Volume 117 • Issue 1898
February 2011 • £4.60
www.electronicsworld.co.uk

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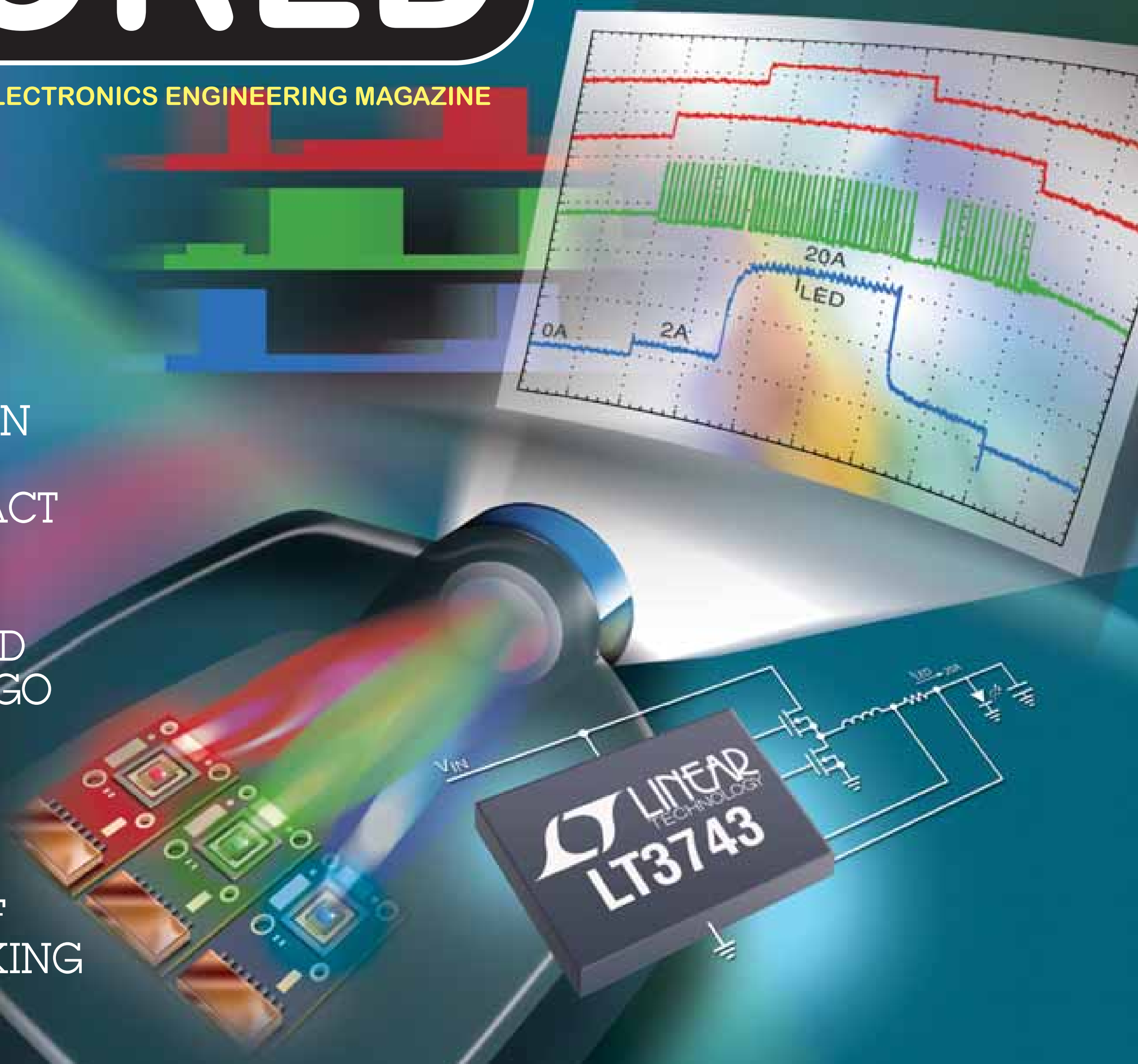
THE ESSENTIAL ELECTRONICS ENGINEERING MAGAZINE



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ENGAGE IN THE NEW COMMS ACT

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WHERE DID EINSTEIN GO WRONG?

