Volume 116 • Issue 1890
June 2010 • £4.60

www.electronicsworld.co.uk

ELECTRONICS WORLD

THE ESSENTIAL ELECTRONICS ENGINEERING MAGAZINE

TWO NEW AUDIO SECTIONS:

- MONTHLY AUDIO TUTORIAL
- QUARTERLY AUDIO COLUMN

ALSO INSIDE:

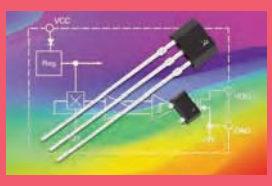
- µRTOS
- MPUS
- STREAMLINING CARRIER BOARD DESIGN

LINKING THE OLD AND NEW WORLDS

OF MOBILE PERIPHERAL DESIGN

TECHNOLOGY
OPTICAL BREAKTHROUGH IN PHONE CAMERAS

FOCUS
G.HN – NETWORKING OVER EXISTING WIRES



PRODUCTS
ANTENNAS, PROCESSORS, DEVELOPMENT SYSTEMS

ALSO IN THIS ISSUE: THE TROUBLE WITH RF... • DESIGN • INSIGHT

The New LeCroy Oscilloscopes

40 MHz – 30 GHz

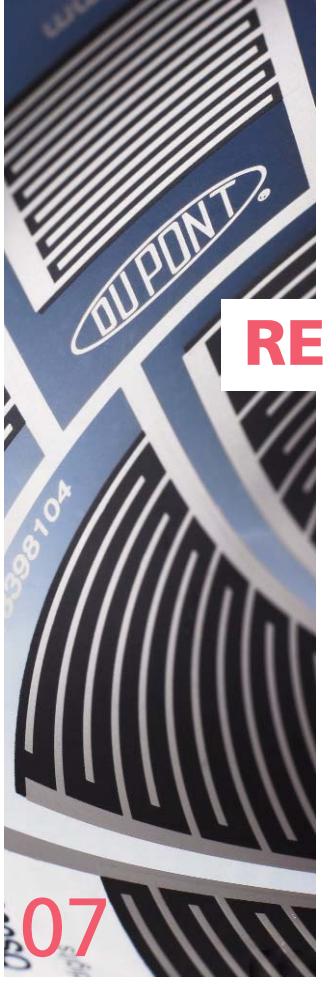
Pay Less, Measure More

FROM £ 550

LeCroy's oscilloscope line is broader than ever, and each product benefits from LeCroy's rich, 45-year heritage of providing deep insight into complex signals. Whether you need to measure, characterize and analyze the highest speed signals using the world's fastest (30 GHz) real-time oscilloscope; require a lower cost, portable oscilloscope; or something in-between, LeCroy has the bandwidth you want and the performance you need.

LeCroy

To learn more, visit www.lecroy.co.uk or call 01235 536973



REGULARS

Cover supplied by TOSHIBA MICROELECTRONICS More about the new MIPI interface on p18 and 19

FEATURES

Electronics World is published monthly by
Saint John Patrick Publishers Ltd,
6 Laurence Pountney Hill, London, EC4R 0BL.

Quasar Electronics Limited
PO Box 6935, Bishops Stortford
CM23 4WP, United Kingdom
Tel: 01279 467799
Fax: 01279 267799
E-mail: sales@quasarelectronics.com
Web: www.quasarelectronics.com

Postage & Packing Options (Up to 0.5Kg gross weight): **UK Standard 3-7 Day Delivery** - £4.95; **UK Mainland Next Day Delivery** - £9.95; **Europe (EU)** - £8.95, **Rest of World** - £12.95 (up to 0.5Kg)
!Order online for reduced price UK Postage!
We accept all major credit/debit cards. Make cheques/PO's payable to Quasar Electronics. Prices include 15.0% VAT.
Please visit our online shop now for details of over 500 kits, projects, modules and publications. Discounts for bulk quantities.

01279 Credit Card Sales 467799

QUASAR electronics
The Electronic Kit Specialists Since 1993

Motor Drivers/Controllers

Here are just a few of our controller and driver modules for AC, DC, Unipolar/Bipolar stepper motors and servo motors. See website for full range and details.

Computer Controlled / Standalone Unipolar Stepper Motor Driver

Drives any 5-35Vdc 5, 6 or 8-lead unipolar stepper motor rated up to 6 Amps. Provides speed and direction control. Operates in stand-alone or PC-controlled mode for CNC use. Connect up to six 3179 driver boards to a single parallel port. Board supply: 9Vdc. PCB: 80x50mm.
Kit Order Code: 3179KT - **£15.95**
Assembled Order Code: AS3179 - **£22.95**

Computer Controlled Bi-Polar Stepper Motor Driver

Drive any 5-50Vdc, 5 Amp bi-polar stepper motor using externally supplied 5V levels for STEP and DIRECTION control. Opto-isolated inputs make it ideal for CNC applications using a PC running suitable software. Board supply: 8-30Vdc. PCB: 75x85mm.
Kit Order Code: 3158KT - **£23.95**
Assembled Order Code: AS3158 - **£33.95**

Bi-Directional DC Motor Controller (v2)

Controls the speed of most common DC motors (rated up to 32Vdc, 10A) in both the forward and reverse direction. The range of control is from fully OFF to fully ON in both directions. The direction and speed are controlled using a single potentiometer. Screw terminal block for connections.
Kit Order Code: 3166v2KT - **£22.95**
Assembled Order Code: AS3166v2 - **£32.95**

DC Motor Speed Controller (100V/7.5A)

Control the speed of almost any common DC motor rated up to 100V/7.5A. Pulse width modulation output for maximum motor torque at all speeds. Supply: 5-15Vdc. Box supplied. Dimensions (mm): 60Wx100Lx60H.
Kit Order Code: 3067KT - **£17.95**
Assembled Order Code: AS3067 - **£24.95**

Most items are available in kit form (KT suffix) or assembled and ready for use (AS prefix).

Controllers & Loggers

Here are just a few of the controller and data acquisition and control units we have. See website for full details. Suitable PSU for all units: Order Code PSU445 £7.95

8-Ch Serial Isolated I/O Relay Module

Computer controlled 8-channel relay board. 5A mains rated relay outputs. 4 isolated digital inputs. Useful in a variety of control and sensing applications. Controlled via serial port for programming (using our new Windows interface, terminal emulator or batch files). Includes plastic case 130x100x30mm. Power Supply: 12Vdc/500mA.
Kit Order Code: 3108KT - **£64.95**
Assembled Order Code: AS3108 - **£79.95**

Computer Temperature Data Logger

4-channel temperature logger for serial port. °C or °F. Continuously logs up to 4 separate sensors located 200m+ from board. Wide range of free software applications for storing/using data. PCB just 45x45mm. Powered by PC. Includes one DS1820 sensor.
Kit Order Code: 3145KT - **£19.95**
Assembled Order Code: AS3145 - **£26.95**
Additional DS1820 Sensors - **£3.95 each**

Rolling Code 4-Channel UHF Remote

State-of-the-Art. High security. 4 channels. Momentary or latching relay output. Range up to 40m. Up to 15 Tx's can be learnt by one Rx (kit includes one Tx but more available separately). 4 indicator LED 's. Rx: PCB 77x85mm, 12Vdc/6mA (standby). *Two and Ten channel versions also available.*
Kit Order Code: 3180KT - **£49.95**
Assembled Order Code: AS3180 - **£59.95**

DTMF Telephone Relay Switcher

Call your phone number using a DTMF phone from anywhere in the world and remotely turn on/off any of the 4 relays as desired. User settable Security Password, Anti-Tamper, Rings to Answer, Auto Hang-up and Lockout. Includes plastic case. Not BT approved. 130x110x30mm. Power: 12Vdc.
Kit Order Code: 3140KT - **£74.95**
Assembled Order Code: AS3140 - **£89.95**

Infrared RC Relay Board

Individually control 12 on-board relays with included infrared remote control unit. Toggle or momentary. 15m+ range. 112x122mm. Supply: 12Vdc/0.5A
Kit Order Code: 3142KT - **£59.95**
Assembled Order Code: AS3142 - **£69.95**

New! 4-Channel Serial Port Temperature Monitor & Controller Relay Board

4 channel computer serial port temperature monitor and relay controller with four inputs for Dallas DS18S20 or DS18B20 digital thermometer sensors (£3.95 each). Four 5A rated relay channels provide output control. Relays are independent of sensor channels, allowing flexibility to setup the linkage in any way you choose. Commands for reading temperature and relay control sent via the RS232 interface using simple text strings. Control using a simple terminal / comms program (Windows HyperTerminal) or our free Windows application software.
Kit Order Code: 3190KT - **£69.95**

PIC & ATMEL Programmers

We have a wide range of low cost PIC and ATMEL Programmers. Complete range and documentation available from our web site.

Programmer Accessories:
40-pin Wide ZIF socket (ZIF40W) £14.95
18Vdc Power supply (PSU120) £19.95
Leads: Serial (LDC441) £3.95 / USB (LDC644) £2.95

USB & Serial Port PIC Programmer

USB/Serial connection. Header cable for ICSP. Free Windows XP software. Wide range of supported PICs - see website for complete listing. ZIF Socket/USB lead not included. Supply: 16-18Vdc.
Kit Order Code: 3149EKT - **£49.95**
Assembled Order Code: AS3149E - **£59.95**

USB 'All-Flash' PIC Programmer

USB PIC programmer for all 'Flash' devices. No external power supply making it truly portable. Supplied with box and Windows Software. ZIF Socket and USB lead not included.
Assembled Order Code: AS3128 - **£49.95**

See website for full range of PIC & ATMEL Programmers and development tools.

www.quasarelectronics.com

Secure Online Ordering Facilities • Full Product Listing, Descriptions & Photos • Kit Documentation & Software Downloads

No.1 FOR KITS

THE 4G WIRELESS MIGRATION

What this piece states is that the 4G wireless migration moves toward flexible and high-performance next generation wireless networks

BY ANIL MUDICHINTALA

The introduction of new mobile devices in the market has led to an enormous increase in wireless data usage. As a result, the demand for enhanced services is continuing to soar, creating a significant movement from users to use rich-media and location-aware services. This in turn has opened up many opportunities for innovative technology leaders and users alike, although this comes hand-in-hand with a host of challenges too.

The Evolved Packet System Standard, also known as long-term evolution – system architecture evolution (LTE-SAE), is the next major contribution coming from the Third Generation Partnership Project (3GPP). LTE adopts independent frequency division multiplexing (OFDM) as its radio access technology, with multiple antenna technologies (MIMO). This standard leads to a significant increase in achievable data rates and throughput. In addition to LTE, 3GPP has also defined Internet Protocol-based, flat network architecture. The LTE radio access network, also called E-UTRAN, consists of eNBs, which provide the LTE user plane (PDCP/RLC/MAC/PHY) and the control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the evolved packet core (EPC).

Being standardised with the aim of reducing latency whilst improving system capacity, coverage, user data rates and cost, LTE has adopted flexible spectrum widths from 1.5MHz to 20MHz. LTE also has adopted new functionalities, such as self-organising networks (SONs), with features that simplify and automate the operation of radio networks, which result in lower OPEX and improved network performance.

With all sectors becoming extremely dependent on wireless activity, one of the greatest challenges for technology providers is ensuring wireless data users can access data as efficiently as they do on a wired network. Unfortunately, smart phone applications are not designed for wireless infrastructure and traditional wireless networks have built-in additional layers, such as RLC/PDCP, in addition to media access control (MAC) to address wireless medium issues. These layers ensure error-free data transmission. Compression and other coding techniques are also used to share the radio resources efficiently, which are scarce in a shared wireless spectrum. These additional processing layers add complexity to the device architecture. Problems increase as data rates go up by hundreds of Mb/s.

There are a number of criteria that drive upgrades and at the top of the list are scaleability and flexibility. The solution must scale from single sector to multi-sector or multi-radio in the base station, and needs to support multi-gigabit wire-speed network scheduling and routing packet throughputs in E-UTRAN. The solution needs to support IP and migration path for traditional networks as well as be interoperable with 3G and 2G networks.

Upgrades are also determined by the solution's configurability to support efficient use of radio and network resources. As usage patterns change based on location and time of day, the solution needs to adapt to support speed versus the number of users. The solution must be configurable to support user plane versus control plane when expanding from single-sector to multi-sector applications. The solution must also provide end-to-end security and data privacy to help protect users against increasing spam, malware, DoS and virus attacks.

Furthermore, Deep-Packet Intelligence is vital, as having built-in intelligence for examining every bit flowing through wireless networks helps operators to have visibility and to manage IP networks efficiently. This also helps in addressing availability, latency, quality issues and will troubleshoot network coverage and security.

Three architecture categories are used to compare against key drivers to address 4G migration, including data plane processors, multicore processors and combination of multicore with accelerators. The ideal solution must provide wire-speed L3 performance and subscriber independent L2 performance, the criteria for which are not wholly met by the preceding options.

An asymmetric multicore approach on the other hand blends multicore processors with networking-optimised accelerator engines. This approach includes an interconnect architecture that connects high-performance processors and accelerators that are software configurable to provide wire-speed performance, independent of subscribers.

Anil Mudichintala is Director for Sales and Marketing at the Semiconductor Solutions Group of LSI Corporation

> **THE EVOLVED PACKET SYSTEM STANDARD, ALSO KNOWN AS LTE-SAE, IS THE NEXT MAJOR CONTRIBUTION COMING FROM THE 3GPP**

EDITOR: Svetlana Josifovska
Email: svetlanaj@stjohnpatrick.com
PRODUCTION MANAGER: Tania King
Email: taniak@stjohnpatrick.com
DISPLAY SALES: Neil Coshan
Tel: +44 (0) 20 7933 8977
Email: neilc@stjohnpatrick.com
PUBLISHING DIRECTOR: Chris Cooke

PUBLISHER: John Owen
SUBSCRIPTIONS:
Saint John Patrick Publishers
PO Box 6009, Thatcham,
Berkshire, RG19 4QB
Tel: 01635 879361
Fax: 01635 868594
Email: electronicsworld@circdata.com

SUBSCRIPTION RATES:
1 year: £46 (UK); £67.50 (worldwide)
MISSING ISSUES:
Email: electronicsworld@circdata.com
NEWSTRADE:
Distributed by Seymour Distribution Ltd,
2 East Poultry Avenue, London, EC1A 9PT
Tel: +44 (0) 20 7429 4000

PRINTER: William Gibbons Ltd
ISSN: 1365-4675

John Patrick Publishers

Optical Breakthrough For Smart Phone Cameras

Cambridge Mechatronics Ltd (CML), a developer of Intellectual Property and components for precision electronic actuators for high volume consumer products, has demonstrated what it calls is a "potentially industry-changing" Optical Image Stabilisation (OIS) system. The demonstration proves that Shape Memory Alloy (SMA) actuators are fundamentally capable of the performance required for OIS in the miniature cameras used in smart phones.

The key development in making miniature OIS possible is CML's 'mass-less' actuator, which uses wire made from Shape Memory Alloy (SMA). When heated using an analogue electronic circuit, the SMA wire shrinks by up to 5% of its length; as the wire cools it gets longer again. CML's SMA actuator technology is already being used to move lenses for the purpose of Auto-Focus (A-F) in growing number of miniature camera designs.

As the wire is only 25 microns thick, SMA-based actuators permit the use of a lens that is more than 30% larger than is currently possible. In addition, as the force provided by the transition of the metal alloy is far greater than that provided by Voice Coil Motors (the most commonly used miniature actuator), it becomes possible to use heavier glass-lenses, as opposed to plastic, further enhancing optical quality.

OIS is the next stage in the continual improvement of mobile phone camera technology, as it enables increased exposure times for still photography and 'shakeless' high-definition video.

The first smart-phones with SMA-based Auto-Focus will ship in late spring 2010. CML believes that its first licensees for the OIS technology will enter mass production in early 2012.

Standard mobile phone Auto-Focus camera image vs an image taken with an SMA OIS camera

■ Numonyx has introduced a set of new devices based on the new class of memory technology called phase change memory (PCM). The new devices deliver higher performance, endurance and simplicity for wired and wireless communications, consumer electronics, PCs and other embedded applications.

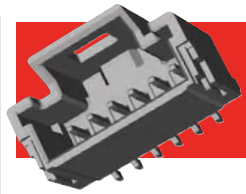
The new embedded memory products blend many attributes associated with flash memory, as well as RAM and EEPROM, while delivering new capabilities in a single device. Introduced as the newly branded Numonyx Omneo PCM, the devices promise up to 300 times faster write speeds and ten times more write endurance than today's flash memory.

"Not since flash memory was introduced in 1988 has the industry seen a new, high-density memory technology," said Glen Hawk, Numonyx vice president and general manager of the Embedded Business Group. "Today, designers have to use different memory types for code storage and execution, as well as data storage. Now, with Numonyx Omneo PCM, they have a simple, one-device solution."

■ AdaCore, Altran Praxis, CEA LIST, Astrium Space Transportation, INRIA ProVal and Thales Communications have kick-started the Hi-Lite project, an open source project designed to increase the use of formal methods in developing high integrity software, particularly to meet the forthcoming DO-178C avionics standard. It is expected to achieve its goal by building tools that are simpler, more powerful and easier to use.

Hi-Lite will bring together the strengths of the project partners to create formal verification tools for both the Ada and C languages. These will enable code verification at a deeper level than current solutions and reduce the need for time-consuming and costly physical testing of high integrity software solutions.

The €3.9m project is funded by the French government and the Essonne general council. It is scheduled to last three years.



RS Components's new comprehensive platform will allow analysing parts in 3D

RS COMPONENTS LAUNCHES A NEW COMPREHENSIVE VIRTUAL ENGINEERING ENVIRONMENT

In the effort to equip design and development engineers with the right components and tools for their projects in the current on-line dominated age, RS Components is rolling out a series of platforms and tools beginning with Phase One that consists of Component Chooser, 3D CAD models library and an mbed-based Embedded Development Platform (EDP).

With Component Chooser – a parametric search tool – engineers can compare, pick and buy components from an extensive selection of manufacturers. The 3D CAD programme will then allow them to select from 45,000 electromechanical models from the RS website to analyse and verify the components further. Whereas the EDP is touted as the rapid proof-of-concept platform that offers modular building blocks and software stacks.

"Engineers are far more dependent on the Internet [nowadays]," said Glenn Jarrett, Head of Electronic Marketing at RS Components. "Peer-to-peer networking is changing the way engineers learn and share; there's a trend for open source applications and IP; there's an expectation for free-to-access resources and we have always supported engineers as technology develops."

RS Components's initial offering will be topped up with two more phases over the coming months that will further aid engineers with searches, evaluations, board design, mechanical design and prototype through to production.

"Some [component] manufacturers do not have anything like this, so they are happy for us to have done it," added Jarrett.

Jarrett, however, would not confirm how much such a comprehensive environment would cost RS Components, but said that the firm had invested around £500,000 alone in partnering with an external data harvesting specialist.

Cambridge Team Achieves New Record Bit Rate for Quantum Key Distribution

The Cambridge Lab of Toshiba Research Europe announced a major breakthrough that will allow ultra-secure encryption of sensitive data sent by banks, hospitals and government organisations.

Researchers have demonstrated continuous operation of quantum key distribution (QKD) with a secure bit rate exceeding 1Mb/s over 50km of fibre for the first time. Averaged over a 24-hour period, this is 100-1000 times higher than anything reported previously for a 50km link. It was achieved using two innovations developed by the Cambridge team: a novel light detector for high bit-rates and a feedback system which maintains a high bit-rate at all times and requires no manual set-up or adjustment.

Significantly, the breakthrough will enable the everyday use of "one-time pad" encryption, the only known method that is theoretically perfectly secret. Although ultra-secure, the application of one-time pad encryption has been restricted in the past as it requires the transmission of very long secret keys – the same length as the data itself. For this reason it has only been used for short messages in situations requiring very high security, for example by the military and security services.

Toshiba now plans to install a QKD technology demonstrator at the National Institute of Information and Communications Technology (NICT) in Tokyo.

Co-ordinator of the Tokyo QKD Network, Dr. Masahide Sasaki, said: "The secure key rate of 1Mb/s over 50km has been a milestone for mission critical applications. The next challenge would be to put this level of technology into metropolitan network operation. Our Japan-EU collaboration is going to do this within the next few years."

The Toshiba QKD system used to demonstrate 1Mb/s secure bit rate over 50km of fibre for the first time

European Consortium presents circuits operating up to 650GHz

The EU-funded 3-year project known as Dotfive and titled "*Towards 0.5THz Silicon/Germanium Heterojunction bipolar technology*" has presented its first results of silicon-based advanced bipolar transistors for future communication, imaging and automotive radar applications working at frequencies up to 650GHz.

The 650GHz imaging receiver has an on-chip folded-dipole antenna in a SiGe technology. The sub-harmonic 162.5GHz LO is supplied by an integrated 6dBm LO driver amplifier. The receiver chip is 1.2 x 0.6mm^2 large, provides a bandwidth of 635-665GHz and yields a -13dBi conversion gain and a 42dB NF. Both chips were implemented in a European SiGe BiCMOS technology with fT = 260GHz and fMAX = 380GHz fabricated at IHP Microelectronics GmbH in Germany.

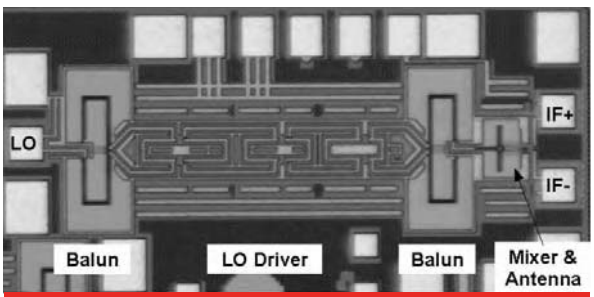


Figure 1: Die micrograph of the 1.2 x 0.6mm2 large 650GHz receiver front-end

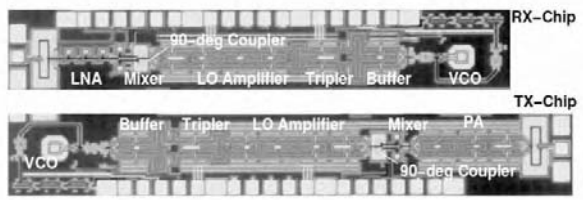


Figure 2: 160GHz transmitter and receiver chip-set micro-graphs

Also a part of the Dotfive project is a 160GHz quadrature transmitter and receiver chipset from the University of Wuppertal in Germany. The 158-165GHz chipset supports QAM modulation schemes and includes VCO, prescaler and amplifier chains. The receiver system NF is 11-14dB and the transmitter output power is 5dBm. IC implementations at millimetre-wave frequencies include a broad set of applications, among them for communication, radar and imaging.

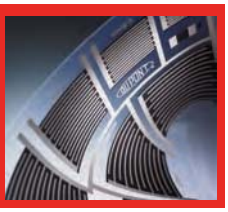
NOVEL INK OFFERINGS FOR PRINTED ELECTRONICS LAUNCHED BY DUPONT

DuPont Microcircuit Materials (MCM) has expanded its portfolio of silver conductive inks formulated for use in printed electronics to meet the need for low-cost processing in the high-growth and emerging markets for touch screens and devices, such as Organic Light Emitting Diodes (OLEDs). The new screen printable inks include DuPont 7723, a low temperature firing silver ink suitable for printing on glass, and DuPont 9169, a low temperature curing Ag ink designed for flexible substrates.

DuPont 7723 offers excellent adhesion to Indium Tin Oxide (ITO) coated glass, says the firm, it is lead-free and solderable, suitable for touch screen devices. Whereas DuPont 9169 has extremely high conductivity, strong adhesion to ITO coated flexible substrates, low contact resistance to ITO and fine line capability.

According to industry estimates, the printed electronics market is expected to reach $10bn by 2012 and, even, $300bn by 2025. Estimates for growth in the global touch-screen module market are similarly strong with a forecast to grow to $6.4bn by 2013 and the market for OLED lighting and displays to exceed $6.7bn in 2014.

DuPont Microcircuit Materials is expanding its offering of silver conductive inks for printed electronics



MINIATURISATION – 'SMALLER IS BETTER'

Christos Papakyriacou, Managing Director for Alpha Micro Components, describes the drive for miniaturisation in the world of components

WHEN IT COMES to embedded solutions and electronic hardware devices as a whole, we are all too familiar with the 'smaller is better' culture. Owning a small, compact gadget with enviable capability is all the more credible than a bulky device which offers the same functionality. The notion is one that has been applicable for a considerable length of time now and one that increasingly takes a hold over the design and application of electronic components used today in the consumer and industrial markets.

The need for miniaturisation has been a steady progression spanning many decades and today is no different with the component industry continually endeavouring to push the boundaries of when it comes to producing smaller products to use. If we look more specifically, in relation to industrial M2M components the need has been largely generated by the manufacturers of this world. For silicon vendors, developing microprocessors, memory components and the like, their dedicated design and development teams have further reduced silicon geometry which enables OEMs to take advantage of the smaller physical form-factors.

An example of this can be seen with personal tracking devices, a need for which to be as small and compact as possible is essential to a successful product and, indeed, driven by the market itself. For these and the likes of other smaller devices now readily available, engineers have been able to improve an existing product, by scaling it down to the desired shape and size, without compromising performance. We can also see this ethos in other applications which include telemetry devices and security central-control panels, whereby it is becoming essential for components to be scaled down to being many times smaller than the original device, yet have the same, if not improved, functionality of its predecessor.

