ω on-chip load resistor for output quick discharge when the switch is turned off. For power-sequencing, the rise time is adjustable by an external ceramic capacitor on the CT pin, which also reduces inrush current.

The APE8937-HF-3 switch is available in an ultra-small, space-saving 2mm x 2mm 8-pin DFN package with thermal pad. The device is halogen-free and fully RoHS-compliant.

www.a-powerusa.com

AVX RELEASES THREE-PHASE MEDIUM POWER FILM

AVX Corporation has released its new FLB series medium power film capacitors. Packaged in a cylindrical aluminium can with terminals that enable direct, three-phase, internal wire connection, FLB series capacitors are comprised of metallized polypropylene dielectric impregnated with a soft polyurethane resin. FLB series capacitors feature a dual safety system consisting of an overpressure disconnect and self-healing technology, as well as exhibit high ripple current and extremely high dielectric strength in operating temperatures spanning -40°C to +80°C. Ideal applications for the series include: power factor correction and output AC filtering in power converters, UPS systems, solar and wind inverters, and motor drives.



The RoHS-compliant FLB series capacitors are available in nine case sizes, six voltages spanning 230-690VAC, capacitance values from 3*20.3μF to 3*335μF, and three capacitance tolerances (±5%, ±10%, ±20%). Unlike aluminum electrolytic capacitors, these capacitors do not have a catastrophic failure mode, as film capacitors simply experience a parametric loss of capacitance of approximately 5%.

www.avx.com

LOW PROFILE, VERSATILE 2MM TEST SOCKETS FROM HARWIN

Harwin launched a new range of PCB-mounted, dual-entry test sockets that accept a 2mm pin. These low-profile devices measure only 5.16mm max above the board when mounted, and feature gold-plated contacts to ensure excellent electrical performance.

The dual entry sockets facilitate easy access. Devices feature a flat upper surface to enable automated pick and place assembly. Both SMT and PTH devices are available: surface mount versions are supplied on tape and reel packaging for automated production or loose for prototyping; through-hole styles are available in three different



colours to facilitate to colour-coding of functions. Devices are rated at 5A, 1500V. They have a contact resistance of 5mΩ (max) and

an operating temperature of -40°C to +80°C.

Key applications include high current test points and wire-to-board connections used in a wide range of market segments such as power supplies, instrumentation, traffic signalling, energy and healthcare.

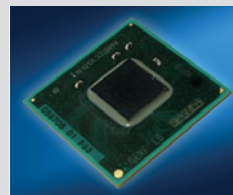
The devices are available from stock.

www.harwin.co.uk

INTEL QUARK SOC X1000 PROCESSORS NOW IN STOCK AT MOUSER

Mouser Electronics is now shipping the new Intel Quark X1000 System on a Chip (SoC), the latest Intel 32-bit processor built for the next generation of connected devices. The Quark X1000 is the first in a new line of Intel processors designed for new applications ranging from Internet of Things (IoT) to wearables, transportation, energy and industrial control.

These new Intel Quark X1000 SoC processors run at 400MHz and are designed specifically for high performance low-power applications. The Quark is backwards compatible with previous Intel processors and software compatible with existing x86



based CPUs such as the Intel Atom and Intel Core line of processors. The Quark is 100% compatible with the Pentium instruction set and even runs PC compatible software.

Performance is enhanced with 16kB of shared instruction and L1 data cache, improving code execution speeds by minimizing the number of times the CPU needs to access external memory. 512kB of on chip SRAM is also available.

www.mouser.com

CONNECTOR SYSTEM COMBINES CAT5E DATA AND 250W POWER IN A SINGLE CABLE

Now available from TTI is TE Connectivity's Cloudsplitter connector system, which delivers Cat5e data performance and up to 250W of DC power in a single cable, integrating eight signal and two power positions; it provides a neat and compact single solution that helps standardize inventory and lower costs.

The system is suitable for a wide variety of applications, including audio visual equipment, industrial equipment, lighting controls, network servers, security systems, set-top boxes and telecommunications.