ANALYST
THE SIX MYTHS OF CHIP MAKING

HIGH PERFORMANCE LED DRIVERS

MEET HIGH BRIGHTNESS LEDS DEMAND

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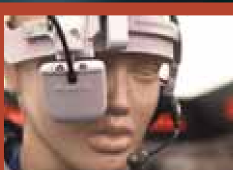
BOUNDARY SCAN TEST VECTOR MIGRATION



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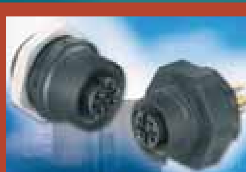

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DACS, CONNECTORS, STORAGE DEVICES AND OTHERS

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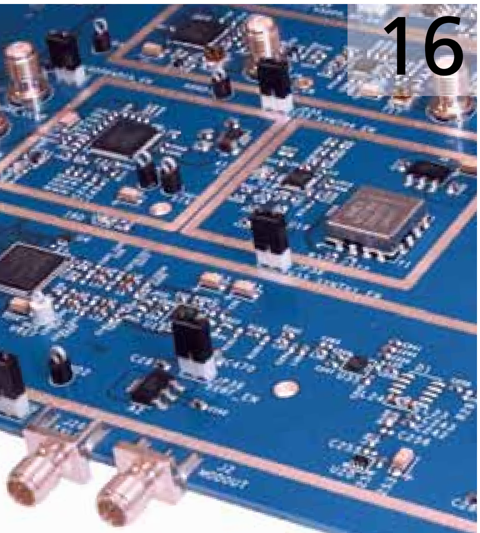

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Electronics World is published monthly by
Saint John Patrick Publishers Ltd,
6 Laurence Pountney Hill, London, EC4R 0BL.

DOUBLE DIGIT VOLUME GROWTH RETURNS TO SIM CARD MARKET

After historically low growth for the SIM card market in 2009, it is a breath of fresh air for SIM card manufacturers to see double-digit growth return for the first half of 2010. Moreover, the outlook for the industry as a whole is quite optimistic in terms of overall volumes in 2010 and 2011

BY GEORGE KRAEV

Unfortunately, SIM card revenues, with the software and services revenues included, are still projected to have a low growth. When software and services are taken out of the equation, revenues for 2010 are actually below the pre-recession levels of 2007.

To some extent, the increase in volume has been driven by the emerging Indian market and the maturing Indonesian one with the price war in Indonesia generating a sizeable number of SIM card orders. While the Indonesian market is rapidly approaching a stage of maturity, India's growth seems limitless for the next five years and would continue to drive the SIM orders up.

On a global level, the return to "business as usual" after the significant inventory drain of 2009 and the return to pre-recession SIM replacement rates largely contribute to a shipment growth.

New SIM form-factors are also causing quite a stir in the industry with Apple devices singlehandedly jumpstarting 3FF.

Propagation of the new form-factor is projected to grow at a steady rate, although mass adoption is not likely to occur in the medium term. This should coincide with the introduction of newer than 3G devices and deployment of LTE networks.

ASPs have been hit hard in the last two years with heavy declines in 2009 and similar levels being seen in the first half of 2010. The decline is projected to slow down to a certain extent as memory sizes increase in a number of markets. The future of technologies such as NFC remains uncertain while a lot of aspirations are riding on their success. Industry rumours about upcoming devices and a recent announcement from Nokia relating to NFC's inclusion in this year's smartphone models suggest that IMS Research's projection from earlier this year of a 40 million NFC IC market in 2011 may be accurate. However, whether the single wire protocol is going to become an industry standard still remains to be seen.

Year 2009 was an odd one for the SIM-card IC market. For the first time in the industry's history the volume of SIM ICs shipped was lower than that of cards. The strong performance of the SIM card market in the first half of 2010, in conjunction with a certain amount of IC inventory replenishment by card manufacturers, has resulted in faster growth for the SIM IC market than the general growth of the SIM card market in 2010. IMS Research expects this trend to continue into 2011.

"THE FUTURE OF TECHNOLOGIES SUCH AS NFC REMAINS UNCERTAIN WHILE A LOT OF ASPIRATIONS ARE RIDING ON THEIR SUCCESS"

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PUBLISHER: Wayne Darroch

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: Pensord Printers
ISSN: 1365-4675

St John Patrick Publishers

Boundary Scan Test Vector Migration into SPEA 3030 Board Testers

Goepel Electronic had joined forces with its German GATE program partner TAP (Tietjen Automatisierte Prueftechnik) to develop a software tool that converts test vectors, generated in System Cascon, into executable test pattern of the SPEA 3030 In-Circuit Tester (ICT). The new method converts the JTAG bus's serial vectors as well as the parallel I/O vectors to the board test system's pin electronics. The utilisation of the SPEA 3030 test channels within the Boundary Scan test parts results in a significant higher test coverage and an even more efficient fault localisation.