"WE SEE THE ETHOS OF MINIATURISATION IN TELEMETRY DEVICES AND SECURITY CENTRAL-CONTROL PANELS, WHEREBY IT IS BECOMING ESSENTIAL FOR COMPONENTS TO BE SCALED DOWN TO BEING MANY TIMES SMALLER THAN THE ORIGINAL DEVICE, YET HAVE THE SAME, IF NOT IMPROVED, FUNCTIONALITY OF ITS PREDECESSOR"

Thanks to advancing silicon technology, modular components are now also being shrunk down to the point whereby much value can be gained by employing such devices with OEM's products. Committed design engineers ensure that new designs can perform more tasks, using less power often in a smaller physical size, to meet end customers' ever increasing expectations.

We have seen our partners develop their portfolios of products to comply with OEM's desire for miniaturised components. The likes of u-blox have applied miniaturisation to its GPS modules by ensuring its components are smaller than ever, with the new 'AMY' solution measuring a mere 6.5mm x 8mm, a fraction of the original TIM module offered seven years ago which stands at 25mm x 25mm. Similarly, u-blox has developed the LEON Quad-band GSM/GPRS module, one of the world's smallest GSM/GPRS modules. The LEON boasts a package size of 29.5mm by 18.9mm by 2.8mm. In addition, The soon-to-be-available LUCY 3.5G Tri-band measures 45mm by 37.5mm by 3mm, which is impressive for the performance and functionality offered. Compared to previous market offerings, the LEON and LUCY demonstrate the extent to which ODM's have committed to the M2M industry's demanding need for new compelling modular platforms.

We can expect to see the general demand continuing for smaller components and products, although this may not be using today's silicon technology. ■

The Most Popular 8-bit Microcontrollers! The Best Customer Support.

The world's most popular 8-bit microcontroller family has the best customer support and the industry's shortest leadtime !

With over 400 different variants, there is an 8-bit PIC® microcontroller for every design. Microchip's 8-bit family now includes microcontrollers with the smallest form-factor, industry-first peripherals and up to 16 MIPS performance.

Pin- and code-compatibility ensure easy migration across the 8-bit family and up to 16-bit designs and Microchip's MPLAB® IDE is absolutely free, and supports ALL of Microchip's 8-, 16-, and 32-bit microcontrollers – from 6 to 100 pins!

With over 8 Billion PIC microcontrollers shipped worldwide and increased investment in product development and customer support, you can count on Microchip to be here for you - especially through the tough times.

Comprehensive support starts with the Microchip Advanced Part Selector (MAPS) and extends throughout the design cycle with free or low-cost development tools, online and regional training and 24/7 technical support.

Microchip is the only supplier to bring USB, LCD, CAN, Ethernet and Capacitive Touch sensing to the 8-bit market.

24/7 Support

- Only Microchip offers full support 24/7
- Increased Field Application Engineer support team
- Increased Customer Application Engineer support team
- Increased Customer Training Support through Regional Training Centers (RTCs)

Here2Help YOU Now&Tomorrow...

For the best product support and availability - think Microchip!

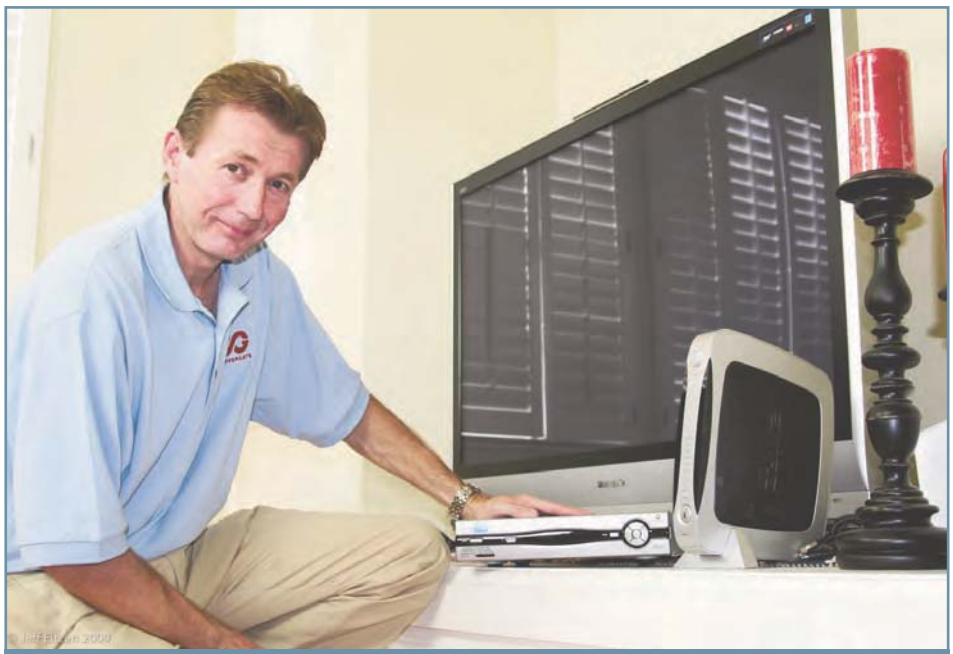
microchip DIRECT
www.microchipdirect.com

www.microchip.com/8bit

MICROCHIP

G.HN: WORLDWIDE STANDARD FOR HOME

Reuven Franco, Director of G.hn Product Development at CopperGate, discusses how G.hn overcomes current interoperability issues to create the truly connected home and explains the impact G.hn will make on home networking



Creating a worldwide standard for a truly connected home

G.HN IS EMERGING as the worldwide standard for home entertainment networking over wires that already exist in the home: phone line, coaxial cable and powerline. The International Telecommunication Union (ITU), which is developing G.hn with major service providers, device manufacturers, silicon vendors and software developers worldwide, is creating this next-generation standard to make the concept of the "Connected Home" a reality.

IP-enabled devices will use the same protocol to communicate over all three media at data rates of up to 1Gbit/s. The standard also features QoS, remote management and co-existence with networks and services sharing the same medium.

Currently, the home networking industry is comprised of diverse technologies that don't always communicate. Networks and services that stream data, voice and video – especially over the same line – can have interference problems that render them ineffective and incapable of offering carrier-class video service and QoE to the end-user.

For example, assume phone-line in the home runs both VDSL and home entertainment networking at the same time. The two systems should co-exist, otherwise they will interfere with each other.

G.hn is a unified PHY/MAC layer technology that can be applied to all media. It opens the doors to advanced capabilities that are not available through existing technologies. It enables implementation of products that will be able to choose the best available medium and path, for example those with the least interference from other networks and services.

Products with multiple ports will easily enable the delivery of services from one medium to another. A service can be received by a G.hn transceiver over the coaxial cable and then be retransmitted over a different medium via a different port (e.g. power line), using the same technology.

> "THERE ARE TECHNICAL AND ECONOMIC TRENDS AFOOT THAT MAKE THE UNIVERSAL ACCEPTANCE OF G.HN CRITICAL"

In addition to the seamless convenience G.hn will deliver, there are technical and economic trends afoot that make the universal acceptance of G.hn critical. For example, the move toward smart energy necessitates IP-enabled meters that can communicate with television sets and other appliances throughout the home. Without G.hn, these devices will continue operating according to different protocols and over different media, causing interference and other issues. Universal acceptance of this standard, on the other hand, will increase bandwidth and interoperability needed for future applications, including smart meters, 3DHD, ultra high-def television, telepresence, telemedicine and more.

The G.hn standard addresses technical issues on both PHY and MAC layers of chips that facilitate the delivery of home networking. In October 2009, ITU Recommendation G.9960 was approved. It specifies the physical layer and architecture of G.hn. ITU recommendation G.9961, specifying the data link layer, is expected to be approved in mid-2010. Supporting the ITU's endeavours is the HomeGrid Forum, a global, non-profit trade group promoting G.hn standardization efforts for next-generation home networking. G.hn chips are expected to be on the market by mid-2010. Products with embedded G.hn chips are expected to be available in early to mid-2011.

Enabling New Services with More Bandwidth

G.hn will help service providers offer

NETWORKING OVER EXISTING WIRES

enhanced Internet Protocol television (IPTV) and Triple Play services to their end users. These offerings have been critical to telcos in their battle against the cable companies and vice versa. Satellite companies also benefit from home networking functionality. And, as more power utilities bring fibre to the home, there is increasing demand for a cost-effective way of streaming data, voice and video within the home in order to enhance – not only IPTV and Triple Play – but also smart energy offerings.

Up until now, however, there have been issues limiting the potential of these services. Carriers are bringing ample bandwidth to the home, but they still need a way of distributing their content throughout the home. Distribution of data, voice and video content to every device in every room of the house requires sufficient in-home bandwidth and interoperable devices.

One way of connecting these devices is with CAT-5. However, laying new CAT-5 wires is cumbersome, time-consuming and expensive. As the number of network-enabled devices increases, laying CAT-5 will become increasingly impractical. By networking over existing wires – phone line, coaxial cable and powerline – G.hn reduces installation time and cost while increasing bandwidth by creating a digital highway over every kind of wire in the home.

More bandwidth creates a fatter pipe for new applications, such as 3DHD, ultra high-def television, telepresence, telemedicine, cloud computing and more.

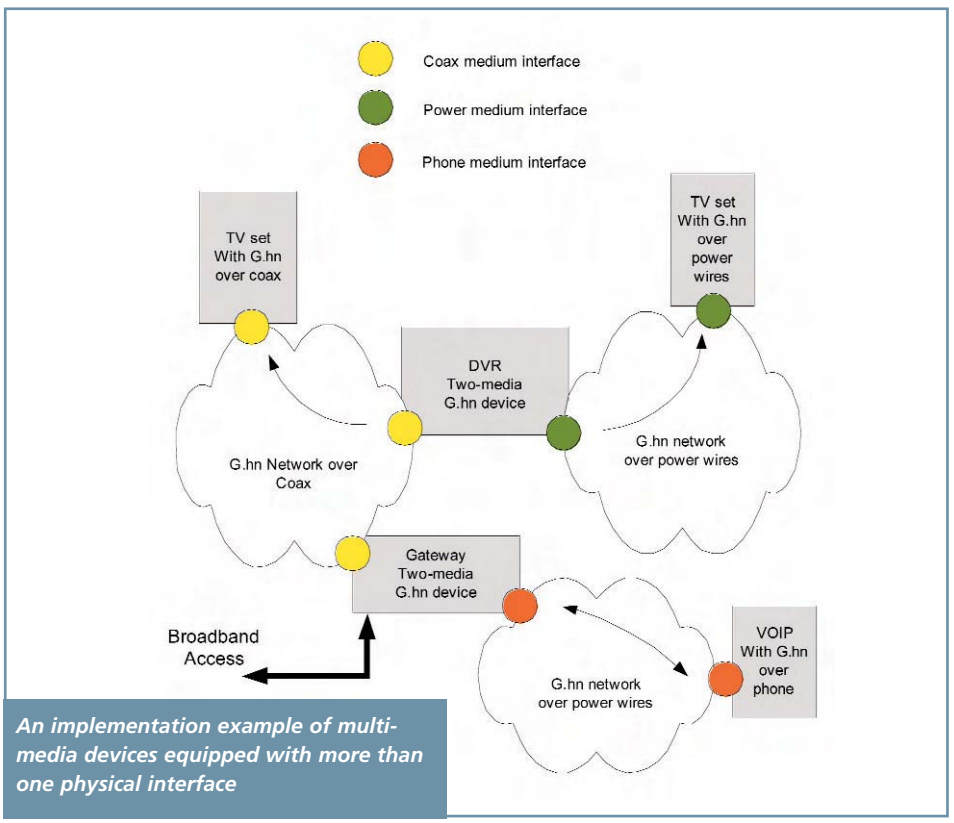
The demand for higher bandwidth is also increasing as more traffic is generated within the home by new, IP-enabled home appliances, like smart meters, washers, dryers, refrigerators and more. New entertainment applications and appliances will demand more bandwidth than any application currently on the market. To meet the demand for bandwidth, but still enable low-cost devices like smart meters, the G.hn standard supports scalable bandwidths of 25MHz, 50MHz, 100MHz and, even, 200MHz when operating over coax in the RF range. Higher bandwidths are interoperable with lower bandwidths. Therefore, products that support different bandwidths can still belong to the same network.

Other existing wireline technologies currently on the market use bandwidths of 30MHz and 50MHz. G.hn's extended bandwidths enable rates that are two-to-four times faster than existing technologies. G.hn also increases available bandwidth via other means. Let's take as an example multicasts, involving several devices using the same content; such as several TV sets on the same channel or a G.hn-enabled MP3 player in the bedroom that is transmitting music over phone line, coax and powerline to speakers in the den, basement and kitchen. With G.hn, users gain transmission efficiency over different media and scale the network to address band requirements.

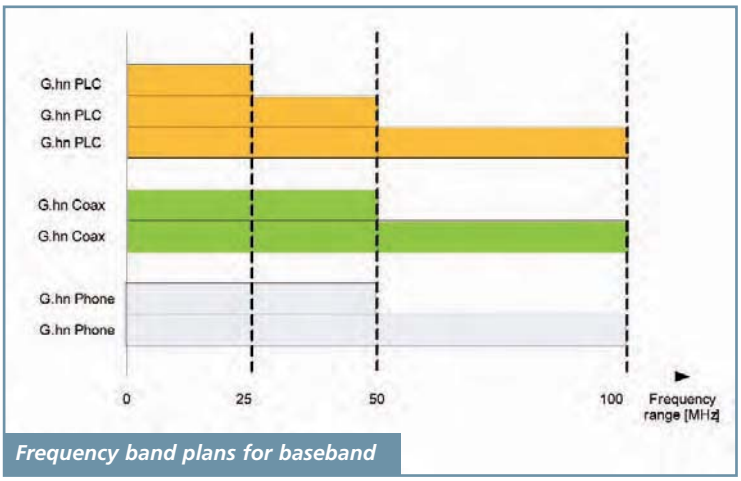
> "WITHIN THE NEXT 18 MONTHS, THE TYPICAL HOME NETWORK WILL EVOLVE FROM A NOISY, DYSFUNCTIONAL TRAFFIC JAM INTO AN EASY-STREAMING SUPERHIGHWAY OF DIGITAL DATA OVER PHONE LINE, COAX AND POWERLINE"

G.hn uses a true multicast scheme. Multicast is the ability to send a single frame to a group of receivers – a multicast group – with a common bit loading. This saves bandwidth, unlike transmitting multiple unicasts to individual receivers of the multicast group, or extending the transmission time if using a pre-defined low bit loading. True multicast also means that G.hn is capable of splitting the transmission into several streams when the common bit loading is not efficient. Each stream can be transmitted to more than one receiver.

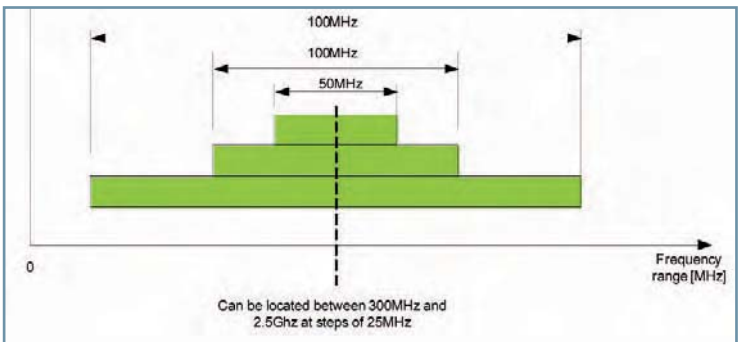
The G.hn acknowledgment scheme of multicasts is also efficient and advanced because it accommodates the size of the group. When the group is relatively small, each receiver can acknowledge explicitly and selectively. For a large group, a single short-time period is allocated. Therefore, each receiver can negatively acknowledge during this time, hence efficiency is high.



An implementation example of multi-media devices equipped with more than one physical interface



Frequency band plans for baseband



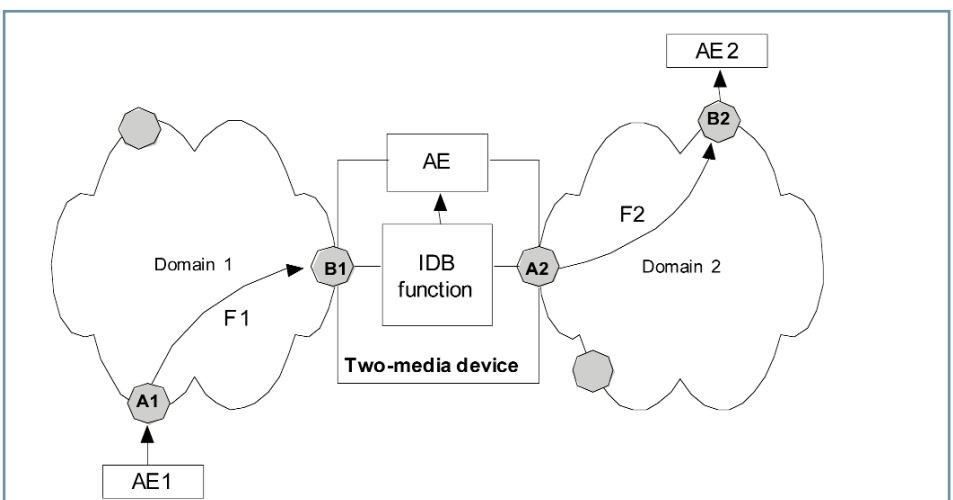
Frequency band plans for coax RF range

Non-G.hn technologies use an acknowledgment mechanism per each receiver, regardless of the size of the group (which is not efficient for large groups), or use a single proxy receiver to represent the entire group. This is notably unreliable because the proxy receiver may experience interference that is different from other receivers.

G.hn is ready for Smart-Grid applications. As power utilities install smart meters, it becomes more important to standardize the power infrastructure, including the home network. For instance, end users might want to view their energy consumption on their flat-screen TV, a feature enabled via their smart meter, television set-top box and the wires connecting these devices.

To be truly Smart-Grid ready, G.hn devices need to be low power, an attribute achieved by a sleep or stand-by mode that sets in when digital traffic falls below a certain threshold. The G.hn-based network has a Domain Master, the transceiver that manages the network, which issues a "sleep" or "wake-up call" according to different criteria.

G.hn also cuts the cost of home networking by using "profiles". The concept relates to a range of device complexity. Every device needn't be of the same complexity (and cost). Nevertheless, each is interoperable with the other, which itself leads to one of G.hn's biggest benefits: economies of scale. With a single standard comes wider acceptance of compatible devices. Among vendors supplying G.hn-enabled devices, there will be competition that will drive prices down. Ultimately, the goal of the G.hn home network is to become entirely self-install, which saves money, time and the hassle of opening one's house to installers.



Example of communication with a two-media (domain) device

G.hn and Self-Install

G.hn will make the deployment of connected-home networks easy and do-it-yourself. Current home networking technologies don't cover the entire home and they're generally limited to enabling communication among only those devices in close proximity to one another. For example, a set-top box (STB) is usually located next to the primary TV set and the residential gateway is usually located next to the primary PC. When a user wants to add a new STB or TV – or wants to move the equipment to a different room in the house – a technician is typically required to do the job. Very often this job involves the installation of new wires.

Complicating matters, many home owners don't want their residential gateway near a PC or in a room with an adequate outlet. In this case, technician is also required to make the necessary adjustments. Third, as consumers increasingly buy equipment in retail stores (for example, an IP camera), problems arise over configuring this equipment to suit the existing network. G.hn will make it easy to self-install this camera into what already exists in the home.

G.hn inherently addresses such problems because it operates over all media and, therefore, can exploit any outlet in the home. In addition, G.hn includes relaying capabilities, which increase wall-to-wall coverage throughout the home.

As for configuration, the G.hn recommendation includes remedies that enable inferring the actual spectral usage without the need of intervention of the customer or the installer. G.hn based products can be designed to bridge traffic among multiple media and can choose the best available medium and path – e.g. those with the least interference from other networks and services.

In conclusion, the Connected Home is becoming a reality with G.hn. Within the next 18 months, the typical home network will evolve from a noisy, dysfunctional traffic jam into an easy-streaming superhighway of digital data over phone line, coax and powerline. G.hn chips will provide the bandwidth necessary for futuristic entertainment and smart energy applications, achievable with self-install hardware. For consumers, carriers and others in the industry, G.hn spells win-win for the next generation. ■

Myk Dormer

The Ongoing Quest for Increased SENSITIVITY

USING SIMPLE, commercially available ISM band radio modules and very slow SK signalling rates, a usable sensitivity approaching -129dBm has been observed (see footnotes). This represents a gain of 10dB over the usual 12dB SINAD sensitivity point for the receiver being used.

Enquiring minds cannot but ask "How much further can these techniques be pushed?" It has already been established that there is a fundamental limitation in the ultimate sensitivity a simple FM receiver can achieve, no matter how far the baseband rate is reduced, or how sharp the baseband filters are, as the IF bandwidth of the receiver, which precedes the non-linearity of the limiter and discriminator, remains unchanged and, so, defines the ultimate noise bandwidth of the link.

A change to a synchronously demodulated, non-constant envelope modulation (single sideband, or possibly certain CW methods) would clearly allow much narrower IF filters to be used – as we see in amateur radio applications, but the complications introduced would mitigate against the use of such techniques in the telecontrol or telemetry areas. Furthermore, the available low-power allocations specify in many cases a narrow-band angle modulated signal.

"IT HAS ALREADY BEEN ESTABLISHED THAT THERE IS A FUNDAMENTAL LIMITATION IN THE ULTIMATE SENSITIVITY A SIMPLE FM RECEIVER CAN ACHIEVE"

There is, however a simple technique which still may have merit: low speed on-off keying. By adopting (effectively) AM modulation, perhaps some of the limitations introduced by the FM discriminator can be side-stepped?

A reference link was established using a simple biphase remote control chipset (CTR44, operating at 1kbit/s) and a -120dBm sensitivity receiver similar to that used in the previous tests. Reliable signalling was observed at a -122dBm signal level. (This is consistent with the previous results and suggests that the simpler control decoder algorithms have similar S/N performance to the M48A modem). Halving the data speed was found to yield a 2dB gain in performance, as before, with no reliable operation possible below a signal level of -128dBm.

A simple modification was then made to the receiver, connecting the data extractor to the RSSI output instead of the discriminator; this results in a simple OOK receiver (of, admittedly, limited dynamic range and poor frequency response).

At 250bit/s this improvised receiver could reliably operate at -125dBm, while a 30 bit per second test was still responding at -127dBm, although the response time of the system is several seconds. Narrowing the receiver IF filter, from 15kHz to 6kHz, resulted in a signalling sensitivity exceeding -130dBm, which is approaching the lower limit of output accuracy for the signal generator used.

While these are interesting results, the hardware used is not something that could be used in a practical ISM band link. The primitive AM receiver is very prone to interference (there being no capture effect as with FM), while the detector used (the RSSI output from an NBFM demodulator device, with no AGC or pretence at linearisation) has a woefully inadequate dynamic range. And the transmit signal used is AM, permitted on 433MHz but hardly anywhere else.

Turning these ideas into a real control link requires a little more thought.

Using the allocation: Many of the useful ISM bands (especially the HF and VHF bands where lower frequency proportional path loss offers greater inherent range) stipulate the use of NBFM in a 25 or 12.5kHz channel.

Using square-wave modulation waveforms at very low modulation frequencies, where the deviation is several orders of magnitude greater than the baseband rate, the spectrum of an FM signal resolves to a pair of carriers, at ±F(dev). All the other modulation products are negligible. An AM receiver with suitably narrow bandwidth filters, centred on one of these sidebands, will 'see' our FM carrier as if it was an on-off keyed signal, assuming sufficient rejection of the other sideband at 2 x deviation away. (Assume we use a ±5kHz deviation carrier. The two sidebands fall safely inside a 25kHz channel. A receiver equipped with filters designed for 10kHz working, tuned to fc -5kHz will have more than adequate rejection of the upper sideband at fc+10kHz).

In this way, a transmitter complying with the FM/FSK modulation

requirements of the regulations can be used with AM based low-rate receivers.

Improving the receiver: Although these tests have shown only modest improvement over previous low speed FSK work, there is an important difference; by demodulating the carrier as an AM signal it will be possible to narrow the IF path filters (within the frequency tolerance and error limits of the frequency defining components of course: see footnote 2), without suffering the S/N penalties associated with a narrower bandwidth (and so reduced deviation) FM discriminator.

This method of receiving only one FM sideband through a narrow filter also suggests an obvious elaboration: equip the receiver with a pair of narrow IF filters and detectors, one tuned to each of the upper and lower sidebands, and derive the baseband signal from the difference. In a way this becomes a specific FSK only implementation of the early Travis-Round FM demodulator.

In addition, I have yet to examine superior (coherent) demodulation methods (compared to the extremely primitive envelope detection I currently use). A further stage of down conversion, to a signal in the tens of kHz, will simplify the implementation of PLL or digital filter based methods.

Provided a method can be implemented to accommodate frequency drift (using a 'comb' of multiple narrow filter/detectors, or some manner of scan/acquire technique), then I can see no reason why an effective receiver bandwidth below 20Hz cannot not be easily realised, at which point the theoretical sensitivity of our long range telemetry link might approach -140dBm.

FOOTNOTE 1:

See previous article in the last issue. Reliable signalling, using 8 byte packets at 37 bits per second, was observed at -129dBm from an under clocked M48 modem device connected to an NRX1-173.25-5 receiver module, with additional data filtering.

FOOTNOTE 2:

Filter bandwidths and stability. Obviously, if the aggregate frequency errors of the transmitter and receiver causes the wanted signal to move outside the bandwidth of the receiver's filters, the system will fail to function.

