January 2015
Volume 121
Issue 1945
£5.20

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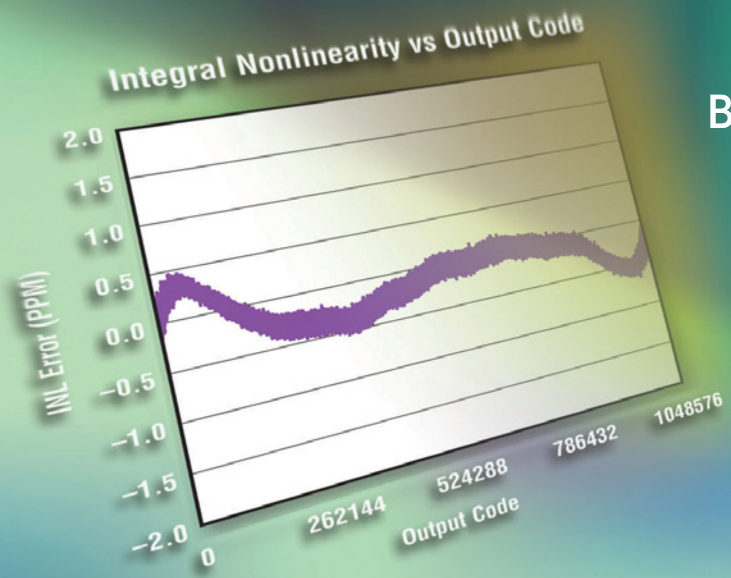
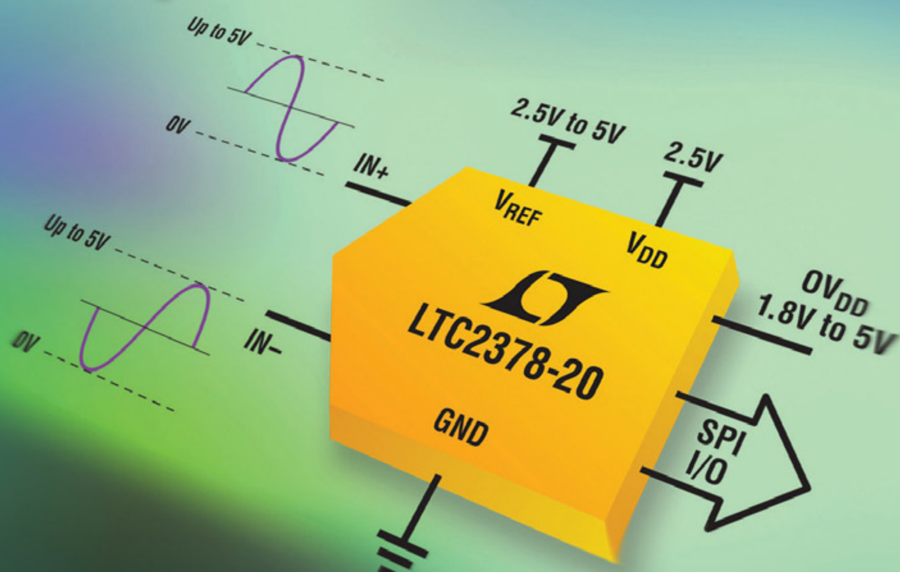
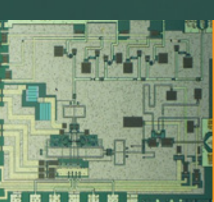




NEW:

- Raspberry Pi projects
- Embedded user interface system design
- Low-power RF design



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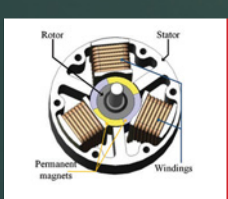

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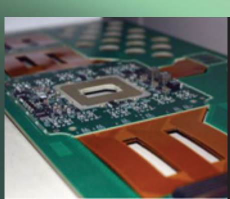
Motor control



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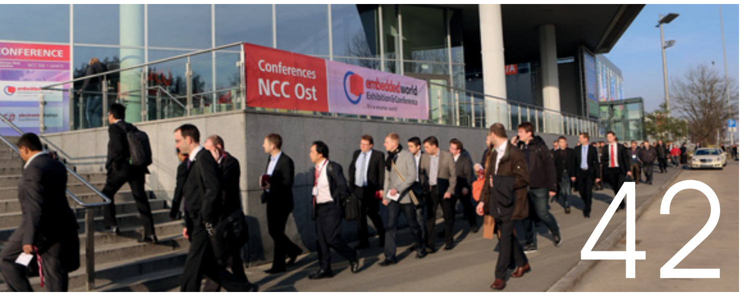

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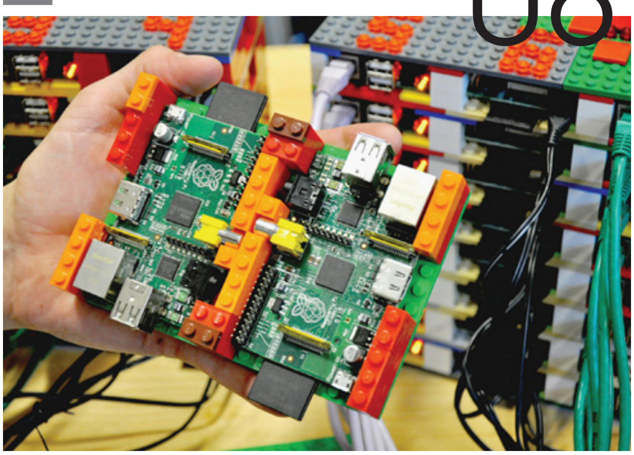

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RoHS AND REACH SCOPE OVERLAP– BUT HOW DO THEY WORK TOGETHER?

On 21 July 2011, RoHS 2 Directive (2011/65/EU) on the restriction of the use of certain hazardous substances in Electrical And Electronic Equipment (EEE) came into force and required EU member states to implement national measures by 2 January 2013. The purpose of the Directive is to protect human health and the environment by banning products that contain hazardous substances in specific concentrations.

Although the scope of RoHS does not cover the manufacturing process, risks arising at that stage have already been considered for the listing of substances in Annex II of the Directive. Such methodology of substances listing is consistent with the one under REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals). When conditions for marketing of EEE are being established, RoHS takes into consideration waste management and recycling, which have a greater potential for exposure of humans and the environment than the manufacturing process does.

REACH applies to all substances (in mixtures or in articles), including those in EEE that fall under the scope of RoHS. This shows where the scopes of the two legislations overlap. However, based on the European Commission Document *"REACH and Directive 2011/65/EU (RoHS) – A Common Understanding" (Doc. CA/36/2014)*, RoHS should be given priority over REACH for issues concerning the use of substances in EEE. The document explores the management of future regulatory action on the same chemical substances under both REACH and RoHS. Specific scenarios concerning restrictions and authorization requirements include:

- RoHS listed vs REACH (Annex XVII) proposed – how to manage future regulatory action?
  - REACH should exclude EEE from the scope of the restriction.
  - The entry in Annex XVII of REACH should indicate that the use of the substance in question in EEE is restricted by the RoHS Directive.

- RoHS proposed vs REACH (Annex XVII) listed – how to manage future regulatory action?

  When RoHS requires taking action in order to establish the same or more stringent measures for EEE:
  - Annex XVII of REACH would need to be amended to remove EEE from the scope of the restriction.
  - The entry in Annex XVII should indicate that the use of the substance in question in EEE is restricted by the RoHS Directive.

- Not any action yet for RoHS vs imminent proposal for REACH (Annex XVII) – how to manage future regulatory action?
  - A restriction could be imposed under REACH.
  - Later to be amended to exclude EEE if/when the substance is added to Annex II to RoHS.

"REACH applies to all substances (in mixtures or in articles), including those in EEE that fall under the scope of RoHS

- RoHS listed vs REACH (Annex XIV) proposed – how to manage future regulatory action?

  Where RoHS has not provided an exemption for the use of the substances:
  - The placing on the market of EEE containing the banned substance is prohibited.
  - The authorization requirement under REACH would apply.

  Where RoHS provides an exemption for the use of the substance:
  - EEE containing that banned substance may be placed on the market in specified cases.
  - Incorporation of the substance in EEE by EU manufacturers would be subject to the authorization procedure under REACH.
  - Possibility is open to exempt the uses covered by the RoHS restriction from the authorization process under REACH.

- RoHS proposed vs REACH (Annex XIV) listed – how to manage future regulatory action?

  Where RoHS restricts without exemptions:
  - The placing on the market of EEE containing the banned substance is prohibited.
  - The authorization requirement under REACH would apply, but there would be no demand for the authorized use of the substance as the substance is proposed to be prohibited under RoHS.

  Where RoHS restricts with exemptions, there will be a need to consider whether there is added value in continuing the authorization requirement under REACH for those exempted applications under RoHS.

- Not yet any action, but risk management measures are considered - How to manage future regulatory action?
  - To include the substance in Annex XIV to REACH and exempt the incorporation of the substance in EEE later, or to delay the REACH procedure, waiting for inclusion of the substance as a RoHS restriction.

By analyzing these scenarios, the Document aims to establish a common understanding on how chemicals under REACH and RoHS should be managed. The Common Understanding document should be taken into consideration in REACH Risk Management Options (RMO) analysis procedures, as well as in the framework of the 2020 Substances of Very High Concern (SVHC) roadmap.

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DESIGN: Tania King
PUBLISHER: Justyn Gidley

ISSN: 1365-4675

PRINTER: Buxton Press Ltd

SUBSCRIPTIONS:
Subscription rates:
1 year: £62 (UK);
£89 (worldwide)
Tel/Fax +44 (0)1635 879361/868594
Email: electronicsworld@circdata.com

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NEW TECHNIQUE CHARACTERISES THE FLOW OF LIGHT IN NEXT GENERATION PHOTONIC CHIPS

Researchers from the University of Southampton have developed a new technique for producing more reliable and robust next generation photonic chips.

Photonic chips made of silicon are expected to play major role in future optical networks, because of its high refractive index which allows for very small optical structures. Squeezing in more optical structures for light distribution, modulation, detection and routing into smaller chip areas enables higher data rates at lower fabrication costs. But as the complexity of optical chips increases, testing and characterising such chips becomes more difficult. Light travelling in the chip is confined in the silicon, so it cannot be detected or measured from the outside.

Southampton researchers have now developed a new method, which will help solve this problem, effectively determining where the light in the chip may be at a particular time. The technique, called Ultrafast PhotoModulation Spectroscopy (UPMS), uses ultraviolet laser pulses of femtosecond duration to change the refractive index of silicon in a tiny area on the photonic chip.

Non-contact characterization tools like UPMS are vital for scientist designing complex photonic chips. The UPMS technique is fast and robust and has the potential to be used for testing in the photonics industry.

"Monitoring the transmission of the chip while the refractive index is locally changed gives a precise picture of how the light flows through it. This allows testing of individual optical elements on the chip – a crucial step in the design optimisation to ensure its flawless operation. Because the changes induced by the technique are fully reversible, this testing method is non-destructive and, after testing, the chip can be used for its intended application," said Dr Roman Bruck, from Physics and Astronomy at the University of Southampton.

The research team expects the technique to become a standard characterisation tool, making photonic chips under development more reliable and bringing them to market quicker.

TSMC DELIVERS FIRST FULLY FUNCTIONAL 16FINFET

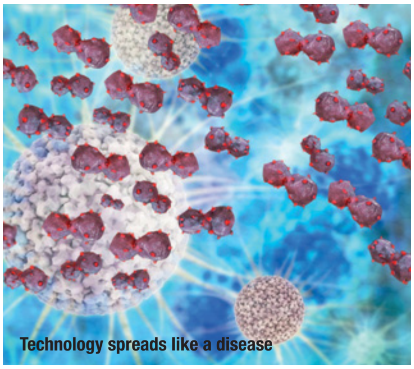
TSMC in collaboration with HiSilicon Technologies has successfully produced the foundry's first fully-functional ARM-based networking processor with FinFET technology. The 16FinFET process promises impressive speed and power improvements, as well as reduced leakage current. All of these advantages overcome challenges that have become critical barriers to further scaling of advanced SoC technology. It has twice the gate density of TSMC's 28HPM process, and operates more than 40% faster at the same total power, or reduces total power over 60% at the same speed.

"Our FinFET R&D goes back over a decade and we are pleased to see the tremendous efforts resulted in this achievement," said Dr Mark Liu, TSMC President and Co-CEO. "We are confident in our abilities to maximise the technology's capabilities and bring results that match our long track record of foundry leadership in advanced technology nodes."

Built on TSMC's 16FinFET process, HiSilicon's new processor enables a significant leap in performance and power optimisation supporting high-end networking applications. By using TSMC's production-proven heterogeneous CoWoS (Chip-on-Wafer-on-Substrate) 3D IC packaging process, HiSilicon integrates its 16nm logic chips with a 28nm I/O chip for a cost-effective system solution.

TECHNOLOGY SPREADS LIKE DISEASE

Scientists investigated the spreading of online innovations using big data and came to the conclusion that social adoption of innovation is similar to the pattern of epidemic contagion. Although these mechanisms have been identified by quantitative theories, their role and relative importance are not entirely understood, since empirical verification has been so far hindered by the lack of appropriate data.


Technology spreads like a disease

Through the analysis of detailed records from Skype, the world's largest voice over Internet protocol, the researchers have brought to light evidence that empirically support the assumptions behind models of social contagion. The study conclusions are that the theoretical framework for disease spreading can be adapted to this complex social contagion process by incorporating effects of social pressure and of the media. Diffusion of innovation can be interpreted as a social spreading phenomena governed by the impact of media and social interactions. The results of the study highlight three mains findings:

- The probability of spontaneous service adoption is constant – meaning people who adopt a service based on pervasive media or advertisements.
- The probability of adoption via social influence is linearly proportional to the fraction of adopting neighbours – meaning the likelihood of users joining the service is directly proportional to the number of friends they have who use it.
- The probability of service termination is time-invariant and independent of the behaviour of peers.

By implementing the detected diffusion mechanisms into a dynamical agent-based model, the research team was able to emulate the adoption dynamics of the service in several countries worldwide. The findings of this first of its kind approach enables to make medium-term predictions of service adoption and disclose dependencies between the dynamics of innovation spreading and the socioeconomic development of a country. The more tech savvy and open a society is, the higher the likelihood of innovation spreading more rapidly.

WORLD RECORD IN DATA TRANSMISSION

Fewer cables, smaller antennas and quicker video transmission may be the result of a new type of microwave circuit designed by Chalmers University of Technology in Sweden.

With an increasing number of users, higher demands on image quality and more wireless systems transmitting enormous amounts of data through the air at the right speed is a major challenge. One solution is to use frequencies of 100GHz and higher, which would give access to a larger band of empty frequencies, enabling a higher data rate. Researchers are already working on producing data circuits that can transmit and receive signals powerful enough at higher frequencies and a Swedish team from Chalmers University of Technology in cooperation with Ericsson has already been successful.

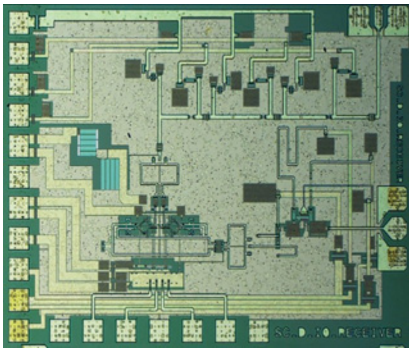
"We have designed circuits for signals at 140GHz, where we have a large bandwidth. In laboratory testing, we have achieved a transmission rate of 40Gbps, which is twice as fast as the previous world record at a comparable frequency," says Herbert Zirath, professor in high speed electronics at Chalmers.

Zirath said that semiconductor materials development has enabled the fabrication of circuits that can transmit high frequency signals with sufficiently high power. The circuits, which are made of indium phosphide, are so small that a microscope is needed to distinguish the details.

The goal is within a few years to achieve wireless data transfer of 100Gbps.

"I believe it is only a matter of a couple of years before our circuits will be used in practical applications," said Zirath.

Some applications for quicker wireless data transmission that Zirath envisions include major cultural and sports events where high-resolution live films need to be transmitted to screens without any delay or long cables, and communication within and between large computer rooms where digital files end up when in the Cloud.



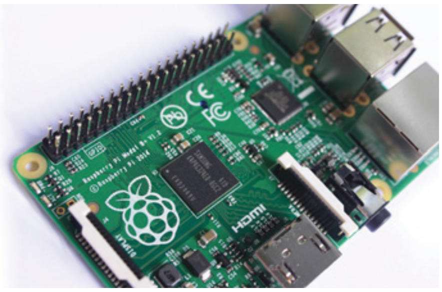
University develops circuit that transmits high frequency signals with sufficiently high power

FIRST IN A SERIES

THIS SERIES INTRODUCES THE RASPBERRY PI SINGLE-BOARD COMPUTER, ITS FEATURES AND BENEFITS, AND HOW TO USE IT IN VARIOUS ELECTRONICS PROJECTS

Introducing the Raspberry Pi

BY **SEAN MCMANUS**

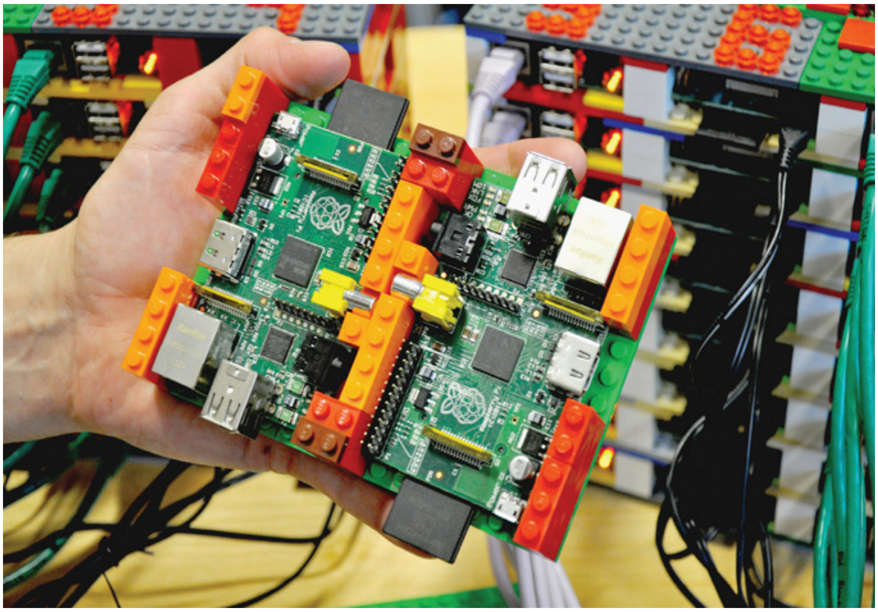


The Raspberry Pi is perhaps the most inspiring computer available today. Although most of the computing devices we use – including phones, tablets and game consoles – are designed to stop us from tinkering with them, the Raspberry Pi is exactly the opposite. From the moment you see its shiny green circuit board, it invites you to work with it. It comes with the tools you need to start making your own software, and you can connect your own electronic inventions to it. It's cheap enough that if you break it a replacement won't break the bank, so you can experiment with confidence.

A lot of people are fired up about its potential, and they're discovering exciting new ways to use it. Dave Akerman (www.daveakerman.com) and friends attached one to a weather balloon and sent it nearly 40km above the earth to take pictures using a webcam.

Professor Simon Cox and his team at the University of Southampton connected 64 Raspberry Pi boards to build an experimental supercomputer (see Figure 1), held together with Lego bricks. The project has cut the cost of a supercomputer from millions to hundreds of dollars, making supercomputing much more accessible to schools and students.

Two of the Raspberry Pi boards used in the University of Southampton's supercomputer, with the rest of the supercomputer seen in the background
[Courtesy of Simon Cox and Glenn Harris, University of Southampton]



The Pi is also being used at the frontier of exploration. The FishPi project (www.fishpi.org) aims to create a vessel that can navigate across the Atlantic unmanned and take environmental measurements along the way, communicating with its base by satellite.

London Zoo is looking at using the Raspberry Pi in a device to detect and photograph animals in their natural habitats, called EyesPi.

Getting Started

Although those projects are grabbing headlines, another story is less visible but more important: the thousands of people of all ages who are taking their first steps in computer science thanks to the Raspberry Pi.

Back in the 1980s, when the notion of a home computer first became a reality, computers were less friendly than they are today. When switched on, there was a flashing cursor, then you had to type commands to get it to do something. On the positive side, a whole generation grew up knowing at least a little bit about how to give the computer its commands and how to create programs for it.

As computers became friendlier and we started to use mice and windows, those skills were no longer needed, so we lost touch with them. Eben Upton, designer of the Raspberry Pi, noticed the slide in skill levels while working at Cambridge University's Computer Laboratory in 2006. Students applying to study computer science had less experience programming than students of the past.

Upton and his colleagues hatched the idea of creating a computer that would come with all the tools needed to program it, selling at only $25. It had to be able to do interesting things so that people were drawn to use it, and had to be robust enough to survive being pushed in and pulled out of school bags many times over.

Getting Familiar With The Raspberry Pi

The Raspberry Pi is a circuit board the size of a credit card. Despite its size, this is a fully-featured computer, capable of almost anything a desktop computer does. When switched on, it has a text prompt, but you can use a graphical Windows desktop to start and manage programs. It may be used for browsing the Internet, word processing and spreadsheets, or for editing photos. It may be used for playing music or video or, indeed, games. There's built-in software so the user can create a website.