The new tool considers the SPEA 3030 system configuration and generates required data, workflow structures and contents of the test plan. The generation of the test pattern is implemented by an OBP driver (on-board programming), developed by the Company TAP. Response vectors of faulty test runs are converted to formats, which can be evaluated in System Cascon. This enables the full fault diagnostic to be executed in the Boundary Scan software.

A software tool now converts test vectors, generated in System Cascon, into executable test pattern of the SPEA 3030 In-Circuit Tester (ICT)

"Now a very simple JTAG/Boundary Scan entry with the SPEA ICT is possible without additional hardware," said Alexander Beck, Goepel Electronic's expert for Boundary Scan integration into ATE systems. "Also, existing projects can be checked for their Boundary Scan ability in ICT adapter systems fast and easily."

Hinrich Tietjen, CEO of TAP, added: "This integration's core application is clearly in the production area with Boundary Scan test contents, e.g. infrastructure test, interconnection test, cluster test, manually generated Boundary Scan test parts and Memory Access test."

The software tool, support in generating Boundary Scan and ICT test parts as well as project transfer are provided by the Company TAP.

The high performance SCANFLEX hardware components have been successfully implemented ensuring full Boundary Scan functionality in the SPEA 3030 test systems for years.

MAJOR COLLABORATION BEGINS ON CUTTING-EDGE ELECTRONICS

A new partnership in the area of microwave semiconductor devices has been unveiled by e2v and academics at The University of Nottingham, which is expected will drive forward the research and manufacturing of cutting-edge electronics.

The aim of the new collaboration is to develop and manufacture advanced semiconductor devices for use in microwave and terahertz applications. Funding of £1m from e2v will see a new purpose-built cleanroom built at the School of Physics and Astronomy on University Park, housing the e2v semiconductor fabrication facility.

"This collaboration enables the manufacture of cutting edge electronics in the East Midlands to continue. We look forward to working with e2v to develop the next generation of devices based on our existing expertise in III-V semiconductor physics," said Dr Chris Mellor, principal investigator of the new collaboration for the University.

The next generation of microwave electronic devices will include a range of devices known as Pi-N diodes, typically used in sensitive microwave receiver systems. The collaboration's initial focus will be to develop new devices which have a much faster response time than currently available and can work over wider frequency ranges.

RF/microwave frequency sources used in radar imaging, as well as mixers and detectors used in the receive chain, are also high on the agenda for the collaboration. Applications of these sources include motorway traffic monitoring, large area security imaging and lightweight radar systems for un-piloted airborne vehicles (UAVs). In addition, the scope of work on novel devices will extend to sub-millimetre wave and beyond, where there is a strong interest in devices for high-resolution imagers that can 'see' through other materials such as clothing or buildings.

"This is an exciting development for physics at Nottingham. Having an internationally-recognised company working in our lab here offers exciting prospects for translating fundamental research in semiconductor materials and devices into new technology," said Professor Laurence Eaves, of the School of Physics and Astronomy.

The collaboration extends e2v's relationship with the University, where the e2v centre for industrial microwave processing (CIMP) focuses on the commercialisation of innovative technologies developed at the University.

CATRENE, the co-operative pan-European R&D programme aiming at a technological leadership of a competitive European ICT industry (EUREKA 4140) is announcing its 4th call for submission of project proposals. The call will be open from 18 January 2011 and will close on 03 March 2011. After the evaluation and selection process, there are mid and end of 2011 dates for labelling of projects. It can be assumed that the projects will start from 1st January 2012 onwards. Related information and guidelines for preparation are accessible on www.catrene.org

Movea, the pioneer in motion-sensing and motion-control technologies for business communications, home entertainment and computer peripherals, announced a technology partnership with Sunrex Technology, a laptop keyboard manufacturer, at the 2011 International Consumer Electronics Show (CES). Together, the companies will actively develop and jointly promote products based on Movea's MotionIC platform and SmartMotion technology. The first resulting products from this partnership will be showcased at CES for availability in Q1 2011.

THE SIX MYTHS OF CHIP MAKING

Malcolm Penn is CEO and chairman of market analyst firm Future Horizons, based in the UK

THE START OF any new year is a good time for reflection and 2011 sees the chip industry mired deep in uncertainty. From last year's 32% growth rate, it kicks off 2011 facing 6% growth, with all the inevitable 'boom to bust' chip industry hand wringing.

Aside from the fact, despite what the numbers say, 2011 is not a classic boom turned to bust, the real problem with the chip industry is far too much short-term, fast buck, get rich quick mentality – from the board and investor level down. Far too few firms take a long-term position, which, for an industry where investment lead times are measured in years not quarters, is a quick recipe for corporate oblivion. Nowhere is this more apparent than with the industry's lemming obsession for business models and fashion gimmicks.