Let us imagine a system operating in the 169MHz (asset tracking) band. Assuming a design using easily sourced, commercially available 2ppm TCXOs, then the worst case frequency error (assuming opposite drift at each end of the link) would be 4ppm, or 680Hz.

With due care it might be reasonable to design such a system around the 2 or 3kHz bandwidth IF filters manufactured for SSB reception.

FOOTNOTE 3:

As an aside, a test comparison was conducted to determine the noise performance/sensitivity of the link when using commercial DTMF tone encoder/decoder devices. Using the common MT8870 decoder, a signalling limit of -124dBm was measured (using the same receiver as for the other tests). The limit here seems to be the bandwidth of the decoder audio filters and the detection/decision techniques used on-chip.

Myk Dormer is Senior RF Design Engineer at Radiometrix Ltd
www.radiometrix.com

Glowing GainMaker

Burkhard Vogel presents a series of short features with general remarks on triodes in audio applications

THE HIFI OF the sixties strikes back! Not only the so-called high end – and extremely high priced – audio equipment is infected by the valve fever, 45 years after its first appearance on the market, the well known fully valve-driven amplifier Luxman SQ 38 is back in a modernised "u" version. Some 4800 Euros and we can bath our ears in well sounding sound-worlds via valve electronic circuits that most of the younger electronic engineer generations didn't learn to unravel. However, a look into the basics of valve, small-signal electronics won't be a heavy task for those who have learned to work with equivalent circuits, rather simple equations and, from time to time, strange looking data sheets.

In this series of short articles I want to present the wide range of the most popular triode gain stages by giving the basic circuits and the small signal equivalent circuits to generate the basic gain formula. From that we can derive many other important equations to analyse most of the pre-amplifier and power amplifier input stages of the valve amplifier world. Finally, with an example triode, each article will be backed-up by some remarkable graphs on important gain stage effects, like gain vs output load, output resistance vs anode current, input impedance vs frequency, etc.

Figure 1: *Triode and two types of pentodes configured as triodes*

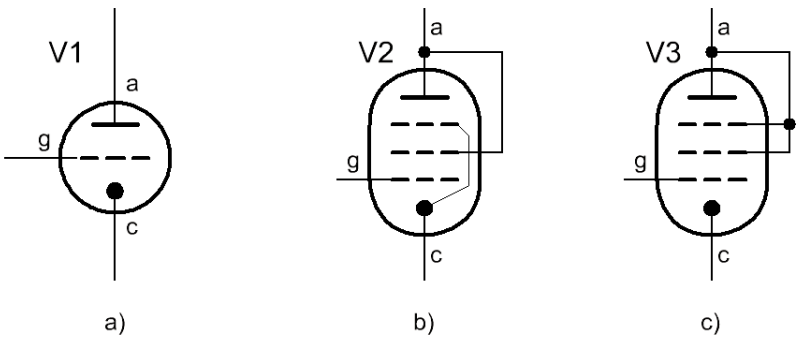
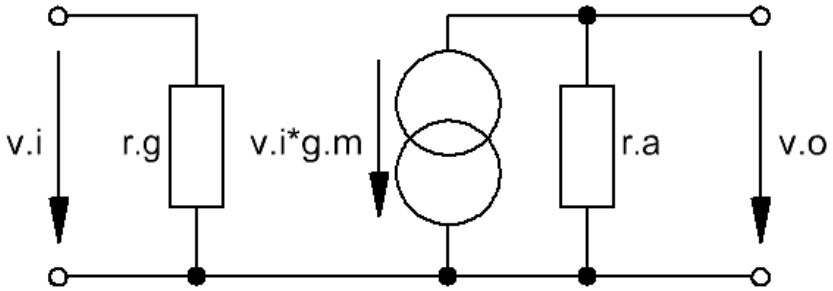


Figure 2: *Current source based, small signal, triode equivalent circuit*



Small Signal Equivalent Circuits

Before we can dive deeper into specific gain stage circuits, we need a short freshening-up of important calculation approaches to get the wanted equations. We will concentrate on triodes only, but also pentodes configured as triodes, because nearly 90% of the valves in small signal audio amplifiers come along in triode configuration. **Figures 1** to **3** show a triode and its small signal equivalent circuits.

Both equivalent circuits will lead to the same gain G (I prefer to take 'G' instead of the well known 'A' because it creates less trouble with the ampere unit 'A' on Mathcad worksheets). The gain G of the Figure 2 case becomes:

$$G = \frac{v_o}{v_i} = -g_m r_a \qquad (1)$$

The gain G of the Figure 3 case becomes:

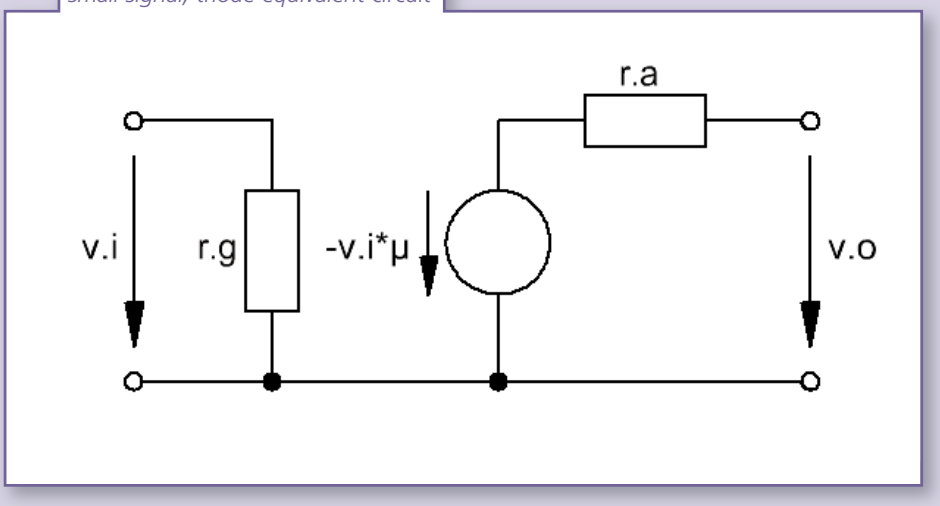
$$G = \frac{v_o}{v_i} = -\mu \qquad (2)$$

The minus sign in both equations indicates a 180° phase shift between input and output signal voltages. Equations 1 and 2 lead to the well-known triode equation that ties together the three internal triode constants gain μ, internal anode (or plate) resistance r_a and mutual conductance (or transconductance) g_m the following way:

$$r_a \, g_m = \mu \qquad (3)$$

With the help of the valve characteristics given in data sheets (a huge collection can be found in the internet at www.tubedata.info) and **Equation 3**, the biggest portion of knowledge on a specific type of valve and its circuitry lays on the table. Only a few things are left that need tackling here: the main valve capacitances that influence frequency and phase responses of any gain stage, and the valve's gain in a specific circuitry environment.

Figure 3: Voltage source based, small signal, triode equivalent circuit



Triode Capacitances

Shown in **Figure 4a** is the main triode capacitances: Cga (grid-anode), Cgc (grid-cathode and Cac (anode-cathode).

For all three capacitances it's very hard to find a common reference point at the circuit ground, thus, it would be a rather heavy task to calculate frequency and phase responses for a gain stage. If we want to change the 3-capacitance-state into one, with only one capacitance at the input and one at the output, we have to go back to the so-called Miller capacitance solution. It transfers the Figure 4a situation into the **Figure 4b** solution. Cga becomes the Miller capacitance C_M, hence, Ci.new and Co.new become:

$$C_{i.new} = C_{gc} + (1+|G|)\,C_M$$
$$C_{o.new} = C_{ac} + C_M \qquad (4)$$

The Gain of the Most Simple Triode Gain Stage

Figures 5 and **6** show the most simple triode gain stage and its equivalent circuit.

By application of Ohm's and Kirchhof's laws we can derive the gain of the Figure 5 triode gain stage as follows.

In Figure 6 we can ignore the signal input current i_i because rg (the triode's internal grid resistance) will be infinite in nearly 100% of the audio cases. Hence, the mathematical derivation music plays at the output of Figure 6 as follows:

$$0 = v_i g_m + i_a - i_o$$
$$i_a = \frac{v_o}{r_a}$$
$$i_o = \frac{-v_o}{R_a} \qquad (5)$$

hence, with Equation 3 gain G becomes:

$$G = \frac{v_o}{v_i} = -g_m r_a \frac{R_a}{r_a + R_a} = -\mu \frac{R_a}{r_a + R_a} \qquad (6)$$

The output resistance Ro can be determined by a simple look on Figure 6. It is thus:

$$R_o = r_a \| R_a = \frac{r_a R_a}{r_a + R_a} \qquad (7)$$

With Ci calculated according to Equation 4, the magnitude of the input impedance Zi becomes:

$$Z_i(f) = \left| R_g \| C_i \right| \qquad (8)$$

*Figure 4: Main triode capacitances in **(a)** and their transfer into an easier to handle state **(b)** via the Miller capacitance*

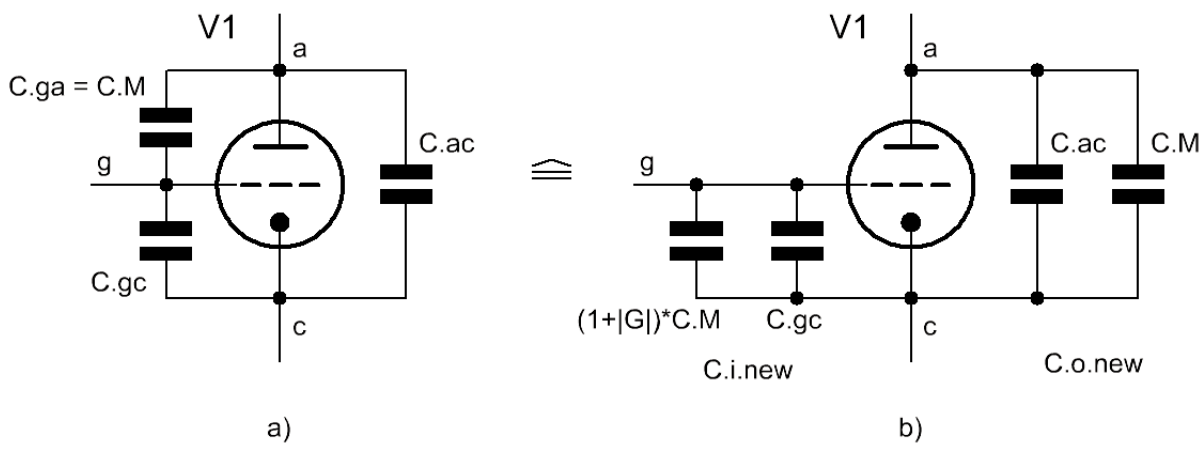


Figure 5: *Triode gain stage*

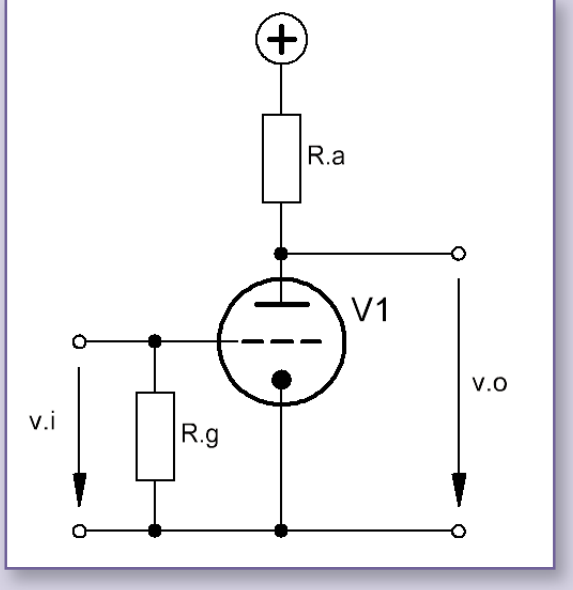
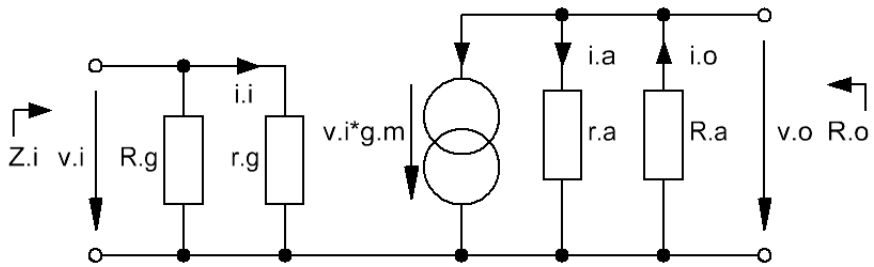


Figure 6: *Equivalent circuit of Figure 5*



In this series of short articles I do not dive into the DC operating point setting of the presented valve amplifier stages. This would be a strain on the size of each article, as well as it would not follow my intention discussing the gain stage's small signal aspects only. Covering all valve DC biasing approaches, for my knowledge, the most modern book comes from Morgan Jones, '*Valve Amplifiers*'.

Coming soon in **Part 2**, we'll see what happens with the gain G, the output resistance Ro and the input impedance Zi, if we add a load resistance RL and a cathode resistance Rc to a real Figure 5 gain stage. This will be the mother of all valve gain stages, the Common Cathode Gain Stage CCS. ■

TOSHIBA
Leading Innovation

Linking the old and new worlds of mobile PERIPHERAL DESIGN

Today's sophisticated mobile phone users demand access to ever more advanced applications and higher and higher levels of rich multimedia content. Among the many challenges facing the electronic designer is how to provide both the bandwidth and the multiple internal and external interfaces – to displays, cameras, audio devices, memory and other peripherals – that are essential to addressing these demands. Here, Sascha Kremer, Toshiba Principal Engineer/Technical Marketing, looks at the move to the Mobile Industry Processor Interface (MIPI®) Alliance standards and how ASSPs can help to address this challenge.

The Smartphone market is predicted to be the main battleground for mobile device manufacturers in the coming years. Competition is already intense among the main players and new entrants are rushing to join the fray, especially in Asia. These devices will feed the world's demand for more, and better quality, rich media content. Higher resolution cameras, HD-video streams and social media applications all depend on high speed transmission of data. The pressure to quickly deliver mobile devices that meet these needs is leading to a standardisation of the interfaces used within mobile phone handsets.

THE MIPI ALLIANCE

The term 'co-opetition' was coined to describe how competing companies collaborate to drive the market forward for the benefit of all involved. The mobile phone industry has many competitive companies, at every tier in the supply chain, but one thing drives them all to pull in the same direction, the goal of developing the marketplace and the products behind it. With around 170 members, the Mobile Industry Processor Interface (MIPI®) Alliance is a good example of such co-opetition. Together, its members have successfully developed a number of standard interfaces, now being used to expedite the development of mobile handset technology. It also has a mandate to continue developing open standards that will drive innovation and accelerate the development of the market; standards which are finding applications across the mobile space.

MAKING MIPI WORK

The first open standards from the MIPI Alliance were focussed on camera (CSI-2) and display (DSI) applications. Both standards are based on the same physical layer D-PHY. This physical layer (D-PHY) behind MIPI's advanced serial interconnect philosophy enables a number of MIPI Alliance standard interfaces to communicate in high speed, with low pin count and high noise immunity. The D-PHY must therefore be present in any device that interfaces with other MIPI compliant peripherals. Current MIPI Alliance specifications based on the physical layer D-PHY version 1.0 are DSI, CSI-2 and UniPro℠ version 1.0 and 1.1 (see Figure 1).

A D-PHY, such as the one from Toshiba shown in Figure 2, is essential for any company looking to implement designs based on the MIPI specifications.

In High Speed mode (HS), the D-PHY provides between 80Mbit/s and typically 1Gbit/s (implementation dependent) bandwidth per lane using an advanced source-synchronous differential SLVS design, which can be scaled with up to 4 data lanes to achieve the needed total bandwidth. In Low Power (LP) mode the D-PHY can achieve up to 10Mbit/s using a single-ended transmission. Toshiba's D-PHY has been developed in accordance with the specification, to meet the low power, low emission and high noise immunity required in a mobile phone environment. Based on 1.2V supplies, it scales well across current and future semiconductor process technologies.

Beside several DSI/DCS based products, Toshiba has also developed the associated CSI-2 IP, which targets the problem of fitting increasingly more sophisticated camera modules in to ever-smaller mobile phones, and interfacing them to the application processor. The module provides up to 4Gbit/s (on four data lanes plus clock) serial connectivity and can support cameras with up to 12Mpixel resolution. A key advantage of the CSI-2 is that, by enabling low pin count solutions, it allows camera signals to be carried across the limited conductors in the flex circuits of flip phone hinges.

In recent years the MIPI Alliance released a further seven specifications, including the Display Serial Interface (DSI) and Unified Protocol (UniPro). The DSI builds on the D-PHY specification, providing a higher layer protocol with error correction (ECC), addressing display-related data communication. It supports both 'smart' (buffered) and 'video mode' (unbuffered) displays and also features a Display Command Set (DCS), which defines a standard software interface. UniPro is PHY-independent but compatible with D-PHY. As such it is applicable across several applications, including cameras, displays and device communication interfaces, making it extremely flexible within the MIPI portfolio.

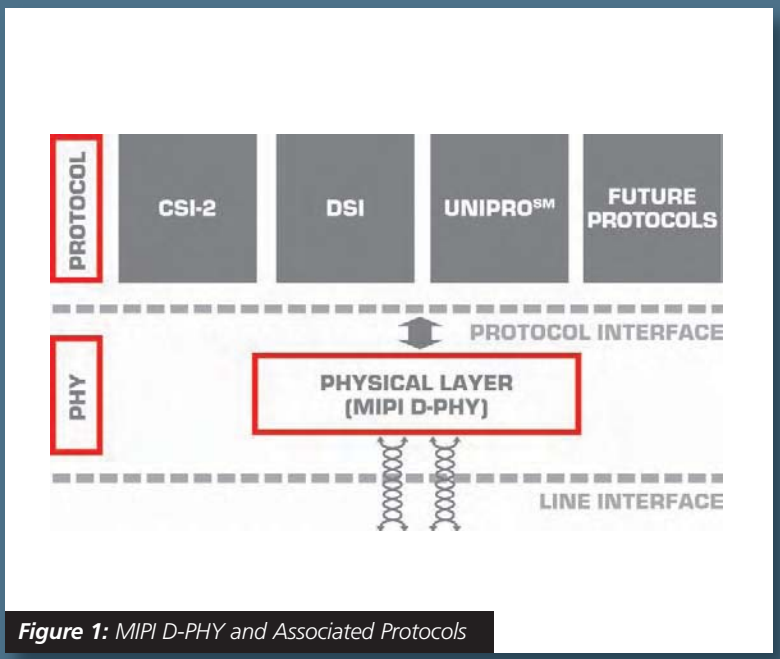


Figure 1: *MIPI D-PHY and Associated Protocols*

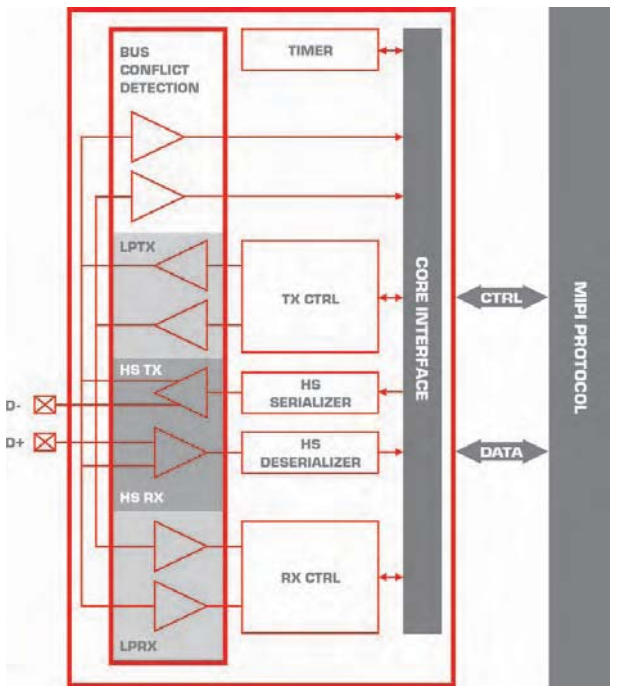


Figure 2: *MIPI D-PHY*

THE TRANSITION TO STANDARDISATION

MIPI entered a world that was already well-served by interface standards. Even during the past seven years, during which MIPI-defined interfaces have been agreed, manufacturers have continued to specify and rely on 'legacy' standards. This is mainly due to the time pressures on development cycles.

As a result, many companies face the challenge of linking the old world and the new in their designs. In order to address what is a very widespread requirement, companies, including Toshiba, are producing application specific standard products (ASSPs) that link legacy systems to the MIPI standards and vice versa.

A typical example is the Toshiba TC358710XBG MIPI display hub/bridge. This mobile peripheral device can be used either as a bridge between a host with an 8/16bit parallel bus interface (MIPI DBI type-B) and other components with MIPI DSI (Display Serial Interface) or as a hub. Set up in bridge mode it can supply up to three different display devices over high-speed serial MIPI DSI links from one parallel MIPI DBI type-B host interface (see figure 3a). Alternatively, in hub mode it can be used to distribute the incoming DSI packets to up to two DSI and one additional DBI based output port. The third DSI port is used in input mode in this configuration (see figure 3b).

Toshiba is extending its mobile peripheral device range with products such as DSI to HDMI display buffers (embedded double main display support). As companies concentrate on their core competencies – for example, application processor design, baseband expertise or peripheral-related capabilities – there will be increasing requirements for 'glue' components that connect mobile device heritage with the new standards

Toshiba Electronics Europe,
Hansaallee 181, D-40549 Düsseldorf, Germany
Tel: +49 (0) 211 5296 0
Fax: +49 (0) 211 5296 792197
Web: www.toshiba-components.com/mobile/peripheral_lsi.htm
E-mail: customsoc-internet@toshiba-components.com

Figure 3a and 3b: *TC358710XBG Application Examples*

µRTOS: Simple Multitasking with Microcontrollers

Professor Dr Dogan Ibrahim, lecturer at the Near East University in Cyprus, describes the design of a C-based, simple multitasking RTOS, using PIC microcontrollers

EMBEDDED SYSTEMS are usually microcontroller-based systems that represent a class of reliable and dependable dedicated computer systems designed for specific purposes. Microcontrollers are used in most electronic devices in an endless variety of ways. For example, it is estimated that there are more than 50 microcontrollers used in intelligent appliances in a modern average household in Europe. Some applications areas are in telephone systems, microwaves, washing machines, cookers, digital TVs, remote control units, Hi-Fi equipment, PCs, MP3 players, mobile phones and so on.

Some microcontroller-based embedded systems are required to respond to external events in the shortest possible time and such systems are often referred to as real-time embedded systems. It is important to understand that not all embedded systems are real-time and, also, not all real-time systems are embedded. For example, most of embedded automotive systems can be classified as real-time systems. Various specialized control functions in a vehicle, such as engine control, brake and clutch control are examples of real-time systems.

Most complex real-time systems require a number of tasks to be processed independently and this requires some form of scheduling and task control mechanisms. For example, consider an extremely simple real-time system which must flash an LED at required intervals and at the same time look for a key input from a keyboard. One solution would be to scan the keyboard in a loop at regular intervals while flashing the LED at the same time. Although this approach may work for a simple example, in most complex real-time systems, a real-time operating system (RTOS) or a multi-processing approach are usually employed. Multi-processing is beyond the scope of this article and this approach requires the use of more than one processor (e.g. more than one microcontroller) and is generally used in parallel computing applications where very high-speed processing, as well as multitasking, are required.

The Basic Principles of an RTOS

An RTOS is a program that manages system resources, schedules the execution of various tasks in the system and provides services for inter-task synchronization and messaging. There are many books and sources of reference that describe the operation and principles of various RTOS systems.

Every RTOS consists of a kernel that provides the low level functions, mainly the scheduling, creation of tasks and inter-task resource management. Most complex RTOSs also provide file-handling services, disk input-output operations, interrupt servicing, network management and user management.