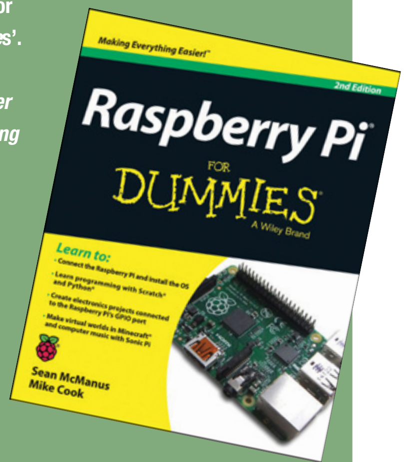
The Raspberry Pi is the perfect tool; however, it is at its best when used for learning how computers work or for creating original programs or electronics projects.

It comes with Scratch, which enables users of all ages to create their own animation and games, while learning some of the core concepts of computer programming along the way. It also comes with Python, a professional programming language used by YouTube, Google and Industrial Light & Magic (the special effects gurus for the Star Wars films), among many others.

RASPBERRY PI FOR DUMMIES OFFER

Sean McManus is a co-author of '*Raspberry Pi For Dummies*'. His previous books include '*Microsoft Office for the Older and Wiser*', '*Social Networking for the Older and Wiser*' and '*iPad for the Older and Wiser*'.

We have copies of '*Raspberry Pi For Dummies*' to give away at the end of the series. Please register your interest by writing to the Editor at svetlanaj@sjpbusinessmedia.com, mentioning the title of the book in the subject field.



Determining The Limitations

For something that costs so little, the Raspberry Pi is amazingly powerful, but it does have some limitations. Although you probably use it as a desktop computer, its power is closer to a mobile device (like a tablet) than a modern desktop PC.

The memory of the Raspberry Pi is more limited than you're probably used to, with just 512MB or 256MB of memory (although this can be expanded just like a desktop PC).

The graphics capabilities also lag somewhat behind today's market: The Raspberry Pi Foundation says the Pi's graphics are roughly like the original Xbox games console released 10 years ago.

Both the Pentium 2 PC and the original Xbox were fine machines, of course, for their time. They're just not as snappy as we're used to, and that's where you might experience some problems. You might find that the Pi can't keep up with the demands of some modern software and that some programs don't run fast enough on it to be useful. However, it's easy to find programs, try them and remove them if they're no good, and plenty of programs for work and play run well on the Raspberry Pi. The Pi gives the freedom to try lots of things you probably wouldn't dare to try – or wouldn't know how to – with your main PC. ●

This is an edited extract from Raspberry Pi for Dummies, 2nd Edition, by Sean McManus, published by Wiley, December 2014

FIRST IN A SERIES

Embedded User Interface Design on a Budget

BY **LUCIO DI JASIO**

The advent of smart phones has turned my embedded-control world upside down. I do resent it and I am going to blame it on Apple!

This used to be a nice and quiet niche market. We used our secret language – assembly, of course. Only the initiated few could decipher it, not to mention master it.

We were proud of making our applications fit into devices with 512 bytes of EPROM, and we were using all of them – literally. Peripherals were for wimps. We used to bit-bang stuff. You need an I2C interface? Here: 40 lines of assembly code. Want a user interface? Here: a blinking (red) LED. Want to splurge? Here is a 2x16 LCD display module.

See, that's what real men did back then.

Then, one morning the iPhone came and all customers started comparing that user experience with ours and started asking for fancy colour displays, touchscreens, sound and connectivity. As if I knew what that meant. Is a 9,600-baud serial port not good enough any more?

You Cannot Write It All!

Seriously, graphics, touch, sound, wired and wireless connectivity are necessary elements of every decent user interface design today, and even when we cannot afford retina displays, we are still expected to provide a lot more user-friendliness. The microcontrollers (hardware) we are dealing with are quite capable but it is the soft stuff that requires a quantum leap.

Say goodbye to the good old days when we could actually write every single line of code composing an application. A quick back-of-the-envelope calculation tells you that, in a time when an 8-bit microcontroller integrates 128kbytes of flash and a low-cost 32-bit microcontroller up to several megabytes, you are going to need hundreds of thousands of lines of code to fill those memories.

Lost In The Jungle

It soon becomes obvious (although not easy to accept) that we have to think differently about our applications. We need somehow to relinquish control, at least for part of the work, and trust somebody else to provide us with some basic building blocks: libraries.

You can only imagine how difficult this was to accept for me. After all, I am the kind of person that never fully trusted a C compiler and always inspected disassembly listings looking for obvious fallacies and inefficiencies. Trusting somebody else's code, possibly thousands of lines of it? Never!

And yet, I did it – I had to! And it's a slippery slope. You add a small library for graphics primitives first, then one small additional bit for touch sensing. Before you realize it, by the time you have an SD card file system in place and some non-volatile storage, you are dealing with a dozen (C language) source files and many more header files, and you are gasping for air in a jungle of compiler warnings and linker errors.

> "Then, one morning the iPhone came and all customers started comparing that user experience with ours and started asking for fancy colour displays, touchscreens, sound and connectivity

MPLAB X And The MLA

It takes a little time to get used to this new world but there are tools that can help. The Microchip Library for Applications (MLA) is one of them. This is a collection of small libraries each dedicated to solving an individual element of the user interface design puzzle. It has been actively developed and expanded for over a decade and has reached a certain level of recognition in the industry for its "obsessive" focus on compatibility across architectures and compactness.

When I say "compatibility", I don't mean across vendors, this is no open-source project by all means. The MLA is a proprietary library released under a license that explicitly prohibits porting to other competing microcontroller architectures. But as long as it's used on Microchip's own microcontrollers, its use is free.

"Compatibility" refers here to the entire gamut of 8-bit, 16-bit, dsPIC and PIC32 microcontrollers offered by the company – a portfolio comprising, as of this writing, over 1,000 different models.

The MLA comes as C source code, so even if you don't get to write every single line of code of your applications, you will be at least able to claim that you could read it all. To me, this is another very important element in any library. Having access to the full source code means having the ultimate ownership of a project, a necessary prerequisite for future maintainability.

The MLA developers have not cut any corners and designed each library module for the maximum efficiency, keeping in mind the impact each decision would have on even the smallest (8-bit) targets. It had some necessary, although not always (eye) pleasing, consequences such as extensive use of conditional inclusion of segments of code, and multiplication of source files and configuration switches.

It is here that a second fundamental (free) tool, MPLAB X IDE comes to the rescue. Unlike its predecessor (MPLAB 8), the new IDE, derived from the Netbeans project, was designed specifically to handle with ease applications that use a large number of library modules. It has special navigation features that allow finding a path in the "jungle" of source files not only possible but quick and efficient. It also comes with a set of three compilers (the MPLAB XC compiler suite) that handles most uniformly the C source language producing 8, 16 and 32-bit binaries as necessary.

Practice Makes Perfect

Looking for a suitable hardware platform to practice with, I settled on the Mikromedia line of products from Mikroelektronika, a company from Serbia probably known to many of you for its large portfolio of inexpensive educational boards and software tools.

The Mikromedia boards are typically designed for a 2.8" TFT display – although larger models are being introduced – and feature a microcontroller of choice plus all the basic elements of a typical embedded design user interface: graphics (QVGA), touch (resistive), sound (MP3), storage (SD card and serial flash), and connectivity (USB, UART, I2C, SPI, Ethernet and wireless on selected models).

Mikromedia boards come preloaded with a bootloader, so you won't need additional hardware to experiment with them.

A True Platform

There are 8-bit, 16-bit and several 32-bit Mikromedia models that can be chosen to fit any application. More importantly, their design is very modular and fits well with the philosophy behind the MLA. Together they form a true platform, helping to solve the real problems every designer faces: migration of code across applications with maximum flexibility and code reuse.

USER INTERFACE DESIGN FOR EMBEDDED APPLICATIONS

Lucio Di Jasio is EMEA Business Development Manager at Microchip Technology. He has been covering various technical and marketing roles within the company's 8, 16 and 32-bit divisions for the past 18 years. Lucio has published several books on programming for embedded control applications, and we have three copies of his book '*Graphics, Touch, Sound and USB, User Interface Design for Embedded Applications*' to give away at the end of the series. If you want to be in with a chance, please write to the Editor at svetlanaj@sjpbusinessmedia.com mentioning the book in the heading.

In Closing

If you are finding yourself feeling a little overwhelmed as I was in this new world of complex demanding application, you are not alone. Chances are you are going to enjoy the ride if you follow the next few installments of this series. ●

Stopband

MYK DORMER IS A SENIOR RF DESIGN ENGINEER AT RADIOMETRIX LTD **WWW.RADIOMETRIX.COM**

Even to an RF engineer, there sometimes seems to be a bewildering number of critical specifications relating to a receiver's performance. Even once the obvious parameters like sensitivity and data rate (or AF bandwidth) are understood, there remains a long list of "rejection" parameters, measuring the ability of the design to tolerate interference on specific, critically-vulnerable frequencies, such as the adjacent channel, the image and second-order responses of the various mixers in the signal path, and various non-harmonic spurii related to associated clocks and frequency sources in the overall design.

Well, there is another one. It hides in the usually quoted blocking parameter – the ability of the receiver design to tolerate a large signal interferer on any frequency not covered under the "specific" parameter measurements – but it is actually the receiver's stopband.

"Stopband" is the term for a filter's ultimate rejection of an out-of-band signal, outside of the obvious close-in-to-the-wanted roll-off characteristics. If you consider your receiver as a (rather complex, rather high-gain, variable frequency) bandpass filter, then the stopband is a measure of the design's absolute ability to co-exist alongside large signal interferers.

"Stopband" is the term for a filter's ultimate rejection of an out-of-band signal, outside of the obvious close-in-to-the-wanted roll-off characteristics

In the past, when frequency agility was more difficult to achieve and discrete signal narrowband interferers were the norm, an argument could be made that usually more vulnerable discrete spurious rejection, such as the (usually) 50-70dB image rejection spec, mattered more than the generally "tougher" blocking limit of (typically) 80-90dB or more. This is no longer true. Easier implementation of multi-channel techniques, combined with wider modulation bandwidths (associated with higher data rates) and greater use of spectrum-spreading (either by DSSS or hopping) has reduced the impact of a single-frequency unwanted signal, but the stopband/blocking performance remains crucial.

Unfortunately, increased use of and dependence on single chip RF techniques have resulted in a generation or two of low-power wireless designs where that crucial stopband performance is noticeably degraded, compared to that achieved by traditional radio design methods.

The stopband performance of a simple (superheterodyne) radio design is dependent on two factors:

- Ultimate out-of-band rejection of the intermediate frequency filters, which is defined by the order of the filter, and stray "leakage" through the signal path;
- Out-of-band phase noise of the local oscillator (or oscillators) driving the frequency conversion mixer(s).

The first of these factors is a simple circuit design issue. It is admittedly easier to achieve 90dB-plus ultimate rejection with bulk crystal and/or ceramic filter elements than with on-chip active filters or DSP systems (and older generation chips were noticeably deficient in this area), but silicon design methods are closing this gap in performance.

Out-of-band phase noise is more of an issue. Conventional low loop bandwidth integer PLLs, or single frequency crystal (or even SAW resonator) frequency sources present noise spectra that rapidly roll off with increased separation from the fundamental output (even if other design issues present enough challenges to fill textbooks) and rarely compromise blocking parameters. These techniques are not, however, applicable to integration on-chip. Here, limitations in achievable VCO performance have led silicon designers to adopt a different approach, using a fractional-N (usually sigma-delta) loop with a wide loop bandwidth and low overall multiplication ratio (so that the vital close-in phase noise is defined by the reference and phase comparator noise instead of the VCO), often combined with a VCO in the 2-6GHz region, followed by frequency dividers to further reduce close-in noise at the much lower wanted frequency.

These techniques now routinely yield narrowband adjacent channel figures of 60dB or better, but as the measurement point moves away from the carrier, the anticipated relative improvement at the alternate channel, and the +3 and +4 channel points are not seen, as the noise spectrum does not begin to roll off until the edge of the loop bandwidth is encountered, at 70-100kHz out or more, and even then the expected (low) noise level at a separation of several MHz from the wanted carrier (but still well within the bandwidth of the front-end filters) is frequently degraded by wideband noise from the divider chain. Very few (if any) silicon "radio solutions" can provide even 75dB of rejection at ±2MHz, where the simplest crystal controlled design will often exceed 90dB.

There is an underlying reason for my spotlighting this specific parameter. As bands become more congested and increasing numbers of everyday devices begin to integrate RF link capabilities (whether this is the much-touted "Internet of Things", or the roll-out of new mobile data services on previously little used spectrum) the stopband/blocking capabilities of low-power radio devices are being put increasingly to the test. As RF engineers, this is a parameter that we cannot "band-plan away" or hide under the sub-clauses of regulations; it is fundamental to the successful operation of low-power wireless links in a new, increasingly hostile radio environment. We need our next generation of devices to not only improve over current "silicon radios" but to match – or better – the performance of older, conventional designs too.

We need to get back to the bench. There is work to be done. ●

A NEW LEVEL OF DATA CONVERSION ACCURACY FOR AUTOMATIC TEST EQUIPMENT SYSTEMS

By Atsushi Kawamoto (Design Manager), Jesper Steensgaard (Staff Scientist), and Heemin Yang (Design Section Leader) – Linear Technology Corporation

The proliferation of complex, high performance system-on-chip integrated circuits has placed great demands on the automatic test equipment (ATE) systems used to manufacture them. Many ATE systems require measurement of critical parameters with extreme accuracy, as they must be significantly more accurate than the devices they are used to test. Modern ATE systems push the boundaries of state-of-the-art signal processing and require parts-per-million (ppm) accuracy. The design of such systems is highly sophisticated, requiring the highest performance integrated circuit components.

At the core of many precision ATE systems is an analog-to-digital converter (ADC). The ADC plays a pivotal role, translating signals from the analog domain to digital for digital signal processing. The accuracy and performance of the ADC often defines the accuracy and performance of the overall system. Now a breakthrough in data conversion performance enables a new generation of higher accuracy lower-cost ATE systems.

Precision ATE System Requirements

Precision ATE systems require high-resolution ADCs to digitize real-world analog signals. Excellent DC specifications (such as offset, gain, and linearity) are typically required for the analog signal chain, including the ADC and supporting signal-conditioning circuitry (such as amplifiers, filters, and references).

In order to achieve ppm-level resolution and accuracy, many precision ATE systems are digitally calibrated to null out any system-level offset and gain errors. As a result, system accuracy is often limited by errors that cannot be suppressed by infrequent calibration, and system designers may be more concerned with potential drift of key parameters than they are with their static values. For example, precision ATE systems may require not only ppm-level accuracy at a fixed temperature, but also sub-ppm/C drift accuracy over a wide operating temperature range.

ADC linearity is of critical concern for overall system accuracy. ADC linearity is determined by complex interactions between the analog input signal and the ADC's internal design and architecture. ADC nonlinearity errors are extremely difficult to calibrate at the system level, since such errors vary substantially from one digital code to another, and because they may be a strong function of temperature. ADC linearity and stability over temperature are crucial for the overall accuracy of precision ATE systems.

Breakthrough Performance

To meet these design challenges, a new family of 20-bit SAR ADCs provides an unprecedented level of performance and accuracy, simplifying the design of high-precision ATE systems. The LTC2378-20 from Linear Technology is the flagship product in a family of pin- and software-compatible SAR ADCs featuring up to 20-bit no-missing-codes resolution and up to 104dB SNR at sample rates from 250ksps to 2Msps. The DC precision of this device is particularly impressive: the ADC integral nonlinearity (INL) errors are typically less than 0.5ppm, and are guaranteed to be less than 2ppm, for all codes over the entire operating temperature range from -40°C to +85°C. The offset error is 13ppm (maximum) with 0.007ppm/°C drift, and the gain error is 10ppm with 0.05ppm/°C drift. This extreme level of performance is achieved while operating at very low power, from 5.3mW at 250Ksps to 21mW at 1Msps. Each device is available in small MSOP-16 and DFN-16 packages.

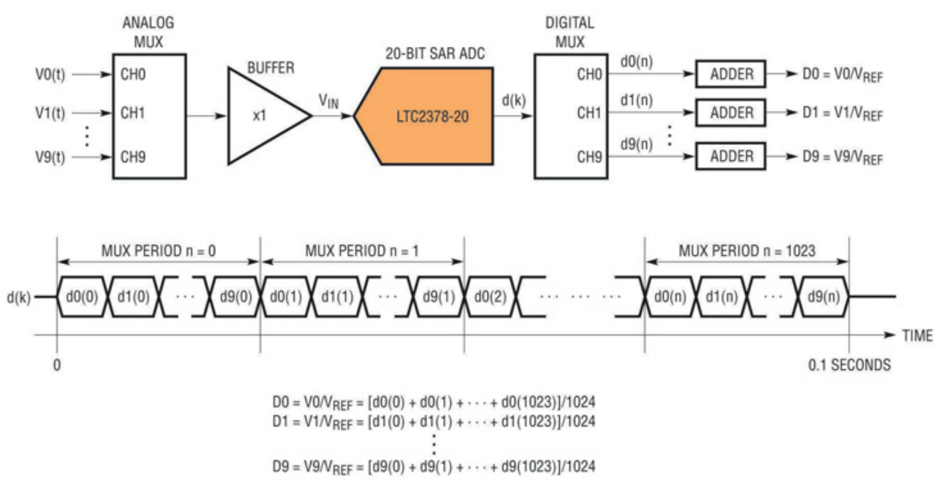


Figure 1: The LTC2378-20 configured to simultaneously read and average 10 analog inputs for a 100ms observation period

Characteristics of SAR ADCs

SAR ADCs are characterized by their ability to acquire a precise snapshot in time of an analog input signal and to complete an analog-to-digital conversion operation within a single clock cycle. SAR ADCs excel at asynchronous "start-and-go" operations, and they are easy to use because the conversion result is available immediately within the same clock cycle. The ability to produce accurate conversion results with no cycle latency, even after long idle periods, makes SAR ADCs ideal for many precision ATE systems. Other types of ADCs, such as delta-sigma and pipelined ADCs require multiple clock cycles to complete a single conversion.

Circuit Architecture

The guaranteed ppm-level linearity and accuracy of the LTC2378-20 is a game changer for many precision ATE systems. The device has been designed using a proprietary architecture that ensures linearity and minimizes its sensitivity to changes in temperature and other operating conditions. As a result, an unprecedented 2ppm INL specification is guaranteed over the entire operating temperature range.

The SAR ADC algorithm is based on a binary-search principle. The analog input is sampled onto a capacitor and is compared sequentially to fractions of a reference voltage selected by the SAR algorithm. The SAR ADC comprises three critical components: a capacitor-based digital-to-analog converter (CDAC), a fast low-noise comparator circuit, and a successive-approximation register. The INL performance of a conventional SAR ADC may be limited by finite matching accuracy of individual capacitors in the CDAC, and many precision SAR ADCs employ analog or digital trimming techniques to improve the matching accuracy. However, as temperature varies and package and board stress is applied, CDAC capacitor matching invariably degrades and may limit the ADC's linearity.

The LTC2378-20 achieves its state-of-the-art INL performance by implementing a proprietary architecture that makes the INL independent of CDAC capacitor mismatch. This makes the device exceptionally robust to the type of temperature variations and package stress effects that are present in harsh industrial environments. Furthermore, the comparator circuit is designed carefully to balance speed, power, and noise, such that the LTC2378-20 achieves an unprecedented 104dB signal-to-noise ratio (SNR), consuming only 21mW at 1Msps without introducing any cycle latency. The power consumption of the LTC2378-20 family of SAR ADCs is proportional to the sampling rate, so that they consume only microwatts when operated at 1ksps.

Accuracy and Speed

The LTC2378-20 achieves a level of accuracy previously available only with much slower ADC architectures, such as delta-sigma or multi-slope ADCs. High-channel-count ATE systems often employ such slow ADC architectures for precision DC measurements, with multiplexers allowing a single meter to service many inputs. The ADC conversion time can often be adjusted over a wide range to trade speed for resolution. However, measurement resolution is often limited to less than 16 bits at sample rates above 100ksps. The ADC device can take a million readings per second, with 2.3ppm noise resolution (standard deviation of noise, 104 dB SNR) of each reading. Results from multiple readings of the same analog signal may be combined digitally to improve the noise resolution, yielding performance exceeding that of multi-slope ADCs. For example, by averaging blocks of 10 samples, the LTC2378-20 effectively operates at 1Msps/10=100ksps with a 0.7ppm noise resolution (114dB SNR).

Delta-sigma and multi-slope ADCs may be configured to average an input signal during an observation/integration period to suppress noise and interference. An observation period of 100ms is often used to simultaneously suppress 50Hz and 60Hz line-frequency interference, resulting in a throughput of only 10 samples per second. Accordingly, it takes a full second to service 10 multiplexed channels with one multi-slope ADC. Figure 1 shows a single LTC2378-20 ADC operating at 102.4ksps, configured with a multiplexer circuit to simultaneously measure all 10 signals (interleaved) during the 100ms observation period. While preserving the suppression of line-frequency interference corresponding to the 100ms observation period, the throughput is increased by the factor of multiplexing (here 10, but can be higher), resulting in much higher productivity of the ATE system. In this example, the noise resolution is increased by averaging across 1024 samples taken from each channel during the observation period, providing 22 bits of noise resolution (0.07ppm or 70nV, rms). The averaging operation can be performed with a simple adder that is easy to implement in either programmable logic or in a processor. Thus, the LTC2378-20 enables significant increases in measurement speed, while maintaining the key advantages of prior architectures.

Because a single LTC2378-20 device can potentially replace several discrete components required for a multi-slope design, a valuable degree of design freedom opens up for balancing cost, board space, and channel count. Replacing a multiplexed meter with one or more LTC2378-20 ADCs can shrink system size, lower power, reduce solution cost, and increase speed by orders of magnitude over traditional approaches. Furthermore, because the device can operate in its native mode as a Nyquist ADC at up to 1Msps, a single LTC2378-20 ADC is ideal for use in systems that otherwise would require more than one type of ADC, such as a multi-slope ADC for high-accuracy low-noise measurements and a SAR ADC for faster lower-resolution measurements.