"LONG-TERM SUSTAINABLE BUSINESS DOES NOT COME FROM SLIGHT-OF-HAND BALANCE SHEET ENGINEERING"

Call me old fashioned – I have every right to be given as I started my chip industry career in 1962 – all of these instant fixes are Emperor's new clothes; there is only one way to make money in this business – by doing the job right. Do that and the revenue and profits are diagnostic; they will naturally happen; the only problem is it does take time and few people today seem to have patience. In our experience, building a long-term sustainable business does not come from slight of hand balance sheet engineering, such as selling off assets and leasing them back; moving to an IDM fab (asset) -lite business model or spinning out high-quality business divisions. Put simply, if a division or business unit is good enough to sell, then it is also good enough to keep.

This leads naturally to what we call our 'six myths of the semiconductor industry', a 'myth' being a widely thought tenet that we believe is simply not true.

Myth #1: The chip cycles are over

Due to the fact that the electronics industry now addresses a much broader application, region and market diversity, it is popular to surmise that the boom-bust cyclicality will moderate. Notwithstanding the fact there is no historical evidence to support this hypothesis, including the last three year's growth pattern, it completely fails to grasp what are the real causes for industry cyclicality, namely the vastly different lead times for semiconductor design and manufacturing decisions (several years) versus those of the market (a few weeks or months); in economic terms the hog and cobweb cycle syndrome. Only when you fix this gap will you bring cyclicality under control.

Myth #2: The market is mature

Many people interpret what they see as a recent decline in the long-term average annual industry growth rate as a sign that the semiconductor market has matured – "the industry's growth days are over" quotes the wisdom. This perception is both superficial and flawed on several fronts.

First it ignores the fact that there is no single homogeneous chip market – for every sector that may have matured there are several others that are at the start of the hockey stick curve. Second, it assumes that we have run out of market opportunities, which is clearly not true. If it were, why bother with long-term research projects such as those at Albany, IMEC, CATRENE and ENIAC? Thirdly, it also confuses unit and value growth and, hence, the real cause and effect issues in play. There has been no change over the past 30 or more years to the underlying 11% annual unit growth.

Myth #3: ASPs will keep declining

Myth 2 leads naturally to the industry Myth 3. For a fact IC value growth has been much lower than the unit growth over the past decade, as a result of the fact IC average selling prices (ASPs) have been on a downward decline.

ASPs however cannot keep falling forever, otherwise there would come a point where vendors would be paying customers to be allowed to supply them with chips. Individual IC prices decline as volumes increase but ASPs are pushed back up as companies introduce higher capacity or higher performing chips, with a price premium. This natural balance has been disrupted over the 2002-2009 period due to a number of one-off phenomena but, as with market Myth 1, there is no historical precedent or economic justification for the assumption that ASPs will (can) keep falling forever; quite the opposite, markets always self-correct, either by someone exiting the market or correcting the causes of the decline. Indeed, this reversal has already started to happen (see **Figure 1**). ASPs have been increasing since Q3-2009 … but interestingly no one believes in the data!

Myth #4: Fabs have no strategic value

This idea gained traction in the post dot-com crash era driven by a variety of attractive financial and short-term reasons with little regard for customer needs, market position or long-term sustainability issues. "Fab-lite is the future" became the IDM mantra, despite the fact that no one has yet described exactly (a) what fab-lite actually is in practice and (b) how the model works.

Clearly dumping asset-intensive activities makes the balance sheet look great, but not everyone can be a Gucci, living off brand and reputation alone. No matter how great the ideas, someone eventually has to make the ICs and this is where the control, power and profits will ultimately reside.

The 2010 supply side shortages and Texas Instruments's move to make analogue ICs on 300mm wafers have thrown the first real rock into the road. Fabs will have no strategic value when Intel, Samsung and TSMC give up on chip manufacturing.

Myth #5: Only the fabless, not IDM, business model succeeds

This is a natural follow on conclusion of Myth, 4 despite the fact that history shows there have been more fabless than IDM company failures, plus being fabless model does not shorten time to market success. Only one of the top 40 fabless firms is less than 10 years old (just) and the average age of the top 10 fabless companies is 20 years, with 33 of the top 40 fabless chip companies over 15.

As with any firm, success is the result of hard work and paying one's dues; the right place at the right time plus a touch of luck and good fortune. Interestingly, the fabless model is increasingly under stress, at the top over issues of the security of wafer supply – the big fabless firms already buy capacity, not wafers – and at the bottom from the increasing cost of IC design and lack of profitable exit strategies. How long before fabless firms have to invest up front in advanced fab capacity to guarantee timely access?