The Cloudsplitter system includes surface mount jacks, cable assemblies, plug kits, tools and bulk cable, and is RoHS/REACH compliant. Cable is available in shielded and unshielded configuration and as pre-terminated cable assemblies in standard lengths of 2, 5, 10 and 25 meters or on bulk reels. Electrical characteristics for the Cloudsplitter connector system are 1.5A/150 VAC/DC for signal data and it provides DC power at 5A up to 50VDC over two integrated power contacts.

www.tti-europe.com



GAN SYSTEMS APPOINTS JIM WITHAM AS CEO

GaN Systems, a developer of gallium nitride power switching semiconductors, appointed Jim Witham as its CEO. GaN Systems's power conversion devices, based on its proprietary Island Technology, are being commercialized in 2014 and the company is expanding globally. Co-founders Girvan Patterson and John Roberts will continue in their current roles as President and Chief Technical Officer, respectively.

Witham has over thirty years' experience in business development, international sales and marketing and operations management, and joins GaN Systems from Neoconix, a manufacturer of high-density, high-performance miniature connectors. As President and CEO of Neoconix, Witham successfully implemented strategic changes which dramatically increased revenue and resulted in the company's acquisition by Unimicron Technology Corporation. Prior to Neoconix, Witham spent five years as President and CEO at Fultec Semiconductor and has also held VP sales and marketing positions at Aegis Semiconductor and Genoa Corporation. Witham also had a senior executive position at Raychem.

www.gansystems.com

NEW KEITHLEY POWER SUPPLIES ALLOW SAFE BREAKDOWN TESTING AT UP TO 10kV

Keithley Instruments introduced two high-voltage power supplies optimized for high-voltage device and materials testing and high-energy physics and materials science research. The power supplies models 2290-5 5kV and 2290-10 10kV are well suited for high voltage breakdown testing of power semiconductor components. This includes devices made of current- and next-generation wide-bandgap materials like silicon carbide (SiC) and gallium nitride (GaN), designed for use in "green", energy-efficient power generation and transmission systems and hybrid and all-electric vehicles.

Other options on the market for sourcing 10kV lack many capabilities built into Series 2290 power supplies. For example, some don't include a communication interface as standard equipment, don't offer an available protection module, or produce significantly higher output ripple than the Series 2290 power supplies. One popular 10kV sourcing solution requires purchasing a complete chassis-based semiconductor test system, then adding a voltage expander, which means it costs 12 times more than the Model 2290-10.

www.keithley.com



TOUCHSCREEN DISPLAY MODULE STARTER KITS FOR RASPBERRY PI APPLICATIONS

RS Components (RS) offers two touchscreen display starter kits for the Raspberry Pi, which provide a quick and easy wiring interface and are ideal for creating portable and low power Raspberry Pi projects and applications.

The starter kits for the 2.8-inch uLCD-28PTU-PI and 4.3-inch uLCD-43PTU-PI modules have been developed by 4D Systems. They provide all the components needed for users to connect their Raspberry Pi to these newly available touchscreen displays to get their project up and running and ready for programming within minutes. A unique aspect of the kits is the 4D Pi adapter shield, which connects to the serial GPIO port on the Raspberry Pi and to the touchscreen display module via a 5-way cable. The adapter shield also replicates the Raspberry Pi GPIO lines and allows users to gain easy access to other Raspberry Pi functions.

These displays deliver a powerful HMI (Human Machine Interface) solution featuring resistive-touch capability, on-board audio amplifier and speaker.

www.rs-components.com



BELDEN TO SHOW INDUSTRY 4.0 LIVE DEMO AT HANOVER FAIR 2014

Belden will showcase its range of world-class networking, cabling and connectivity solutions for mission-critical applications in alternative energy, safe railway transport systems and reliable energy-efficient data centre management at this year's Hanover Fair.

During the show, Belden – located in hall 9 booth D24 – will highlight a number of solutions for challenging applications, using specialized products from its Belden, Hirschmann and Lumberg Automation branded ranges.

A key focus will be the Smart Factory. Aligned with Industry 4.0, the Smart Factory initiative sets out to create fully flexible production lines. This makes it possible to produce unlimited variations of models on the same line. To do so effectively requires smarter machines, able to adapt immediately to changed requirements and communicate with each other throughout the value stream. The fair will feature a live demo production line to show how the company's latest modules respond as changes occur during production.

www.belden.com



ALTium UNVEILS AUTOMOTIVE SAFETY SUPPORT PROGRAM FOR ISO 26262 CERTIFICATION

Altium made immediately available its TASKING ISO 26262 support program, an offering that assists TASKING compiler users within the automotive industry with ISO 26262 certification.