Precision ATE system designs have a new choice to improve signal chain performance. The 20-bit SAR ADC, LTC2378-20 provides an unprecedented level of accuracy (INL guaranteed at 2ppm) and low noise (104dB SNR) at a high conversion rate (1Msps) and low power consumption (21mW). The combination of high accuracy, low noise, and no-cycle latency makes LTC2378-20 highly versatile for use in precision measurements and control systems, enabling a new generation of highly accurate, flexible and cost-effective precision ATE systems.

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SMART CONTROL OF BRUSHLESS DIRECT CURRENT ELECTRIC MOTORS


Figure 1: BLDC motor

DR IVAN SKORYK FROM DURBAN UNIVERSITY OF TECHNOLOGY PRESENTS THE PROS AND CONS OF THE TWO MAIN METHODS FOR SMART CONTROL OF BLDC MOTORS

During the past few decades, Direct Current brushed electric motors (DC motors) were slightly modified to become BrushLess Direct Current electric motors (BLDC motor). Their application has become rather popular, since they contain fewer mechanical parts, weigh less, offer faster dynamic response and higher reliability, and their torque/motor-size ratio and efficiency are better than those of their predecessors, the brushed DC motors.

BLDC motors are broadly used in a wide variety of applications, successfully replacing brushed DC motors. But despite their benefits, they require sequential commutation of stator windings with the help of a special electronic controller, which is not needed for running brushed DC motors. The important requirement for the electronic controller is to provide maximum motor performance, to control current consumption and produce maximum torque from the motor's shaft.

BLDC Motor Construction

Figure 1 shows a BLDC motor. Inside it looks lust like a brushed DC motor turned inside out, where permanent magnets are on the rotor and windings on the stator (see Figure 2).

As a result of such a rearrangement, there are no brushes or mechanical commutators in this motor, and all the disadvantages associated with the sparking of brush DC motors are removed.

BLDC motors are classified as synchronous devices, because the rotor rotates at the same frequency as the magnetic field of the stator. The stator comprises steel laminations, slotted axially to house an even number of windings along the inner edge (see Figure 2). The rotor is made from permanent magnets (neodymium permanent magnets are usually used, as they provide the best magnetic-force/size ratio) with two to eight north-south pole pairs. The BLDC motor's electronic controller sequentially energizes the stator coils generating a rotating electric field that pushes the rotor around. Efficient operation can only be achieved by energizing the windings at the exact moment. In order to know that precise moment, the exact relative position of the rotor and stator of the motor must be known.

Because BLDC motors have no mechanical or electrical contact between the stator and rotor, alternative arrangements are required to indicate their relative positions and, for this, one of two methods may be used – either employing a Hall sensor or measuring the voltage produced by back electromotive force (EMF).

Smart Motor Control

Since the main function of the electronic controller is to provide smart commutation of the BLDC windings with reference to the relative position of the stator and rotor, its operational quality determines the ultimate performance of the motor.

At the heart of the electronic controller can be either a microcontroller unit (MCU), outfitted with a pulse width modulator (PWM) and at least three analogue-to-digital converter (ADC) channels, or a specially manufactured unit.

A common topology of an electronic controller for a BLDC motor is shown in Figure 3. The MCU produces pulse-width modulated (PWM) signals supplied to MOSFET (Metal-Oxide Semiconductor Field Effect Transistor) or IGBT (Insulated-Gate Bipolar Transistor) drivers. The drivers usually have three pairs of these transistors, each pair driven by a low and a high side driver respectively. They switch the necessary transistors to commutate the wanted windings of the motor, in tune with the signal via the driving bus. The acknowledgement signal brings exact information about the rotor and stator's relative positions, received either via the sensing feedback signal from the Hall sensors or, in a sensorless way, via the ADCs that convert the induced voltage by back EMF.

Sensed And Sensorless Feedback

When sensorless feedback is used, the back EMF voltage serves as acknowledgement signal, so a special filter and voltage divider are needed before the signal is fed into the ADC. The filter removes noise and the voltage divider lowers any excessive voltage created by back EMF at high revolutions per minute (RPM), otherwise the ADC will fail to operate.

Equally, the Hall sensors need to be installed at an exact place, otherwise they will generate the acknowledgement signal at the wrong time, leading to reduced torque and excessive current consumption.

Two ways to achieve the feedback signal are shown in Figure 3, but only one can be used at a time for motor control; it is for the designer to decide which one to use for the application.

Sensorless feedback is quite popular in many applications, however it has one great disadvantage: when RPM is below a certain level the voltage induced by back EMF becomes insufficient for sensing, as the EMF voltage value is directly proportional to the motor's RPM. This makes the operation of a BLDC motor ineffective due to absence of an acknowledgement signal, effectively corresponding to open-loop operation.

There's another disadvantage of a sensorless feedback: when the motor is stationary, no back EMF voltage is generated, depriving the MCU of information about the stator and rotor's relative positions.

The solution, which can help when sensorless motor control is used, is to start the BLDC motor in an open loop configuration by energizing the coils in a pre-determined sequence until the motor reaches sufficient RPM to generate enough back EMF voltage to switch to normal (efficient) closed-loop operation.

As a general rule of thumb, those applications requiring the motor to operate predominantly at low RPM need contactless Hall sensors to generate a stable feedback signal.

Using MCUs in electronic controllers will help connect several controllers with a host controller via I2C, Serial Peripheral Interface (SPI) or other available buses to provide simultaneous control of several BLDC motors at once. Also, additional inputs can be used for RPM regulation, and reverse and forward (R/F) switching.

The PC board of an MCU-based electronic controller is shown in Figure 4.

Figure 2: The inside of an BLDC motor

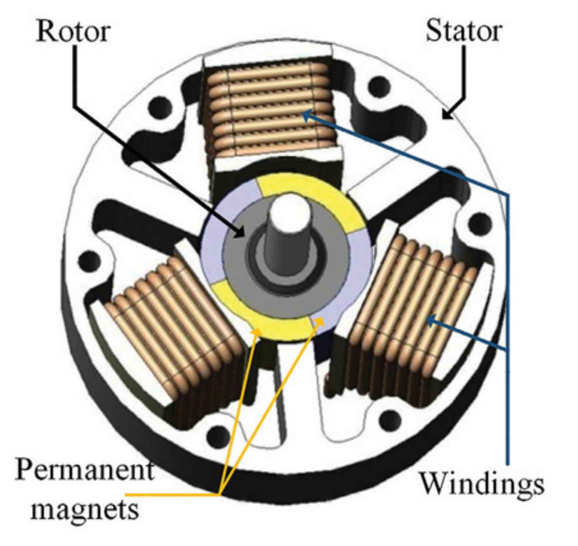


Figure 3: Circuit diagram of a BLDC controller

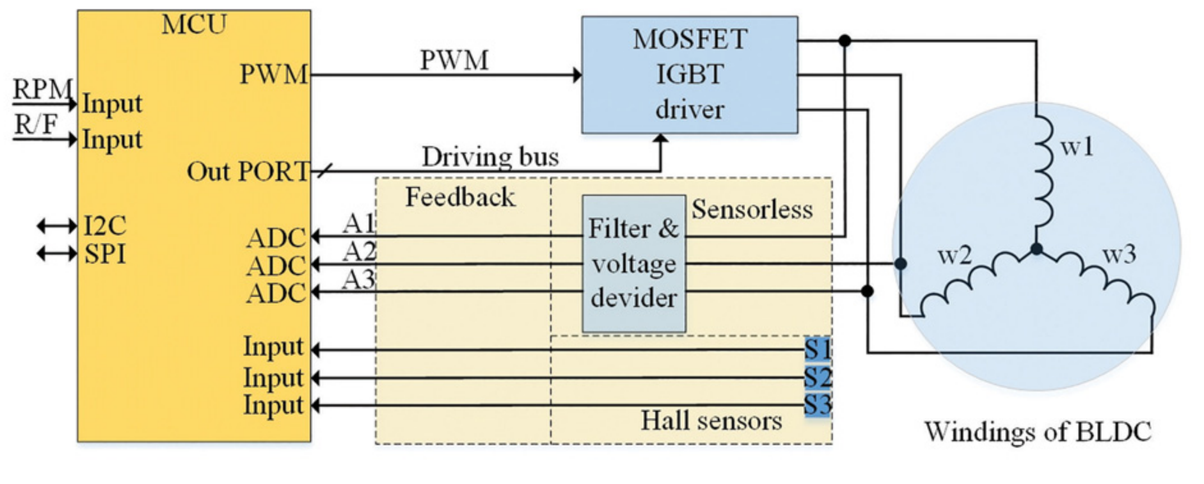
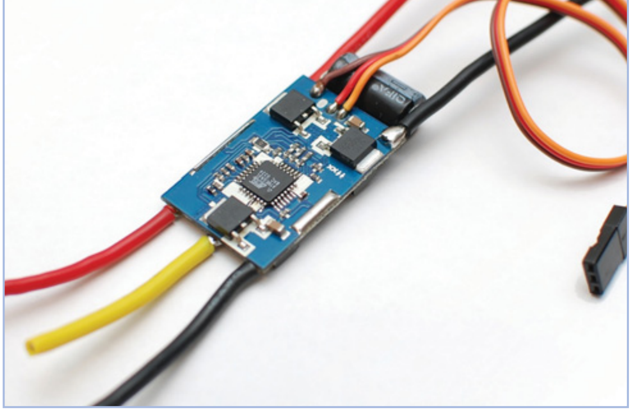


Figure 4: The board of an MCU-based BLDC electronic controller



Specialized Motor Controllers

Another option is to use specialized controllers; a list of the most popular controllers is shown in Table 1. Some have embedded MOSFET power switches that don't require external power transistors and some have only embedded MOSFET drivers and require external transistors to commutate the motor windings. One key advantage of specialized motor controllers is they don't require firmware like an MCU does.

External Power Switches

One overriding requirement for high performance of the BLDC motor is the use of proper power switches or transistors. Both MOSFETs and IGBTs can be used for commutation of the motor windings, although IGBTs are the preferred choice for motor control applications due to their better performance at relatively low operation frequencies and high current conditions. When using MCUs or specialized controllers external transistors are required, which they should be chosen according to their load conditions and specifications, depending on the electrical characteristics needed for a certain BLDC motor in an application. Principal applications and operational features of IGBTs and MOSFETs are shown in Table 2.

Effective Ways

This article presents two effective ways for smart control of BLDC motors with the help of electronic controllers. Motor control can be established with a customised MCU or a specialized controller. It can provide sensorless and sensor motor control with IGBT or MOSFET devices for motor winding commutation.

The main features of each approach can be summarized as:

- Using MCUs for motor control increases flexibility and interoperability, however it also increases cost and requires a designer to create firmware for the MCU. If flexibility and interoperability are not needed, then a specialized motor controller from well-known vendors can be used to reduce costs and design time;
- Depending on the application of the BLDC motor, sensorless or sensored feedback can be used to obtain acknowledgement information about the rotor and stator's relative positions. The designer, however, should take into account that the sensorless motor control can't provide effective control when the motor is stationary or RPM is not high enough to provide adequate back EMF voltage; in this case Hall sensors or open-loop motor operation techniques should be applied.
- Readily available IGBTs and MOSFETs can help make proper choice of the required device for the application, and provide the highest performance for motor control; for example, to control high-power BLDC motors, IGBTs are preferred to MOSFETs.

Table 1: BLDC electronic controllers

Type of controller	Feedback	Number of phase (windings)	External power switches	Manufacturer
STK6103	Sensorless	3-Phase	None (output current up to 3 A)	Sanyo
ML4425CS (ML4425)	Sensorless	3-Phase	Required	Micro Linear
MSP430	Hall sensor	3-Phase	Required	Texas Instruments
Si9979	Hall sensors	3-Phase	Required	Vishay Siliconix

Table 2: Main operation and application features of IGBT and MOSFET devices

	IGBT	MOSFET
Operation	Low frequency < 20kHz; Narrow or small line of load variations; Low duty cycle.	High frequency applications > 200kHz; Wide line or load variations; Long duty cycles.
Application	Motor control: Frequency < 20kHz; Constant load, typically low frequency; High average current, low frequency < 50kHz.	Switch mode power supplies (SMPS); Hard switching > 200kHz; Low-voltage applications < 250V; Battery charging.

ENSURING ROBUST AND ENERGY-EFFICIENT SENSORLESS OPERATION OF BLDC MOTORS

THOMAS FREITAG FROM MELEXIS ANALYSES THE CONTROL AND REGULATION OF 3-PHASE BRUSHLESS DIRECT CURRENT MOTORS IN VEHICLES

There are growing demands in the automotive sector to further reduce vehicle fuel consumption and lower CO2 emissions to conserve fossil fuel resources and mitigate environmental impact. This in turn has led to a proliferation of highly efficient electric motors.

This article focuses on the control and regulation of 3-phase Brushless Direct Current (BLDC) motors in vehicles. It will look at how conventional automotive motor control systems dependent on rotor position sensors are now being supplanted by more advanced, sensorless deployments.

Growing Need For BLDCs

BLDCs are increasingly being used in electrical auxiliary units, such as water/oil/fuel pumps and blowers in air conditioning systems. They are more reliable and more energy-efficient than standard, mechanically commutated motors.

Some form of distributed electronics architecture is normally employed, as shown in Figure 1, where the intelligence of a given accessory unit is located within the unit itself, thus combining mechanics, motor and electronics hardware and software into an integrated implementation. Such an approach allows optimization of the system at all levels, in terms of its mechanical, electromechanical, electronic and software elements. And the short cable lengths reduce power losses and the effects of EMI.

From a semiconductor perspective there are key points that need to be addressed when implementing a motor control system. PCB real-estate is at a premium, so highly integrated solutions are preferred – taking up minimal board space and requiring very few external components. A wide operating temperature range needs to be supported due to the uncompromising setting in which the system will be located. Likewise, a high degree of robustness is necessary, with the ability to withstand voltage transients and load dump conditions.

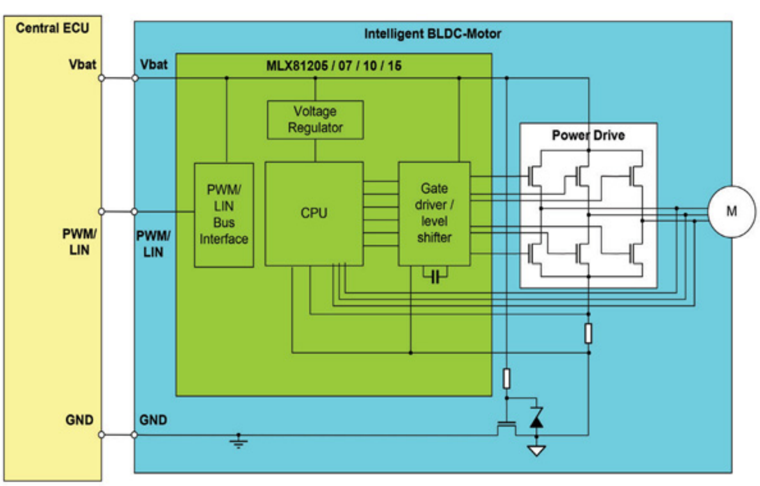


Figure 1: The distributed electronic concept

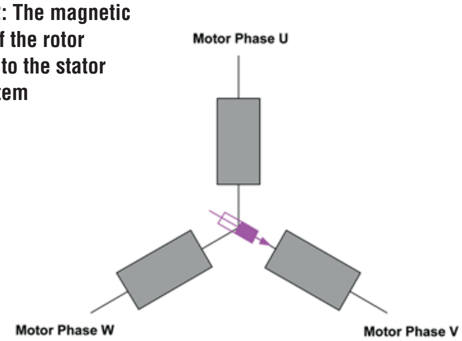


Figure 2: The magnetic vector of the rotor relative to the stator coil system

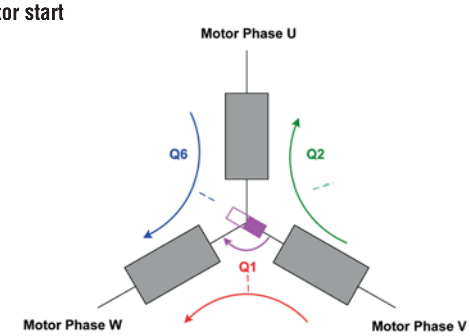


Figure 3: Energizing the motor start

Sensorless BLDC Motor Control

The need for sensorless operation can be for either reliability reasons (dispensing with electromechanical components which are prone to fault) or cost driven.

For a sensorless system, the following requirements must be considered:

- Reliable operation of the mechatronic unit under broad range of load conditions, operating voltages and temperatures;
- Minimized start times of the motor;
- Various motor designs with different current profiles;
- Various dynamics (speed, load inertia, etc);
- Motorized or regenerative operation.

Depending on the specific application, these requirements will be weighted differently – in some cases the motor may be situated in a particularly difficult operational environment, so ruggedness should be prioritised. In other cases there may be a need for a platform approach where the system has to work in conjunction with an array of different motors. Basically, sensorless control is achieved by determining the rotor position. As only two of the three phases are excited at a time, the back EMF (BEMF) voltage of the inactive inductance can be used to furnish information on rotor position.

Operation can be subdivided into three distinct stages:

1) Rotor position detection at standstill;

2) Starting the motor with rotor position detection from the standstill position;

3) Running the motor with rotor-bearing identification.

Let's look first at rotor position detection while at a standstill. In Figure 2 the rotor is shown in relation to the stator. Due to the retroactive effect of the rotor's magnetic vector, the inductance of the stator coils depends on the rotor position and will therefore be different in most BLDC motors. Figure 2 shows the inductances V, U and W. Based on these different inductances, it is possible using a suitable test method to capture the necessary data to determine rotor position to a high degree of accuracy.

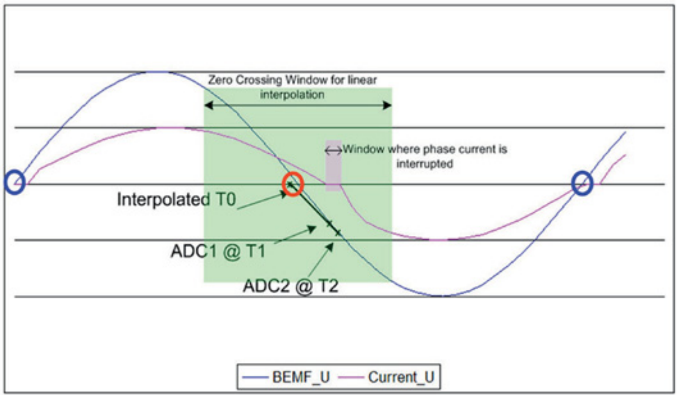


Figure 4: Phase 3 waveform

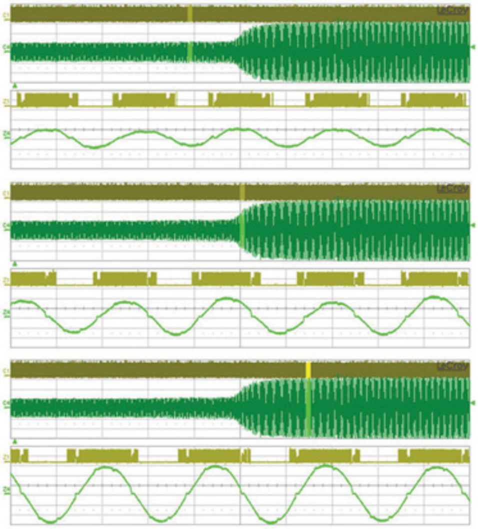


Figure 5: Phase current and phase voltage when the motor is starting up

Motor Start

With regards to motor start with rotor position detection from a standstill refer to Figure 3. The viscosity of oil is, for example, extremely temperature-dependent, so that for applications such as oil pumps, the motor start will occur under unknown load conditions. In order for the rotor to move in the correct direction of rotation (see Figure 2), it is necessary to apply a torque-producing current Q1. Regardless of its design, the motor is started in block mode, with the coil U utilised for measurement purposes.

Through PWM modulation two alternating currents, Q2 and Q6, are introduced to the coils UV and UW (even-numbered PWM intervals for Q6 and odd intervals for Q2); Q1 is not affected by this juxtaposition. Since UV and UW are influenced by the rotor position, Q2 and Q6 analysis of the two current streams allows rotor position to be calculated without the need for Hall Effect sensors.

Once the rotor has reached the end of a 60° interval, the system commutates and a new cycle begins. The speed is determined by the length of time needed to complete each 60° interval. The BEMF and the commutation signal can be used to measure the speed to make sure it is above the minimum value needed for sensorless control to be supported. This method is self-adaptive. As a function of the load torque, the 60° interval is reached sooner or later; even the terminals of the rotor can be monitored to aid acquisition of timeouts and possibly increase the torque-producing current.

Third Stage

Now let's look at the third stage, where the motor is running, regardless of the current profile used with rotor position detection via BEMF. Once the motor has accelerated sufficiently and evaluated BEMF, detection of the rotor position can be utilised. To be able to realize short-locked loops (high dynamic range) should continue to be recovered from the BEMF signal, the zero crossings of the BEMF from which the commutation plus the necessary control information are taken.

In motors with sinusoidal commutation however, phases are at all three signals continuously, so an evaluation of the BEMF seems impossible at first glance.