Myth #6: The 21st century business model of focus not breadth

As with asset dumping, current business wisdom calls for a ruthless culling of business activities, for example: become specialized; go fab-lite; merge with each other; narrow the R&D scope; cull the product line/divisions; and outsource everything.

It rather begs the question, just where do firms now add value, plus it totally ignores (a) what the market needs and (b) the longer-term viability issues. Customers actually need a variety of solutions and firms need a continuum of new products and markets. My bet is on the broad-range firms of old like STMicroelectronics and Renesas, except even here they are sometimes apt to loose religion.

Success is about execution not quick fixes and models; sadly these myths conveniently fit with short-term corporate ambitions. The bad news is that bean counting, finance-driven managers have taken over from the visionary entrepreneurs and technologists … the good news is, for the few remaining visionaries, it has never been easier to be successful in this industry. ■

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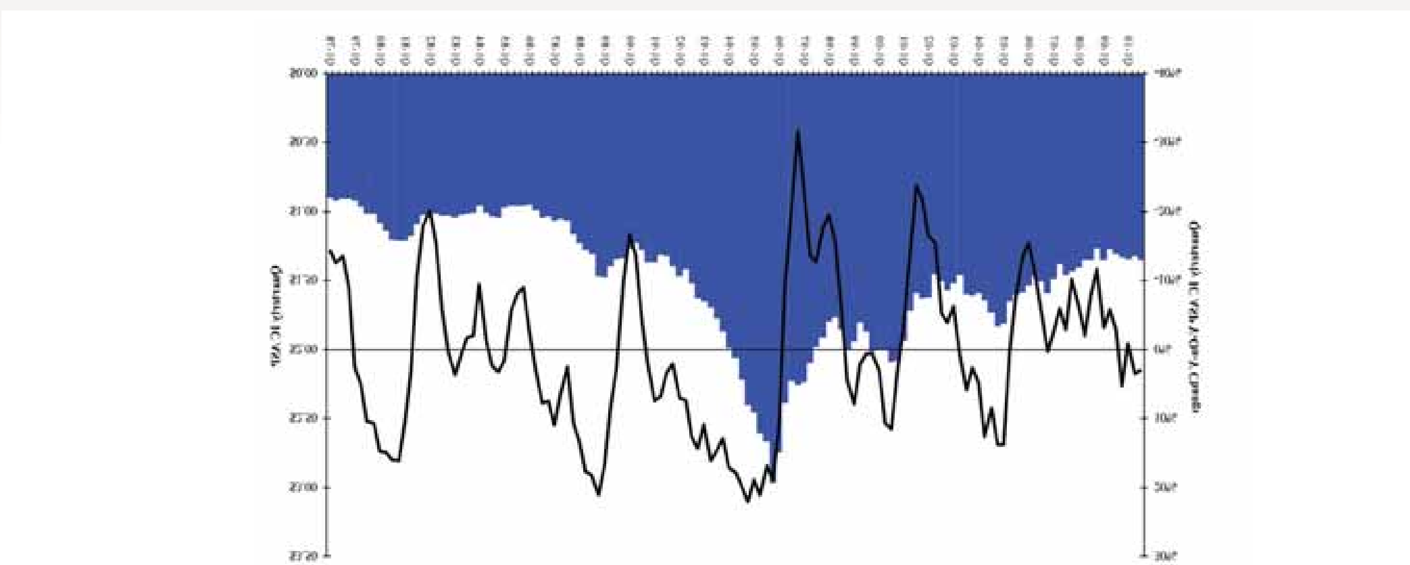


Figure 1: *Average Selling Prices (ASPs)*

High Brightness LEDs Demand HIGH PERFORMANCE LED Drivers

By Jeff Gruetter
Product Marketing Engineer, Power Products
Linear Technology

BACKGROUND

High brightness (HB) white LEDs (Light Emitting Diodes) are quickly replacing incandescent lighting in many home, institutional, government and industrial applications. In many cases, the higher efficiency of the LEDs reduces power consumption by as much as 88%, dramatically reducing carbon emissions required to generate the electricity to power them. Large arrays of white LEDs are replacing CCFL lighting for backlighting large LCD-TFT panels found in HDTV applications. LED's higher efficiency, long life and ability to offer local dimming capability have enabled LCD HDTVs to attain contrast ratios in excess of 7,000,000:1, exceeding the CCFL-based designs by orders of magnitude. So it is not surprising that with the proliferation of LED lighting in so many applications that their growth rate continues to accelerate. According to Strategies Unlimited, the HB white LED general lighting market is forecast to exceed $5 billion by 2012, corresponding to a compound annual growth rate (CAGR) of 28% from 2009 to 2012. So far, most of this growth has been dominated by lower current LEDs, primarily in the 100mA to 500mA range. However, higher current LED applications, requiring 2A to 20A of current to drive a single LED are becoming more common place. The first of these were found in automotive headlights but they can now be found in applications ranging from high power architectural lighting to high performance DLP (Digital Light Projection) projectors. The enhanced performance of these applications will continue to fuel the high growth rate of high current LEDs in the foreseeable future