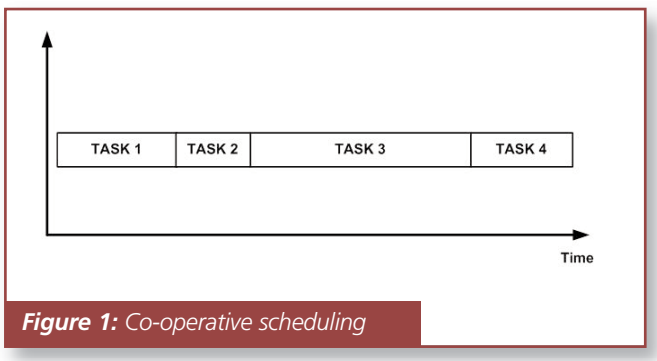


Figure 1: *Co-operative scheduling*

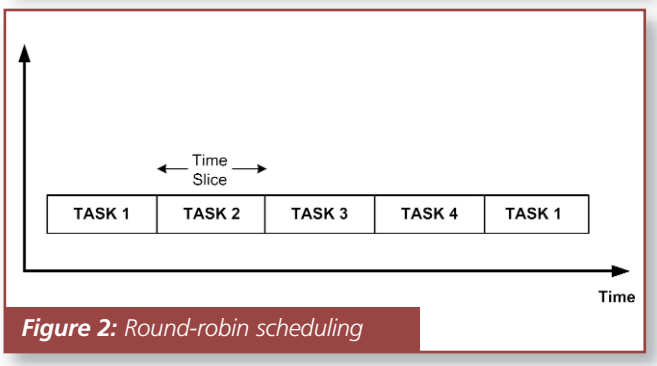


Figure 2: *Round-robin scheduling*

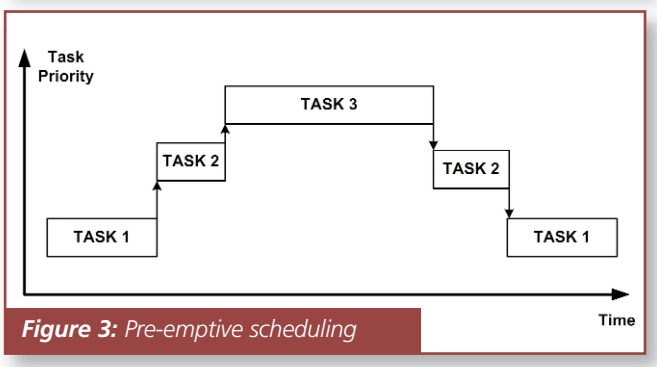


Figure 3: *Pre-emptive scheduling*

A task is an independent thread of execution in a multitasking system, usually with its own local set of data. A multitasking system consists of a number of independent tasks, each running its own code and communicating with each other in order to have orderly access to shared resources. The simplest RTOS consists of a scheduler that determines the execution order of the tasks in the system. Each task has its own context consisting of the state of the CPU and associated registers. The scheduler switches from one task to another one by performing a context switching where the context of the running process is stored and context of the next process is loaded appropriately so that execution can continue properly with the next task. The time taken for the CPU to perform

context switching is known as the context switching time and is negligible compared to the actual execution times of the tasks.

Although there are many variations of scheduling algorithms in use, the three most commonly used algorithms are:

- Co-operative scheduling
- Round-robin scheduling
- Pre-emptive scheduling.

The type of scheduling algorithm to be used depends on the nature of the application and, in general, most applications use either one of the above algorithms, or a combination of them, or a modified version of these algorithms.

Co-operative scheduling (see **Figure 1**) is perhaps the simplest algorithm where tasks voluntarily give up the CPU usage when they have nothing useful to do or when they are waiting for some resources to become available. This algorithm has the disadvantage that certain tasks can use excessive CPU times, thus not allowing some other important tasks to run when needed. Co-operative scheduling is used in simple multitasking systems with no time critical applications. A variation of the pure co-operative scheduling is to prioritize the tasks and run the highest priority computable task when the CPU becomes available.

Round-robin scheduling (see **Figure 2**) allocates each task an equal share of the CPU time. Tasks are in a circular queue and when a task's allocated CPU time expires, the task is removed and placed at the end of the queue. This type of scheduling can not be satisfactory in many real-time applications where each task can have varying amount of CPU requirements depending on the complexity of processing involved. One variation of the pure round-robin scheduling is to provide a priority-based scheduling, where tasks with the same priority levels receive equal amounts of CPU time.

Pre-emptive scheduling is the most commonly used scheduling algorithm in real-time systems. Here, the tasks are prioritized and the task with the highest priority among all other tasks gets the CPU time (see **Figure 3**). If a task with a priority higher than the currently executing task becomes ready to run, the kernel saves the context of the current task and switches to the higher priority task by loading its context. Usually the highest priority task runs to completion or until it becomes non-computable, for example by waiting for a resource to become available. At this point the scheduler determines the task with the highest priority that can run and loads the context of this task. Although the pre-emptive scheduling is very powerful, care is needed, as an error in programming can place a high priority task in an endless loop and, thus, not release the CPU to other tasks. Some multitasking systems employ a combination of round-robin and pre-emptive scheduling. In such systems, time critical tasks are usually prioritized and run under pre-emptive scheduling, whereas the non-time critical tasks run under round-robin scheduling, sharing the left CPU time among themselves.

So far, we have said nothing about how various tasks work together in an orderly manner. In most applications, data and commands must flow between various tasks so that the tasks can co-operate and work together.

Figure 4: *Program listing of µRTOS*

```
/*          uRTOS PIC18 Multitasking          */

#pragma disablecontexsaving
#define MaxTsk 3
#define freq 8
#define Prescale 64
#define T 1000
#define Timervalue 256-(T*freq/(4*Prescale))
#define StopTask while(1){Swap=1; INTCON.F2=1;}
#define SwapTask {Swap=1; INTCON.F2=1;}

unsigned char TMR0 = Timervalue;
unsigned char Temp,Twreg,Tstatus,Tbsr,Swap = 0;
unsigned char Saved[MaxTsk][3];
unsigned char TaskNumber=0;
unsigned char TStack[MaxTsk][4];
unsigned int TCount[MaxTsk];
unsigned int TTime[MaxTsk];

void interrupt()
{
   TMR0L = TMR0;
   Twreg = WREG;    Tstatus = STATUS;    Tbsr = BSR;

   TCount[TaskNumber]++;
   if((Swap == 1) || (TCount[TaskNumber] >= TTime[TaskNumber]))
   {
     TCount[TaskNumber] = 0;
     if(Swap == 1)Swap=0;

     Saved[TaskNumber][0] = Twreg;    Saved[TaskNumber][1] = Tstatus;
     Saved[TaskNumber][2] = Tbsr;
//
// Save return address of current task
//
     TStack[TaskNumber][0] = TOSL;    TStack[TaskNumber][1] = TOSH;
     TStack[TaskNumber][2] = TOSU;
     asm POP
//
// Get next task, and save its return address on TOS
//
     TaskNumber++;
     if(TaskNumber > MaxTsk-1)TaskNumber=0;
     asm PUSH
     Temp = TStack[TaskNumber][0];    TOSL = Temp;
     Temp = TStack[TaskNumber][1];    TOSH = Temp;
     Temp = TStack[TaskNumber][2];    TOSU = Temp;
//
// Restore task registers and return from interrupt
//
     INTCON=0x20;
     Temp = Saved[TaskNumber][1];     BSR = Saved[TaskNumber][2];
     WREG = Saved[TaskNumber][0];     STATUS = Temp;
   }
   else
   {
     INTCON = 0x20;    WREG = Twreg;    STATUS=Tstatus;    BSR = Tbsr;
   }
   asm retfie 0
}

void SetUpTmrInt(void)
{
   T0CON = 0xC5;    TMR0L = TMR0;    INTCON = 0xA0;
}

void InitTask(unsigned char TaskNo, unsigned int t)
{
   TStack[TaskNo][0] = TOSL;    TStack[TaskNo][1] = TOSH;
   TStack[TaskNo][2] = TOSU;    TTime[TaskNo] = t;
   asm POP
}

void StartTasks(void)
{
   SetUpTmrInt();
   Temp = TStack[0][0];    TOSL = Temp;
   Temp = TStack[0][1];    TOSH = Temp;
   Temp = TStack[0][2];    TOSU = Temp;
   asm RETURN
}
```

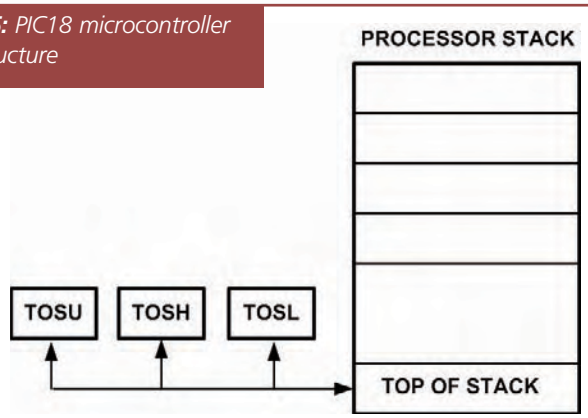


***Figure 5:** PIC18 microcontroller stack structure*

One very simple way of doing this is through shared data held in RAM where every task can access. Modern RTOS systems, however, provide local task memories and inter-task-communication tools such as mailboxes and pipes so that data can be passed securely and reliably between tasks. In addition, tools such as event flags, semaphores and mutexes are usually provided for task, as well as inter-task synchronization purposes.

RTOS Systems for PIC Microcontrollers

There are several commercially available, shareware and open-source RTOS systems for the PIC microcontroller family. Brief details of some popular RTOS systems are given in this section.

Salvo (www.pumpkininc.com) is a low-cost, event-driven, priority-based, multitasking RTOS designed for microcontrollers with limited program and data memories. It can be used for many microcontrollers, including the 8051 family, ARM, Atmel AVR, M68HC11, MS430, PIC microcontroller family and others. Salvo is written in ANSI C and supports a large number of compilers, including Keil C51, Hi-Tech 8051, Hi-ech PICC-18, Microchip MPLAB C18 and many others. A demo version (Salvo Lite) is available for evaluation purposes. The SE and LE versions are for systems requiring smaller number of tasks with less features, while the Pro version is the top model aimed for professional applications. The Pro version supports unlimited number of tasks with priorities, event flags, semaphores, binary semaphores, message queues and many more features.

CCS is a C compiler developed and distributed by Custom Computer Services Inc (www.ccsinfo.com) for the PIC microcontrollers. There are several versions of the compiler depending on the type of microcontroller used in the target design. The PCW models of the compiler support built-in RTOS. The provided RTOS is co-operative and requires no interrupt features. The RTOS provides a number of functions to start and terminate a task, to send messages between tasks, to synchronize tasks using semaphores and so on. When a task is scheduled to run, control of the processor is given to that task. When the task is complete, or does not need the processor any more, control returns to a dispatch function, which gives control of the processor to the next scheduled task. Because the RTOS does not use interrupts and is not pre-emptive, the user must make sure that a task does not run forever.

CMX-Tiny+ (www.cmx.com) supports a large number of microcontrollers, including the PIC24 and dsPIC family. This is a pre-emptive RTOS, supporting a large number of features such as event flags, messages, cyclic timers, semaphores and so on. This RTOS can be configured to operate as a co-operative scheduler if required. Although CMX-Tiny+ is a highly sophisticated RTOS, it has the disadvantage that the cost is relatively high and it is not available for lower members of the PIC family.

PICos18 (www.picos18.com) is an open-source pre-emptive RTOS for the PIC18 microcontrollers, developed under the GPL license. The full documentation and the source code is provided free of charge for people wishing to use the product.

MicroC/OS-II (http://micrium.com) is a low-cost priority based pre-emptive RTOS which has been ported to many microcontrollers including the PIC microcontrollers. This RTOS is developed in ANSI C with full source-code and documentation provided, and is used over hundreds of real-time products all over the world. MicroC/OS-II is a highly sophisticated RTOS, providing semaphores, mailboxes, event flags, timers, memory management, queues and so on.

FreeRTOS (www.freertos.org) is an open-source royalty-free RTOS that can be downloaded and used in commercial applications. This RTOS has been ported to many microcontrollers, including the PIC family of microcontrollers. FreeRTOS is pre-emptive but can be configured for co-operative or hybrid operations. The software supports interrupts, queues, mailboxes, binary

```
//
// Flash the LED
//
void Task0(void)
{
   InitTask(0,1);

   while(1)
   {
     if(flag == 1)
       PORTB.F0 = ~PORTB.F0;
     else PORTB.F0 = 0;
   }
}


//
// Stop flashing
//
void Task1(void)
{
   static unsigned int i = 0;
   InitTask(1,1);

   while(1)
   {
     while(PORTB.F1);
     flag = 0;
   }
}


//
// Start flashing
//
void Task2(void)
{
   InitTask(2,1);

   while(1)
   {
     while(PORTB.F2);
     flag = 1;
   }
}


//
// Main program. Call each task and the start Task0
//
void main(void)
{
   TRISB=0x06;

   Task0();
   Task1();
   Task2();
   StartTasks();
}
```

***Figure 6:** A simple µRTOS multitasking example*

semaphores, counting semaphores, mutexes and so on.

Finally, OSA-RTOS (http://picosa.narod.ru) is a freeware RTOS for PIC microcontrollers distributed under the BSD license. This RTOS is compatible with a large number of C compilers, including the Microchip C18, mikroC and CCS. The full source code and the documentation are available from the website. OSA is a co-operative multitasking RTOS, offering many features such as semaphores, events, data queues, mutexes, memory pools, system services and many more.

Development of the µRTOS

This section describes the development of a simple, yet effective RTOS for micro-controllers, called the µRTOS. Although µRTOS has been primarily developed for the PIC18 series of microcontrollers, it is written using the C language and, thus, it should be possible to modify and adapt it for other types of microcontrollers.

One of the classical approaches to RTOS design is to use Task Control Blocks (TCBs). A TCB is basically a structure that stores the essential information about a task, such as the return address, CPU registers, task state, local event flags, etc. µRTOS has been designed to have a simple architecture and thus is not based on TCBs.

µRTOS uses a round-robin type scheduler with the addition of allocating variable CPU time to individual tasks. Thus, for pure round-robin type applications all tasks can be configured to have the same CPU time allocations. Task durations, however, can be configured if desired so that tasks can be allocated different maximum CPU times.

Task scheduling in µRTOS is based on 1ms timer interrupts where context switching occurs within the timer interrupt service routine. Data flow between the tasks can be achieved using common variables declared at the beginning of the program. In addition, task synchronization tools are not provided in this simple RTOS.

Figure 4 shows the program listing of µRTOS. The code is based on the mikroC language from mikroElektronika (www.mikroe.com), which is currently one of the popular C language compilers for PIC microcontrollers.

Each task in µRTOS is organized as a C function, running forever in a loop. The first thing a task does is to call kernel function InitTask which saves the task return address in an array called TStack. In addition, the maximum allocated duration of each task (in ms) is also stored in array TTime. The program counter of a PIC18 microcontroller is 24-bits wide and is stored in three 8-bit stack registers TOSL, TOSH and TOSU after a procedure call or an interrupt (see **Figure 5**). These registers are accessed by µRTOS during the saving and restoring of task return addresses.

In an application, the main program initially calls all the tasks in turn so that their return addresses can be saved. Then function StartTasks is called. This function calls to SetUpTmrInt to configure timer TMR0 so that timer interrupts can be generated every milliseconds for the kernel. In addition, the return address of Task 0 is pushed onto the stack and a RETURN is executed so that task execution starts from Task 0. At the core of the kernel we have the timer interrupt service routine (ISR). The ISR determines the next task to run and performs the necessary context switching. The following operations are carried out within the ISR:

- Timer register TMR0 is reloaded for one millisecond interrupts;
- Current CPU registers W, STATUS and BSR are saved;
- If allocated duration of current task has not expired, then timer interrupts are re-enabled and ISR passes control back to the same task with no context changing;
- Otherwise, the return address of current task is saved in array TStack;
- Task number of the next task is determined and its return address is pushed onto processor stack;
- CPU registers W, STATUS and BSR of next task are restored;
- Timer interrupts are re-enabled and ISR passes CPU control to the next task.

Using µRTOS

Here is an example to show how µRTOS can be used in a simple multitasking application. An LEDs is connected to port pins RB0 of a PIC18F452 microcontroller, operated from a 8MHz crystal. Similarly, port pins RB1 and RB2 are connected to push-button switches such that logic 0 is applied to the corresponding microcontroller pin when a switch is pressed. Three tasks named TASK0, TASK1 and TASK2 are created (see **Figure 6**) with the following functions:

TASK 0: This task flashes the LED connected to port pin RB0 as long as a Flag is set.

TASK 1: This task clears the Flag when button connected to RB1 is pressed, thus stops the flashing.

TASK 2: This task sets the Flag when button connected to RB2 is pressed, thus re-starts the flashing.

Each task initially calls to function InitTask with its task number and maximum duration and then enters its endless loop. Task0 flashes the LED as long as the Flag variable is set. Task1 and Task2 both wait in a while loop until either switch RB1 or RB2 is pressed. Pressing RB1 clears the Flag and, thus, the flashing stops. Similarly, pressing RB2 sets the Flag and, as such, the flashing is re-started by Task0. Notice that a Macro called SwapTask can be used to stop execution of the current task and pass control to the next task, i.e. it can be used to force a context switching when a task has completed its execution or it has nothing else useful to do.

The main program initially calls to all the tasks so that their return addresses are saved and then calls to function StartTasks to start execution from Task0. Notice that variable Flag is used as a shared variable and thus it must be declared at the beginning of the program.

Simple and Effective RTOS

The development of a simple, yet effective RTOS system for the PIC18 series of microcontrollers has been described. Although there are several commercially available microcontroller RTOS systems, some are expensive, or use too many resources of the target microcontroller. The RTOS described in this paper (µRTOS) is simple and uses only a timer and very small RAM memory of the target microcontroller. It should be possible to use the µRTOS in many small real-time multitasking applications. The code given in Figure 4 is configured for three tasks, 8MHz clock frequency and 1ms scheduling time. These parameters can easily be changed to suit any other application. ■

Martin Unverdorben, Field Application Engineer at Kontron, goes in detail of the benefits of Computer-on-Modules and how to implement them into a design

Streamlining Carrier Board DESIGN

DESIGNING application-specific embedded computer solutions from scratch is a monumental undertaking. For nearly all applications, even down to handheld devices, the COM Express Computer-on-Modules approach reduces this task to the development of the carrier board. But still there are many rules to obey and traps to avoid. Practical design guides and an extensive community assist engineers in developing customized solutions with application-specific carrier boards, shortening time to market.

Computer technology is evolving quickly. And new system designs need to be fast to market. Thus, embedded system design engineers need to save as much time in system design as possible.

The fastest and easiest method for designing a system is through the solitary use of COTS (commercial off-the-shelf) components such as standard boards and standard extension cards based on reliable standards. However, this is not a fit for embedded applications, which require very specific feature sets and unique form-factors. On the other hand, the development of fully custom designs is far too time-consuming and expensive, except for the highest volume applications. Computer-on-Modules (COM) provide the needed solution that combines the simplicity and cost effectiveness of COTS with the flexibility and customizability of custom designs.

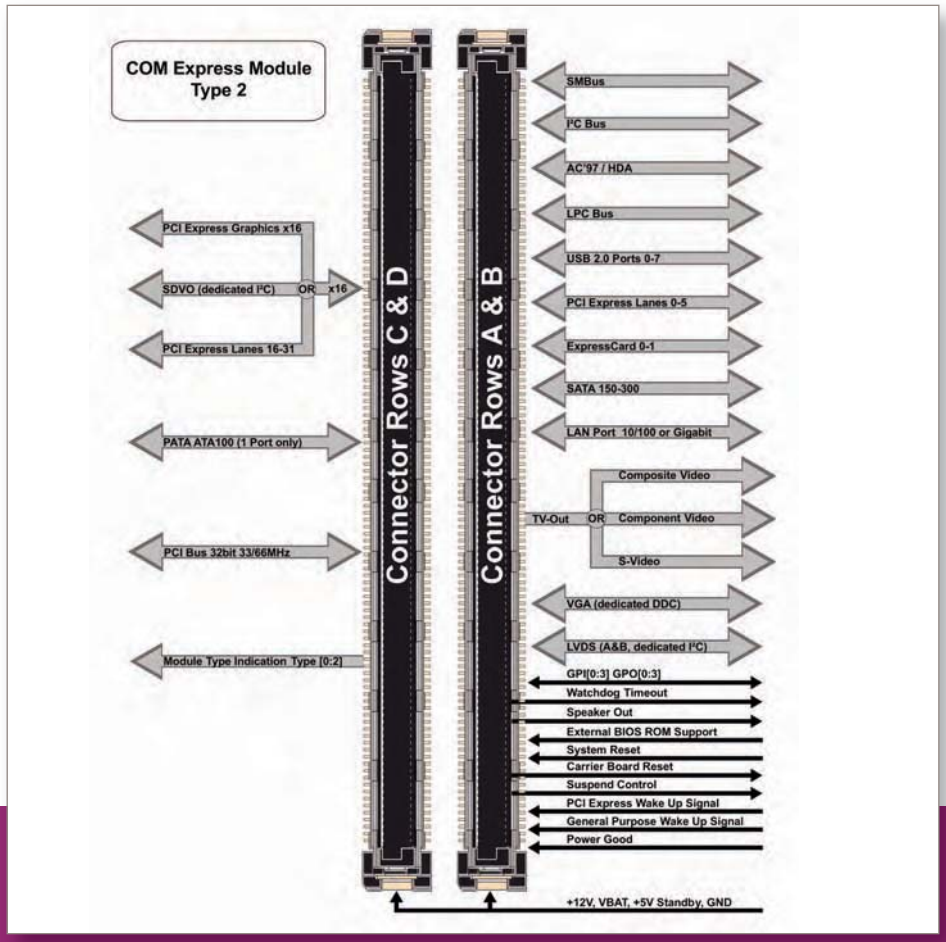


Figure 1: *COM Express Type 2 connector layout*

From COMs to COM Express

With a COM solution, developers only have to take care of the interfaces and switching circuits on the individual carrier board. This results in the engineer being able to lend his complete concentration to the application. However, he is still faced with designing the carrier board, which serves as the conduit between the COM and all internal or external devices that he wishes to connect to the carrier board.

Since June 2009, the COM Express standard has offered a carrier board design guide published by the PICMG to support

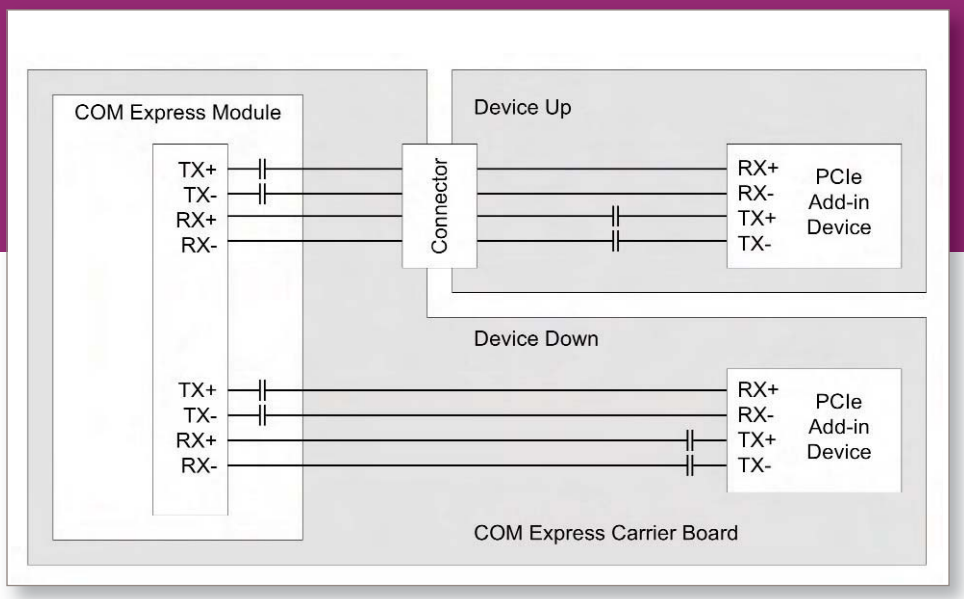


Figure 2: *PCIe Rx coupling capacitors – placement of the capacitors for "Device Up" and "Device Down" cases*

developers and help simplify development efforts. The PICMG Carrier Design Guide 1.0 offers comprehensive information for developers of custom-designed carrier boards for COM Express modules. In combination with the latest COM Express specification and the module vendors' product manuals, the design guide greatly simplifies design efforts and guarantees optimal interchangeability of Computer-on-Modules from different manufacturers.

And the interchangeability of different footprints is ensured as well, since the COM Express specification currently specifies two module sizes: basic (125mm x 95mm) and extended (155mm x 110mm). But the carrier design guide can also be used to implement two new smaller form-factors, the 95mm x 95mm compact (microETXexpress) and the 84mm x 55mm ultra (nanoETXexpress), which are expected to be integrated into the PICMG standard shortly.

The compact and ultra form-factors fill the need for SFF (small form-factor) variations such as in handheld devices. So COM Express is truly a fit for all applications and suits all size requirements. By offering the widest spectrum of module sizes it is the most open standard for Computer-on-Modules. But, openness in size is not the only thing designers need. There are still other important factors to consider. Let's then take a look at what the design guide delivers in detail.

It's All In The Detail

The COM Express Carrier Design Guide includes numerous connection diagrams and external switching circuits plus descriptions of ideal implementation solutions for all COM Express interfaces routed via the COM Express connectors. The connector is one essential point of the specification; it must fit the needs of both today's and tomorrow's requirements.

What does COM Express then define exactly? Via one or two 220 pin connectors, the COM Express modules are connected to the carrier board. Presently, the contact layout is specified in five different pin-out types (type 1 to type 5). One of the most essential features and benefits of COM Express is the consistency of the interfaces routed via the first physical interconnector to the carrier board, the type 1 single connector.

Type 1 offers GbE, LPC, Serial ATA, USB 2.0, VGA, LVDS, optional TV, power management, GPIO and other miscellaneous I/O via a single physical connector.

Type 2 extends type 1 by an additional connector, defining PCI Express Graphics (1 x 16), an IDE port, PCI and signal lanes for module type identification. Connector types 3-5 are simply variants of the second physical interconnector. But, according to the reports from market research company VDC (Volume 3 of VDC's Merchant Computer Board for Retail-Time and Embedded Applications (MCBREA)), COM Express modules with Type 1 and Type 2 connectors will account for 93% of all COM Express modules in 2010. They cover all relevant interface standards like PCI, PCIe, PEG, SDVO, LVDS, Serial ATA (SATA), USB, Gigabit Ethernet, AC97 and GPIOs. Thus, the COM Express Type 1 and Type 2 specifications fit the needs of most with respect to second source in long term and, also, with respect to availability.