For a motor with sinusoidal commutation, the BEMF and motor current will be sinusoidal. Therefore, depending on the load current/

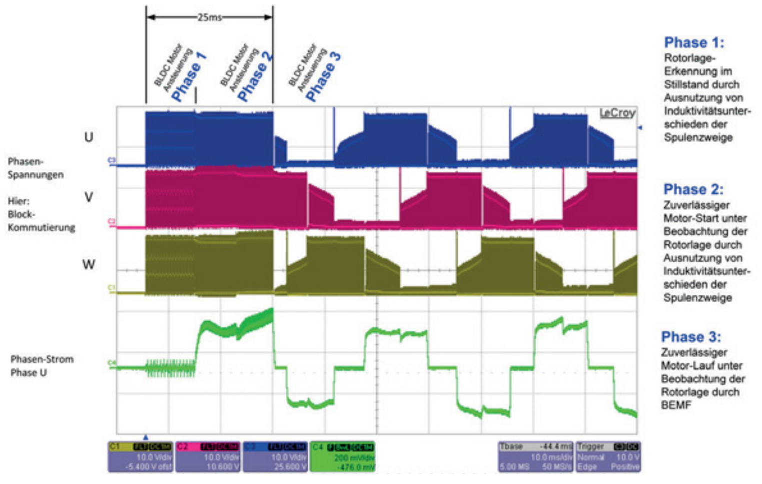


Figure 6: Phases 1, 2 and 3 of a block commutated motor

BEMF, a leading or lagging of phase can be seen.

It is possible to detect a zero crossing of the current (i.e. determine the moment at which the inductance is de-energized) from the feedback signals of the motor. The phase current is then maintained at this point for a short period, so that BEMF values for the coil covering two phases can be taken. The zero crossings of the BEMF are then calculated through interpolation.

Figure 5 shows an example of a motor during sinusoidal commutation starting up under load conditions. A phase current and phase voltage are depicted for the three different load cases. The windows for the BEMF measurement are clearly visible. At the rise of the motor current, a variable load can be seen. For energy-saving purposes, it is also possible to limit the number of windows to one per sine period.

The BEMF data accessed by the system enables the phase currents to be controlled, so that ultimately BEMF and phase current can be held in phase with one another – which corresponds to optimum efficiency of the motor.

Figure 6 illustrates the launch and ramp-up of a BLDC motor under load. As already mentioned, since phase 2 is self-adaptive through the start time, motor start remains reliable under all load conditions. ●

SERIES OF AEC-Q100 QUALIFIED DRIVER ICS

Based on its own proprietary architecture Melexis has developed a series of AEC-Q100 qualified driver ICs specially targeted at the control of BLDC motors used in automobile designs, where sensorless implementations are particularly attractive. They offer engineers highly-integrated single-chip solution for control of these motors. The driver ICs consist of the functional blocks, as shown in Figure 7. Software compatibility exists between all the members of this product series; they only differ in relation to the number and variety of I/Os they support and their memory capacity.
The sensorless controlling of BLDC-less motors via determining of the rotor position using a Melexis MLX81207 driver IC is shown in Figure 8. The central processing unit of the ICs has direct access to the power transistors of the output stage, which offers considerable flexibility when it comes to setting a variety of different switching profiles. Sensorless control of BLDC motors is cost-effective and reduces the overall bill of materials. Rotor position can be detected on all three phases, allowing a reliable start, high dynamic response and robust operation of the BLDC motor. Sophisticated IC solutions with a high degree of integration will facilitate the further progression of such systems in the future.

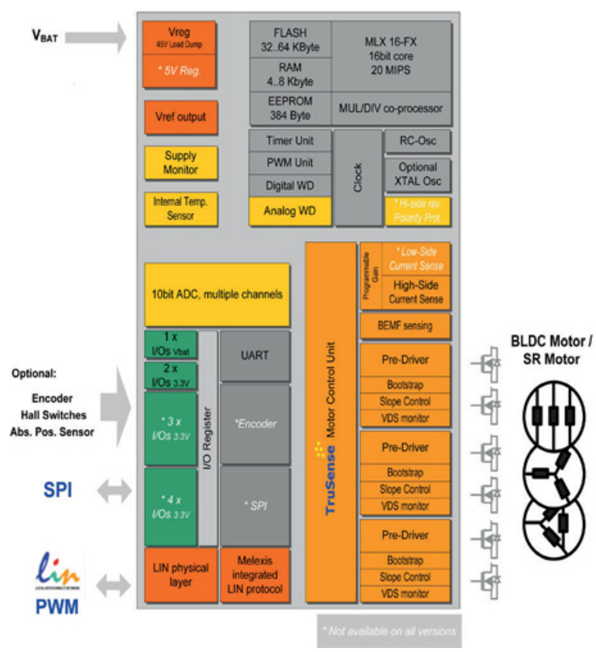


Figure 7: MLX81205/07/10/15 functional block diagram

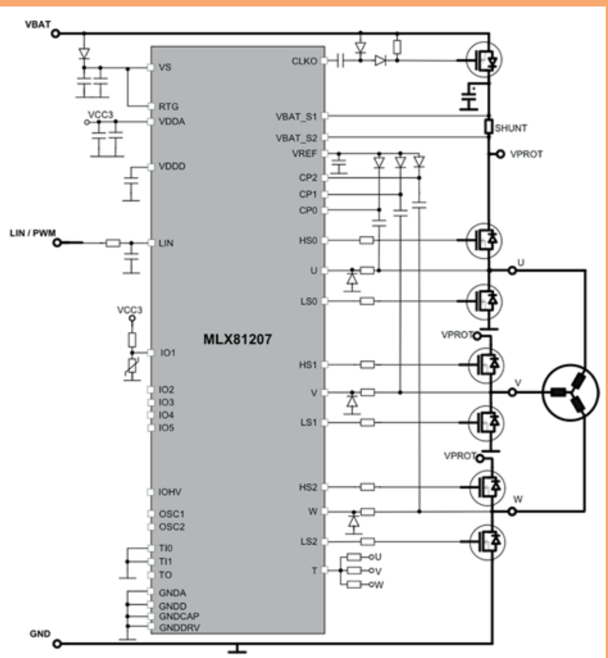
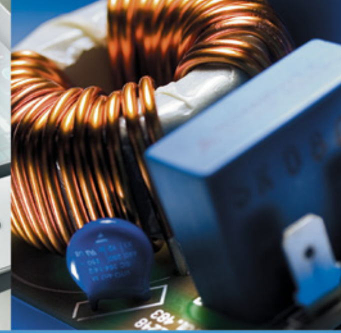


Figure 8: Single-chip solution and detectable signals for sensorless control of BLDC-less motors







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ELECTRONIC COMPONENTS

NEW METHOD FOR OPTIMAL CONTROL OF STEPPER MOTORS

ALI EMAMHUSSEINI OF THE DEPARTMENT OF ELECTRICAL ENGINEERING AT THE ISLAMIC AZAD UNIVERSITY IN IRAN PRESENTS A NEW METHOD FOR OPTIMAL CONTROL OF STEPPER MOTORS, IN THE FORM OF THREE MAJOR CHANGES IN THE USUAL ALGORITHM

Many developments in electronics and the computer sciences have made fundamental changes to control systems, and as a result each new generation is becoming more intelligent and more accurate and efficient, at lower cost.

Stepper motors are an integral part of industrial control and robotics. With the development of digital control systems, stepper motors can control rotation axis with high accuracy, with the help of software and a limited number of hardware accessories.

Control System Hardware

Although there are several methods for controlling stepper motors, this article will discuss the closed loop control approach. The hardware implementation of this method is shown in Figure 1. It consists of three major sections: computer communication, driver circuit and feedback.

Motor commands are handled by the computer. They are sent to the driver circuit via the interface and have their electrical signals strengthened in the drive section. Optical sensors are aimed at the rotating disk mounted on the motor shaft. The computer acts as controller and processor to control the shaft position.

Software And Algorithms For The System

The usual method of controlling the angle traversed by a stepper motor is to first determine the number of steps 'travelled' by the motor, using the following equation:

$$n_s = \O_{tot}\O_{stop} \qquad (1)$$

Here θ_{tot} is the total angle travelled, θ_{step} is the angle travelled per step and n_s is the total number of steps required. By considering the number of steps, the stimulation pattern applied to the motor phases and the travelled angle by reading the feedback system until the desired angle is reached, the process continues until the desired value is achieved. In this method, the motor speed is constant, without any monitoring of the motor and feedback system.

In our study we suggest three major changes to this algorithm to allow optimizing control of the stepper motor in real time.

Stepper motors have a startup frequency. If the frequency of the input pulses exceeds that value, the motor may move out of step or stop altogether. So in our algorithm, the input pulse frequency is variable, see Figure 2, where f_{min} is the frequency of the motor's driver, f_{max} is the highest frequency that can be accessed during motion, θ is the angle at which the applied frequency reaches f_{max} and H_θ is equivalent to θ_{tot}-θ.

By counting the travelled angles as half steps and with a small amount of processing, the feedback system's accuracy can be doubled. We've named this method 'half step counting'. Figure 3 shows the passing gaps at the edge of the rotating disk with the optical sensor. Pulses are generated and, by counting them, the value of the angle travelled can be determined.

The number of gaps encountered on the rotating disk is

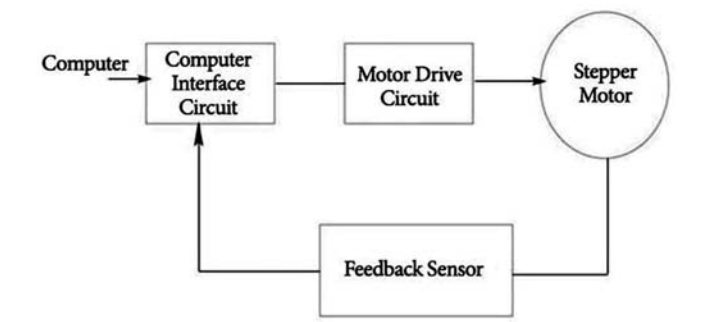


Figure 1: Diagram of the overall hardware

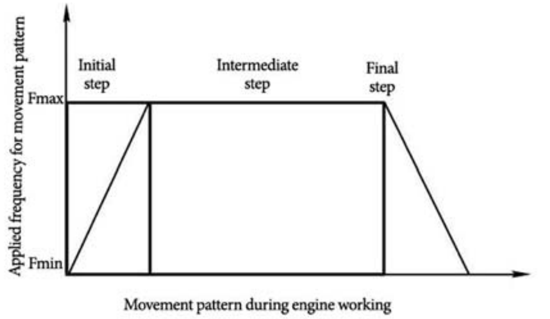


Figure 2: Counting the angles travelled as half steps

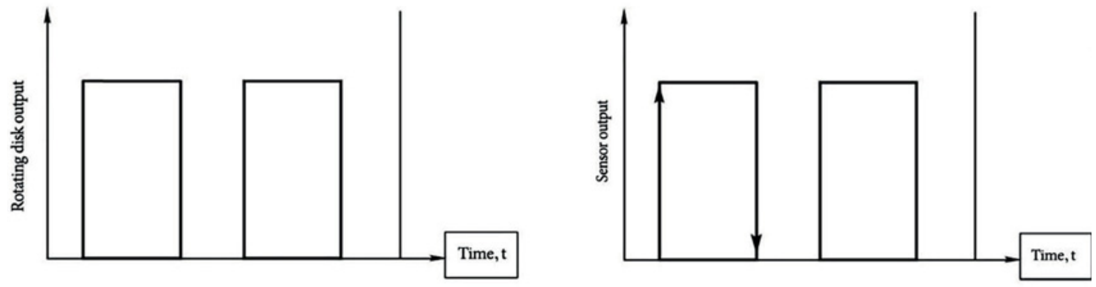


Figure 3: Applying the half-step procedure to measure the angle of disk rotation

equal to the number of generated pulses when the stepper motor rotates 360 degrees. For some engines this value is 200, as after a full round is completed, the sensor produces 200 pulses to be counted and measured. But, at a closer look, we can see that each pulse has rising and falling edges. So, by counting the number of edges instead of number of pulses, the accuracy of the measurement for the travelled angle can be increased two-fold, bringing the value of the travelled angle for each step to 1.8 degrees.

In the feedback system the travelled angles then increase by 0.9 degrees, because a full circle provides 400 measured pulses instead of 200, due to vibration and other artifacts of the mechanical system. To resolve this discrepancy, by applying smart control to the width of the counted pulses in the feedback system, we can filter out the undesirable pulses. Figure 4 shows a few examples of undesirable pulses created by the mechanical part of the feedback system and the modifying effect the filter has on them.

The mode of action is shown in Figure 5. It can be seen that whenever a pulse is measured by the feedback system, its width algorithm versus time is measured and this pulse is considered a valid half-step when its width fits Equation 2, which is within the specified range.

$$t_{min} < t < t_{max} \qquad (2)$$

The t_{min} and t_{max} values can be determined experimentally and could be considered constant for the entire route of the rotating disc, suitable during changes in motor speed. For better filter performance and especially when we want variable motor speed, other filter parameters should be considered as a function of time, as is the case with the so-called adaptive filters.

The parameter changing method is shown in Figure 5. The two values at the beginning of a motion are $t_{min}0$ and $t_{max}0$. Over time, whenever a valid half-step is counted by the feedback system, these values change too. The method we proposed to change these parameters is using the average value of travelled half-step widths, which varies with time according to Equation 3. Also, we consider Equation 4 for the value of t_{max} , set for the next step.

$$t_n(new)=t_n(old) +(1-t_n(old)/(n+1) \qquad (3)$$

$$t_{max}(new)=1.8t_n(new)$$
$$t_{min}(new)=0.2t_n(new) \qquad (4)$$

In Equation 4, 'new' means the new value of the parameter, with 'old' being the old value, and n is the number of counted valid pulses until that time. Of course, it should be considered that only valid pulses could change the system parameters.

The overall performance algorithm for this control system is shown in Figure 6.

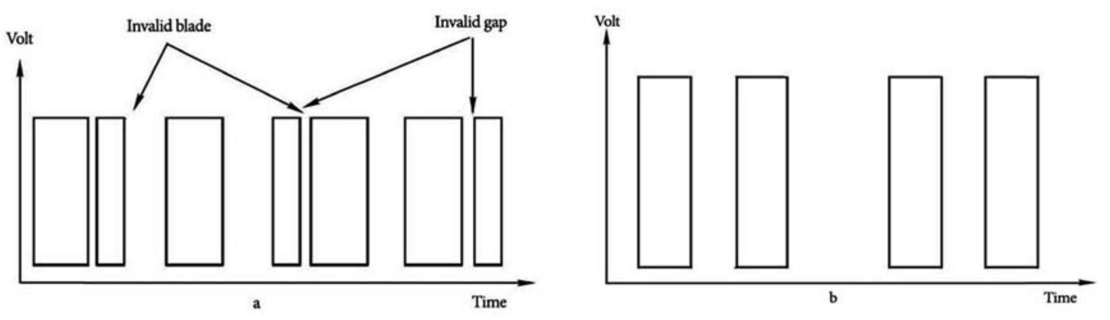


Figure 4: Intelligent mode of action to eliminate the undesirable vibration in the feedback signal: (a) Filter input; (b) Filter

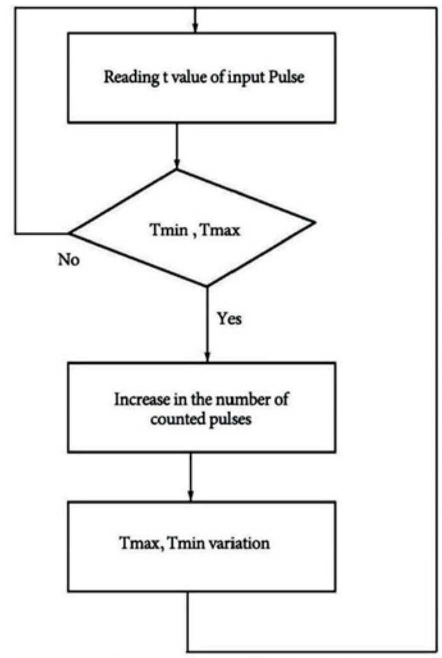


Figure 5: Filter mode of action as adaptive filter output

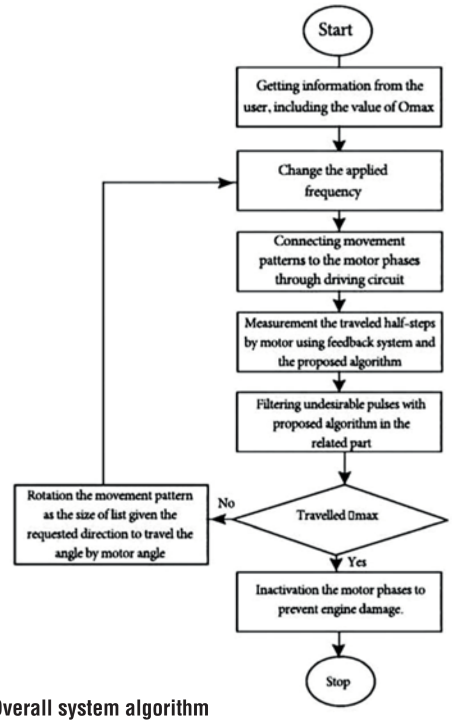


Figure 6: Overall system algorithm

Controlling Stepper Motors

The method reviewed in this article for the control of stepper motors is designed as an accessory for PCs, and relies on the PC for information processing to increase the efficiency of the system and reduce error. We've optimized the motor control algorithm with a microcontroller, which is easily implemented in industrial applications. ●

ADDING INTELLIGENCE TO CONTROL

JOSEPH JULICHER, ENGINEERING MANAGER FOR MCU08 APPLICATIONS AT MICROCHIP TECHNOLOGY, DESCRIBES HOW TO EASILY ADD INTELLIGENCE TO A POWER SUPPLY FOR FAR-REACHING BENEFITS

There are few applications addressed by integrated electronics that don't require some modest form of power regulation, be that a simple current/voltage supply or a more sophisticated and optimised solution. However, with an increased focus on efficiency at every level, it is becoming more common to include some form of intelligence. Even a relatively unsophisticated control algorithm can deliver performance benefits such as reduced power consumption, while with a little more effort, any device can now include more advanced features such as maximum-power tracking, refined battery charging, environmentally-aware settings and improved fault tolerance.

This is a perfect scenario for low-cost microcontrollers; even the smallest device is now powerful enough to execute complex algorithms, while providing machine and human interfaces.

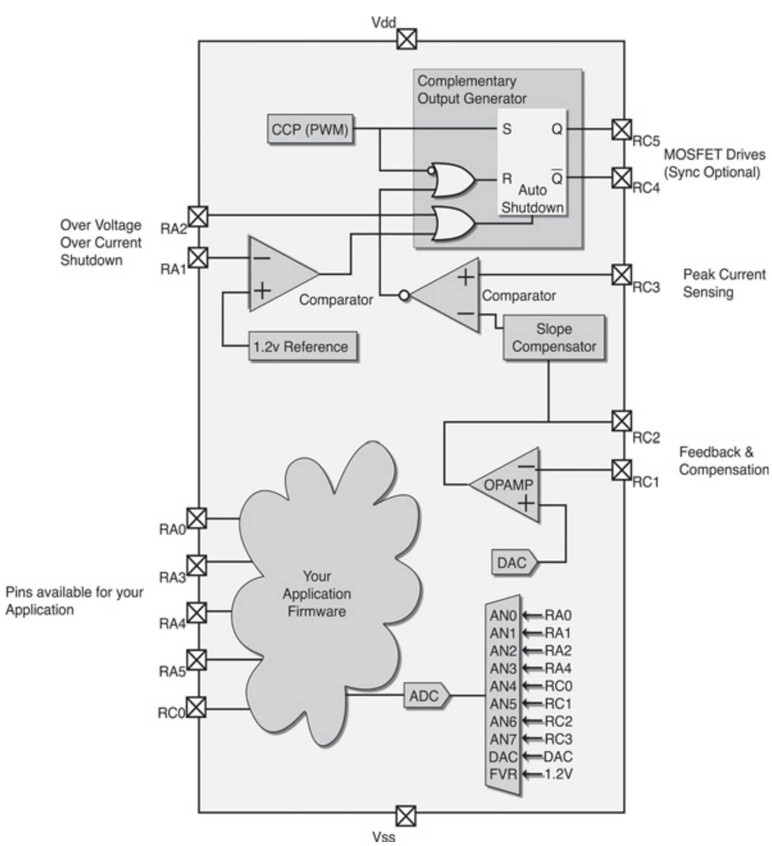


Figure 1: A typical power supply based on the PIC16F753

The ability to accommodate some form of standardised communication interface, such as SMbus, LIN or Ethernet adds another level of value.

Risk And Reward

A low-risk method of making power smarter is to simply monitor the supply using an MCU and relay the parameters it measures to a back system over some form of communication interface. This approach needs minimal additional components and design effort, typically limited to adding some method for sensing the voltage, current and perhaps temperature. Monitoring other parameters, such as duty cycle or supply frequency will allow more sophisticated control over power-specific features, including voltage levels.

There are a number of Switched Mode Power Supply (SMPS) Application Specific Standard Products (ASSPs) that offer a method of modifying functionality based on decisions made after measuring critical parameters. They offer a simple way to increase efficiency, a task that can be handled by a wide range of microcontrollers; serial interfaces effectively enable an MCU to modify the functionality of a power supply based on monitored parameters.

A further benefit of this approach is that the power supply itself remains under the control of the SMPS ASSP. This means the design team does not need any specific power supply design knowledge beyond understanding the parameters available for modification and their effects; the key control theory remains the domain of the SMPS engineer.

The next step along the implementation curve – and one that offers potential cost savings – is to integrate the SMPS ASSP and MCU functionality into a single device. It is increasingly possible to achieve this in a high-performance MCU with integrated fast-sampling ADC, an approach that affords a fully digital, all-software implementation. Of course, this approach incurs the need for greater SMPS design expertise, and the overall performance will be related to how much processing power the MCU can deliver (often limited by system-level power requirements).