EMERGING HIGH POWER LED APPLICATIONS

The introduction of high current LEDs enabled high power lighting applications to use them, replacing relatively inefficient incandescent bulbs. In applications such as architectural lighting and DLP projectors, which traditionally require 500watt to 1,000W halogen bulbs, 20A LEDs can offer the same light output (in lumens) but only require 20% of the electrical power. In architectural applications, the LED driver must be very efficient and offer wide dimming ratios to maintain a constant light output in a wide array of ambient conditions. In high end DLP projection applications, an array of red, green and blue (RGB) LEDs replaces the traditional halogen bulb, color wheel and array of mirrors (mems). However, in order to mix colors accurately, a LED driver must be able to rapidly switch between two disparate regulated peak current states and overlay PWM dimming without disruption. Designing high current LED driver ICs that are capable of meeting these demanding speed and accuracy requirements while optimizing overall efficiency, has posed many new challenges for IC designers

LED LIGHTING FOR DLP PROJECTORS

High-end DLP projectors have historically used high power incandescent bulbs combined with a color wheel and an array of mirrors to project a relatively high resolution image. As many of these projectors require 500W to even 5kW bulbs, thermal management of the entire system is a major design obstacle. Even with substantial thermal management systems requiring constant airflow cooling, bulb life spans are relatively short and are very expensive to replace. New designs use an array of high current RGB LEDs in lieu of a high power bulb, color wheel and mirrors, which dramatically reduces the magnitude of wasted heat, while improving the accuracy of color mixing, dramatically improving contrast ratios and overall resolution. However, in order to reach the desired level of performance, they require a unique LED driver design. First, the driver must be able to deliver up to 20A of continuous LED current and pulsed currents up to 40A. Secondly, it must offer efficiency in excess of 90% to minimize thermal considerations. Finally, in order to achieve the wide dynamic range required in color mixing, it must be able to switch between three well regulated current states rapidly and accurately without any disruptions.

THE LT3743

The LT3743 is a synchronous step-down DC/DC converter designed to deliver constant current to drive high current LEDs. The device's 5.5V to 36V input voltage range makes it ideal for a wide variety of applications, including industrial, DLP projection and architectural lighting. The LT3743 provides up to 20A of continuous LED current from a nominal 12V input, delivering in excess of 80 Watts. In pulsed LED applications, it can deliver up to 40A of LED current or 160 Watts from a 12V input. Efficiencies as high as 95% eliminate any need for external heat sinking and significantly simplify the thermal design. A frequency adjust pin enables the user to program the frequency between 100kHz and 1MHz so designers can optimize efficiency while minimizing external component size. Combined with a 4mm x 5mm QFN or thermally enhanced TSSOP-28 package, the LT3743 offers a very compact high-power LED driver solution.

The LT3743 has both PWM and CTRL_SELECT dimming (see figure 1), offering 3,000:1 dimming capability at three LED current levels, making it ideal for color mixing applications such as those required in DLP projectors. Similarly, the LT3743's unique topology enables it to transition between two regulated LED current levels in less than 2µs, enabling more accurate