As a general design rule, engineers who want to be on the safe side should always stick to the "smallest common denominator". Therefore, they should prefer Type 1 and Type 2 COM Express modules as they are assured to be supported by all vendors, whereas proprietary standards or variants, even if they can be found on the market, might become unavailable in the long term.

A ROSE BY ANY OTHER NAME

COM Express modules were originally developed in 2003 by Kontron and Intel under the brand name "ETXexpress". With the implementation of the standard by the PICMG in 2005, the industry adopted the "COM Express" moniker to represent the vendor independent standard.

In 2005, Kontron introduced the microETXexpress (referred to as "compact" by the PICMG) as a smaller-footprint. microETXexpress is 100% compatible to the Type 2 connector, as defined by the COM Express COM.0 specification.

In 2008, it followed this with the introduction of the even smaller nanoETXexpress (PICMG's "ultra"), which is COM Express compatible in respect to the type 1 connector and pin-out.

Safety First

So far we have learned that we have tremendous freedom of size with this standard and we have covered its most important interface types. If these interfaces are suitable, we need to check whether the

connector itself is useful for the application. Is it robust enough? Does it fill the need for even highest speeds?

A major difference compared to previous COMs is the connection between module and carrier board. Instead of a card-edge connection, the low profile, high density, face-mounted connectors used on the COM Express modules have a lower attenuation, which lengthens the possible circuit length on the carrier board and, in turn, allows greater design freedom. In addition, COM Express connectors are more shock and vibration proof than card-edge connectors and, also, more immune to EMI.

So COM Express is the safe way, especially when one considers future interface standards, such as PCIe Gen 2 and USB 3.0. These three factors: freedom of size, most attractive interfaces and robust connectors, have lead to a tremendous variability of potential processor and chipset implementations which are again important for the reliability of a COTS standard used for custom-specific designs.

Nearly all flavours of the x86 architecture are supported, from cost-efficient Intel Celeron and AMD Sempron, to low-power Intel Pentium M, to high performance Intel multi-core solutions. And, as of 2008, Intel Atom based modules allow small and especially energy-efficient applications in the embedded area to be upgraded with full x86 functionality.

COM Express is the standard that offers the widest x86 processor range. Thus, you have enormous flexibility in choosing a computing core with COM Express based COMs. But this is not all: the highly flexible COM Express specification also allows designers to place every interface in the precise location that it is required. Additionally, only those interfaces that are required by the application need to be loaded. Interfaces can be implemented either on the carrier board or via an extension card through any of the internal interfaces.

Once the processor, module size and feature set have been decided upon, the dimensions of the carrier board and location of all interfaces can be determined and the carrier board design process can begin. But, unlike other COM variations that leave the task of developing the carrier board more or less completely to the developer, the COM Express Carrier Design Guide walks them through nearly every step of the process. This is a major advantage because with so much freedom in sizes and interfaces, it can be a challenge to design the most future proof and interoperable embedded boards with COMs from different vendors, which is essential for long term investment security.

Design Guide To Show The Way

The COM Express Carrier Design Guide represents the culmination of the design expertise of hundreds of COM Express engineers. The content of the guide consists of a summary of good design principles for computer boards and external interfaces according to the PICMG COM.0 specification, as well as the logic necessary for the interaction with all standard interfaces.

The guide simplifies developers' work throughout the design process and helps them to avoid mistakes. It describes in detail the design and function of all defined COM Express interfaces and the implementation of all supported standards, including PCIe, LAN, USB, SATA, SDVO and LVDS, to name just a few. There are also sections covering power and reset, BIOS considerations, carrier board PCB layout guidelines and mechanical considerations covering such topics as form factors and the mounting of heat spreaders.

Each interface chapter begins with the description of the single signal lanes, followed by example schematics, and ends with routing considerations such as lane reversal, impedance definitions and reference ground isolation. The guide contains around 50 example schematics, ranging from a watchdog timer to an AT/ATX power supply diagram, to several implementations of different PCI Express devices. Some examples of PCB stack-ups are also provided to assist in the design process. Additionally, an entire chapter in the guide is devoted to creating carrier board designs with maximum interoperability. Many of the examples detailed in the design guide can be used not only for carrier board design, but also for general PCB design. Thus, it is a most important summary of embedded computer designs. Let's go through a few examples from the guide to illustrate.

Figure 1 summarizes the Type 2 signals and shows a graphical representation of the A-B and C-D COM Express connectors on the COM Express module. The pin-out for connector rows A and B remains the same

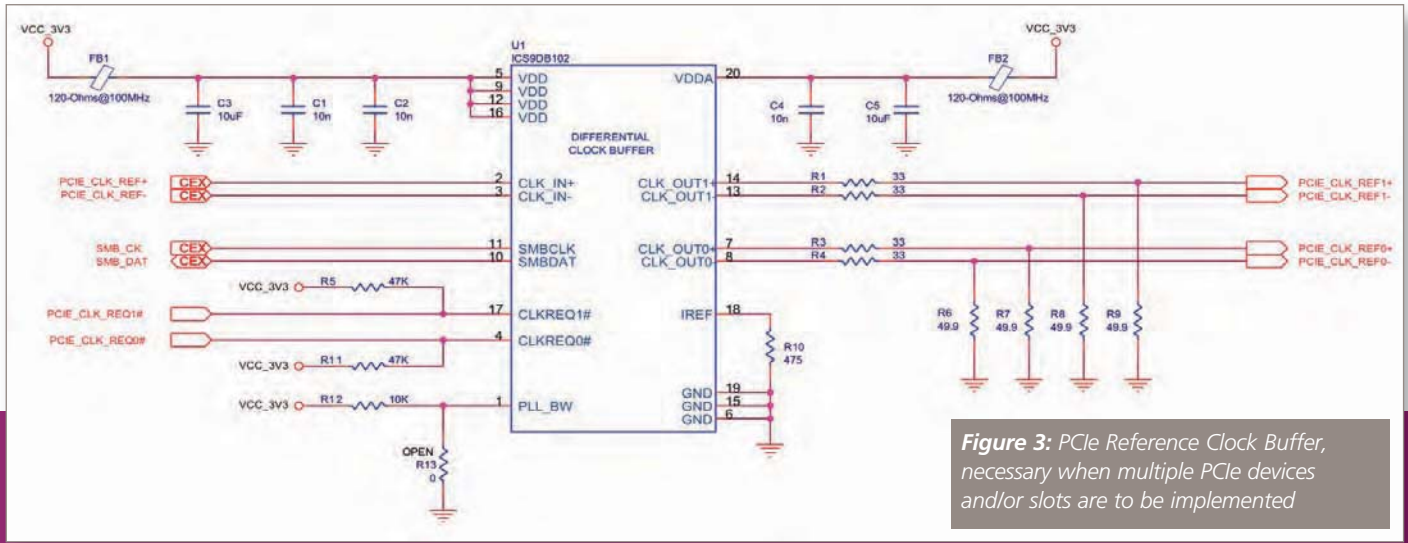


Figure 3: *PCIe Reference Clock Buffer, necessary when multiple PCIe devices and/or slots are to be implemented*

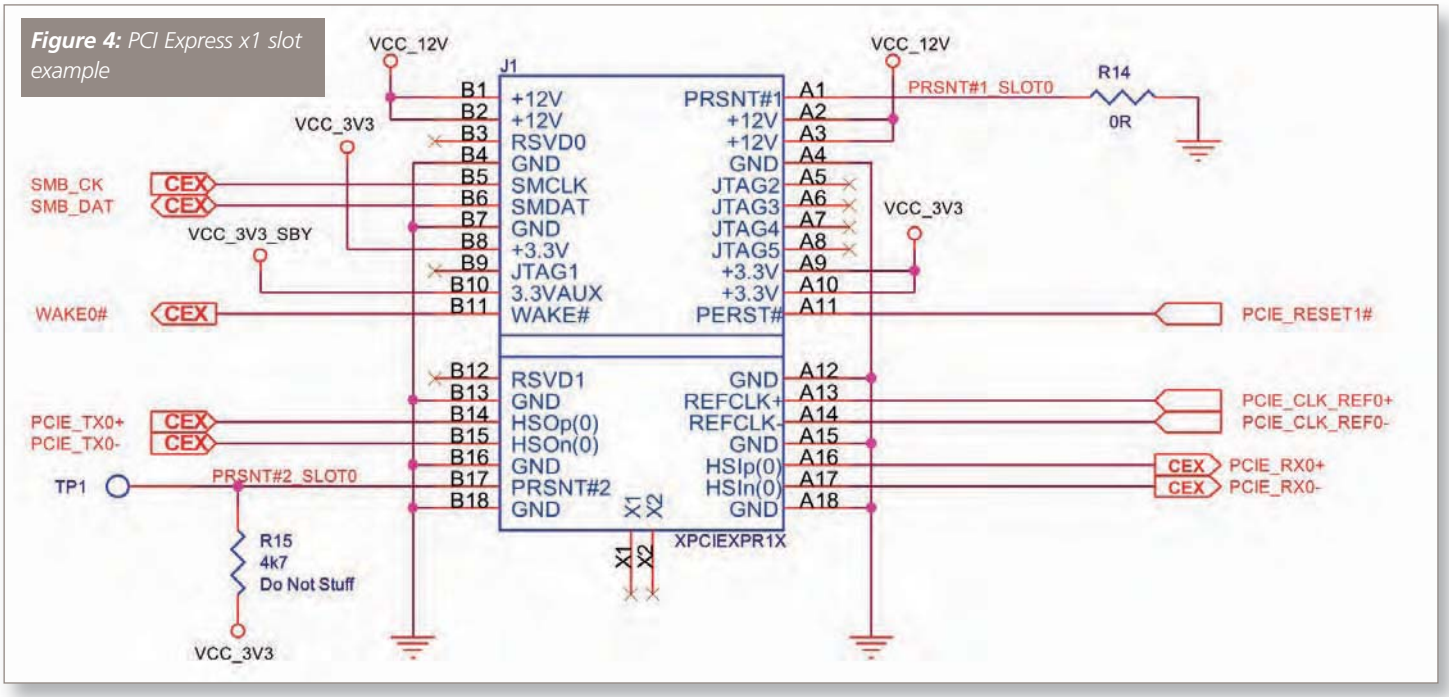


Figure 4: *PCI Express x1 slot example*

regardless of the module type, while the pin-out for connector rows C and D is dependent on the module type.

Most interesting for many custom designs are the PCI Express interfaces, because they are used most often for the dedicated configuration of the custom feature set. Implementing a PCIe device on a COM Express board is fairly straightforward. Let's take a look at what steps are involved in the implementation of a general PCIe device.

The general purpose PCI Express interface of the COM Express Type 2 module on the COM Express A-B connector consists of up to six lanes, each with a receive and transmit differential signal pair. The six lanes may be grouped into various link widths as defined in the COM Express spec.

According to the COM Express specification, the PCIe lanes on the A-B connector can be configured as up to six PCI Express x1 links or may be combined into various combinations of x4, x2 and x1 links that add up to a total of six lanes. These configuration possibilities are based on the COM Express module's chipset capabilities. The COM Express specification defines a "fill order" from mapping PCIe links that are wider than x1 onto the COM Express pins. For example, the spec requires that a x4 PCI Express link be mapped to COM Express PCI Express lanes 0, 1, 2 and 3.

COM Express allows PCIe target devices to be placed "Device Down" (down on the Carrier Board) or "Device Up" (via a slot card, mini-PCIe card, ExpressCard, AMC card, etc.) There are several distinctions between a PCIe "Device Down" and "Device Up" implementation, including location of coupling caps and allowed trace length.

Before the PCIe device can be integrated, one copy of the PCIe reference clock pair must be brought out of the module. This clock is a 100MHz differential pair and is sometimes known as a "hint" clock. The clock allows the PLL in the target PCIe device to lock faster onto the embedded clock in the PCIe bit stream.

If the carrier board implements only one PCIe device or slot, then the PCIe reference clock pair from the module may be routed directly to that device or slot. However, if there are two or more PCIe devices or slots on the carrier board, then the module's PCIe reference clock should be buffered using a PLL based "zero-delay" buffer. Each target device should get an individual copy of the reference clock. The reference clock pairs should be routed as directly as possible from source to destination.

Now let's take a look at an example PCIe implementation. This schematic shows a PCI Express x1 slot configuration. In the example, COM Express PCIe lane 0 is connected to the slot. Other lanes may be used, depending on what is available on the particular module being used. No coupling caps are required on the PCIe data or clock lines. The PCIe TX series coupling caps on the data lines are on the COM Express module. The PCIe RX coupling caps are up on the slot card. Slot signals REFCLK+ and REFCLK- (pins A13 and A14) are driven by the Clock Buffer, which is shown in **Figure 3**.

If there is only one PCIe target on the Carrier Board, the Clock Buffer may be omitted and the slot REFCLOCK signals may be driven directly by the COM Express module. The slot PWRGD signal (pin A11) is driven by a buffered copy of the COM Express PCI_RESET# signal. A buffered copy of CB_RESET# could also be used. If the Carrier board only has one or two target devices, an unbuffered PCI_RESET# or CB_RESET# could be used.

The slot signals PRSNT1# and PRSNT2# are part of a mechanism defined in the PCI Express Card Electromechanical Specification to allow hot-plugged PCIe cards. However, most systems do not implement the support circuits needed to complete hot-plug capability.

Nets SMB_CK and SMB_DAT are sourced from COM Express module pins B13 and B14 respectively. The SMBUS supports card-management support functions. SMBUS software can save the state of the slot-card device before a Suspend event, report errors, accept control parameters, return status information and card information such as a serial number.

Support for the SMBUS is optional on the slot card. WAKE0# is asserted by the slot card to cause COM Express module wake-up at module pin B66. This is an open-drain

signal. It is an input to the module and is pulled up on the module. Other WAKE0# sources may pull this line low; it is a shared line. Slot JTAG pins on A5-A8 are not used.

Just the Beginning

These are just a few examples of the wealth of information provided in the design guide. However, even given this valuable resource, in the end, perhaps the most important asset is the community surrounding a particular standard.

In the COM Express world, a tremendous amount of additional resources are available. Since the publication of the COM Express specification in 2006, a large community has evolved around the standard. This resource guarantees long term support and provides many additional avenues through which developers can receive support. For example, embedded computing manufacturers such as Kontron not only offer design consulting and concept optimization services, but also specialized training in all relevant topic areas.

Hands-on training is by far the preferred method of learning, so design engineers would do well to take advantage of these offerings. Additionally, Kontron's Boards&More service also includes the complete development of carrier boards, allowing even companies without a design team to take advantage of the COM building blocks for individual application designs.

A World Class Standard

With COM Express Computer-on-Modules, developers do not have to worry about designing the core computing functionality since this is a standard COTS product. It allows them to concentrate on their field of expertise, whether this lies in specific interfaces, application technology or software programming, and still have the ability to engineer application-specific computing hardware with a minimal time to market.

With the COM Express specification and the carrier design guide published by the PICMG, they get a vendor independent "how-to" for their specific embedded solution, plus an extremely scalable computing COTS platform in terms of footprint, performance and connectivity. The possibility to efficiently reuse their gained expertise in COM solutions enables them to develop applications from multi-core solutions to handheld devices for every vertical market. And, with the rich ecosystem of additional services and knowledge resources, designing an application-specific carrier board with dedicated interfaces becomes quite an easy task, indeed. ■

Meeting the Demands of the Industrial

Daniel Huebner from Renesas Technology Europe

analyses the market trends and requirements for industrial multimedia applications from processor point-of-view

THE AVAILABILITY of inexpensive embedded computer modules based on powerful and highly-integrated 32-bit processors has permanently changed the specifications for new industrial products. This is part of an unbroken trend towards high-quality graphical user interfaces that is gathering pace due to continued price reductions in colour displays. In addition, we are beginning to see completely new applications as a result of the processors' support for audio and video applications.

Over the last few years, there has been a high level of hype surrounding new technologies for graphical user interfaces (GUI), even in the industrial field. This has been driven by two main factors. First, it is influenced by the availability of powerful and inexpensive processor solutions and lower prices for display technologies. And second, the GUI trend has spread from consumer electronics to industrial sectors.

The mobile phone market serves as a benchmark here, with Flash- and 3D-based GUIs, audio/video functions and touchscreen-based data entry technologies becoming more familiar. This evolution has come to industrial displays too, even in the white goods market. Buttons and dials were the norm just a few years ago, but today we are seeing products with high-resolution graphical displays that are able to play good-quality video clips. User guides and help menus on complex devices are much easier to understand if people can just follow instructions directly on the device instead of studying a manual.

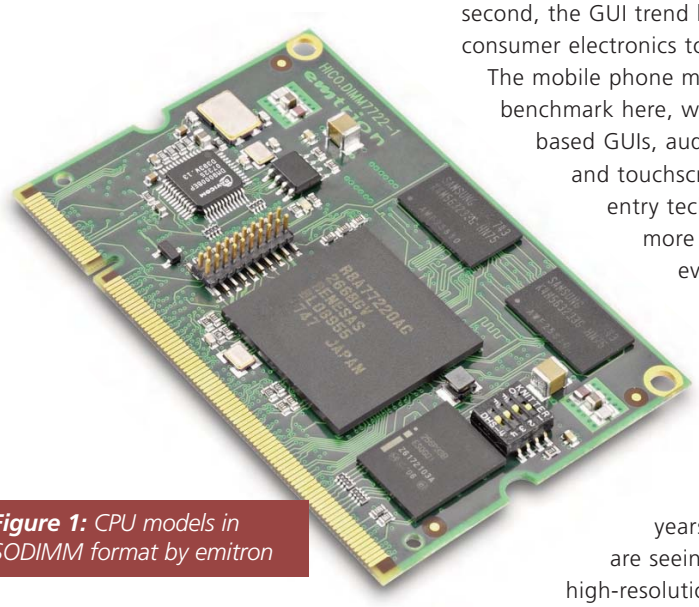


Figure 1: *CPU models in SODIMM format by emitron*

Evolutionary Steps

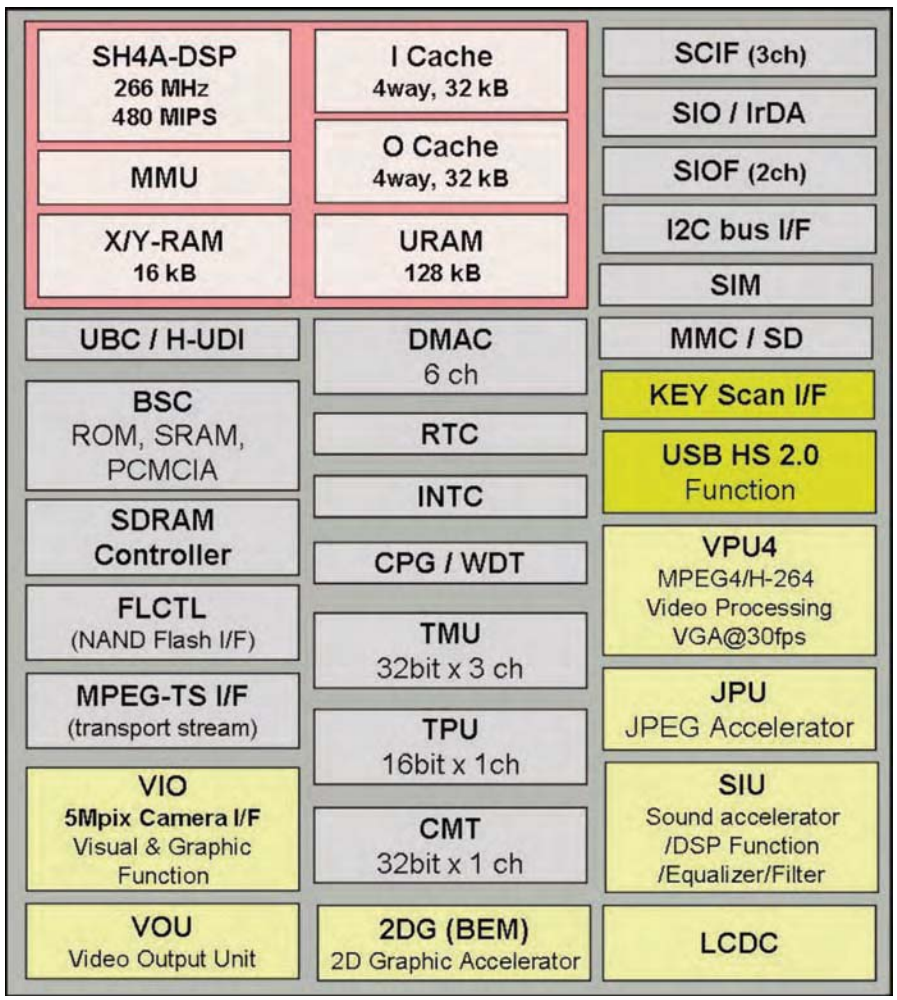
The need to reduce development cycles and costs in the industrial sector has led to a more widespread use of commercial tools and frameworks that help developers create complex GUIs relatively quickly. This is why solutions like the Qt Cross-Platform Application Framework from Trolltech can be found in more and more industrial applications. This trend extends to the generation of dynamic GUIs using familiar Flash technology. Adobe Flash leads in this area. Developers of embedded systems for industrial, medical or automotive applications are using Flash more often – for the simple reason that it reduces the time needed to develop complex user interfaces by up to 50%. Developers use high-level Flash tools to create GUI components that can then run on the target platform with a Flash player – without having to write graphical code.

Another evolution in this area is a change in the choice of operating system. As embedded Linux is license-free, it is increasingly used in cost-sensitive applications, as well as in the development of GUIs. There are multiple open-source graphics libraries available for Linux, with GTK being one example.

Support for audio and video applications is emerging as another industry trend. One reason for this may be the increasing need for security systems. However, many other systems are now equipped with cameras to record high-quality video, including IP

MULTIMEDIA Applications

Figure 2: *Block diagram of the SH7722*



network cameras, industrial cameras and a wide range of consumer devices. This trend has been increasing ever since high-integration processors started supporting new coding standards like H.264, eliminating the need for highly complex DSP systems.

As an example of how this can be used, video-enabled entry phone systems in older buildings can simply be upgraded using streaming-enabled IP network cameras on a WLAN, without any need for laying cables. In this type of application, video compression is essential – with H.264 for example – to transmit the video data using a reasonable bandwidth.

For many appliances utilizing cameras like surveillance units, video door bells or video conference systems, the trend is moving towards high definition (HD) resolution for the video capture and the transmission of the captured video data over IP based networks. Since many of these applications are powered by batteries or other supplies with reduced power capacities, low power multimedia microprocessors are mandatory. Furthermore, for today's embedded camera systems, simple capturing and transmission is not sufficient. Each frame in the picture needs to be processed to carry out object recognition, picture stabilization and many other actions that affect the original video material. This operation typically requires high computing power for fixed and floating point operations.

Development Requirements for Hardware and Software

Many of these product evolutions have resulted in new challenges for developers. In the past, systems were developed using 16- or 32-bit microcontrollers that were sufficient for the lower level of requirements at the time. Alongside peripherals, these microcontrollers include the necessary memory like RAM or Flash.

On the software side, too, developers worked with real-time operating systems and drivers that had gradually evolved over a number of years. Now, however, with the trend towards industrial multimedia applications, developers are getting to grips with new subjects, such as the connectivity of highly-integrated processors. They need to be able to design fast memory interfaces, such as SDRAM, DDR1 or DDR2. Camera, LCD and touchscreen interfaces may also be required, as well as PC-related technologies like high-speed USB 2.0, SD cards and Gigabit Ethernet interfaces.

On the software side, developers work

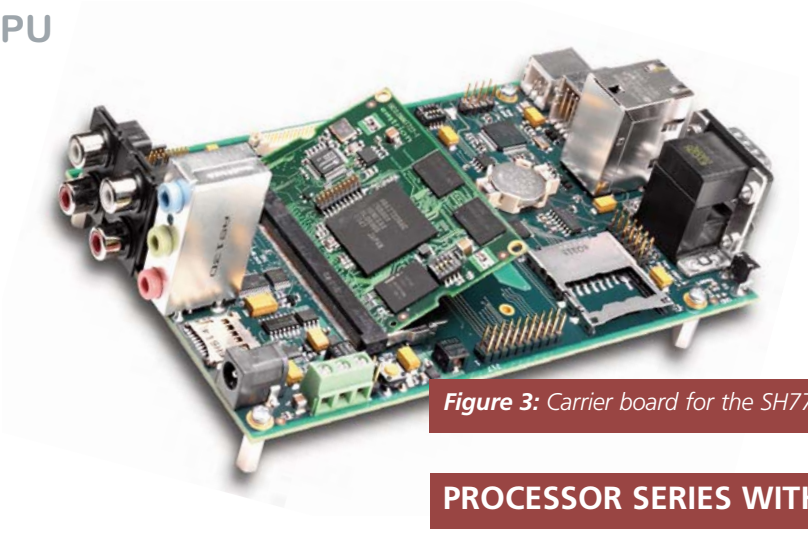


Figure 3: *Carrier board for the SH772x series*

at far higher levels of abstraction than before. As mentioned above, operating systems like Linux, Windows CE and QNX are rapidly gaining ground. But the developer also needs a good knowledge of graphical libraries and industry-standard APIs like Open Max IL and OpenGL, so that the required functions can be implemented rapidly. For high-quality audio and video processing in new-generation systems, developers also need a good grounding in multimedia codecs such as MP3, AAC, MPEG-4 and H.264.