Hybrid Approach

The middle ground between the two scenarios described above is what some term the hybrid approach. In this case, a mixed-signal controller which integrates the necessary analogue peripherals is an integrated device; one example is the PIC16F753, which features an operational amplifier, slope

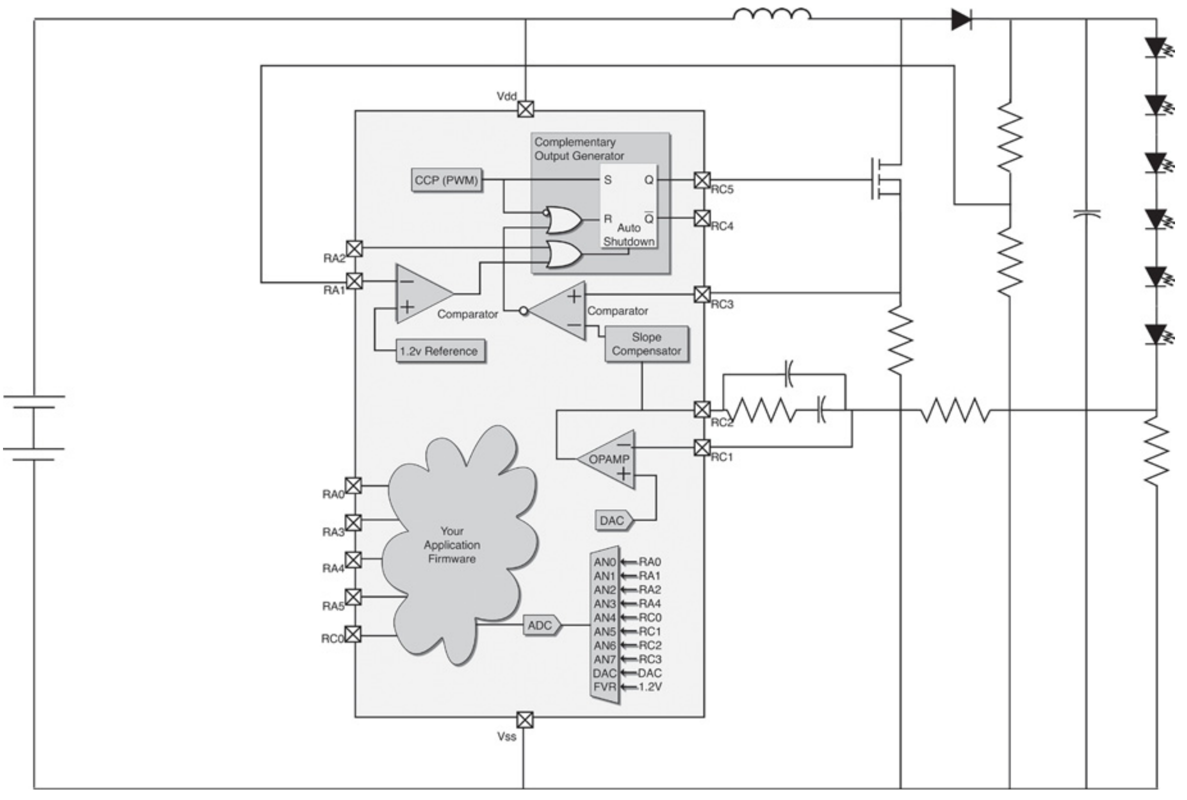


Figure 2: An example of the PIC16F753-based power supply operating as a boost, regulating current in an LED string

compensator, DAC, comparators and PWM controller in a single 14-pin package.

Each of the peripherals is programmable, allowing them to be combined in a variety of ways to create a large number of current-mode power supplies. As they are software-controlled, configuration is dynamic, allowing adaptation to changing power supply conditions. This could see the device configured to operate as a hysteretic controller with a simple firmware feed-forward regulator when in standby mode, but allowing the supply to be quickly reconfigured for continuous current mode at a different operating frequency when more power is demanded.

Because the supply's control resides entirely within the MCU there is no need for additional components to be added later in the design cycle, which simplifies the design and lowers the component count. Furthermore, as the solution is fully integrated, the firmware has total visibility of the power supply parameters without significantly changing the design process, while the communications and intelligence interface can be developed and verified by the power supply engineering team.

A typical power supply based on the PIC16F753 is shown in Figure 1; most implementations are minor variations of a common SMPS configuration. The Complementary Output Generator (COG) produces a complementary output with a programmable deadband from rising and falling inputs, while the Compare/Capture/PWM (CCP) module is configured to produce a programmable-frequency rising edge. The comparator, C1, produces the falling edge when the current exceeds the output of the slope compensator. The CCP and C1 can be combined to create a maximum duty cycle, needed by some topologies such as boost, flyback and SEPIC. The operational amplifier, OPA, is used to provide feedback and compensation, while the DAC is used to provide the op-amp's reference – although the Fixed Voltage Reference, FVR, can also be used if programmable levels are not required. The slope compensator can be reset by the comparators or the COG; it uses a programmable current sink to decay a pre-charged capacitor; in this case, the charge level is set by the OPA.

This is a relatively simple configuration and Figure 2 shows an example of it operating as a boost supply regulating current in an LED string. The flowcharts in Figures 3a-c depict the levels of intelligence that can be added once it has been configured, allowing a range of applications.

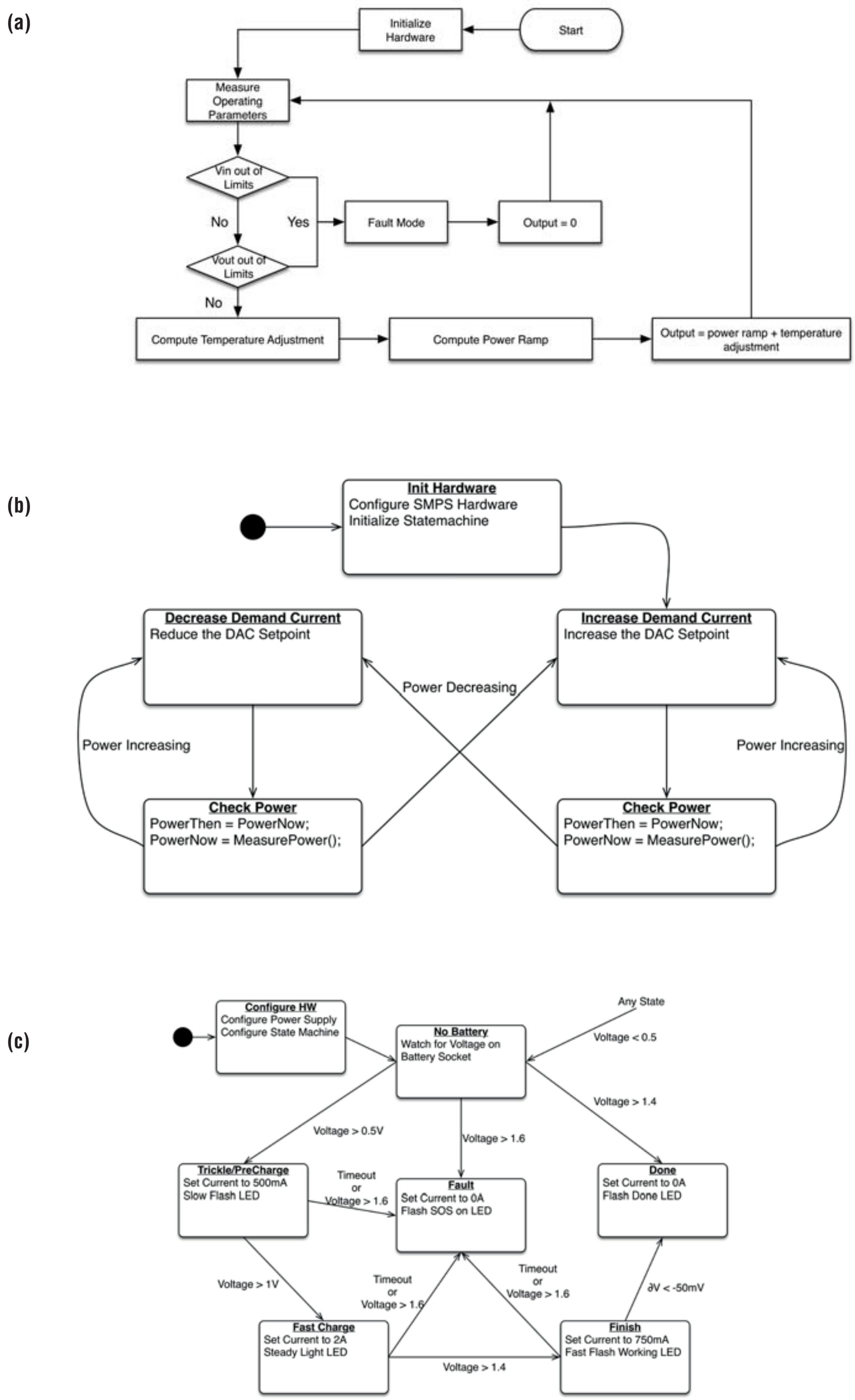


Figure 3a-c: The flowcharts depict the levels of intelligence that can be added once the PIC16F753-based power supply

Adding Intelligence

The addition of intelligence to a power supply has far-reaching benefits and can either be achieved simply, by adding an MCU, or more completely by using a more capable, fully integrated solution such as a high-performance dsPIC or mixed-signal MCU that integrates all the performance and peripherals needed to realise a sophisticated single-chip SMPS.

However delivered, smart power has the potential to impact significantly on electrical device operation and, more importantly, efficiency. With today's highly capable, low-cost and fully integrated solutions, adding intelligence has never made more sense. ●

FEEDBACK CONTROL SYSTEM PART 2

THIS IS THE SECOND ARTICLE IN A TWO-PART SERIES BY **MAURIZIO DI PAOLO EMILIO**, PHD IN PHYSICS AND TELECOMMUNICATIONS ENGINEER, WHO DISCUSSES TWO POSSIBLE CONTROL SYSTEMS FOR REDUCING NOISE INTRODUCED TO A CO2 LASER AND HOW TO CONTROL ITS POWER TO REDUCE THERMAL LENSING, TYPICALLY FOUND IN OPTICAL COMMUNICATIONS

The structure of a control system (see Figure 1) typically consists of a controller and a machine. The controller can be software or hardware, such as a computer or power converters. The machine may be a motor, or, as in the case of a power supply, an inductor or capacitor circuit.

The machine can also consist of two parts: the plant and the feedback device(s). The plant receives two types of signals: controller output from the power converter and noise (unwanted signals). In simple terms, the job of the control system is to drive the plant in response to commands while overcoming unwanted signals.

The controller is defined by control laws, such as Proportional-Integral-Differential (PID), very familiar to control engineers. The process of tuning – setting the gains to achieve the desired performance – amounts to adjusting the parameters of the control laws. Most controllers let designers adjust the gains, and the most flexible controllers allow designers to modify the control laws themselves.

When tuning, most control engineers focus on achieving a quick, stable, command response. However, in some applications, rejecting noise is more important than responding to commands.

All control systems should demonstrate a robust performance because even nearly identical machines and processes vary somewhat from each other and can change over time.

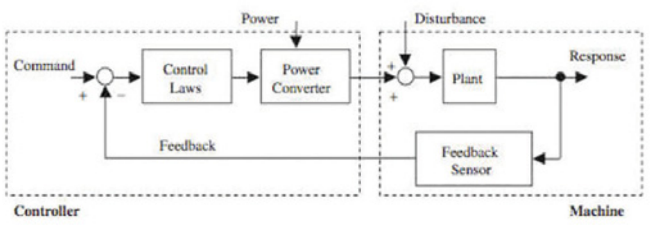


Figure 1: Structure of a control system

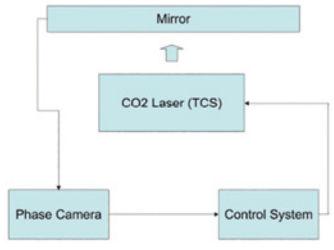


Figure 2: General configuration of a control system

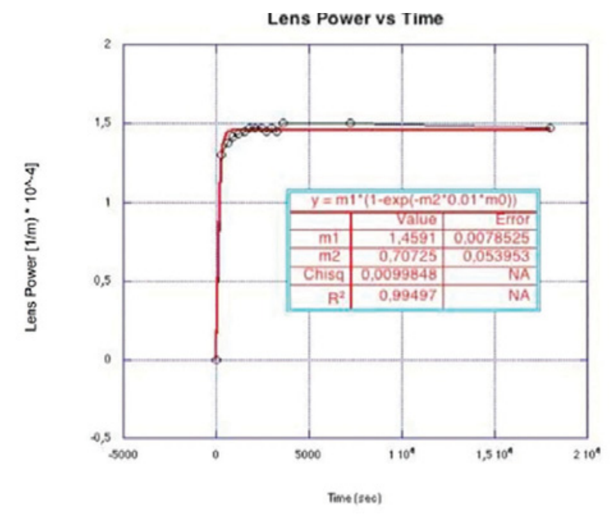


Figure 4: Lens power (YAG)

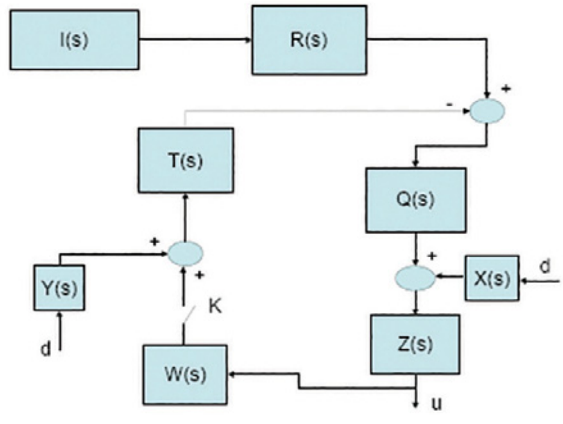


Figure 3: Feedback control system

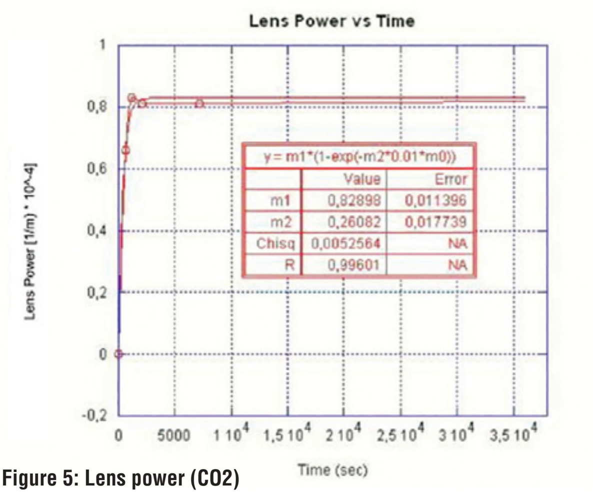


Figure 5: Lens power (CO2)

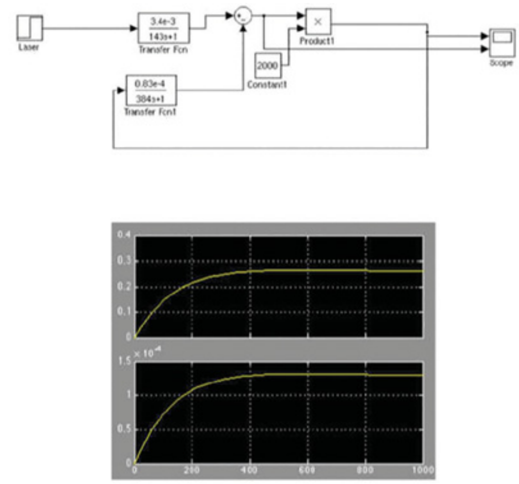


Figure 6: The system without control blocks

Robust operation means control laws must be designed with enough margin to accommodate reasonable changes in the plant and power converter. Virtually all controllers have power converters. The control laws produce information, but power must be applied to control the plant. The power converter can be driven by any available power source, including electric, pneumatic, hydraulic or chemical.

Machine Structure

The machine's plant is the element or elements that produce the system response. Plants are generally passive and they usually dissipate power. Examples include a heating element and a motor coupled to its load.

Control systems need feedback because the plant is rarely predictable enough to be controlled open-loop – without feedback. This is because most plants integrate the power converter output to produce system response.

Voltage is applied to inductors to produce current; torque is applied to inertia to produce velocity; and pressure is applied to produce fluid flow. In all these cases, the control system cannot control the output variable directly but must provide power to the machine and then monitor the feedback to ensure the plant is on track.

Problems And Solutions

The idea of this system is to automatically control thermal effects (see the first article in this series in the last issue) of mirrors changed by CO2 power (Figure 2). The control system can be represented by the diagram in Figure 3 where:

- I(s): transfer function of the YAG laser power.
- R(s): transfer function of the mirror heated with only the YAG laser. The mirror heated by the YAG laser determines the the curvature (thermal lensing effect).

$$R(s) = \frac{3.3 * 10^{-3}}{143s + 1}$$

The lens power (or diopter, the unit of mirror curvature) of the mirror heated with only the YAG laser as a function of time is shown in Figure 4.

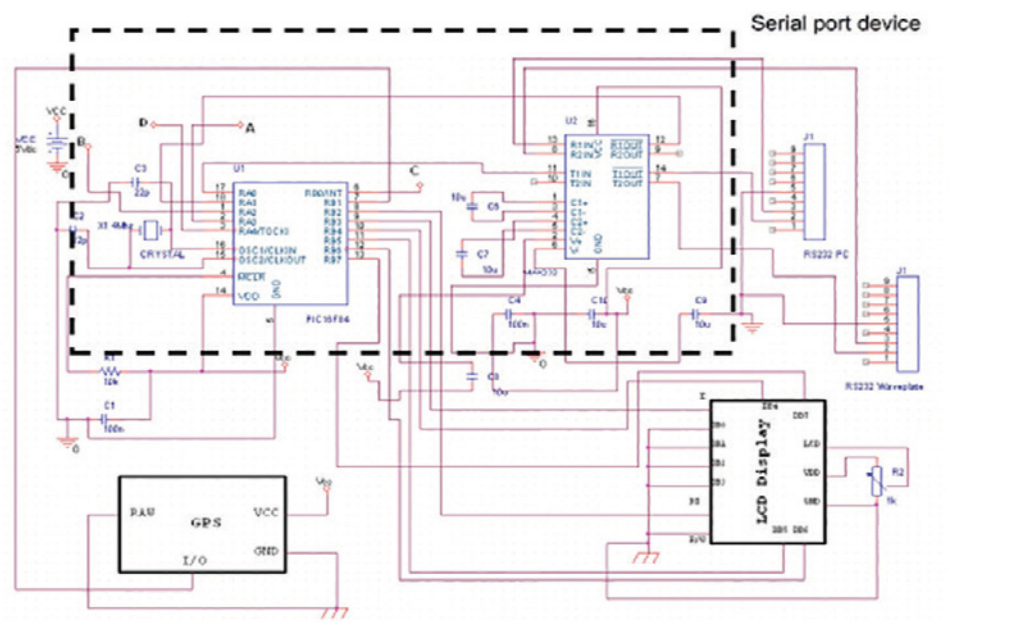


Figure 7: Controller W(s)

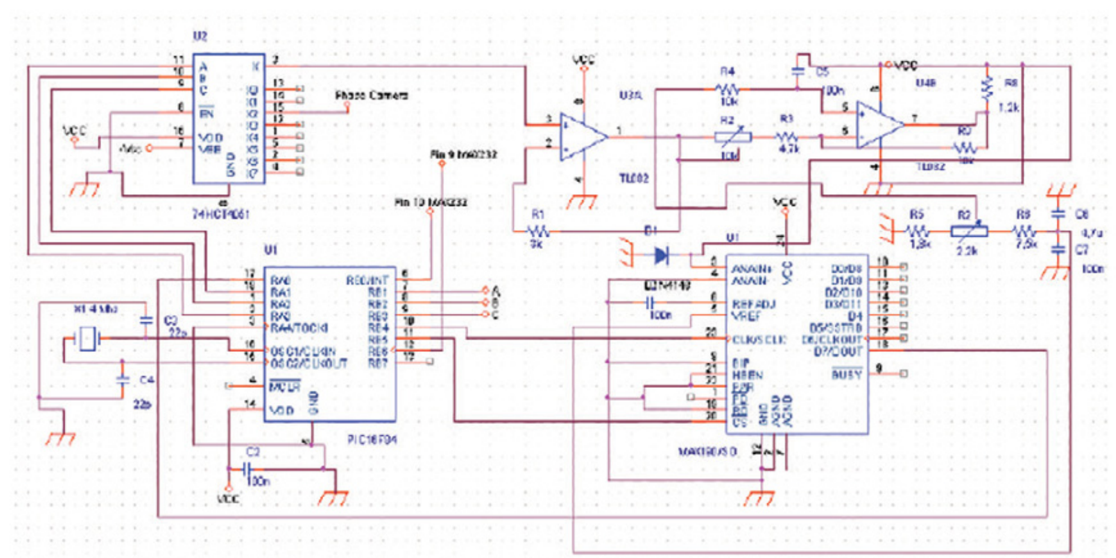


Figure 8: Controller Z(s)

- T(s): transfer function of the mirror when heated with only the CO2 laser

$$R(s) = \frac{0.83 * 10^{-4}}{384s + 1}$$

This laser as function of time is shown in Figure 5.

- Q(s): transfer function of the phase camera, a constant 200. The phase camera is a high-resolution wave-front sensor that measures the complete spatial profile and phase of any frequency component of a laser field containing multiple frequencies.
- Z(s) and W(s): transfer functions of the controller.
- X(s) and Y(s): noise transfer functions of the transmission and feedback lines.
- K: flip mirror; a TCS on/off switch.