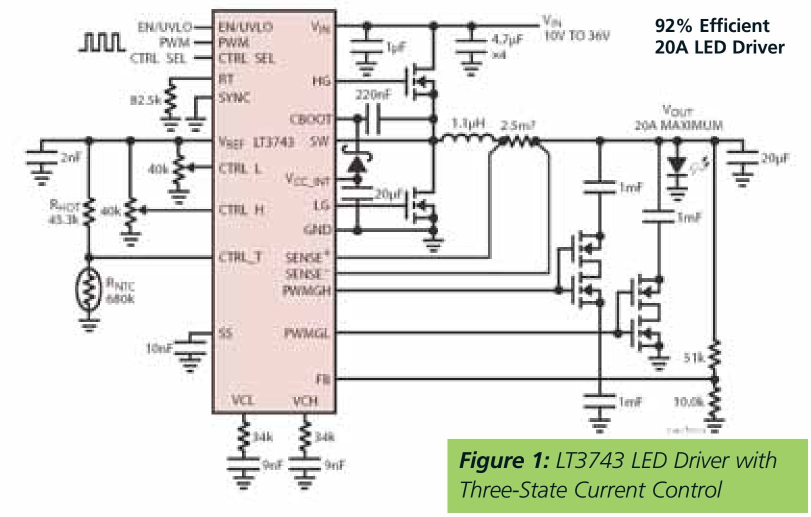


Figure 1: *LT3743 LED Driver with Three-State Current Control*

Figure 2: *LT3743 Efficiency vs. Duty Cycle*

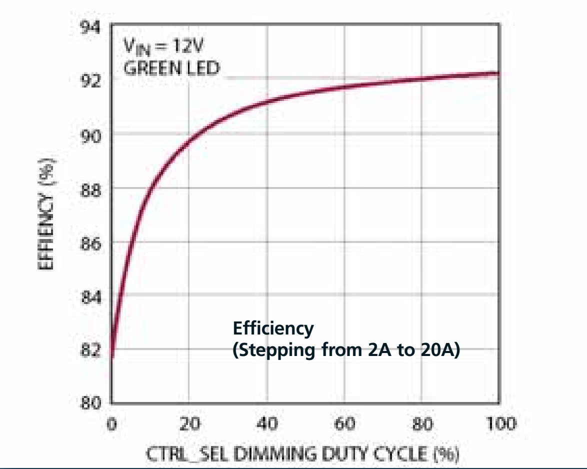


Figure 3: *Three-State LED Current Control*

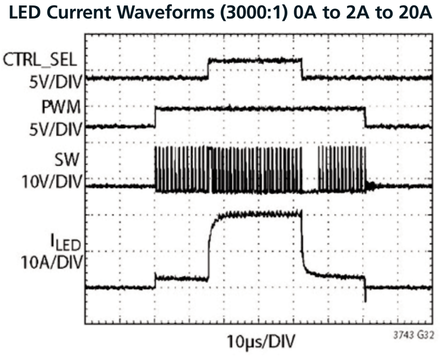
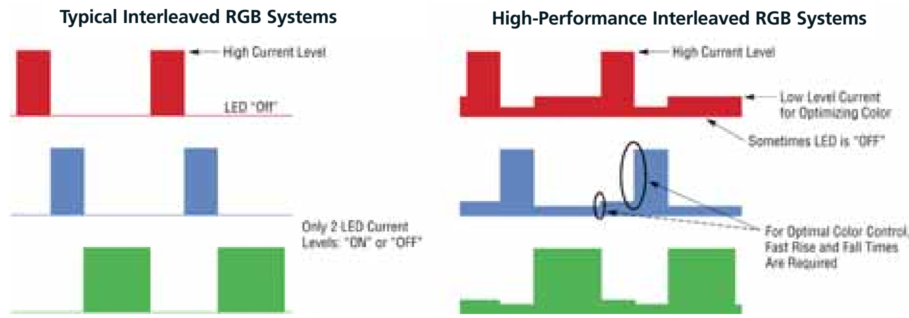


Figure 4: *Dual Current Color Mixing vs. Three-State Coloring Mixing*



color mixing in RGB applications. LED current accuracy of ±6% is maintained in order to ensure the most accurate luminosity of light from the LED. Additional features include output voltage regulation, open-LED protection, overcurrent protection and a thermal derating circuit.

HIGH EFFICIENCY OPERATION

In driving LEDs which require drive currents as high as 20A, conversion efficiency is critical. First, in order to maintain the high efficiency of the LEDs in delivering light, an IC driver must also offer high efficiency to minimized wasted energy in the form of heat. Secondly, many applications such as DLP projectors and architectural lighting require very compact solution footprints. As a result, the LED driver IC should not require any additional heat sinking to dissipate wasted power. In DLP applications, this enables designers to eliminate the requirement for cooling fans and the audible noise associated with them. As DLP projectors use RGB LEDs to accurately mix colors, running each LED at relatively low duty cycles (approximately 30% on average), it is imperative that high efficiency is maintained even at these relatively low duty cycles. The LT3743 utilizes a unique design implementing synchronous rectification and external switched load capacitors for both the CTRL_L and CTRL_H current circuits to deliver efficiencies greater than 90% for the most commonly required duty cycles. Figure 2 shows how the LT3743's efficiency varies with duty cycle while driving a green LED with current between 2A and 20A. Other industrial applications, such as laser diode drivers, also require this high efficiency in pulsed applications.