All in all, complexity is increasing. But to keep development times short and ensure that costs remain low over the long term, there is an increasing trend towards reference systems and highly optimized modular solutions. Using embedded computer modules is the key to maintaining development costs at a reasonable level, especially for applications with production volumes in the small to medium range.

One Complex World

The world of hardware and software for embedded systems has become rather complex, especially with the latest GUI technologies as well as audio and video support. The hardware and software components need to provide a significant amount of support to ensure development is both rapid and efficient.

This requirement can be met by collaborations, such as the one between Renesas and emtrion, a Platinum Alliance Partner for SuperH-based system solutions. The results include availability of complete reference systems and optimized modules, as well as comprehensive software solutions for complex multimedia applications. ■

PROCESSOR SERIES WITH THE RIGHT KNOW-HOW

There are processors today that combine all of the functions needed for the applications described in this article on a single chip. Renesas, for example, has developed a 32-bit RISC processor family, SH772x, which is specially designed for multimedia applications. It is a highly-integrated single-chip SoC solution for audio, video and speech processing, as well as for graphics acceleration in sophisticated GUIs.

The SH7722, SH7723 and SH7724 processors are an extension of the SH7721 and include integrated multimedia interfaces, such as video in/out, a 5-megapixel camera interface, audio processors, MPEG-4/H.264 acceleration, LCD controllers, 2D graphic acceleration and SD card controllers. These processors will be followed next year by the SH7724, which will add Ethernet connectivity to the multimedia capabilities.

The SH7722 (Figure 2) works at a clock speed of up to 333MHz and also has a DSP extension for processing different audio codecs. At 400MHz, the SH7723 is faster and also includes an L2 cache, as well as a powerful FPU. It enables video recordings or decoding to be implemented with MPEG-4 or H.264 at a frame rate of up to 30fps under Linux or Windows CE. At the same time, it supports resolution of up to D1 with extremely low power consumption. One performance class higher is the SH7724 with 500MHz and high definition video processing. Its Video Input Unit (VIU) allows the connection of either two digital CMOS cameras with 5MPixel or two cameras using the ITU-R BT.656/601 standard, like PAL/NTSC cameras. The VPU is responsible for capturing frames from each attached camera and stores this into memory. The Video Engine Unit (VEU) is able to automatically convert every single recently captured frame in hardware. Available operations include resize, YCrCb to RGB conversion, rotation, dithering and many more.

Powerful video compression is mandatory in order to capture video in high definition 720p, meaning a resolution of 1280x720 pixels at 30 frames per second. This is why the SH7724 integrates a MPEG4/H.264 VPU which enables the encoding and decoding of video streams with 720p at 30fps in hardware. This again saves power and CPU load.

Partnering for Easier Design Development

A Renesas Platinum Partner, Germany-based emtrion, provides CPU modules in SODIMM format for both of these processors – and makes the developer's job much easier (Figure 1). Along with the processor itself, both CPU modules include the memory components, the USB 2.0 host and device interfaces, and a 100MBit Ethernet interface. All signals are available on a 200-pin SODIMM connector that is practically identical in both of the CPU modules.

The two modules use very little power, making them ideal for use in mobile devices. They include different carrier boards equipped with all the components customers usually need, such as audio and video codecs, power supply and plug. They are delivered with detailed documentation that describes exactly how the components are connected, making it easier for customers to develop their own solutions. The reference system can be used as an evaluation board, but it can usually be implemented directly into serial production devices in the industrial arena with no changes needed.

Developers can tailor the modules to specific product requirements with the easy-to-use carrier boards (Figure 3). These enable customers to significantly reduce development time for their own projects.

Jeff Gruetter, Product Marketing Engineer at Linear Technology, says that the unprecedented acceleration of LED backlighting applications in modern cars has created many specific performance requirements for LED driver ICs

Automotive Infortainment LCD-TFT Panels Require Rugged LED Drivers For LED BACKLIGHTING

THE MARKET SIZE for all LEDs will reach $10.3bn by 2012, states Yole Development in France. High and ultra-high brightness LEDs combined will represent approximately $4.45bn of this total; almost 5.5 times the $783m market size in 2007 (based on packaged LEDs).

One of the major drivers of this staggering growth is the adoption of LED lighting in modern cars. LED applications include Thin Film Transistor-Liquid Crystal Display (TFT-LCD) panel backlighting in infotainment systems and gauge clusters, interior lighting, brake lights, day-time running lights, turn signal indicators and, most recently, head lights.

How can such an impressive growth potential in automotive lighting be supported? First of all, LEDs are ten times more efficient at producing light than incandescent bulbs and almost twice as efficient as fluorescent lamps, including cold cathode fluorescent lamps (CCFL), thus reducing the amount of electrical power required to deliver a given amount of light output (measured in lumens), as well as the dissipated heat. As LEDs are further developed, their efficiency at producing lumens from electrical power will only continue to increase.

Secondly, in a very environmentally conscience world, LED lighting does not require the handling, exposure and disposal of the toxic mercury vapour commonly found in CCFL/fluorescent bulbs. Third of all, incandescent bulbs need to be replaced about every 1,000 hours, while fluorescent bulbs last up to 10,000 hours compared to a 100,000+ hour lifetime for LEDs. In most applications, this allows the LEDs to be permanently embedded into the final application without the need for a fixture. This is especially important for backlighting automotive navigation/infotainment panels that are embedded into a car's interior, as they will never require replacement during the life of the car. Additionally, LEDs are orders of magnitude smaller and flatter then their counterparts, so the LCD panels can be very thin, thereby requiring minimal space in the interior of the car. Furthermore, by using a configuration of red, green and blue LEDs, an infinite number of colours can be delivered. LEDs also have the ability to dim and turn on/off much faster than the human eye can detect, enabling dramatic improvements in backlighting of LCD displays while simultaneously allowing dramatic contrast ratios and high resolution.

One of the biggest challenges for automotive lighting systems designers is how to optimize all the benefits of the latest generation of LEDs. As LEDs generally require an accurate and efficient DC current source and a means for dimming, the LED driver IC must be designed to address these requirements under a wide variety of conditions. Power solutions must be highly efficient, robust in features and be very compact, as well as cost-effective.

Arguably, one of the most demanding applications for driving LEDs will be found in automotive infotainment TFT-LCD backlighting applications, as they are subjected to the rigours of the automotive electrical environment, must compensate for a wide variation of ambient lighting conditions and must fit in a very space-constrained footprint, all while maintaining an attractive cost structure.

Automotive LED Backlighting

Benefits, such as small size, extremely long life, low power consumption and enhanced dimming capability have triggered the widespread adoption of LED TFT-LCD backlighting in today's vehicles. Infotainment systems usually have an LCD screen mounted somewhere in the centre of the dashboard, so both the driver and the passenger can easily view their location, perform audio tuning and a variety of other tasks.

Additionally, many cars also have LCD displays that entertain passengers in the rear seat with movies, video games and so forth. Historically, these displays used CCFL backlighting, but is becoming more common to replace these relatively large bulbs by very low-profile arrays of white LEDs which provide more precise and adjustable backlighting, as well as a service life that will easily outlive the vehicle.

The benefits of using LEDs in this environment have several positive implications. First, they never need to be replaced, since their solid state longevity of up to 100k+ hours (11.5 service years) surpasses the life of the vehicle. This allows automobile manufactures to permanently embed them into "in cabin" back lighting, without requiring accessibility for replacement.

Styling can also be dramatically changed as LED lighting systems do not require the depth or area as do CCFL bulbs. LEDs are also generally more efficient than fluorescent bulbs at delivering light

Figure 1: *Navigation LCD display*

output from the input electrical power. This has two positive effects. First, it drains less electrical power from the automotive bus, and equally important, it reduces the amount of heat that needs to be dissipated in the display eliminating any requirement for bulky and expensive heat-sinking.

Another important benefit of LED backlighting is the wide dimming ratio capability provided by a high performance LED driver IC. As the interior of a car is subjected to a very wide variation of ambient lighting conditions, ranging from direct sunlight to complete darkness, with every variation in between, it is imperative that the LED backlighting system is capable of very wide dimming ratios, generally up to 3,000:1. With the proper LED driver IC, these wide dimming ratios are relatively easy to attain which are not possible with CCFL backlighting. **Figure 1** shows a typical LCD based infotainment screen.

Design Parameters for Automotive LED Lighting

In order to ensure optimal performance and long operating life, LEDs require an effective drive circuit. These driver ICs must be capable of operating from the caustic automotive power bus and also be both cost- and space-effective. In order to maintain their long operating life, it is imperative that the LEDs current and temperature limits are not exceeded.

One of the automotive industry's major challenges is overcoming the electrically caustic environment found on the car's power bus. The major challenges are transient conditions known as load dump and cold crank. Load-dump is a condition where the battery cables are disconnected while the alternator is still charging the battery. This can occur when a battery cable is loose while the car is operating, or when a battery cable breaks while the car is running.

Such an abrupt disconnection of the battery cable can produce transient voltage spikes up to 40V as the alternator is attempting a full-charge of an absent battery. Transorbs on the alternator usually clamp the bus voltage to approximately 36V and absorb the majority of the current surge; however, DC/DC converters down stream of the alternator are subjected to these 36V to 40V transient voltage spikes. These converters are expected to survive, and regulate an output voltage during this transient event. There are various alternative protection circuits, usually transorbs, which can be implemented externally; however, they add cost, weight and take up space.

"Cold Crank" is a condition that occurs when a car's engine is subjected to cold or freezing temperatures for a period of time. The engine oil becomes extremely viscous and requires the starter motor to deliver more torque, which in turn, draws more current from the battery. This large current load can pull the battery/primary bus voltage below 4.0V upon ignition, after which it typically returns to a nominal 12V.

However, there is a new solution to these dilemmas: Linear Technology's LT3599, which is capable of both surviving and regulating a fixed output voltage through out both of these conditions. Its input voltage range of 3V to 30V, with transient

Figure 2: *90%-efficient 12W LED backlighting circuit using the LT3599*

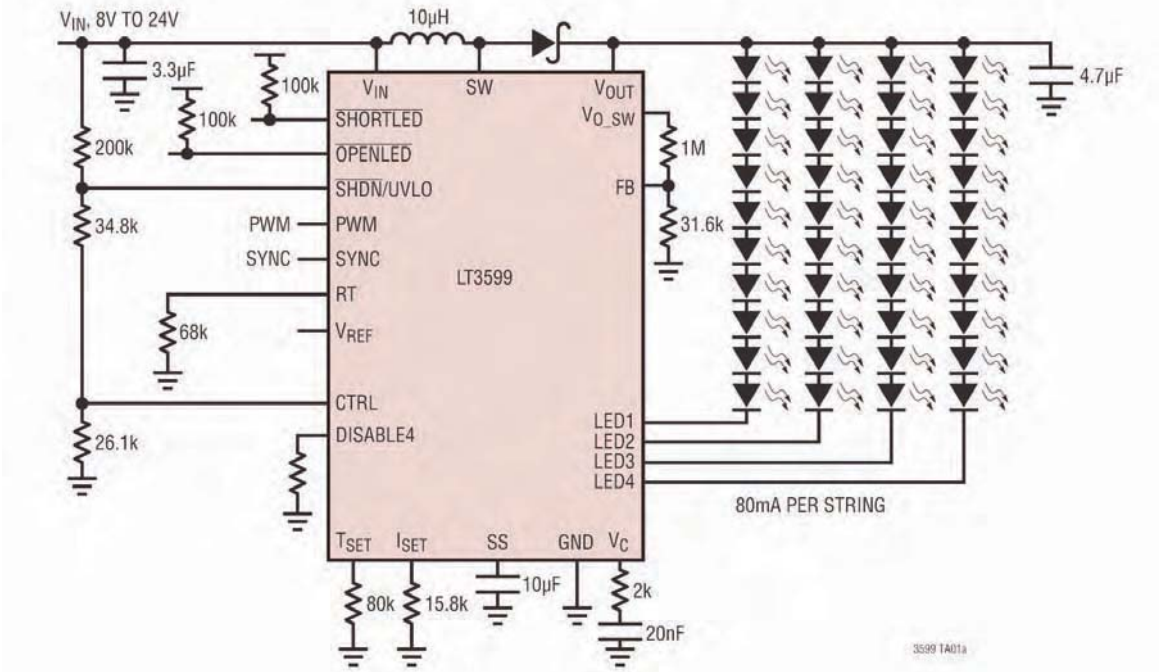
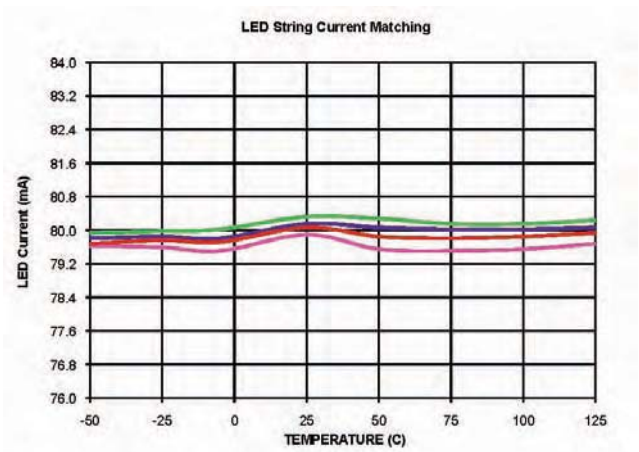


Figure 3a and **3b:** *LED current matching and efficiency of LT3599 in Figure 2*



protection to 40V, makes it ideal for the automotive environment. Even, when VIN is greater than VOUT, which could occur during a 36V transient, the LT3599 will regulate the required output voltage.

As most LCD backlighting applications require between 10 and 15W of LED power, the LT3599 has been designed for it. It can boost the automotive bus voltage (nominal 12V) to as high as 44V to drive up to four parallel strings, each containing ten 100mA LEDs in series. **Figure 2** shows a schematic of the LT3599 driving four parallel strings, each string comprised of ten 80mA LEDs, delivering a total of 12W.

The LT3599 utilizes an adaptive feedback loop design which adjusts the output voltage slightly higher than the highest voltage LED string. This minimizes power lost through the ballasting circuitry to optimize the efficiency. **Figure 3** illustrates the LT3599's efficiency that can be as high as high as 90%. This is important because it eliminates any requirement for heat sinking, enabling a very compact, low-profile footprint. Equally important for driving arrays of LEDs is to provide accurate current matching to insure that the backlighting brightness remains uniform across the entirety of the panel. The LT3599 is guaranteed to deliver less than 2% LED current variation across its -40˚C to 125˚C temperature range.

The LT3599 uses a fixed frequency, constant current boost converter topology. Its internal 44V, 2A switch is capable of driving four strings of up to ten 100mA LEDs connected in series (see Figure 3b). Its switching frequency is programmable and synchronizable between 200kHz and 2.5MHz enabling it to keep switching frequency out of the AM radio band while minimizing the size of the external components. Its design also enables it to run one to four strings of LEDs, if fewer strings are used; each string is capable of delivering additional LED current. Each string of LEDs can use the same number of LEDs or can be run

asymmetrically with a different number of LEDs per string.

The LT3599 can dim the LEDs using either True Colour PWM dimming or analogue dimming via the control pin. True Colour PWM dimming offers dimming ratios as high as 3,000:1, which are often required in automotive applications. By PWMing the LEDs at full current, any colour shifts of the LED light are eliminated and the frequency is so high, it is undetectable by the human eye. Analogue dimming offer a very simple means to achieve dimming ratios of up to 20:1 by varying the level of CNTRL pin voltage. Which means of dimming required will be dependent of the variations of ambient light that the LCD panel is subjected to.

Furthermore, the LT3599 has integrated protection features that include open and short circuit protection and alert pins. For example, if one or more LED strings are open circuit, the LT3599 will regulate the remaining strings. If all of the strings are left open, it will still regulate the output voltage and in both cases would signal the OPENLED pin.

Similarly, if a short circuit occurs between VOUT and any LED pin, the LT3599 immediately turns off that channel and sets a SHORTLED flag. Disabling the channel protects the LT3599 from high power thermal dissipation and ensures reliable operation. Other features that optimize reliability include output disconnect in shutdown, programmable under voltage lockout and programmable LED temperature de-rating. The high voltage capability and high level of integration of the LT3599 offers an ideal LED driver solution for automotive back-lighting applications.

Trying to Meet Specific Requirements

The unprecedented acceleration of LED backlighting applications in cars has created many specific performance requirements for LED driver ICs. These LED drivers must also provide constant current in order to maintain uniform brightness, regardless of input voltage or LED forward voltage variations, must operate with high efficiency, offer wide dimming ratios and have a variety of protection features to enhance system reliability. These applications also require very compact, thermally efficient solution footprints.

Linear Technology has taken these design requirements "head on" with LED driver ICs like the LT3599. Additionally, Linear Technology has developed an entire family of high current LED driver products aimed specifically at automotive applications ranging from LCD backlighting to turn signals and even headlight applications. Today's automotive lighting system designers now have an easy and effective LED driver source for their most challenging LED lighting designs. ■

PLC with PIC16F648A Microcontroller

Part 20

Professor Dr Murat Uzam from Nigde University in Turkey presents a series of articles on a project that focuses on a microcontroller-based PLC. In this article four examples are provided to show the use of priority encoder macros described in the previous parts

IN THIS SECTION, we will consider four examples – UZAM_plc_8i8o_exN.asm, N = 34, 35, 36, 37 – to show the usage of priority encoder macros.

In order to test these examples you can download the files from http://host.nigde.edu.tr/muzam/ and then use the program UZAM_plc_8i8o_exN.asm, N = 34, 35, 36, 37 by MPLAB IDE and compile it. Following that, by using the PIC programmer software, take the compiled file "UZAM_PLC_8i8o_exN.hex" and with PIC programmer hardware send it to the program memory of PIC16F648A microcontroller within the UZAM_PLC. After loading the "UZAM_PLC_8i8o_ exN.hex", switch the 4PDT in "RUN" and the power switch in the "ON" position.

To check the correctness of each program, you are referred to the related information for each priority encoder macro provided in Tables 1, 2, 3, 4 of the previous article. Note that in the current set-up of UZAM_PLC, with 8 inputs and 8 outputs, we are not able to test the priority encoder macros "encod_dec_bcd_p" and "encod_dec_bcd_p_E", which require 10 and 11 inputs respectively. However, if you use the extension board together with the UZAM_PLC main board then you can set up an example for these two priority encoder macros.

The first example program, "UZAM_plc_8i8o_ex34.asm", is shown in **Figure 1**. It shows the usage of the 4×2 priority encoder macro "encod_4_2_p". The schematic diagram is depicted in **Figure 2**. In this priority encoder, four input lines, 3, 2, 1 and 0 are defined as I0.0, I0.1, I0.2 and I0.3 respectively, while the output lines A1 and A0 are defined as Q0.0 and Q0.1.

The second example program "UZAM_plc_8i8o_ex35.asm" is shown in **Figure 3**. It shows the usage of the 4×2 priority encoder with Enable input macro

```
.
      #include <definitions.inc>    ;basic PLC definitions, macros, etc.
      #include <cntct_mcr_def.inc>  ;Contact & Relay based macros
      #include <p_enc_mcr_def.inc>   ;priority encoder based macros
.
;--------------- user program starts here ------------------------

      encod_4_2_p       I0.0,I0.1,I0.2,I0.3,Q0.0,Q0.1 ;rung 1

;--------------- user program ends here --------------------------
.
```

Figure 1: *The user program UZAM_plc_8i8o_ex34.asm*

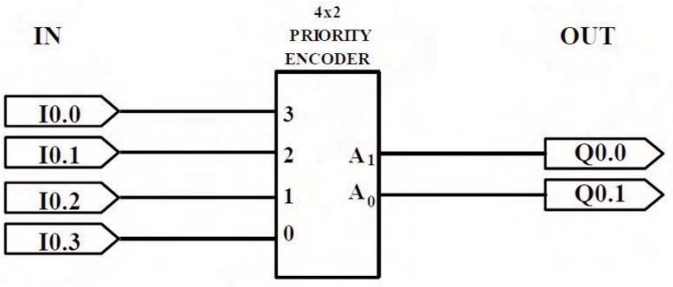


Figure 2: *Schematic diagram for the user program UZAM_plc_8i8o_ex34.asm*

```
.
      #include <definitions.inc>    ;basic PLC definitions, macros, etc.
      #include <cntct_mcr_def.inc>  ;Contact & Relay based macros
      #include <p_enc_mcr_def.inc>   ;priority encoder based macros
.
;--------------- user program starts here ------------------------

      ld                I0.7                          ;rung 1
      encod_4_2_p_E     I0.0,I0.1,I0.2,I0.3,Q0.0,Q0.1

;--------------- user program ends here --------------------------
```

Figure 3: *The user program UZAM_plc_8i8o_ex35.asm*

TRANSFORMER MANUFACTURE

WINNERS! WINNERS! WINNERS!

CONGRATULATIONS

to the following winners of the reader offer competition that run in the January issue of **Electronics World** magazine.

Each winner receives the Si1120 Slider Board Demo Kit from **SILICON LABS**:

1. **PIETRO CREMONINI**, Italy
2. **WOJCIECH STODULY**, Poland
3. **CLAIRE ANDREWS**, UK
4. **EMILIO BALDI**, Australia
5. **ABDULNASSER NOFAL**
6. **ERMANNO BERNASCONI**, Switzerland
7. **ANDREW LUTLEY**, UK
8. **PIERPAOLO PIEROZZI**, Italy
9. **ROBERT ALBEE**, USA
10. **YU KWONG YIU**, Hong Kong

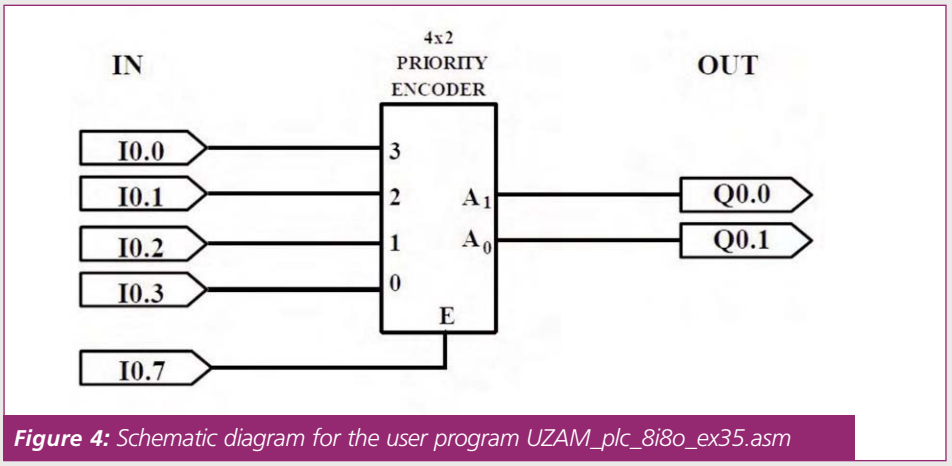


Figure 4: *Schematic diagram for the user program UZAM_plc_8i8o_ex35.asm*

```
;
      #include <definitions.inc>    ;basic PLC definitions, macros, etc.
      #include <cntct_mcr_def.inc>  ;Contact & Relay based macros
      #include <p_enc_mcr_def.inc>   ;priority encoder based macros
;
;--------------- user program starts here ------------------------
                                                              ;rung 1
encod_8_3_p       I0.0,I0.1,I0.2,I0.3,I0.4,I0.5,I0.6,I0.7,Q0.0,Q0.1,Q0.2

;--------------- user program ends here --------------------------
;
```

Figure 5: *The user program of UZAM_plc_8i8o_ex36.asm*

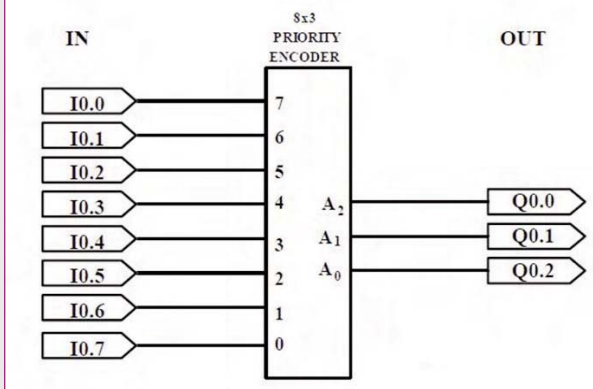


Figure 6: *Schematic diagram for the user program UZAM_plc_8i8o_ex36.asm*

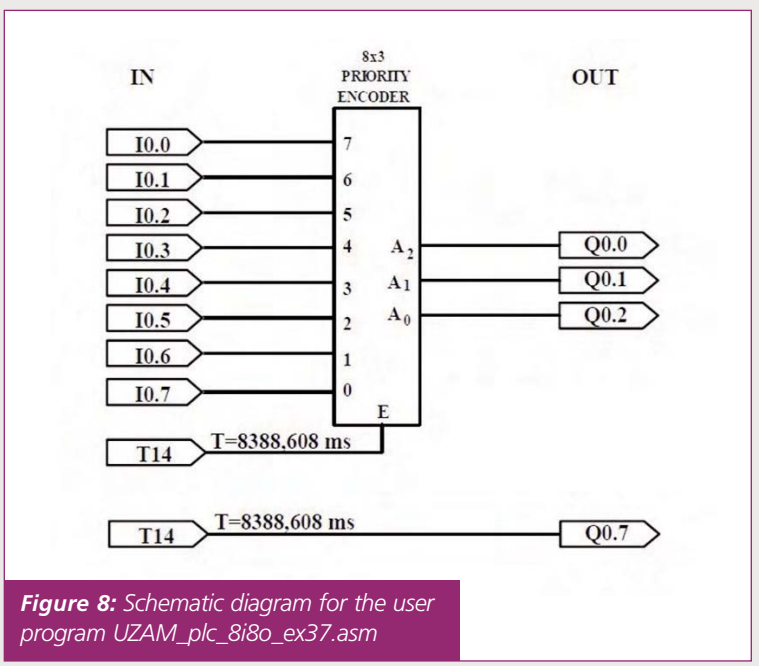


Figure 8: *Schematic diagram for the user program UZAM_plc_8i8o_ex37.asm*

```
;
      #include <definitions.inc>    ;basic PLC definitions, macros, etc.
      #include <cntct_mcr_def.inc>  ;Contact & Relay based macros
      #include <p_enc_mcr_def.inc>   ;priority encoder based macros
;
;--------------- user program starts here ------------------------
ld                T14                                         ;rung 1
encod_8_3_p_E     I0.0,I0.1,I0.2,I0.3,I0.4,I0.5,I0.6,I0.7,Q0.0,Q0.1,Q0.2

in_out            T14,Q0.7                                    ;rung 2

;--------------- user program ends here --------------------------
;
```

Figure 7: *The user program UZAM_plc_8i8o_ex37.asm*

"encod_4_2_p_E". The schematic diagram is shown in **Figure 4**. In this priority encoder, four input lines, 3, 2, 1 and 0, are defined as I0.0, I0.1, I0.2 and I0.3, while the output lines A1 and A0 are defined as Q0.0 and Q0.1. In addition, the active high enable input E is defined to be E = I0.7.