The transfer function of the system is:

$$u(s) = F(s) * I(s) + F'(s) * I(s)$$

with:

$$F(s) = \frac{Q(s)R(s)Z(s)}{1 + Q(s)T(s)Z(s)W(s)}$$

$$F'(s) = \frac{T(s)Q(s)Z(s) + X(s)Z(s)}{1 + Q(s)T(s)Z(s)W(s)}$$

We assume negligible system noise, d = 0.

The Controller W(s)

Behaviour of the system without the control blocks Z(s) and W(s) is shown in Figure 6. Our goal is to automatically mitigate the signal in the output of the phase camera (error signal) by heating the mirror with the CO2 power of the thermal compensation system. The transfer function W(s) (Figures 6 and 10) comprises the following electronic circuits:

- Control Logic: It analyzes the signal of the phase camera. The phase camera signal is bipolar (+5V, -5V):
  - 0/+5V: positive curvature of the mirror;
  - 0/-5 V: negative curvature of the mirror.

The job of the control logic is to change the CO2 laser power as a function of the phase camera signal: if this signal is positive, the control logic must increase the CO2 power; if negative, it decreases the CO2 power.

- Serial port device: adjustment of the power is done by means of a waveplate, controlled via the serial port. Optical waveplates (also called retarder plates) are transparent plates with a carefully adjusted birefringence (optical property of a material having a refractive index that depends on the polarization and propagation direction of light), mostly used for manipulating the polarization of light beams. A waveplate has a slow axis and a fast axis, perpendicular to the surface and the beam direction, and to each other.

Serial Port Device

This device (Figure 7) sends commands to the waveplate via the serial port. The principal commands are forward and backward rotation of the waveplate.

The angle of rotation is proportional to the power sent onto the mirror. We use a PIC microcontroller (PIC16F84) to manage the signal in the output of the phase camera.

The job of the Z(s) controller (Figure 8) is to acquire the output signal of the phase camera and send it to the microprocessor, which analyzes this data and sends commands via the serial port to the waveplate to change the laser's power.

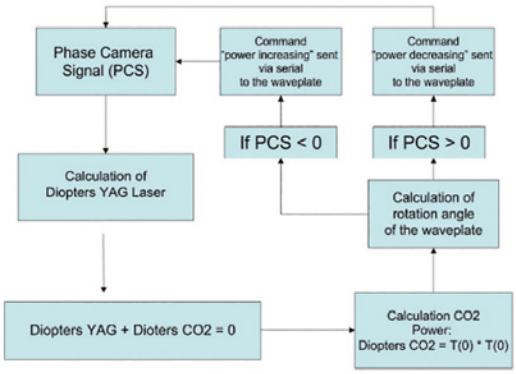


Figure 9: Logic function of the PIC's Z(s)

The analog-to-digital converter (ADC) used is the MAX190, a monolithic ADC featuring differential inputs, internal voltage reference, internal clock and parallel or serial µP interface. It provides three interface modes: two 8-bit parallel modes and a serial interface compatible with the SPI, QSPI and microwire serial-interface standards. We set the MAX190 to work in serial mode. A multiplexer is used to set a channel to send data to the MAX190 for digitizing.

Setup

The Z(s) control system is connected to the waveplate's serial port, but it may also be connected to the serial port of the PC. In this case, the PC sends a BREAK signal (approx 0.5s long) to reset the control system. Then it sends the identification string, using the 19200 baud, 8-bit, no parity mode.

In the current version, the identification string is WZPICADC100003. After receiving the valid identification string, PC should send the 14 configuration bytes using the above mode. After reception of the configuration bytes, the system Z(s) calculates the 8-bit checksum of the received data and sends it back to the PC, which compares it to the checksum calculated from the original data. If the checksums match, the PC assumes the configuration bytes have been received correctly, and it's ready. The PC changes the serial port's mode to 115200, 57600 or 38400 baud, 8-bit, even parity, and sends the "0" byte to start data acquisition.

Following this setup, the Z(s) control system connects to the serial port of the waveplate. The logic function of the PIC's Z(s) and W(s) can be as shown in Figure 9. The PIC's Z(s) communicates with the waveplate and sends a serial command via MAX232 as a function of the ADC signal. Another PIC's W(s) system manages the GPS and display, and communicates with the PC for managing the software.

The Parallax Global Positioning System (GPS) receiver module (Figure 11) is a fully integrated, low-cost unit, complete with an onboard patch antenna. It provides standard, raw NMEA0183 (National Marine Electronics Association) strings or specific user-requested data via the serial command interface, tracking up to 12 satellites, and has WAAS/EGNOS (Wide Area Augmentation System/European Geostationary Navigation Overlay Service) functionality for more accurate positioning. The module provides current time, date, latitude, longitude, altitude, speed and travel direction/heading among other data, and can be used in a wide variety of hobbyist and commercial applications, including navigation, tracking, mapping, fleet management, autopilot and robotics.

The plan of the microprocessor is created by Easy PIC 5 from Mikroelektronika. The EasyPIC5 is a full-featured development system for almost all Microchip microntrollers, designed to be used by students and engineers to test and explore the capabilities of PIC microcontrollers. It also allows these microcontrollers to be interfaced with external circuits and a broad range of peripheral devices, allowing the user to concentrate on software development. ●

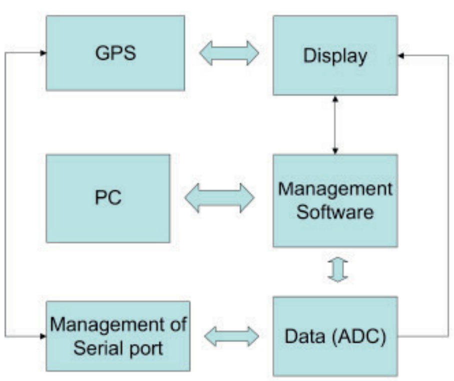
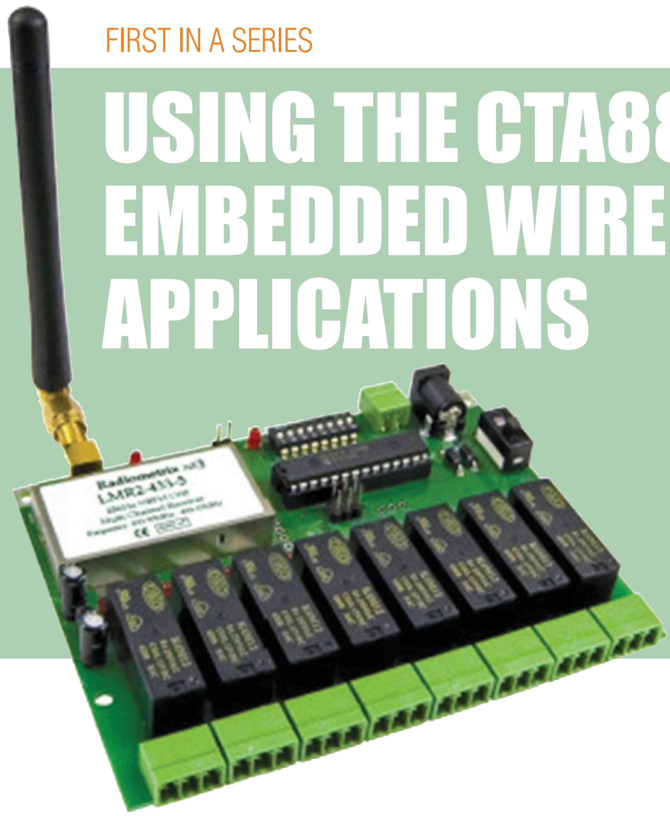


Figure 10: Logic function of the PIC's W(s)

Figure 11: GPS

FIRST IN A SERIES

USING THE CTA88 DEMO KIT IN EMBEDDED WIRELESS AUTOMATION APPLICATIONS



IN THIS SERIES, PROFESSOR DOGAN IBRAHIM OF THE NEAR EAST UNIVERSITY, NORTH CYPRUS, WILL PRESENT SEVERAL DIFFERENT TYPES OF RF SYSTEMS FOR EMBEDDED APPLICATIONS. IN THIS ARTICLE, HE DESCRIBES THE RADIOMETRIX CTA88 TX/RX DEMO KIT AND ITS USE IN EMBEDDED AUTOMATION

The interconnection of embedded devices and sensors using wireless techniques has become highly important in many industrial, commercial, health and domestic applications, and more recently the IoT (Internet of Things). The IoT is a concept where an unprecedented number of devices (things) can be connected to the Internet and each can monitor or control other devices or apparatus.

"Things" in the IoT refers to a wide variety of devices such as vehicles, home appliances, medical equipment, industrial equipment, washer/dryers and many other systems and devices, all equipped with intelligent built-in sensors and connected to the Internet via unique IP addresses. It is estimated that there will be nearly 26 billion devices using the IoT by 2020.

In addition to the IoT, several technologies can be used to interconnect embedded devices and sensors remotely to each other. Some commonly used ones are:

- Infrared
- Bluetooth
- ZigBee
- RF

Each technology has its advantages and disadvantages. For example, infrared is simple, very low-cost, low-power, low-speed technology that requires both the sending and receiving devices to be in line of sight of each other; the range is very short.

Bluetooth is short-range, high-power, medium-cost and medium-speed wireless technology, requiring devices to be paired.

ZigBee is based on wireless mesh networking, providing low-cost, low-power, low-speed communication; again the range is short, typically 10-100m.

In this article we are interested in other, more basic RF communication building modules to establish wireless links between embedded devices and sensors over long ranges and without the use of any standard communications protocols. The advantages of using basic RF devices is that the range is usually much longer; we can create our own protocols to suit the applications; and using basic RF building blocks is much simpler than other technologies.

There are many wireless embedded applications where security and data encryption are not key requirements, and using basic RF TX/RX modules is justifed.

The CTA88 Demo Kit

The CTA88 demo kit from UK-based RF design and manufacturing firm Radiometrix is a set of compatible transmitter (TX) and receiver (RX) boards that provide eight parallel channels of RF wireless communication using basic RF technology (see Figures 1 and 2).

The kit has the following features:

- 8-bit address and 8-bit data select switches;
- 8 relays to control mains-powered devices rated up to 8A, 250VAC/30VDC;
- Visual indication of valid code received and active relays;
- RF module range testing;
- 8 push-buttons for momentary control of relays;
- Momentary-latched outputs;

- Toggling, time-delayed, set-reset and raw serial outputs;
- Dynamic relay state changes;
- Simple plug-and-play setup;
- RF remote control demonstration;
- Screw antenna connector.

The TX Board

The block diagram of the TX board is shown in Figure 3. There are several versions of this board, but the one used here operates in the 458MHz ISM band and is based on the LMT2-458 series of transmitter modules, the AFS2 series of RF amplifier (500mW) and the CTA88 encoder/decoder chip. The board is populated with eight push-button switches connected to the inputs, and jumpers and DIL switches for configuring the board. The board accepts eight external opto-isolated data inputs at 2.5-50V (5mA).

Pressing a switch on the TX board activates the corresponding relay on the RX board, although there are several operating modes as discussed later.

The RX Board

The block diagram of the RX board is shown in Figure 4. The one we've used here contains the LMR2-458 receiver module and the CTA88 encoder/decoder chip. The board is populated with eight relays capable of operating at mains voltages of up to 8A.

The CTA88 encoder/decoder is a single-chip 8-channel IC with eight address bits that can be used with radio modules operating anywhere from 27MHz to 869MHz. This chip can be operated in either encode or decode mode, using 1kbps differential Manchester bit balancing with preamble and checksum.

The use of this chip is very simple: it is connected to a transmitter module on the TX board, and to a receiver module on the RX board. It is put into encoder mode in TX applications by connecting its TXMODE pin to the supply voltage (see Figure 5). In this mode, the data input is applied to its D0-D7 inputs and the device address is set using the A0-A7 inputs. The TXD and TXE outputs are connected to a transmitter module. Various operating modes can be selected using the C0-C2 inputs. Some TX operating modes are:

- Send single burst once only;
- Send continuously;
- Send single burst on any change of input;
- Send continuously while any input is high;
- Send bursts on average every 1.75s.

When operated in decoder mode (see Figure 6), the TXMODE pin is grounded; the D0-D7 pins are the outputs. Device address and operating modes are selected by the A0-A7 pins and the C0-C2 pins respectively, with the receiver module connected to the RXD input. Some RX operating modes are:

- Output last data received (150ms timeout);
- Output last data received (3s timeout);
- Hold last data received;
- D0-D3 set, D4 resets D0, D5 resets D1 and so on.

Figure 1: CTA88 TX demo board (standard 10mW output)

Figure 2: CTA88 RX demo board

Figure 3: Block diagram of the TX board

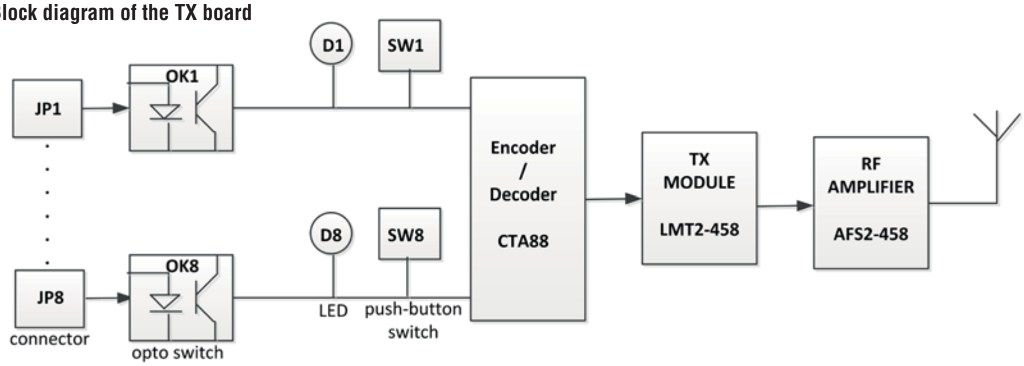


Figure 4: Block diagram of the RX board

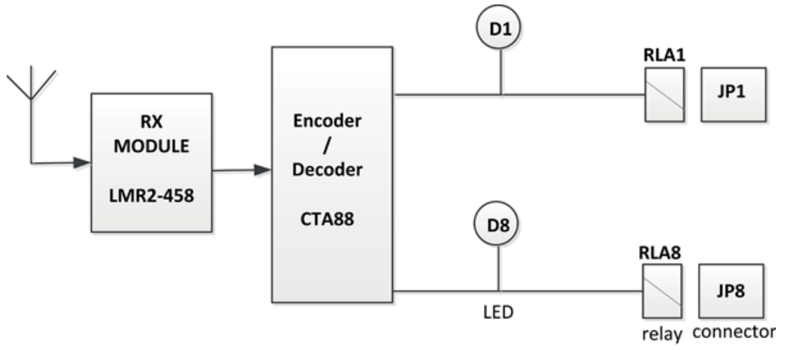


Figure 5: CTA88 chip in encoder mode

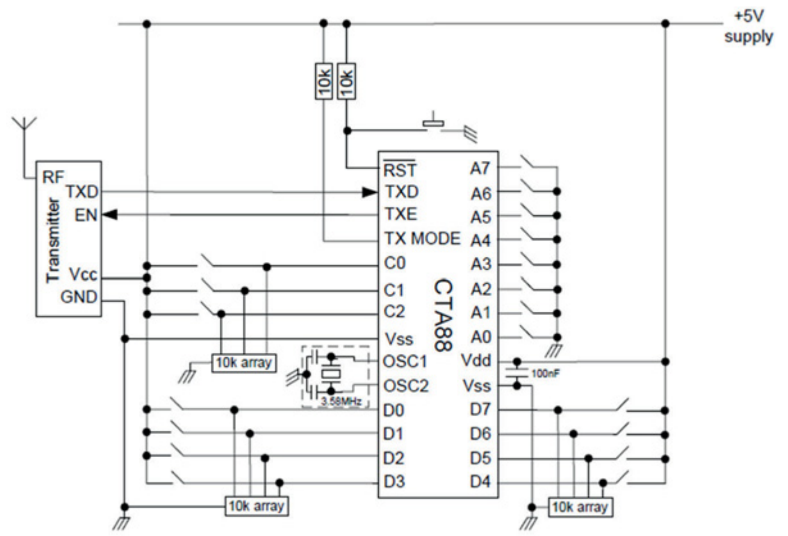
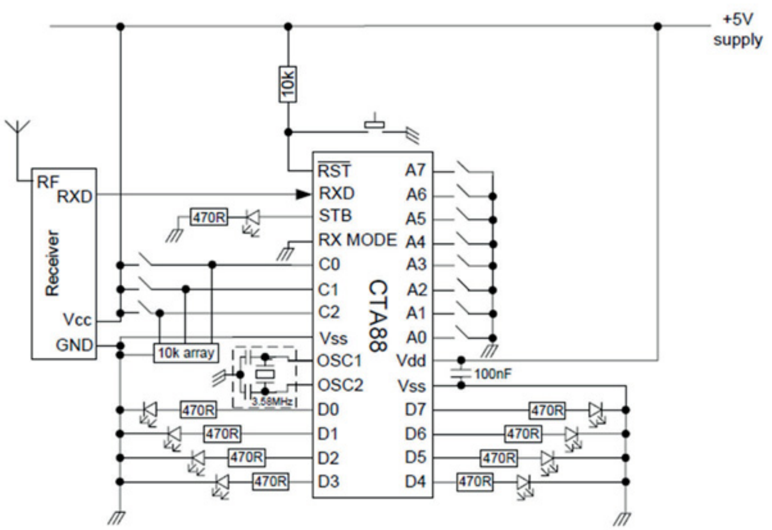


Figure 6: CTA88 chip in decoder mode



Using The CTA88 Demo Kit

We used this demo kit in a very simple project with the Raspberry Pi computer, with the aim to show how it can be interfaced with a computer and used in ON/OFF control applications.

In the project two mains-operated lights (or two sets of lights in a remote building) are connected to the relays on the RX board. The relays on the RX board support 240V mains operation at up to 8A. In this example the TX board is operated in the "send while any data input is high" mode (C2, C1, C0 = 100), and the RX board in the "output last data received" mode (C2, C1, C0 = 001).

A simple multi-thread program is developed on the Raspberry Pi with one thread controlling each light in the example. The desired ON and OFF absolute times of the lights are hard-coded in the program for simplicity. Figure 7 shows the block diagram of the project.

As shown in Figure 9, the Python program consists of the main program and two multi-tasking threads operating in parallel, one thread controlling each light. Inside the main program, the GPIO pins are defined as outputs. As the ON and OFF times of each light are hard-coded, the program creates two threads, each running the function ControlLights. This function receives the ON/OFF times and the light identity as its parameters. The threads run in continuous loops and compare the current absolute time (obtained from Python time module) with the required ON and OFF times. When the current time is equal to an ON time, the appropriate light is turned ON by sending logic 1 to the its channel of the RX board, energising the relay to turn the light ON.

The project setup is shown in Figure 10 with the Raspberry Pi interfaced with the CTA88 demo kit through a small breadboard and the T-Cobbler connector. Notice that next to the antenna the TX board contains the 500mW AFS2 RF amplifier module.

The example given here is very simple but it can be extended for more useful remote control applications using the CTA88 demo kit.