Automotive embedded systems must be underpinned by high reliability and safety. This remains of critical concern to the automotive industry and follows a number of embarrassing, and potentially life-threatening, failures of coding in automotive embedded systems.

Automotive systems safety issues compound when numerous systems must interoperate, while providing passenger comfort and features. To mitigate the compounding safety risks associated with these embedded systems, the ISO 26262 standard provides guidance along with requirements and processes for testing and certifying automotive embedded software and development tools for safety.

With this in mind, Altium has launched its TASKING ISO 26262 Support Program to provide automakers and parts suppliers with a qualification kit and optional qualification services to comply with ISO 26262 assessment requirements related to confidence in use of TASKING compilers in safety relevant systems.

www.altium.com



PREMIER FARNELL TO ACQUIRE AVID TECHNOLOGIES

High-service distributor Premier Farnell will acquire AVID Technologies, a privately-owned engineering design services company based in Twinsburg, US, for \$13m. AVID's design expertise includes analog, wireless, power management, Field-Programmable Gate Array (FPGA) and embedded technologies.

The acquisition is a key step in Premier Farnell's strategic evolution and provides its customers with a wealth of new services and solutions. With the industrial control space a major focus for Premier Farnell, AVID's expertise enables the company to offer unique design services, tools and turnkey solutions in the fast growing wireless, power management and FPGA technologies at the early stage of the electronic design cycle. Market segments served by AVID include industrial controls and automation, defence, aerospace, medical, automotive and wireless communications.

"This acquisition illustrates perfectly how we are evolving our global strategy to establish partnerships with customers at the earliest stage of their designs," said Premier Farnell CEO Laurence Bain.

AVID was founded in 1985, and currently has approximately 50 employees who will continue to work at their existing base in Twinsburg, Ohio.

www.premierfarnell.com

NEW ENTITY CALLED KNOWLES CAPACITORS CREATED

With a combined history exceeding 175 years, Dielectric Laboratories (DLI), Novacap, Syfer Technology and Voltronics have come together into a single organisation, Knowles Capacitors. This new entity is a division of Knowles Corporation of USA, an independent publicly traded company. A result of the merging of some of the world's leading speciality capacitor manufacturers, Knowles Capacitors becomes a team of great people sharing a common vision.

Knowles Capacitors head office will be in Norwich, UK, and headed up by Howard Ingleson the previous MD of Syfer Technology. The R&D facility for multilayer ceramic capacitors (MLCCs) and EMI filters will be retained at this location as well as other existing sites in the US. Manufacturing will take place at various locations, notably volume MLCCs at the Knowles facility at Suzhou, a major city located in the southeast of Jiangsu Province in Eastern China.

Knowles Capacitors, by virtue of its founding brands, is now a premier global source for MLCCs, single layer capacitors, EMI suppression filters, trimmer capacitors and thin film devices.

www.knowlesc capacitors.com



10 PORT & 20 PORT USB CHARGING & SYNC HUBS

Powersolve professional USB charging & sync hubs are ideal for schools, businesses or in fact any application requiring multiple connection to USB devices, for either charging or data transfer



PSUSB-10CH & PSUSB-20CH

Features

- Charges and syncs up to 10 devices (PSUSB-10CH), or 20 devices (PSUSB-20CH)
- Charge current 2A for 10 port hub and 1.1A for 20 port hub
- Supports high speed 480 Mbps, full speed 12 Mbps and low speed 1.5 Mbps operation
- Compatible with all USB compliant devices
- 10 or 20 USB 2.0 downstream ports, depending on model
- Over current detection and protection and surge and ESD protection
- 3 x 10 port devices can be connected in cascade to give up to an optimum of 30 USB ports
- 2 x 20 port devices can be connected in cascade to give up to an optimum of 40 USB ports
- Supports Windows 98SE/ME/2000/XP/Vista/7/8/ and Mac OS 8.6/9.X/10.X and higher

10 Port 60 Watt USB Charger (charging only)



PLV60-USB

Features

- Universal 90-264VAC Input
- IEC320 C8 2 pin AC Input Connector (UK power cord included)
- Outputs switchable from 10 x 5V 1A or 5 x 5V 2.4A
- Will charge most devices powered by standard USB 5VDC chargers
- EMC to EN55022 'B', CISPR22 'B' & FCC 'B'
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