The third example program "UZAM_plc_8i8o_ex36.asm" is shown in **Figure 5**. It shows the usage of the 8×3 priority encoder macro "encod_8_3_p". Its schematic diagram is depicted in **Figure 6**. In this priority encoder, eight input lines, 7, 6, 5, 4, 3, 2, 1 and 0, are defined as I0.0, I0.1, I0.2, I0.3, I0.4, I0.5, I0.6 and I0.7, while the output lines A2, A1 and A0 are defined as Q0.0, Q0.1 and Q0.2.

The forth and last example program, "UZAM_plc_8i8o_ex37.asm" is shown in **Figure 7**. It shows the usage of the 8×3 priority encoder with Enable input macro "encod_8_3_p_E". The schematic diagram is depicted in **Figure 8**. In this priority encoder, eight input lines, 7, 6, 5, 4, 3, 2, 1 and 0, are defined as I0.0, I0.1, I0.2, I0.3, I0.4, I0.5, I0.6 and I0.7, while the output lines A2, A1 and A0 are defined as Q0.0, Q0.1 and Q0.2. In addition, the active high enable input E is defined to be E = T14, the free running reference timing signal with T = 8388.608ms. This means that this priority encoder will be enabled for ½T = 4194.304ms and will be disabled for the next 4194.304ms and this process will continue. ■

THE 7-POINT PATH TO BETTER SPEC WRITING

THIS IS A NEW REGULAR, QUARTERLY COLUMN WRITTEN BY AUDIO TEST SPECIALIST AUDIO PRECISION (AP,WWW.AP.COM). HERE, DAVE MATHEW LOOKS AT THE IMPORTANCE OF SPECIFICATIONS, EXPLAINS WHY WE ALL NEED TO TAKE MUCH GREATER CARE OVER THEIR PREPARATION AND USE, AND GIVES SOME GUIDANCE

BEING ABLE TO create detailed product specifications is a must-have skill for every engineer, designer and manufacturing company. Internal engineering specs define products and provide benchmarks for manufacturing quality assurance, while published specifications, usually less complete and rigorous than the engineering specs, inform the user of the device's capabilities and limitations with the goal of safe and proper operation.

Of course, a published spec can also be a powerful sales tool for an audio device, especially at the consumer end of the market, where a certain degree of tension between truth and marketing can often be visible. But are things really much better in the pro audio, industrial audio or commercial audio worlds? A cursory sampling of specifications in these markets reveals incompleteness, inconsistency and plain sloppiness, both in the choice of specs presented and in how they are expressed.

Specifications should be important to all engineers, so here are some recommendations about how specifications ought to be written.

1. Be selective

Decide which characteristics of the device are important enough to be included in the spec: those which define its key features, its performance, or its compliance with industry standards. In addition to purely descriptive features such as dimensions, number of inputs, their operating levels and connector formats, the specifications of an audio device usually include the results of four core categories of measurements:

- Level, expressed in volts (V), watts (W), or sound pressure level (SPL).
- Frequency Response, expressed as a statement or graph, or, at least, as a Frequency Range.
- Distortion, expressed as total harmonic distortion (THD), total harmonic distortion plus noise (THD+N), and intermodulation distortion (IMD) of various flavours.
- Noise, expressed as an absolute voltage, as signal-to-noise ratio (SNR), or as dynamic range.

For multichannel devices you may also see separation, crosstalk and interchannel phase. Balanced devices may spec common mode rejection, and devices with mechanical drives will show "wow and flutter" figures.

2. Use the 'best practice' method of measurement

If a standard applies, use the standard's recommendation and ensure it's up to date (see '*Audio Standards*' right). For unusual testing methods or characteristics new to the industry, consult the current literature and clearly state your method, testing conditions and so on.

3. Spec conservatively

It's always possible to tweak a device (by carefully selecting components, for example) so that it will surpass the typical

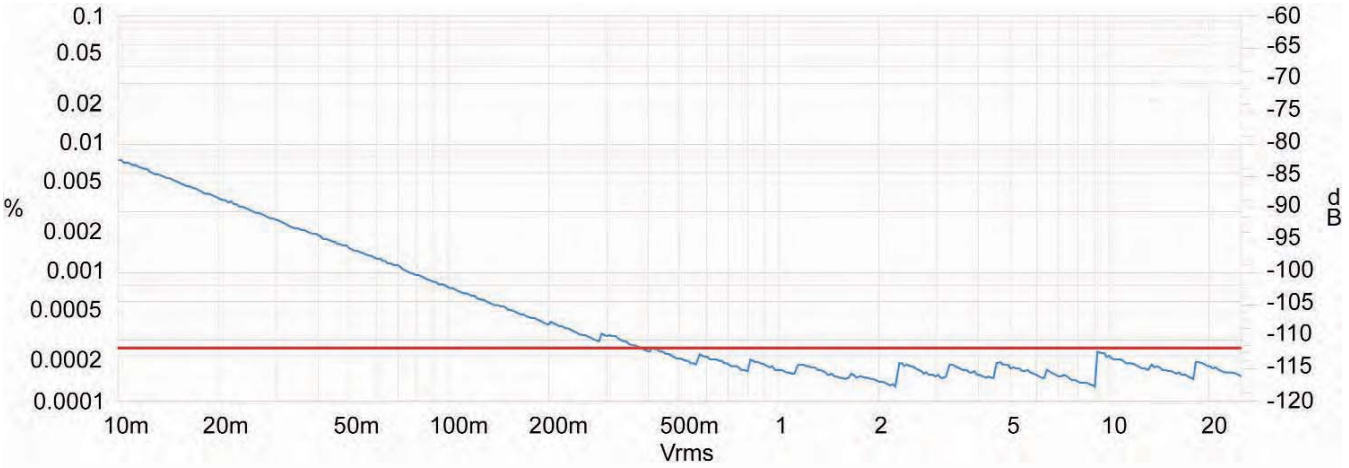
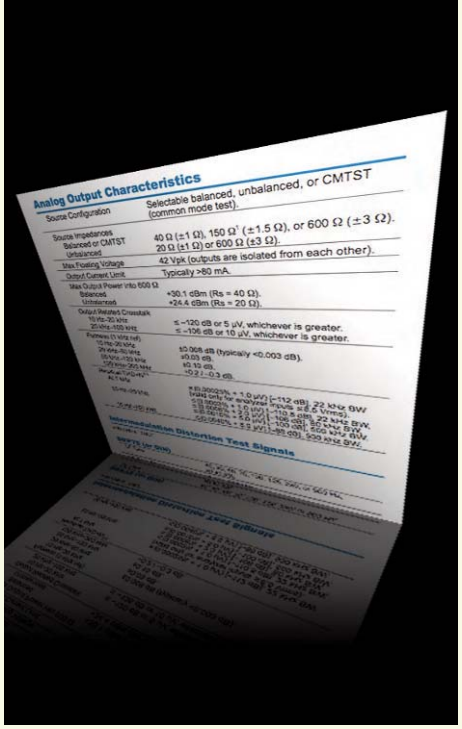


Figure 1: *The output from an audio analyzer showing a graph of THD+N against amplitude. The sharp inflections in the trace on the right are artifacts of range switching (a characteristic of all audio analyzers), and the rise at the left is the inevitable approach of the noise floor. The red line shows -112 dB*



performance of the devices. Do not use such results for specifications. It is also possible to find a "sweet spot" in a characteristic and report that as a performance specification. That is misleading, even if the specification specifically mentions the sweet spot.

For example, the graph in **Figure 1** shows the residual THD+N versus amplitude for one of our analyzer systems. For audio analyzers, this is a key specification, one we would like to 'push' to potential customers.

We claim ≤ –112dB residual THD+N in a 22kHz bandwidth. You can see that for most amplitudes above 400mV the THD+N is well below this. If you are working at 2V amplitude, it is about –116 dB. We find, at least in our end of the business, that it is important not to mislead our customers.

(The sharp inflections in the trace are artifacts of switching between ranging circuits; the rise at the left is the inevitable approach of the noise floor.)

4. State ranges and conditions

Stating ranges and conditions is absolutely essential. Many specifications mean nothing if these parameters are not provided. Yet, most manufactures do not include this information in their specifications, or what they do include is incomplete. Every level measurement is made at some frequency or range of frequencies. Every frequency measurement is made at some level or range of levels. Be very clear as to the level and frequency of the stimulus signal, and to the level range, bandwidth and filtering in the analyzer.

External conditions and device configuration conditions, too, will affect device performance. What is the mains voltage? The ambient temperature? Is the device volume control set to low, medium or high? Are all channels being driven, or only the channel being measured?

If there isn't room for the conditions in the brochure, there certainly is in the data sheet. Annotate specifications when more

AUDIO STANDARDS

Over the years, various organisations, including the now-defunct IHF (Institute of High Fidelity) and EIA (Electronic Industries Alliance), as well as the still-extant AES (Audio Engineering Society) and the IEC (International Electrotechnical Commission), have described methods for performing audio measurements and published guidelines for stating the results clearly. Standards have been written for specifying amplifiers, microphones and loudspeakers, for audio embedded in broadcast carriers and for audio embedded in digital bitstreams.

As a result, most of the measurements cited in audio specifications have a standard method: for example, noise-shaping delta-sigma digital converter measurements require an analyzer equipped with a filter described in the AES17 standard; and, even today, years after the dissolution of the Institute of High Fidelity, home theatre manufacturers spec noise using the IHF recommendation and may express it as "65dB, IHF-A".

However, even where they are defined and exist, standards can embed biases. Standards committees are, after all, made up of human beings who possess different opinions – and, often, varying degrees of entanglement with audio equipment manufacturers!

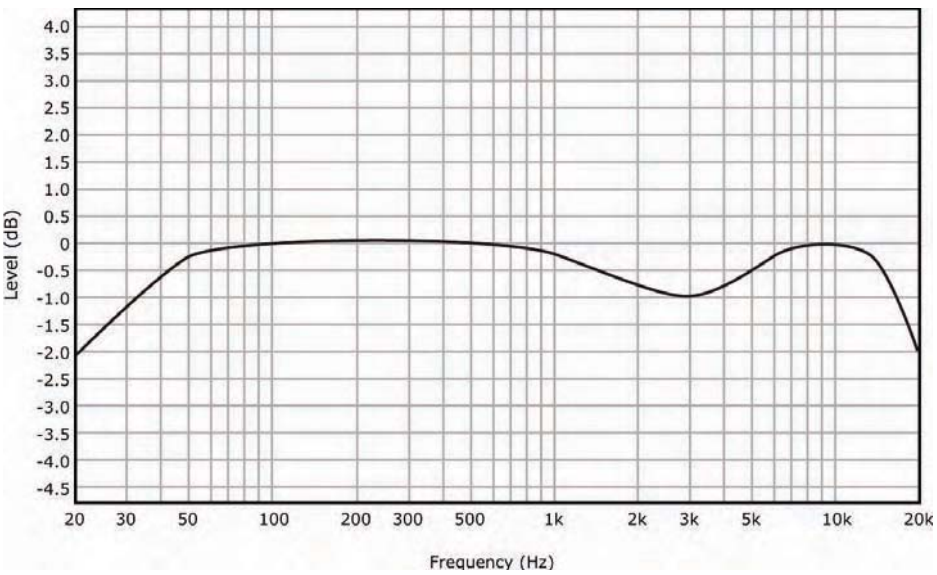


Figure 2: *A graph depicts this frequency response in a way that is instantly comprehensible, whereas accurately describing it in words would take several sentences and could still remain ambiguous*

detail is required and use footnotes or endnotes.

5. Express results using standard units; do not mix units

Here is one of the biggest problems in interpreting specifications: simply decoding the units chosen for the specification and comparing them to a similar specification stated in different units. One unit claims THD+N at –81dB. Another touts a mere 0.0089% THD+N. Which has lower distortion and noise? (In this case, they are the same.)

Audio levels, for example, can be expressed in pascals, volts, watts or fractions of full scale. These can be in absolute terms such as average, peak, peak-to-peak, or rms, or they can be in the relative terms of decibels or percent. On top of all that, a relative measurement can be related to one of a number of constants, or to a previous measurement in the same test. Remember also to display secondary units if necessary. For example:

Residual Noise 22Hz to 22kHz BW, < 1.0µV [–117.8dBu]

6. Use graphs

Express the specification graphically (for example as an x-y curve, a polar pattern plot, or a waterfall display) when appropriate. Even a clearly stated specification such as +0, –2dB, 20Hz to 20kHz is nowhere near as informative as the graph below (see **Figure 2**), which shows not only the expected 2dB droop at the low and high ends, but also an audio-colouring 1dB dip in the mid-range. Use a graph when you can.

7. Use uniform units, formatting and numerical expressions

Messy formatting makes a lot of extra work for the reader, even for those who can navigate through the fog of mixed units and expressions. For the less experienced, messy formatting is a minefield. Don't mix expressions like 5,000Hz and 5kHz; don't say millivolts here and mV there: be consistent.

Stop Variability

It's clear that there is a lot of variability in how specifications are written. Of course, marketeers will continue do what they must to tell a good story and sell a million widgets. The reader of brochures and data sheets should be wary of specs that don't state their testing conditions properly, or which mix or confuse units. ■

Dave Mathew is Senior Technical Writer at Audio Precision

WIDE-RANGE FORMERS OF THREE-PHASE VOLTAGE AND THEIR APPLICATION

THE SCHEME OF a three-phase voltage sine waveform generator, reconstructed in the range of frequencies 50-500Hz is given here.

Traditional three-phase voltage generators, as a rule, are capable to work only on one fixed frequency, which essentially narrows the area of their practical application.

A fairly simple three-phase voltage generator of a sine-form with smooth frequency adjustment can be created on the basis of a broadband RC generator of sine voltage (microcircuit DA1-DA3) developing output voltages with a phase displacement of 90°. At the connection to the generator of an electronic analogue of Scott's transformer (microcircuit DA4-DA5), a three-phase signal is formed on the output of the device. **Figure 1** shows a practical scheme of a three-phase voltage generator adjusted by frequency in the range of 50-500 Hz.

The working frequency of the generator is defined by the expression:

$$f = \frac{1}{2\pi RC}$$

where R = R7 + R8 = R9 + R10; C = C1 = C2.

The frequency of generation can be calculated from the expression:

$$f[\text{Hz}] = \frac{4825}{R[\text{kOhm}]}$$

The frequency of the generator can be smoothly changed within the limits of the decade by adjustment of a double potentiometer R7R9 and step-like by switching frequency-setting elements – the capacitors C1, C2. Capacitor C0 is intended to simplify the start-up of the generator. Using the switch SA1, it is possible to stimulate the E1 signal on the input of the device from the external generator, however fine tuning of the potentiometers R7R9 is necessary for reception of the needed phase displacements. ■

Michael A. Shustov
Russia

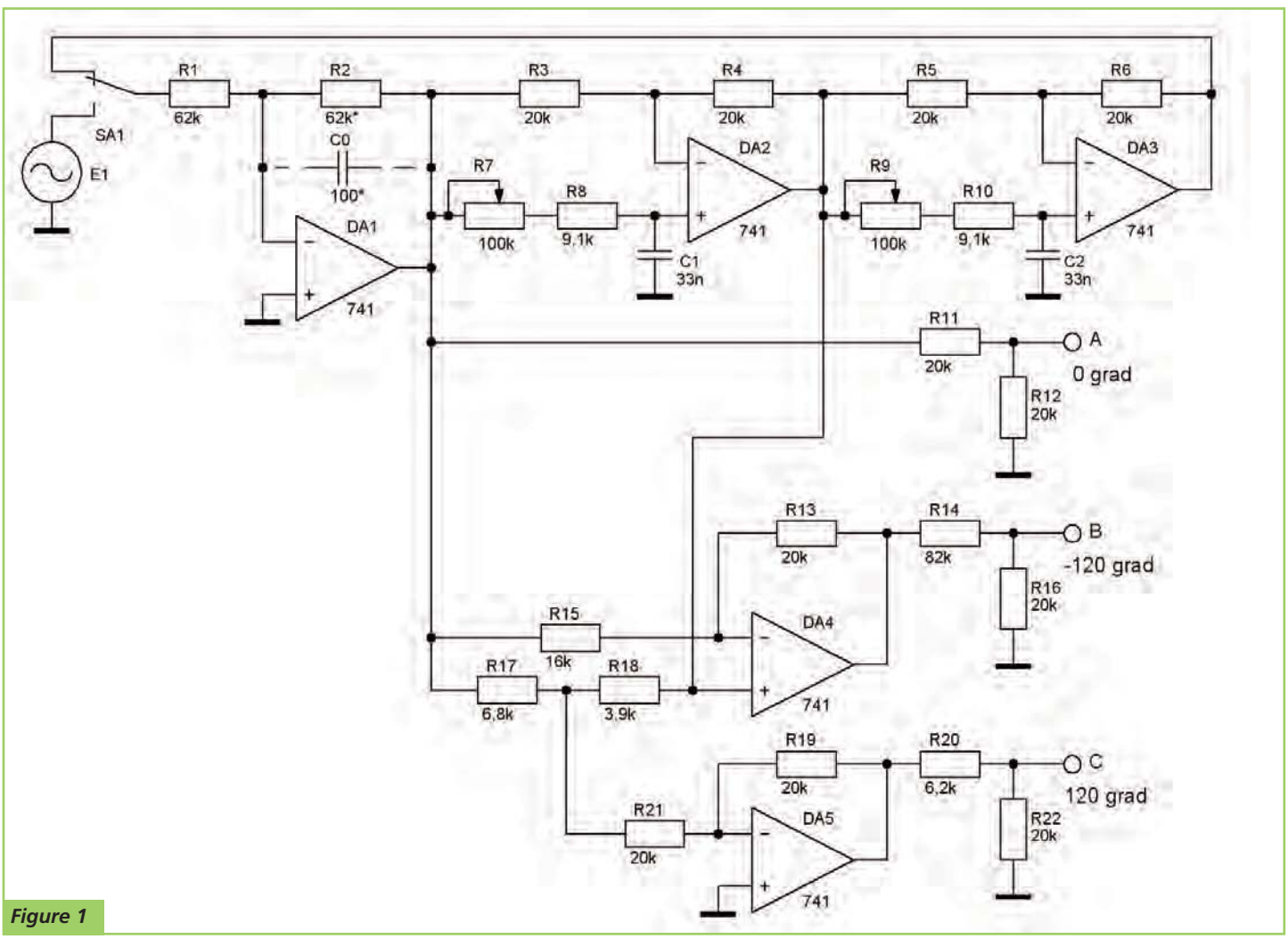


Figure 1

SUBSCRIBE TO ELECTRONICS WORLD

AND SAVE 13%

...AND receive a FREE one year subscription to the digital publication – delivered to your inbox (WORTH £36.50)

One year subscription for only £40 (UK) and £60 (Overseas)

- FREE DELIVERY to your door
- SAVE 19% on the Shop Price
- NEVER MISS an Issue
- Solutions & Case studies for the professional engineer
- Fresh ideas, tips and tricks
- Analysis of what's coming next in technology
- Features on a wide range of markets from automotive to medical
- In-depth technical articles
- International coverage around the globe

CALL OUR HOTLINE:

UK: 0870 428 1426

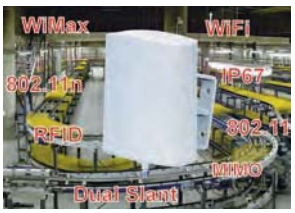
International: +44 1635 879361

SUBSCRIBE ONLINE:

www.electronicsworld.co.uk

ANTENNAS DESIGNED FOR HOSTILE AND EXPOSED ENVIRONMENTS

Huber+Suhner has announced its Sencity Spot-S antenna family which will be of interest to systems integrators, OEMs and public operators looking to install the latest antenna technology across their W-LAN, WiFi, ZigBee and MIMO based systems in industrial and commercial applications. Typical installations are expected to include public hotspots, WiMax, RFID systems and industrial automation. Importantly, Sencity antennas support both 2.4 and 5GHz bands with vertical polarization, dual-slant diversity and MIMO. Rated to IP66, the new antennas are particularly suited for installation in harsh environments and can be supplied with a variety of mounting options for maximum flexibility. These include wall and pole mounting with tilt and pan brackets for all models.



Manufactured from Lexan EXL 9330 to give excellent mechanical strength, the enclosure also offers high chemical resistance, good UV stability and a flammability rating to UL-94-V-0. Operating temperature range is very wide at -40°C to +80°C.

www.hubersuhner.co.uk

NEW SIX-CORE INTEL XEON PROCESSORS ON ATCA NODE BLADE FROM KONTRON

Kontron announced that its existing Kontron AdvancedTCA node blade AT8050 and its Kontron server board KTC5520 are available with the newly released Intel Xeon processor 5600 series. This provides TEM and network equipment providers a second feature-rich processor option for the two products that were originally designed with the Intel Xeon processor 5500 series.

Clients with much-needed performance upgrade requirements can now better design and deploy the right high-performance systems exactly where they are needed across today's data-intensive 3G/4G and broadband networks.

The key feature differences with the Intel Xeon processor 5600 series compared to the 5500 series are: six cores instead of four; 12 threads versus 8; 32nm technology compared to 45nm; increased performance within the same thermal power envelope; new low-power platform consumption with LVDDR3L plus a new hardware-based security technology called Advanced Encryption Standard - New Instructions (AES-NI).

www.kontron.com/atca

MIKROELEKTRONIKA RELEASES LV 24-33 V6 DEVELOPMENT SYSTEM

mikroElektronika has announced its LV 24-33 v6 Development System as an addition to its PIC24/dsPIC33 development tool product line. The new system supports 64, 80 and 100 pin PIC24 and dsPIC33 microcontrollers. The board includes new features such as CAN, Serial RAM, USB comm connectors and many more.

Each feature of the board is supported by example written in mikroC PRO, mikroPascal PRO and mikroBasic PRO compiler for dsPIC. Also, tool comes with the full colour printed documentation.

There is an on-board CAN Module (MCP2551, the High-Speed CAN Transceiver). The system also contains on-board Touch Screen controller with a connector for easier Touch Panel connecting.

The mikroICD is a hardware tool designed for testing and debugging programs on PIC24.

www.mikroe.com

ALPHA MICRO EXPANDS FTDI PORTFOLIO WITH PROGRAMMABLE USB 2.0 VINCULUM VNC2

Alpha Micro Components, the independent franchised distributor of electronic components, announced that it has added the Vinculum VNC2 from Future Technology Devices International Limited (FTDI) to its portfolio of products.

The VNC2 is a programmable dual USB 2.0 full speed Host/ Slave system on chip (SOC) controller which builds on and enhances the capacities and functionality of the VNC1L, the initial member of FTDI's Vinculum family. This has been achieved while reducing the device cost as well as introducing the capability for designers to develop their own application firmware and programme the host controller themselves.

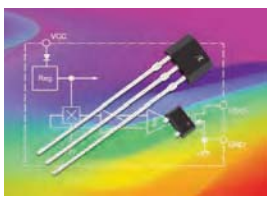
The VNC2 is the latest addition to the Vinculum family of USB Host Controller ICs and suits a broad range of USB consumer and industrial related applications including camera, mobile accessories, data loggers, toys, keyboards, game controller interfacing, Point of Sale applications, medical devices and USB to USB bridges.

www.alphamicro.net

HALL-EFFECT LATCHES WITHSTAND HIGH-VOLTAGE TRANSIENTS AND HIGH TEMPERATURES

The new A1225, A1227 and A1229 from Allegro MicroSystems Europe are a family of Hall-effect latch ICs that combine enhanced protection against high transient voltages with the ability to operate over extended temperature ranges up to +150°C.

These extremely temperature-stable and stress-resistant sensor ICs are especially suited for applications that require high-voltage transient protection close to the sensors, but where space or distance considerations preclude the use of external protection devices. Typical uses include motor commutation in sunroofs and power windows within the automotive market.