Figure 7: CTA88 lights control project block diagram

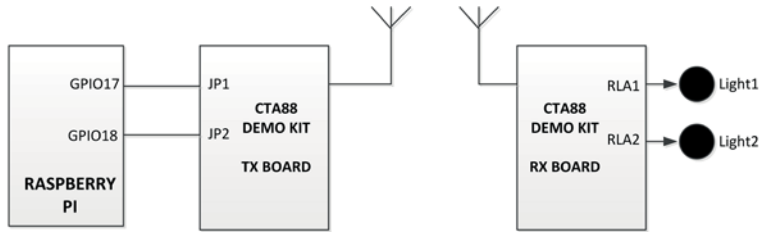


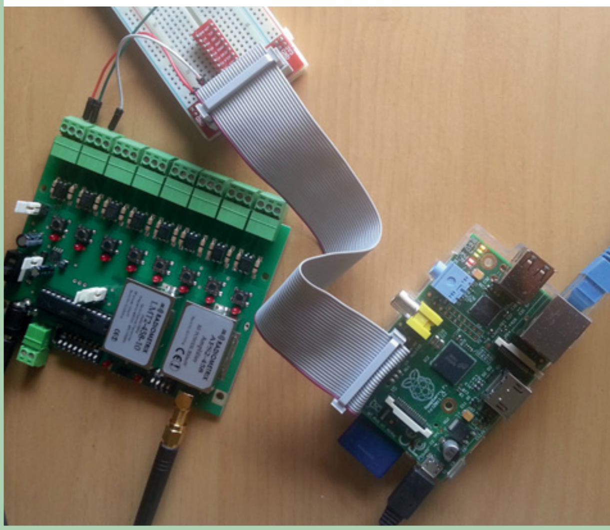
Figure 9: Raspberry Pi program for the example project

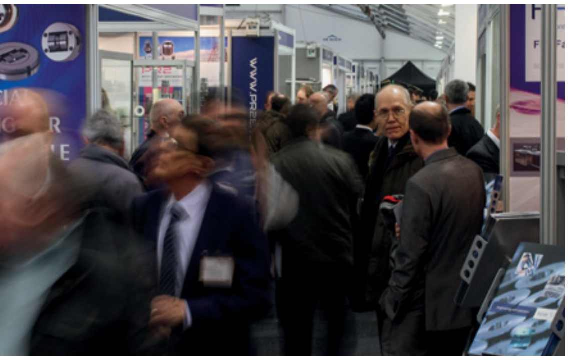
```
#------------------------------------------------------------------
#
# CTA88 DEMO KIT MAINS LIGHTS CONTROL
# ===================================
#
# This is a very simple Python program that demonstrates how the
# Raspberry Pi computer can be interfaced to the CTA88 demo Kit
# in order to control two sets of mains operated lights (L1 and
# L2), for example in a remote building.
#
# The absolute ON and OFF times are hard coded into the program
# for simplicity.
#
# The GPIO pins GPIO17 and GPIO18 are connected directly to the
# input connectors on the TX board.
#
# Two multi-tasking threads are created where they run in parallel
# and each thread controls a set of lights.
#
# Program: Lights.py
# Date : October, 2014
# Author : Dogan Ibrahim
#--------------------------------------------------------------------
import RPi.GPIO as GPIO                # import GPIO module
import time                            # import time module
import thread                          # import thread module

L1 = 17                                # light 1 connected to GPIO17
L2 = 18                                # light 2 connected to GPIO18

L1_ON = "10:00:00"                     # L1 ON time
L1_OFF = "11:00:00"                    # L1 OFF time
L2_ON = "10:10:00"                     # L2 ON time
L2_OFF = "12:00:00"                    # L2 OFF time

GPIO.setmode(GPIO.BCM)                 # set BCM pin numbering
GPIO.setup(L1, GPIO.OUT)               # Configure L1 as output
GPIO.setup(L2, GPIO.OUT)               # Configure L2 as output
#
# threads
#
def ControlLights(L, ON_Time, OFF_Time, Light):
      while True:
            tim = time.strftime("%H:%M:%S", time.localtime())
            if ON_Time == tim:
                  print (Light, " Turned ON")
                  GPIO.output(L, 1)
            elif OFF_Time == tim:
                  print(Light, " Turned OFF")
                  GPIO.output(L, 0)
            time.sleep(1)
#
# Create the threads
#
thread.start_new_thread(ControlLights, (L1, L1_ON, L1_OFF, "L1"))
thread.start_new_thread(ControlLights, (L2, L2_ON, L2_OFF, "L2"))

while True:                            # wait here forever
      pass
```

Figure 8: PDL of the program

```
BEGIN/MAIN
        Import required libraries
        Define ON and OFF times
        Configure GPIO17 and GPIO18 as outputs
        Start thread ControlLights to control light 1 (L1)
        Start thread ControlLights to control light 2 (L2)
        DO FOREVER
                Wait
        ENDDO
END/MAIN

BEGIN/ControlLights
        Get current absolute time
        IF current time = ON time of a light THEN
                Turn the light ON
        ELSE IF current time = OFF time of a light THEN
                Turn the light OFF
        ENDIF
END/ControlLight
```

Figure 10: Project setup





SOUTHERN
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10th to 12th February 2015

www.industrysouth.co.uk

Southern Manufacturing And Electronics Adds A Further Day

Southern Manufacturing and Electronics 2015 show returns to FIVE, Farnborough, from February 10th to 12th 2015. The UK's longest running and best supported electronics show lasts three days for the first time, signalling its increasing importance as an international event.

For many, the Southern Manufacturing and Electronics Show has been the most important national electronics show in the UK. At close to 18,000 square metres and hosting some 800 exhibitors, the show is a landmark event, and its growing prominence has attracted the attention of an unprecedented number of international vendors this year. Along with a comprehensive cross-section of the UK electronics industry, visitors to the 2015 event will meet a large number of firms from the rest of Europe, the US, Taiwan and Japan.

Ruwel International is a leading PCB manufacturer from Germany, serving the automotive, renewable energy and industrial sectors. PCB Baltic is another PCB manufacturer travelling from northern Europe to take part in the show. Polish CEMS firm Assel will showcase its 32 years of manufacturing experience. ERNI Electronics GmbH, headquartered in Germany, is a global supplier of connectors and EMS services, operating from bases across Europe, the Far East and the US. Other European firms include Selteka EMS Services; NORWE GmbH, supplying plastic coil formers; AC/DC power products firm Cosel Europe; and motors, drives and controls supplier from Italy, Delta Line.

From the US, Lodestone Pacific is a manufacturer of wound component parts. Canada's MG Chemicals manufacturers chemicals used in the electronics industry.

From Taiwan, Hiwin Technology Corporation produces linear motion systems, while Furukawa Electric of Japan will show its cabling range.

Most of the more familiar names from the UK scene return in 2015, including RS Components, Anglia Live, Midas Components, Mouser Electronics, Component Force, Blundell Production Equipment, MYDATA Automation and many others.

Along with the large components houses, there are numerous specialist vendors attending, such as RFI shielding firm Kemtron, sensors firms Magni-tec and Variohm Eurosensor, and ruggedised data keys specialist Nexus GB. OEM suppliers are represented by companies such as TDK-Lambda, Delta Line and PowerPax.

The show is one of the primary market places for service providers such as PCB manufacturers, CEM providers, and kitting, design and testing companies. In attendance will be Eurocircuits, Arrival Electronics, Cogent Technology, Spirit Circuits, York EMC, Easby Electronics, North Devon Electronics, Kiwa Blackwood and the Eurotech Group.

Bigger Show

Electronics is only one element of a much bigger show that features all aspects of manufacturing, and among the specialist areas is the live Machinery Demonstration Zone. On show will be CNC machine tools and machining centres, CAD/CAM tools, advanced adhesives, fasteners and joining technology, laser cutting, packaging solutions, labelling and marking, pressings, fabrications and enclosures, metrology and test equipment, coating and finishing, motors, drives and controls and handling and storage solutions.

As well as the exhibition and demonstration areas, the free seminar programme is a hugely popular feature. Two programmes run concurrently in two theatres, focused on manufacturing and electronics respectively. Topics include technology, innovation, business management, marketing and a more recent one - industrial legislation. Free access to such high-calibre technical and business acumen is another compelling attraction for electronics professionals.

Highlights

Highlights of the 2015 programme include Intellectual Property: Trade Marks & Designs with Rebecca Silva of Cleveland IP. Silva's colleague Stephen Turner delivers another session on patents on February 12th.

CE Marking is examined in detail in two sessions with Nick Wainwright of York EMC Services and Peter Evans from the CE Marking Association. Pete Dorey from TÜV SÜD Product Service gives further insight into the EMC Directives, while in Negotiating the Export Regulations Minefield Kings College London and Ken Ball from techUK review export controls for UK's Electronics Manufacturing supply chain. Other presentations in the 28 session programme look at examples of manufacturing best practice from around the world, SC21, lean manufacturing and Designing for Success and others.

Entry to the show and technical workshops is free to business visitors, and FIVE Farnborough offers complimentary car parks and simple access by road or public transport.

A full listing of seminars can be found at ***www.industrysouth.co.uk****, together with the registration form, or call 01784 880 890.*

EMBEDDED WORLD 2015
Exhibition Centre Nuremberg
24th – 26th February 2015
www.embedded-world.eu

embedded world 2015
Exhibition & Conference
... it´s a smarter world

Embedded World 2015: "We are the Internet of Things!"

Embedded World Exhibition & Conference – the world's biggest exhibition for embedded technologies with two internationally renowned conferences – brings the embedded community back to Nürnberg from 24-26 February 2015.

The theme of the Embedded World conference this year is "We are the Internet of Things". Embedded hardware and software engineers and developers come together to turn the future milestones of the Internet of Things (IoT) into reality. The backbone of the IoT is formed by networked, energy efficient, secure and reliable embedded systems that engender the countless applications constituting the IoT, and it is up to the embedded community to realise this technical revolution.

Event Pogramme

The programme for the Embedded World conference that runs in parallel to the trade fair includes many top-class papers and a large range of practical workshops. The most innovative embedded system developers in the world meet at the biggest European conference on embedded system development to exchange views on cutting-edge developments at the highest level, discuss ideas and set trends.

The main topics under the keyword "Engineering Focus" at the 2015 conference are IoT and Security & Safety. Daily keynotes examine the topics from various perspectives. Prominent industry figures, like Tyson Tuttle, CEO of Silicon Labs, Scott Aylor, Corp VP and GM – Embedded Systems Division at AMD, and Gareth Noyes, Senior Vice President Strategy and Corporate Development at Wind River, will share their visions and describe future developments and challenges.

The conference tackles the Security & Safety of Embedded Systems on all three days of the event. The session keynotes will be presented by well-known experts on topics such as hardware attacks and IoT security.

These themes are also reflected in the exhibition halls to accompany the conference. The special presentation areas provide the link to the international conferences. In the M2M Area companies will show their new product developments from the M2M communication segment.

Electronic Displays Conferences

The Electronic Displays Conference is one of the most important information and opinion platforms for the industrial displays sector. Developers, scientists, users and decision-makers meet to exchange knowledge at this conference accompanying the exhibition. The conference offers companies the opportunity to present their latest research findings and new trends to the visiting professionals and discuss applications and current market developments.

Highlights in 2015 include the sessions on touch screens, optimization of LCDs and OLEDs, their applications and future markets, and others. Practical presentations on HMI/GUI, driving and interfaces and display measurement are also on the programme.

The knowledge transfer continues after the papers; The "Author Interviews" offered after each session have been very popular in the past years, providing an excellent opportunity for discussion in small groups.

As before, the conference will also pay tribute to the new generation of scientists: students can submit their bachelor, diploma or masters theses that deal with displays. The best student's paper will be chosen from all the theses entered to win the edC Student Paper Award.

The electronic displays area builds directly on the topics dealt with at the electronic displays conference in a similar way to the M2M area and the embedded world conference. The companies in hall 1 show visitors new display technologies such as LCD, OLED, touch screens and more.

On the third day of the exhibition, the programme includes a special attraction for students – the Embedded World Student Day. Here visitors can learn of various study courses relevant to embedded systems.

More about the programme and how to register and attend is available at: ***www.embedded-world.eu***

WHAT THE READERS SAY...

IVOR CATT'S ARGUMENTS

As a published electronic engineer and former professor I have received several requests for comment on theories and ideas. I have responded to all of them and attempted to be open minded and honest in my replies.

After initially rejecting Ivor Catt's arguments I now see some merit in some of his statements.

The analysis of reflections in wave guides is traditionally based on EM or ExH radiation. A coax cable is often analyzed as a wave guide.

The experiment he described is repeated daily by digital PC board designers, who routinely have to control the signal qualities along the various high-speed (GHz) traces in electronic systems where a trace of a couple of inches must be treated as a transmission line.

These and other strip lines can have many taps and stubs, and keeping the signals synchronized everywhere on a board can require complex trace patterns to equalize the time delays and reflections. This type of waveform is commonly observed; you only have to look at your PC's motherboard to see them.

This is also a common problem in any cable system, including power lines.

The rejection of the use of pulse generators is ridiculous, as there is no such thing as DC. The power source had to be turned on sometime, and then turned off, resulting in a very low frequency AC signal, or if it is done only once, i.e. there was no further experimentation, which is doubtful, it is a unit pulse which, after Fourier analysis, is also AC.

The phenomenon Catt is examining is demonstrated in schools: http://web.physics.ucsb.edu/~lecturedemonstrations/Composer/Pages/76.18.html which I found using a 30s Google search.

There are plenty of ICs available, capable of driving a transmission line at these speeds, priced at a few pennies.

From the experimental point of view the use of a reed relay in such an application is surprising as the contact noise in these normally lasts for several milliseconds and can be observed with any scope. I can only assume that the initial bounce and subsequent arc was conveniently long.

As for the experiment, this type of observation is easily carried out on a twin lead cable such as 300-ohm antenna cable, which can be tapped anywhere along their length, and can even be set up as open lines with movable taps.

In his earlier paper, 34 years ago, Catt referred to the signal in a transmission line travelling in a dielectric at less than c, at c as claimed in this paper.

The idea of the two fields may provide a useful representation to explain some phenomena, but the fact remains that if one of the conductors breaks the resulting arc is made up of electrons and/or ionized material. Further, by logical extension one must consider the case where the fields are infinite, but almost cancel each other.

On other point is why do we need a conductor?

Years ago, an English teacher at school stated that an aircraft wing works by deflecting air downward. As every technically-minded student knows it is Bernoulli's theorem and a vacuum above the wing that makes planes fly: but both are partially true. A wing which is of zero thickness also works, but it is a little weak.

It makes you think though.

Finally the change in field at the switch travels to the shorted end and then back to the switch before the information at the other end of the line can influence the signal at the switch. It has to pass down the line twice. Until that happens the switch end sees the characteristic impedance of the cable and forms a voltage divider with the termination resistor.

Poor old Ocham gets blamed for everything.

David German

A CAPACITOR IS A TRANSMISSION LINE

The leads to a capacitor are connected to one end of the capacitor plates, not to their centre, as a capacitor is always wrongly drawn. The energy is a TEM wave that enters the capacitor sideways. The fields of a Transverse Electromagnetic (TEM) Wave are sideways, normal to the capacitor plates, and there is no forward magnetic field. So Maxwell's Displacement Current, which causes a magnetic field in a plane parallel with the plates, is incompatible with the TEM Wave.

Classical electromagnetic theory therefore is internally inconsistent, unless we exclude the TEM Wave from the theory. But surely the energy travelling in a USB cable is easily seen to be TEM.

A useful illustration of this point was in Wireless World, December 1978, now at: **http://www.ivorcatt.org/icrwiworld78dec1.htm**

Ivor Catt

KEEP UP THE GOOD WORK

I have just read Myk Dormer's '*Experiments with a UART*' article in the October issue of Electronics World and it is brilliant!

Every month I first turn to Myk's articles, read them and then chuckle. Myk has a great writing style that both entertains and educates just as Lord Reith (BBC) would probably advocate.

Keep up the good work!

Mike Meakin

WHAT THE READERS SAY...

SINGLE-POINT GROUND

The term 'single-point ground' can have different meanings.

Harry Joseph, in the letters page of the September issue of EW, associates the term with an audio cable which is grounded at one end only. However, if there are more than two signal processing units in the system, the ground connections of different signal links will be located at widely separate points. It is misleading to describe such a system as having a 'single-point ground'.

A Google search reveals the usual meaning of the term. On cars, lorries, aircraft and spacecraft, the conducting structure of the vehicle is used as a convenient return path for many signals and power supplies. These return currents create voltages along the structure and these are a source of EMI. To minimise the effect of these voltages, a point on the structure is designated to be at zero voltage and all the return conductors are connected to this one point. Since such a configuration eliminates resistive coupling, it is believed to be an effective way of reducing EMI.

> "Classical electromagnetic theory therefore is internally inconsistent, unless we exclude the TEM Wave from the theory

When I built my first valve radio, I was advised to drill a hole in the aluminium chassis and use it to fix a solder tag. All the return conductors from the amplifier stages were soldered to this one tag, the only exception was the wiring to the heaters. This was carried by a twisted pair strung on a daisy chain between the valves, and driven by a low-voltage winding on a mains transformer. The radio worked well, apart from an incessant 50Hz hum. Stray magnetic field from the heater wiring was coupling into the sensitive input stages. The large signal loops formed by the wiring formed ideal pick-up loops.

In the 1960s, I designed a Ground Trainer for the Martel missile. The customer insisted that I implement his grounding philosophy. A point at the bottom of the equipment rack was designated as the single-point ground. Three braided conductors were connected to this point, designated 'power ground', 'logic ground' and 'analogue ground'. These braids were enclosed in insulating sheaths. Power supplies had to be referenced to power ground, logic circuits were constrained to use logic ground, and analogue circuits were connected exclusively to analogue ground. That was a memorable project.

There is an influential body of opinion which still maintains that single-point grounding is the preferred option for systems where the return conductors are 'electrically short'. It is reasoned that such a configuration is a significant improvement on systems where the structure is used as the return path.

The final article in the series 'Circuit Modelling for EMC' in the July 2014 issue of EW explains why this is a thoroughly bad idea. It also explains why the technique described by Harry Joseph is so effective in minimising EMI.

Even so, many system designers have been persuaded to adopt the concept of the 'single-point ground'. Designs based on this idea are implemented on aircraft now in the sky.

Ian Darney

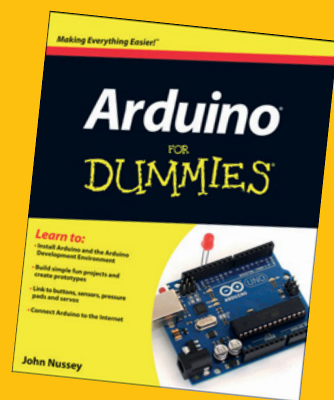
ARDUINO PROJECTS BOOK WINNERS

During the course of last year we run a series of articles covering the Arduino and simple projects using it.

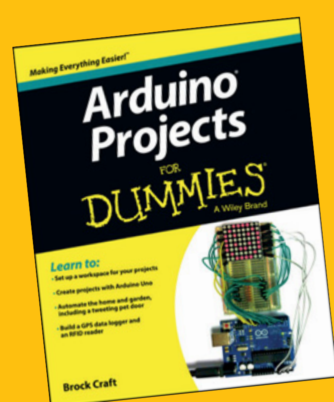
We offered copies of each book to be won by readers.

The winners are:

'Arduino for Dummies' by John Nussey:
1. Damian Moni Moyano, Argentina
2. John Nightingale, UK



'Arduino Projects for Dummies' by Brock Craft:
1. Søren Kragh Nielsen, Denmark
2. Tamás Fehér, Hungary



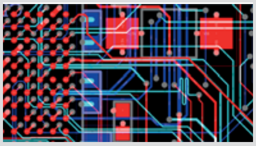
Congratulations to our winners! from EW

PULSONIX RELEASES PCB SOFTWARE 8.5

Pulsonix, the printed circuit board (PCB) EDA company, is releasing its latest professional PCB software, Pulsonix 8.5, offering several new features.

Introducing the IPC-2581 netlist export and Gerber X2 manufacturing outputs to Pulsonix, Westdev has reflected the need to move forward with the changing demands of its customers and their manufacturing processes. Both of these new and extended formats provide capabilities that will become standards used by customers creating high-technology designs.

The new Panel Editor feature enables users to take control over pre-fabrication processes and allows multi-PCB designs to be panelised ready for plotting and on to manufacture. The Panel Editor also allows adding test coupons, fiducial markers, documentation and fabrication details.



In conjunction with technology partners providing enhanced library options, Pulsonix has signed joint agreements to enable import of a new format into its library system. Agreements have been signed with PCB Libraries, Accelerated Designs and SnapEDA, with each vendor providing different specialist libraries to enhance the Pulsonix libraries.

www.pulsonix.com

NEW DESIGN OPTIONS FOR HAR-FLEX CONNECTORS

Harting has introduced a number of new devices in its Har-flex family of compact, versatile and rugged board-to-board and board-to-cable 1.27mm pitch connectors. Straight and angled connectors are now available as PCB models which, when combined with the connectors for flat ribbon connection, allow PCBs to be combined into complex systems perfectly adapted to their surroundings. All Har-flex connectors are available with six to 100 contacts, in increments of two. Fully assembled cables are also available.

The compact but rugged design of the Har-flex connectors also guarantees reliable operation under adverse conditions. Two large holders ensure that the connectors are firmly held in place after soldering. A low-wear insertion and withdrawal procedure is achieved by a very smooth contact point between the male and female contacts.

Har-flex connectors are also suitable for high data rates, handling modern transfer protocols such as Gigabit Ethernet or PCI Express.

www.harting.com

PRECISION HALL-EFFECT ANGLE SENSOR ICS

New from Allegro MicroSystems Europe are the A1332 and A1334, a family of high-resolution 360° angle sensor ICs based on magnetic circular vertical Hall (CVH) technology.

These new contactless Hall-effect magnetic sensors are based on system-on-chip (SoC) architectures and provide high output refresh rates and low signal-path latency to support a wide variety of demanding applications. Both devices are ideal for automotive and industrial applications that include electronic power steering (EPS), transmission systems, sensing motor and throttle/pedal positions, and other parameters that require the accurate measurement of angles.

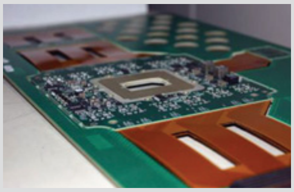
The A1332, with an onboard 32-bit processor and EEPROM for factory and customer programmability, includes segmented and Fourier linearisation functions for supporting challenging off-axis/side-shaft magnetic sensing configurations that are commonly found in electronic power steering and transmission applications. The A1332 also supports on-axis/end-of-shaft magnetic sensing configurations, and can produce high-accuracy angle measurements with an output refresh period of 32µs.

www.allegromicro.com

READY TO TACKLE INCREASINGLY DEMANDING PCB ASSEMBLY PROJECTS

Speedboard Assembly Services has enhanced its Printed Circuit Board (PCB) assembly capabilities, following investment in an IBL BLC 509 Vapour Phase oven, where Vapour Phase allows better control and stability over the entire soldering process, compared to traditional reflow soldering, regardless of board characteristics.

PCBs manufactured using Vapour Phase do not experience the high temperature differences ('delta Ts') typically produced during traditional reflow soldering, which can cause component and/or board damage. The Vapour Phase process works by heating the PCB, which has already been through screen-print and one or more pick and place stages, in the vapour of boiling Galden, an inert liquid which is ideal for the wetting of lead-free alloys without risk of oxidation.



During Vapour Phase soldering, a PCB cannot become hotter than the vapour in which it is suspended. Its position within the vapour (e.g. height above the boiling Galden) governs the maximum temperature the PCB will be able to reach.

www.speedboard.co.uk

HONEYWELL HAS A NEW PRESSURE SENSOR OFFERING

Honeywell has extended its Wing Union/Hammer Union Pressure Sensor portfolio with two new models, 435 and 437, and a protective cage option. These accurate, highly durable, configurable pressure sensors are built to measure drilling fluid pressure and flow to keep oil field equipment operating while preventing damage or equipment failures.

The new models, offering pressure ranges of 5,000-20,000psi, provide a durable all-welded, stainless assembly with Inconel X-750 wetted parts, which protect against abrasive and corrosive media. Having been tested to endure vigorous amounts of shock and vibration, the pressure sensors provide reliable performance. The protective cage option on the new models provides protection against miss-hits during installation of the wing union and offers additional electrical connector protection on the pressure sensor. It is RFI/EMI protected and is CE approved. All configurations of the new models are intrinsically safe and carry global approvals and CFMUS/ATEX/IEC-Ex certification, and are suitable for use in hazardous environments.

www.honeywell.com

SICK PROFILER 2 KEEPS A LOW PROFILE FOR HIGH QUALITY INSPECTION

Sick has introduced Profiler 2, a short range distance sensor for accurate measurement of 2D profiles, shapes and surfaces that combines a high-performance resolution of two microns with a wide measurement range.

The Sick Profiler 2 delivers plug-and-play performance ideally suited to production line quality inspection programmes in the electronics industry. Its ability to measure complex profiles with just one laser line and analyse up to four areas at once saves on hardware costs and installation time.

The versatile Profiler 2 is ideal for measuring shapes, profiles and object angles, detecting multiple edges, monitoring gap sizes and measuring the width and thickness of components. Examples include checking the heights and lengths of geometries in assembled PCBs.

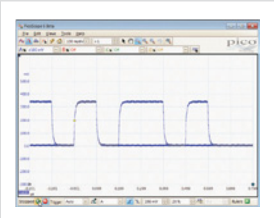
The Sick Profiler 2 scans a 32mm wide field from a range of up to 125mm high, assessing complex profiles over up to four areas at once with just one laser line, with high reliability.

www.sick.co.uk

PICOSCOPE BREAKS THE 100,000 WAVEFORMS PER SECOND BARRIER

The latest release of the PicoScope 6 software for PC oscilloscopes has a greatly improved continuous update rate of over 100,000 waveforms per second. This is faster than any other PC oscilloscope and beats many expensive benchtop oscilloscopes.

The new fast persistence mode is available on all Pico oscilloscopes from the PicoScope 3000 Series upwards with the PicoScope R6.10.2 beta software or later. Using dedicated hardware inside the scope, this mode can achieve update rates up to 120,000 waveforms per second on USB 3.0 deep memory scopes such as the PicoScope 6000C/D Series. With USB 2.0 deep memory scopes the update rate can now reach 80,000 waveforms per second.



Even faster capture rates are possible using rapid trigger mode, which collects bursts of up to 10,000 waveforms at a rate of up to 1 million waveforms per second into segmented memory for later viewing.

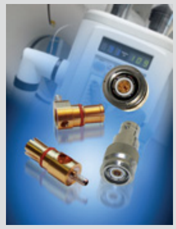
www.picotech.com

CONNECTOR SOLUTIONS FOR MEDICAL ELECTRONICS SYSTEMS

Intelliconnect offers a wide range of connectors suitable for use in diagnostic, treatment and wearable medical device technologies.

The versatility of Intelliconnect products in medical systems is demonstrated by the wide range of applications they are suitable for, including connectors for RF cancer treatment, radiation dosimeters and detectors, bio-medical test equipment and bionics.

Intelliconnect also manufactures micro-miniature waterproof coaxial connectors for use in cochlear ear implants. This very demanding application requires a rugged and reliable quick-disconnect waterproof connector capable of making several thousand disconnects during its product lifetime.



The Intelliconnect design meets IP68, is comfortable to wear close to the skin and may be used in normal domestic environments including swimming pools, showers, baths and high humidity environments such as saunas, steam rooms and so on.

In addition to standard coaxial and triaxial types, Intelliconnect provide a fast turnaround custom design service for non-standard medical connector requirements.

www.intelliconnect.co.uk

ULTRA-LOW-POWER FRAM WITH INTEGRATED COUNTER FUNCTION

Fujitsu Semiconductor Europe (FSEU) released MB85RDP16LX, an ultra-low-power FRAM device with integrated binary counter function.

The new device incorporates multiple optimisations to slash energy consumption below 10% of standard FRAM solutions. Target sectors include industrial automation involving energy harvesting for rotary encoders, motor control and sensors. The ultra-low-power device can enable self-powering solutions such as the Wiegand wire-based platform being offered by iC-Haus.

Significant energy savings have been achieved by integrating the counter function into the FRAM device. Conventional system environments using standard memory require the MCU to read data from the memory device before performing computation and then writing new data back to the memory to complete the counting operation. In contrast, MB85RDP16LX replaces these separate read/write operations with a single command from the MCU, resulting in energy savings of up to 94%.

The power-up time of MB85RDP16LX has been optimised to 5µs, which is 38 times faster than standard FRAM devices, enabling extremely fast device wake-up.

http://emea.fujitsu.com/semiconductor

HIGH-SPEED CAN FD INTERFACE PROTOCOL ANALYSIS

With its R&S RTE and R&S RTO oscilloscopes, Rohde & Schwarz is one of the first suppliers to offer analysis solutions for the CAN flexible data (CAN FD) interface protocol. A new option enables design engineers to analyze CAN interfaces that support the high-speed CAN FD bus protocol. These interfaces are seeing increased use in automotive and industry applications due to rising data rate requirements.

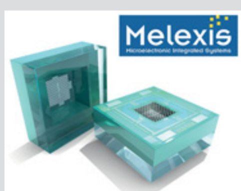
Introduced in 2012, the CAN FD serial bus protocol with a maximum data rate of up to 15Mbps boosts controller area network (CAN) performance. This benefits several industries, and in particular the automotive industry in developing modern motor management solutions.

The R&S RTx-K9 option now enables R&S RTE and R&S RTO oscilloscope users to analyze interfaces of this type and trigger protocol details. Hardware-based decoding makes finding errors with the oscilloscopes especially fast, which accelerates design verification and the commissioning processes for chipsets with CAN FD interfaces.

www.rohde-schwarz.com

HIGHLY ROBUST MEMS-BASED PRESSURE SENSORS

Melexis has introduced two new pressure sensor products which combine high sensitivity and strong linearity. Fully automotive qualified (exceeding AEC-Q100 requirements), the MLX90815 and MLX90816 are discrete micro-electro-mechanical (MEMS) devices for measuring absolute pressure in demanding operational environments. The MLX90815 is designed for optimal performance when determining pressures from 0-30bar absolute, while the MLX90816 covers full scale pressures ranging from 30-50bar absolute. Both have a maximum deviation in their linearity of just 0.2% FS. Typical sensitivity for the MLX90815 is 1.5mV/V/bar and for the MLX90816 it is 0.5mV/V/bar.



The sensor element incorporated into every one of these MEMS devices consists of a piezo-resistive Wheatstone bridge connected to a micro-machined silicon pressure membrane, fabricated using Melexis's own proprietary process technology. As pressure is applied to the membrane, a differential voltage change occurs across the outputs of the Wheatstone bridge while a bias voltage is applied to the bridge inputs.

www.melexis.com

HIGH-EFFICIENCY POWER MODULES WITH ULTRA-WIDE INPUT VOLTAGE

Ericsson has introduced the PKB5000W series of open-frame isolated 120W eighth-brick DC/DC power modules that offer high current output and high efficiency. Importantly, the new PKB5000W module features an ultra-wide input range of 18-75VDC, which means that the device is also suitable for 24V or 48V telecom systems.

Joining the recently announced PKU5510E, PKE5000 and PKE3000, the PKM5000W series expands upon Ericsson's portfolio of converters that offer highly flexible power conversion to applications that require an ultra-wide input voltage range.

The PKM5000W comes in the industry-standard through-hole eighth-brick format, measuring 58.4 x 22.9 x 9.91mm (2.3 x 0.9 x 0.39 inches). In addition to the open-frame version of the module, an optional baseplate version is also available for applications that require conduction cooling.

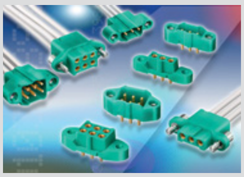
Offering outstanding thermal performance and derating capabilities, the module delivers very high efficiency of typically 91.5% at 12V full load.

www.ericsson.com

NEW 10A HI-REL POWER CONNECTOR FROM HARWIN HANDLES UP TO 175degC

Harwin has launched a family of high density power connectors that can handle currents up to 10A. Based on a 3mm pitch, the new M300 connectors are designed for rugged environments and withstand twice the number of operations as older generation products.

The M300 connectors feature a 4-fingered Beryllium Copper female contact which delivers superb electrical and mechanical performance. Devices suit 18-22AWG applications and are designed for use in temperatures of between -65degC and +175degC, rated for 1000 operations. They pass shock (EIA-364-27: 100g 6ms No Discontinuity > 1µs) and vibration (EIA-364-28 10g No Discontinuity > 1µs) testing. Jackscrews are available for extra security.



Other features include keyway polarisation and identification of the #1 position, and the connector bodies are moulded in environmentally-friendly material.

To aid design activities, Harwin provides CAD models and test reports, and live technical support is always available.

www.harwin.co.uk

EXPANDED PARTNERSHIP AND PORTFOLIO AT MOUSER

Mouser Electronics has expanded its strategic partnership and worldwide distribution agreement with Analog Devices (ADI) to include ADI's recently acquired RF and microwave products from Hittite Microwave – marketed as "Hittite Microwave Products from Analog Devices".

The Hittite Microwave Products from Analog Devices apply to analog, digital and mixed-signal semiconductor technologies used in a wide variety of wireless and wired communication and sensor applications, for automotive, broadband, cellular infrastructure, fiber optic, microwave and millimeter wave communications, military, space and test and measurement systems among others.

The Hittite Microwave product line available now from Mouser Electronics, includes high performance microwave, RF, and millimeter-wave products and subsystems, capable of operating over frequencies from DC up to 110GHz. Products include digital ICs, RF ICs and monolithic microwave ICs, as well as state-of-the-art Gallium Arsenide semiconductor devices.

Mouser.com also houses an industry-first interactive catalogue, data sheets, supplier-specific reference designs, application notes, technical design information and engineering tools.

www.mouser.com

FIBRE OPTIC LINK SERVICE FROM OMC SUITS INDUSTRY 4.0/SMART FACTORY APPLICATIONS

OMC believes its fibre optic links are an ideal solution for industrial automation systems designers who are widely adopting Smart Factory/Industry 4.0 working practices that rely on the collection and feedback of large amounts of equipment performance data which is then used to fine-tune production processes and increase efficiency.

OMC produces glass and polymer fibre optic cable assemblies for many demanding industrial applications, and has developed its own proprietary ACA (Active Component Alignment) technology to ensure that its fibre-optic data links perform consistently and reliably from link to link. The company also designs complete optical links, including the transmitter, receiver and cable assembly, which are performance-matched during manufacture to ensure that the system's optical budget is sound regardless of how the components are matched up in production.

Industrial machinery and smart factory environments are often noisy and challenging environments for electrical signals, so optical transmission is often more appropriate.

www.omc-uk.com

POWER INTEGRATIONS REVOLUTIONIZES SWITCH-MODE POWER-SUPPLY DESIGN

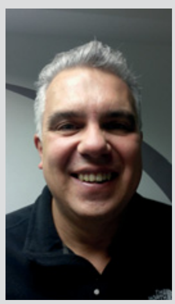
Power Integrations introduced a new class of power supply ICs, called InnoSwitch. This is a family of highly integrated switcher ICs that combine primary, secondary and feedback circuits into a single, worldwide safety-rated, surface-mount package. With these ICs, designers can easily meet all global regulatory standards for efficiency and no-load consumption, while minimizing component count and providing highly accurate constant voltage and constant current up to 25W.

The InnoSwitch family is ideal for smart mobile device chargers and adapters for a wide range of applications such as set-top boxes, networking equipment and computer peripherals.

Inside the new device, highly accurate secondary-side direct voltage and current measurements are communicated across the safety isolation barrier using high-speed digital FluxLink technology. This proprietary new feedback technique permits precise control without the need for a bulky optocoupler, while avoiding the performance compromises inherent in primary-side regulation (PSR), such as limited accuracy and efficiency and poor transient response versus no-load consumption.

www.power.com

FISCHER'S MINIMAX CONNECTOR FAMILY AVAILABLE AT ASTUTE



Astute Electronics, a supplier of electronic components and value-added services, is introducing Fischer's MiniMax connector family that combines high density, signal and power in miniature package, with a profile of less than 7mm inside the box.

The high performance, rugged connector family is now available both in 19- and 24-pin configuration, giving designers more flexibility, especially where space and weight restrictions play a role.

Gary Evans, Astute Electronics's E-Mech Divisional Manager, said: "The combination of power and signal contacts offered by the Fischer MiniMax Series enables more functionality into smaller devices and lowers the total cost of ownership. This connector is ideally suited for handheld or wearable applications, instrumentation and test equipment.

While the 24-pin configuration is available with four power and 20 signal contacts, the 19-pin configuration features four power and 15 signal contacts as standard, with the ability to increase the number of power contacts depending on the cable used.

www.astute.co.uk

PANASONIC ENTERS WI-FI MODULE MARKET

Panasonic Automotive and Industrial Systems has entered the Wi-Fi market with three different new Wi-Fi module series, with additional modules combining Wi-Fi with other wireless technologies and multi-frequency options.

The PAN90x0 Series radio modules combine 802.11b/g/n wireless radio (2.4GHz), a baseband processor, medium access controller, encryption unit, boot ROM with patching capability, internal SRAM, in-system programmable flash memory and other powerful supporting features and peripherals. The low-power operation supports deep sleep and standby modes by using an on-board power management unit.

The PAN90x5 Series modules enable both Wi-Fi and Bluetooth functionality to be incorporated into new designs. Devices combine an excellent 802.11b/g/n and Bluetooth Smart Ready wireless radio (2.4GHz), baseband processor and other supporting features and peripherals. MIMO 2x2 technology allows simultaneous data transmission over multiple streams using the same frequency. This results in greater range and higher throughput.

These two low-power system-on-chip (SoC) solutions enable wireless network applications to be built cost effectively.

http://eu.industrial.panasonic.com

EVE PLATFORMS FOR HMIS WITH CAPACITIVE TOUCH

FTDI Chip has further enlarged the portfolio of development modules to accompany its Embedded Video Engine (EVE) technology for human machine interfaces (HMIs) implemented with an object-oriented approach. The latest EVE platforms are targeted at intelligent display systems using capacitive touch and are based on the FT801 EVE chip released earlier this year. Both of the new modules' touchscreens are able support from 1-5 independent touch points, thus allowing a wide variety of different gestures, from rotations and swipes to pinches and zooms. They can source power at 5V via their 2.1mm power jack, USB Micro-B port or SPI master connector. Alternatively they can be linked to a 3.3V supply via their I2C interface.

The VM801B (B refers to Basic) is a compact (106.7mm x 68.6mm) development module with a choice of a 5" or 4.3" display, plus an integrated projected capacitive touchscreen and a fitted, plastic bezel in a choice of black or pearl finish.

www.ftdichip.com

RS COMPONENTS RAISES THE BAR WITH NEW BLACKFIN DSPS

RS Components is stocking the first DSPs in Analog Devices's new power-efficient high-performance ADSP-BF70x Blackfin family.

The ADSP-BF70x Blackfin family is based on Analog's new Blackfin+ core, which supports 16-bit and 32-bit fixed-point processing and offers many efficiency improvements. With 800 MMACS of processing power at less than 100mW, this advanced core delivers double the performance or half the power of competing devices.

The flagship device in the new family, the ADSP-BF707, has 1MB of on-chip SRAM and 512kByte of L2 ROM, eliminating external memory in many applications. A 16-bit L3 interface to external DDR2 or LPDDR SDRAM devices is also provided.

Extensive peripheral integration includes a 4-channel 12-bit 1MSPS ADC, a USB2.0 OTG controller, two CAN2.0B interfaces, ePPI Video interface, and /I2S audio support. There are also powerful security features, including crypto hardware accelerators for fast secure boot and IP protection and memDMA encryption/decryption for run-time security.

uk.rs-online.com

ADI HITTITE MICROWAVE PRODUCTS BOOST SILICA'S RF COMMUNICATIONS OFFERING

Silica, an Avnet company, has announced the availability of Analog Devices's (ADI) Hittite Microwave products, extending the distributor's wireless communications portfolio by over 1100 new standard products across 36 device families. Together with ADI products already stocked by Silica, the total RF and microwave offering is now over 2000 parts covering the complete signal chain for communications systems operating at frequencies up to 110GHz.

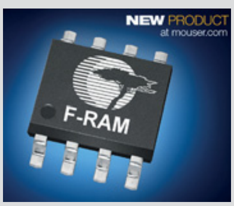
Hittite Microwave devices include highly integrated components, development platforms and modules. The range spans amplifiers, filters, signal processors, modulators and demodulators, PLLs, transceivers, and frequency dividers, detectors and multipliers.

Silica's Vice President Sales and Marketing Europe, Mario Orlandi, said: "Rapidly developing broadcast, automotive systems, defence and satellite communications markets are creating unprecedented demand for high bandwidth communications links across the RF spectrum. Adding Hittite Microwave devices to our inventory is an important part of our on-going investment to make implementing cost-effective, reliable wireless links faster and easier for our customers."

www.silica.com

PARALLEL FRAM NON-VOLATILE MEMORY FROM CYPRESS NOW AT MOUSER

Mouser Electronics is now stocking Parallel FRAM Non-Volatile Memory from Cypress Semiconductor. Cypress's family of Ferroelectric Random Access Memories (FRAMs) read and write just like conventional SRAM while retaining data when power is removed just like Flash memory. These highly-reliable FRAMs feature a variety of interface and density options, and are available in memory sizes ranging up to 4Mbit, with data retention provided for up to 151 years.



The Cypress Parallel FRAM non-volatile memory, available from Mouser Electronics, can be used as a drop-in replacement for any standard SRAM with the advantage of retaining data when power is removed. FRAMs are considered one of the industry's fastest, most energy-efficient non-volatile memory solutions. All FRAM cells are inherently low power and operate without a charge pump. The Cypress FRAM memory cells feature an extremely high-endurance rate of 100 trillion read/write cycles while maintaining low-energy consumption.

www.mouser.com

MOLEX LAUNCHES NEW CUSTOMISED POF/HPCF CABLE ASSEMBLIES

Molex recently launched a new fully customisable Plastic Optical Fibre (POF) and Hard Polymer Clad Fibre (HPCF) assemblies and harnesses including hybrid POF. Designed to offer a rugged and cost-effective solution, these assemblies and harnesses provide maximum flexibility for optical cabling in medical electronic applications such as diagnostic imaging, optical sensors or data and galvanic isolation purpose such as X-ray machines and dental equipment.

Molex Polymicro 200/230 PolyClad Optical Fibre accommodates short-to-medium distance data communications and withstands the harsh conditions that can be found in clinic and hospital settings, including exposure to fluids, chemicals and radiation. Supporting the new product family is a powerful, free configuration tool designed to help customers identify the exact assemblies and harnesses needed.

"Medical device designers are able to specify POF assemblies and harnesses in terms of connector types, jacket material and colour, temperature range, UL certification, cable lengths and tolerances, numerical aperture and fibre size," said Mickaël Marie, Moled European business manager.

www.molex.com

PASTERNACK INTRODUCES NEW RF COMBINERS OPERATING UP TO 6GHZ

Pasternack Enterprises, a manufacturer and supplier of RF, microwave and millimeter wave products, has introduced a completely new line of broadband RF power combiners. The broad bandwidth of these new combiners makes them the perfect complement to systems using components such as power amplifiers, antenna feeds, attenuators and switches. A special area of usage for these power combiners is in combining individual power amplifiers together into a large power block in an amplifier system.

The new RF power combiners from Pasternack are offered in the popular 2-way and 4-way configurations and deliver high power up to 600W and operate over a broad temperature range between 55°C to 85°C, expanding the versatility of this product offering to a wide range of military and commercial applications.

Pasternack's broadband RF combiners offer frequency ranges from 20MHz to 6GHz, low insertion loss from 0.35-1dB and low VSWR up to 1.30:1.

www.pasternack.com

PROTEUS 25

Pioneering Electronics Design Software

1989-2014

- 1989 Autorouter added to PCB for DOS
- 1990 Schematic capture added
- 1991 World 1st schematic capture for Windows®
- 1992 Topological route editing
- 1993 Fully integrated circuit simulation
- 1994 Rip up and retry autorouter
- 1995 Shape based power plane support
- 1996 True mixed mode SPICE simulation
- 1997 Interactive simulation
- 1998 PIC® microcontroller simulation
- 1999 8051 microcontroller simulation
- 2000 World 1st MCU co-simulation
- 2001 Language support for MCU simulation
- 2002 Electra adaptive shape based router
- 2003 World 1st 32 bit MCU support with ARM®-7
- 2004 Integrated Proteus VSM and MPLAB™
- 2005 Redesigned GUI across Proteus Suite
- 2006 3D visualisation engine
- 2007 World 1st USB simulation
- 2008 HDL support in simulation
- 2009 Shape based autorouter included
- 2010 VSM Studio IDE introduced
- 2011 Design rule aware manual routing
- 2012 ARM® Cortex™-M3 MCU simulation
- 2013 New application framework

2014

- NEW Project clips enable re-use of blocks of circuitry inside a project across multiple projects
- NEW Dynamic teardrop control including per pad override
- NEW Integrated Arduino™ toolchain with VSM Studio and common Arduino™ shields
- NEW Library import tools (BSDL,PADS ASCII)
- NEW New Project notes module for generic entry of notes and reports
- NEW Major upgrade to BOM module to improve physical output and simplify styling
- NEW Improved support for paste, solder, fanout and stitching vias during footprint creation

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