The A1225/7/9 devices include Allegro's advanced offset cancellation technique which, along with high-speed 4-phase chopping, gives lower noise on the output, less switch-point variation with temperature and faster settling times. The resulting improvements in noise and switch-point drift lead to much better switching accuracy and repeatability.

The improved high-voltage transient protection allows the devices to survive the tests specified in ISO 7637-2 and a 40 V load dump for less than 0.5s with minimal external protection.

www.allegromicro.com

FOREMOST ELECTRONICS INTRODUCES IP VIDEO SURVEILLANCE JOYSTICKS

Specialist Emech distributor Foremost Electronics has announced the availability of the CH Products IP Video Surveillance Joysticks. The IP Desktop is a USB controller specifically designed to provide the network video monitoring industry with a responsive and accurate pan, tilt and zoom camera positioning controls. Featuring a three-axis Hall Effect joystick, twelve programmable switches and USB interface, the IP Desktop integrates seamlessly with any video surveillance software platform recognizing joystick inputs via Microsoft's DirectX.

The software driver creates a joystick/mouse combination device, including a fourth "R" axis that may be used for a shuttle/recorder function. This assigns functions to buttons 1 and 2 so that button 1 toggles between "Z" and "R" axes and button 2 toggles between "Joystick" and "Mouse" modes. In Joystick mode buttons 3-12 remain available for end user assignment.

The Joystick travel is 36° (18° from centre) with spring return centering and the housing is high impact glass-filled nylon.

www.4most.co.uk

NEW VEAM CIR-M12 DATABUS CIRCULAR BAYONET CONNECTOR

ITT Interconnect Solutions's new VEAM CIR-M12 Databus connector has been designed to meet the challenge of enabling a variety of different data types to be transmitted between coaches in modern mass transit systems. In particular, customers in this sector requested a solution that bundled multiple Ethernet and MVB lines into a singular connector.

ITT ICS mounted its new Quadrax QXM12 contacts into FRCIR connector circular bayonet series hardware. With this pioneering design, four conductor wires and the associated braid from shielded cables are integrated into the QXM12 contact. A special plastic insert groups multiple QXM12 contacts and their cables into a singular connector. With this connector, designers can incorporate data transfer from Ethernet, MVB, WTB and video lines, according to VG95234 (where applicable), within the same connector, handling diverse data feeds such as engine diagnostics, brake controls, environmental conditioning, passenger display systems, networking and lighting control.

www.ittcannon.com

ANSMANN'S ZEROWATT "GREEN" POWER TECHNOLOGY ARRIVES IN THE UK

ANSMANN, the specialist manufacturer of batteries, battery chargers and power supplies for industrial, consumer and hobby applications, has announced the arrival of its patent-pending ZeroWatt "green" power technology in the UK. ZeroWatt technology eliminates the consumption of standby power by electronic equipment without compromising normal usage or convenience. Standby power consumption is the electrical power drawn from the mains by electronic equipment that has either been placed in sleep mode by remote control or has actually been switched "off" but is still connected to the mains and therefore "on".

ANSMANN's is making the ZeroWatt power technology available under licence to manufacturers worldwide for incorporation into their electronic equipment designs. ZeroWatt exceeds both the requirements of the US Energy Star programme and the EU's similarly stated ecological objectives.

ANSMANN is also announcing the first of its eco-friendly industrial and consumer power products utilising the ZeroWatt technology including battery, travel and microUSB device chargers and mains adapters.

www.ansmann.co.uk

AVX'S HIGH CAPACITANCE PULSECAP TANTALUM CAPACITORS BOOST TRANSMITTER POWER

AVX Corporation has developed a new range of high capacitance PulseCap tantalum capacitors that feature a low profile and high capacitance. The PulseCap tantalum capacitors are designed for applications that require bulk capacitance to boost transmitter power, such as solid state drives (SSDs), PCMCIA/USB wireless express cards, smart meters, GPS transmitters and GSM high-speed wireless data handling.

Two case sizes of tantalum products are available: case sizes "6" (14.5 x 7.5 x 2.0mm) and "4" (7.3 x 6.1 x 2.0mm) are rated from 1000µF to 3300µF (3.3mF) with a voltage rating of 4V to 10V. A maximum case height of 2mm makes the PulseCap Series ideal for reduced-height applications. The 'undertab' termination style, where traditional 'J' leads are replaced by terminations that do not protrude outside of the outline of the case, increases volumetric efficiency and allows parts to be positioned very closely together, delivering significant space savings.

www.avx.com

IP67 RATED POWER SUPPLY FOR USE IN HARSH ENVIRONMENTS

Powersolve has announced the TEX-120 series of industrial power supplies designed for applications in harsh environments. Providing a maximum output of 120W, the unit's rugged die-cast aluminium housing is water, ice, oil and dust resistant and is approved to IP67 and NEMA 4X requirements. An International safety approval package also includes CB scheme as well as ATEX and IECEx.

As a result, the TEX-120 series produced by TracoPower, offers a cost-efficient power supply solution for industrial automation applications in challenging corrosive environmental conditions.

The power supply's construction is shock and vibration proof and, as such, the units can be mounted directly on to a machine or system. Easy installation is provided by waterproof I/O plug connectors and the metal case works as an efficient heatsink allowing operation across ambient temperatures from –40 to +85°C.

The power supplies have an input range of 90-264VAC and 85-375VDC, an option of 18-75VDC and adjustable DC outputs of 12-15V or 24-28V.

www.powersolve.co.uk

NEW 12GHZ TDR/TDT SAMPLING OSCILLOSCOPE FROM PICO TECHNOLOGY

The PicoScope 9211A TDR/TDT Sampling Oscilloscope is a new instrument specially designed for time-domain reflectometry (TDR) and time-domain transmission (TDT). It provides a low-cost method of analysing cables, connectors, circuit boards and IC packages.

The PicoScope 9211A works by stimulating the device under test using its two independently programmable, 100-ps (typical) rise-time step generators. It then uses its 12GHz sampling inputs to build up a picture from a sequence of reflected or transmitted pulses. The results can be displayed as volts, ohms or reflection coefficient against time or distance.

As well as TDR/TDT analysis, the PicoScope 9211A can also be used for mask limit testing of a wide range of communications standards including SONET/SDH, Fibre Channel, Ethernet, InfiniBand 2.5G and 5.0G, XAUI, ITU G.703, ANSI T1/102, RapidIO 1.25G and 3.125G, G.984.2, PCI Express 2.5G and 5.0G, and Serial ATA 1.5G and 3.0G. Over 150 industry-standard masks are included.

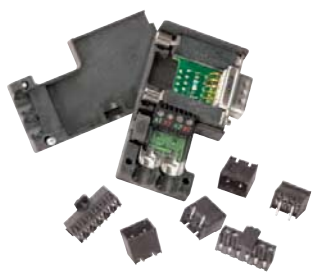
www.picotech.com

THROUGH HOLE REFLOW (THR) CONNECTOR SOLUTIONS

In response to the increased use of surface mount devices (SMD), Wieland Electric has introduced a range of Through Hole Reflow (THR) connector solutions for use with two piece connectors and single piece terminal blocks. Savings of up to 30% in manufacturing costs can be achieved using Wieland's THR printed circuit board connectors, which are available in 3.5mm, 3.81mm, 5mm and 5.08mm. The temperature resistance required for the reflow process is achieved through the use of a new insulating material.

Using this technology THR and SMD can be processed simultaneously, using the same equipment. On the solder templates, the holes for the THR compatible connectors can be placed next to the SMD components. During the board printing process, the lead-free solder paste is pressed into the holes and during the mounting of components onto the board, the solder pins are placed through the paste and into the holes.

www.wieland.co.uk



LECROY DEMONSTRATES TECHNOLOGY FOR HIGH BANDWIDTH REAL-TIME OSCILLOSCOPES UP TO 60GHZ

LeCroy Corporation announced that the sixth-generation of Digital Bandwidth Interleave (DBI) technology has been successfully demonstrated in its design labs in New York. This latest generation technology will use new front-end chips, which provide lower noise and higher native bandwidths. The combination of new silicon and improved DBI techniques can produce low-noise digital oscilloscopes with true analogue bandwidths up to 60GHz, doubling the capabilities of LeCroy's current industry-leading bandwidth performance of 30GHz.

Product development efforts using the new technology have begun and are expected to yield a fresh pipeline of high-end products during the next two years. The first products using this new technology will be announced before the end of calendar 2010 and will provide four simultaneous channels with 45GHz real-time bandwidth.

"We continue to be impressed with the market demand for our high-bandwidth oscilloscopes," said LeCroy President and Chief Executive Officer Tom Reslewic. "Design engineers working with high-speed serial data links are faced with enormous challenges to ensure that designs achieve targeted levels of performance. Recently, there has been a marked increase in design activity and interest in very high speed applications, such as 100Gb Ethernet. These applications are driving the development of oscilloscopes with increasingly higher bandwidths."

www.lecroy.com

ALPHA SOLDERING MATERIALS AT SMT SHOW

Alpha Cookson Electronics Assembly Materials will show its extensive range of solder and soldering related chemicals on stand 9.624 at SMT / Hybrid Packaging in Nurnberg.

On show for the first time in Europe will be Alpha SACX Plus 0307, a low silver, lead-free alloy specially designed with proprietary additives to deliver soldering and reliability performance similar to higher silver SAC alloys (e.g. SAC305 etc) at up to 30% lower alloy cost.

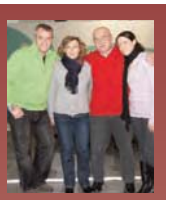
This SACX 0300 variant is used to stabilize/reduce the copper content in the wave solder bath, depending on process conditions. As with all Alpha Metals's wave solder alloys, Alpha's proprietary Vaculoy process is used in the manufacturing route to remove certain impurities, particularly oxides.

Of interest to those concerned about the potential human health and environmental dangers posed by halogens, will be the Alpha range of "Zero Halogen" solder pastes, fluxes and cored solder wires. The result of extensive research and development, these products truly represent "halogen-free" with no compromise in performance.

www.cooksonelectronics.com

www.alphametals.com

CONNECTOR ASSEMBLY SPECIALIST OPENS SALES OFFICE IN ITALY



PEI-Genesis has continued to expand its operations in Europe with the opening of a sales office in Italy.

Located in Milan, the office will be staffed by a team of four personnel headed by Nicola Della Malva, Sales Director Italy, and will be served by PEI's European connector assembly facility in Southampton, UK.

PEI-Genesis offers a 48-hour assembly service for a wide range of connectors from leading manufacturers such as Amphenol, ITT Interconnect Solutions, Glenair and Polamco.

This rapid service is made possible by the company's strategy of holding a massive $60m inventory of over 30,000 component parts and using purpose-designed machines to automate the connector assembly process.

"We see a great deal of potential for PEI-Genesis in Italy as more and more engineers and buyers become aware of the company's 48-hour connector assembly service. We have a knowledgeable, enthusiastic and experienced team here in Milan, and we are all looking forward to building a successful business over the coming months and years," said Malva.

www.peigenesis.co.uk

TTI ADDS MOLEX IN FINLAND AND ESTONIA

TTI, Inc., the global distributor of passive, interconnect, relay and switch and discrete components, has announced that its European franchise agreement with leading connector company, Molex, has been extended to cover the important territories of Finland and Estonia. The agreement gives customers in these countries access to Molex's complete product portfolio via TTI's broad and deep European inventory and superior logistics programs.

"As we have expanded our reach within the Nordic Area we have established Finland and Estonia as a key focus area for new business development. As part of our strategy in 2009 we introduced Murata's world-beating Passive lines into this area to great effect. We intend to replicate this success with Molex's strategically important connector range, which is similarly regarded worldwide as a global market leading brand," said Marc Winfield, Regional Vice President Sales, TTI Europe.

www.ttieurope.com

ROBOT KITS WEBSITE

Robot Bits

www.RobotBits.co.uk

Robot kits and components for fun and learning!

Whether you're just getting started or looking for parts for your next robot; RobotBits has everything you need to power your next creation: Motors, gearboxes, chassis, wheels, controllers, motor drivers and more!

RobotBits stock kits and components from many of the well known brands including: POB Technologies, Pololu, Arduino, Dimension Engineering, Devantech and Solarbotics.

TEST & MEASUREMENT

SANS INSTITUTE RECOMMENDS FOR MORE **CODE DEVELOPMENT PRACTICES**

A group of organisations, led by the SANS Institute and Mitre Group, are calling for corporate customers to request more secure code development practices from their software suppliers. Software security specialist Fortify Software says that the announcement by a consortium of more than 30 enterprise customers of software vendors is good news as it gives companies the draft text for use in their procurement contracts with vendors.

"Best practice in code development has been under active discussion by the software vendor community for some time, but it's good to hear that the SANS Institute has grasped the bull by the horns and done something practical about the issue," said Richard Kirk, Fortify's European director.

"Our own observations suggest that a large number of successful hacker attacks are caused, in part, by software flaws, which give the hackers a small chink in an application's armour to prise open," he added. According to Kirk, by encouraging companies to include suitable language in their procurement contracts, the consortium will hopefully drive the software development industry to adopt the best practices that a number of experts have been calling on for some time.

Our panel of commentators says the following on this development:

IVOR CATT, ELECTRONICS ENGINEER, UK:
I am glad to see the idea that any contract with a software supplier will require satisfactory security in the software.

PROFESSOR DR DOGAN IBRAHIM FROM THE NEAR EAST UNIVERSITY IN NICOSIA, CYPRUS:
No matter what improvements the software developers make, there are always bound to be issues with security. The trick is minimising the damage (e.g. security and safety vulnerabilities) the code can do. Users of Microsoft software are well aware of the concept of updates and security. The fact that so many security updates are necessary shows the importance of the development of secure and reliable code.

It is highly pleasing to hear that the software vendors will hopefully be following the best practice in code development. Such an act will no doubt result in much more reliable and especially more secure and hacker-free code to be developed. The Sans Institute and Mitre Group should be congratulated for their efforts for calling corporate customers to demand more secure code development and testing procedures to be implemented by software suppliers. Most software hacker attacks are caused by software developed without using "the best" code development practices. With the initiative of the new consortium we expect future software development projects to use new code development and testing standards that will result in highly secure software, requiring less updates, as well as being hacker-free.

BARRY MCKEOWN, RF AND MICROWAVE ENGINEER IN THE DEFENCE INDUSTRY, AND DIRECTOR OF DATOD LTD, UK:
This subject is an extremely difficult issue to address as there are many more variables to consider, both in the short and longer term.

There is a clear and present need to change the culture of the software industry with respect to security and system vulnerabilities, especially as it is the same old weakness points that are not being denied access and closed down. By introducing lawyers to achieve this goal though is debatable, as currently the software industry response to a "customer in trouble" notice is to allocate immediate software engineering resources to assist the customer. If this contractual obligation is introduced and results in lawyers being the first responders neither the customer nor the software vendor benefits: only the lawyers (again!) financially.

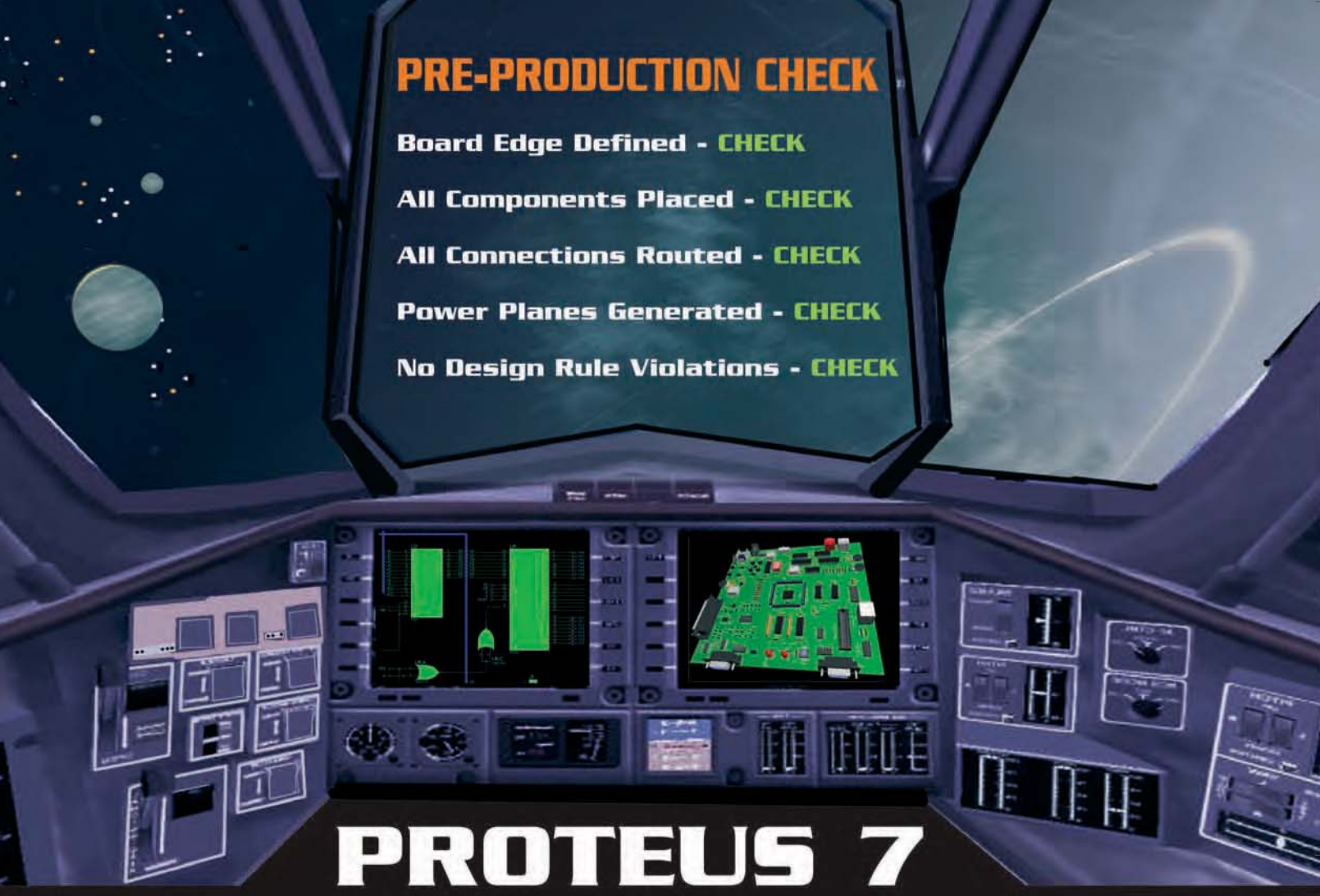
I suspect that in the longer term only, once the fragmented software industry institutionally has reach the maturity of the IEEE and IEE as a professional career structured and organised body and away from the erroneous self educated "nerdy" viewpoint popular with the general public, will the issue be addressed.

HAFIDH MECHERGUI, ASSOCIATE PROFESSOR IN ELECTRICAL ENGINEERING AT THE UNIVERSITY OF TUNISIA:
Currently the world of computing is regarded as the support of human knowledge and the communications in the technical, scientific, economic and social fields. By using very developed software, the data-processing machines now ensure the monitoring of automation in terrestrial transports, piloting of planes and rockets, control of the nuclear power plants and electronic commerce and so on. So, the software of management and treatment solutions must be protected as an error in a bank card, for example, or a confidential protocol in data transmission can have repercussions such as violation of secrets and hacking into accounts. Thus to improve safety in the data processing world, software assurance is a necessary step toward systems security.

The industry should adopt a best practice approach to software code development. The security must be built in from an earliest point in the application's development. The software must also be conducted through security tests prior to acceptance.

The government agencies should take to implement a comprehensive software security assurance (SSA) program.

There must be a new "culture of security" that addresses software that is conducted and outsourced – software as-a- service (SaaS) – and requires a reallocation of resources and even a new way of thinking. Vendors should be contractually accountable for all their software.



PROTEUS 7

Design with Confidence:

The latest version of the Proteus PCB Design Software provides a multi-stage Pre-Production Check which will detect and prevent a variety of common mistakes prior to your boards being sent for manufacture.

PROTEUS DESIGN SUITE Features:

- Hardware Accelerated Performance.
- Unique Thru-View™ Board Transparency.
- Over 35k Schematic & PCB library parts.
- Integrated Shape Based Auto-router.
- Flexible Design Rule Management.
- Polygonal and Split Power Plane Support.
- Board Autoplacement & Gateswap Optimiser.
- Direct CADCAM, ODB++, IDF & PDF Output.
- Integrated 3D Viewer with 3DS and DXF export.
- Mixed Mode SPICE Simulation Engine.
- Co-Simulation of PIC, AVR, 8051 and ARM7.
- Direct Technical Support at no additional cost.

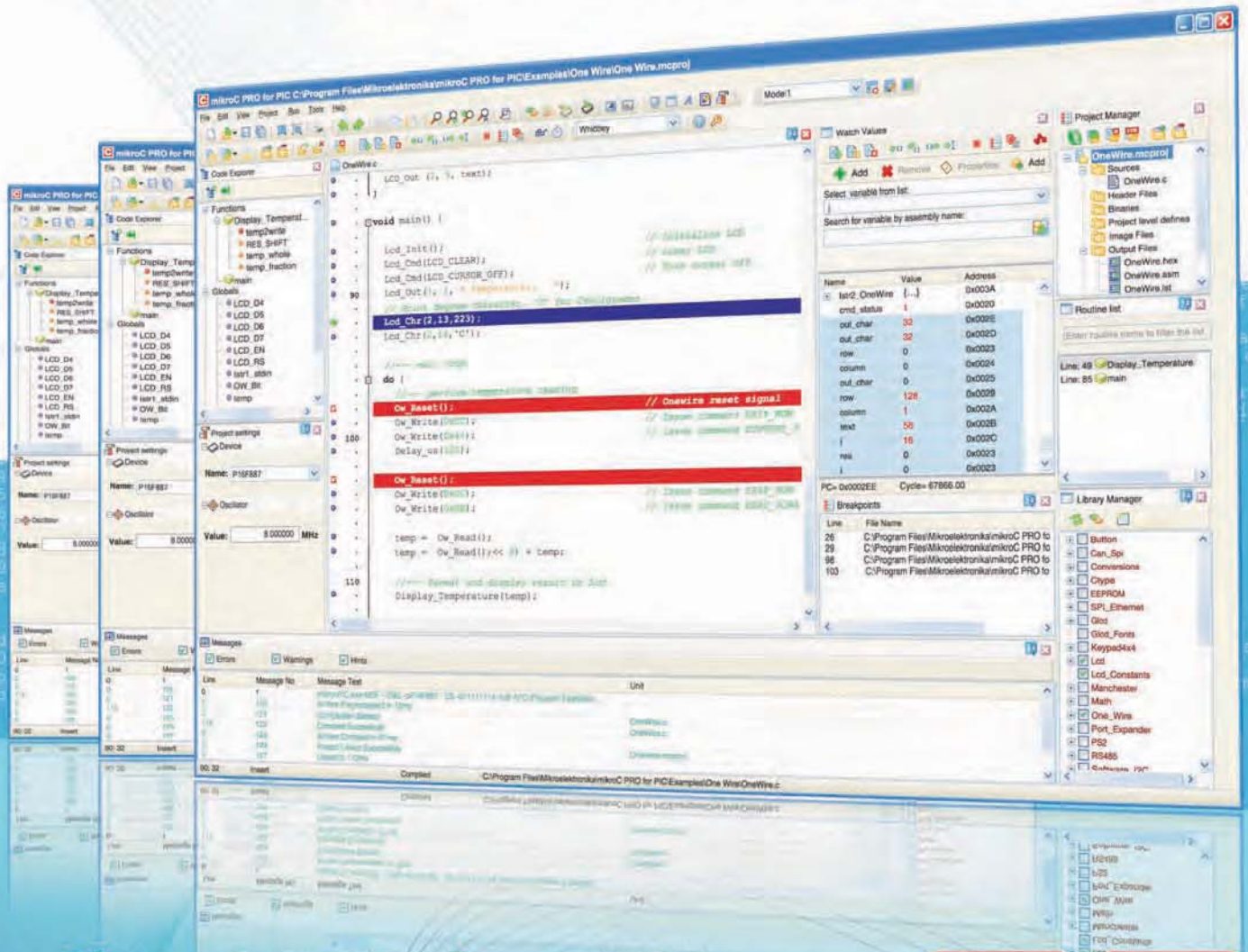
All levels of the Proteus Design Suite include a world class, fully integrated shape-based autorouter at no additional cost - prices start from just £150 exc. VAT & delivery

labcenter Electronics www.labcenter.com

Labcenter Electronics Ltd. 53-55 Main Street, Grassington, North Yorks. BD23 5AA.
Registered in England 4692454 Tel: +44 (0)1756 753440, Email: info@labcenter.com

Visit our website or phone 01756 753440 for more details

THE COMPILER YOU NEED



mikroC PRO for PIC®

C compiler for PIC®12, PIC®16 and PIC®18

Compiler mikroC PRO for PIC provides all the power and flexibility of ANSI C and is accompanied with the most advanced IDE on the market. Many practical examples and a comprehensive documentation allow a quick start in programming PIC microcontrollers.

- FREE UPDATES OF NEW COMPILER VERSIONS
- FREE TECHNICAL SUPPORT
- WIDE-RANGE OF HARDWARE AND SOFTWARE LIBRARIES
- NUMEROUS EASY TO USE PRACTICAL EXAMPLES

THE EASIEST WAY TO PROGRAM PIC MICROCONTROLLERS

MikroElektronika
DEVELOPMENT TOOLS | COMPILERS | BOOKS
...making it simple

GET IT NOW
www.mikroe.com