THREE-STATE CURRENT CONTROL

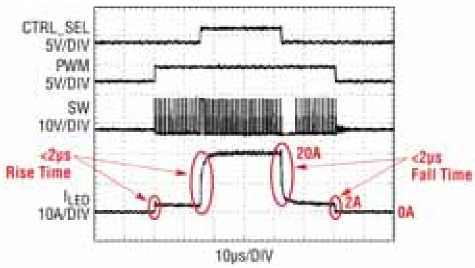
The LT3743 utilizes a unique design that enables three-state current control with 3,000:1 dimming for each current level. Figure 3, shows how these different current levels are controlled. First, when the PWM signal goes high, it sets the LED current from zero to the current level set by CTRL_L, in this example I_{LED} =2A. Then, when the CTRL_SEL pin goes high, I_{LED}=20A. All of these current levels are maintained with +6% accuracy ensuring consistent brightness levels. Conversely, when CRTL_SEL goes low I_{LED} returns to 2A, and when the PWM signal goes low, I_{LED} goes into its off state. The LT3743's individual CTRL_L and CTRL_H control loops enable these current levels to transition very quickly, ~2µsec while maintaining very high efficiency.

This three-state current control enables high end DLP projector applications using RGB LEDs to deliver unprecedented color accuracy and dynamic range. Figure 4 shows how three-state current control delivers this higher performance when compared to a dual state control. Traditionally, the dual state control would either turn each of the RGB LEDs either completely on or off depending on the relative duty cycle to define the color. This makes the projected color accuracy completely dependent on the color accuracy of the individual LEDs, which can vary considerably. However, as high end DLP projectors demand the highest quality image and color reproduction possible, a new means to achieve this is required. Namely, to achieve the highest color accuracy possible, variations in the individual LEDs must be corrected by mixing with the other two color LEDs to offer the most accurate color level. For example, when the red LED is turned on at full current, the blue and green LEDs are turned on at lower current levels so they can be mixed to produce the most accurate red. The 3,000:1 dimming capability both on the PWM and the CRTL_S pins further enhance the dynamic range of the mixed colors. The dynamics of this color mixing can be seen in figure 4.

FAST TRANSITION TIMES BETWEEN CURRENT LEVELS

To maintain the most accurate color mixing capability, not only must the LED drivers provide three-state current control and precise PWM dimming at three different current levels, they must also transition from a relatively low current regulated state (~2A) to a much higher regulated current level (~20A) so that the PWM dimming edges are preserved. The LT3743's unique design enables it to make these transitions very rapidly. Namely, as can be seen in figure 5, the LT3743 can transition from a 2A constant current state to a 20A state in under 2us making it ideal for color mixing RGB applications.

Figure 5: *2us Rise & Fall Times Using the LT3743 with Three-State Dimming Using PWM & CTRL_SEL*



In addition to RGB LED color mixing applications, industrial applications driving high power laser diodes also require this ability to transition between two well regulated current levels, such as 2A to 20A, in the ~2µs to ~5µs range for pulsed laser applications.

CONCLUSION

The unprecedented acceleration of LED lighting applications in industrial and commercial lighting has created many specific performance requirements for LED driver ICs in high current LED applications. In industrial applications, these applications range from high power interior/exterior lighting to driving laser diodes for cutting and shaping raw materials. Commercial applications range from general architectural lighting to the newest generation of high end DLP projectors. All of these applications require high performance LED driver ICs. This new generation of LED drivers must deliver very high efficiency, offer very wide dimming ratios and have the ability to transition from three disparate currents levels very rapidly. Of course, these applications also require very compact, thermally efficient solution footprints. Fortunately, the LT3743 meets all of these criteria.

Net Neutrality and a New COMMUNICATIONS ACT

Barry McKeown, Director of Datod Ltd, explains why it is of crucial importance to engage in the spectrum debate in the lead up to the new Communications Act in the UK

IMMEDIATELY PRIOR TO the autumn recess the new UK Coalition Government announced that it intends to place before Parliament, in late 2012, a new Communications Act. It was the previous 2003 Communications Act that empowered OFCOM. But what has OFCOM achieved for the UK communications industry and infrastructure and does it matter?

In a previous article in *Electronics World* "The Spectrum Anomaly", August 2010, I outlined some of the reasons just why it matters. Also in the September issue of the magazine, Cambridge Consultants Ltd and the *Last Note* panel raised similar issues relating to the US Whitespace Frequency initiative by the FCC. The enlightened remarks of FCC Commissioner Baker at the Broadband for All Conference, Stockholm, 28 June 2010, "*Spectrum Management – Updating the Framework for the Broadband Era*" (downloadable from the FCC web site) are extremely pertinent here.

Consider the following additional case: in June 2008, OFCOM announced the start of the UK 4G Digital Dividend Review 550-630MHz and 790 to 845MHz, and associated spectrum auctions. The following extracts are from the OFCOM Executive Summary document:

"…**1.5** Our objective for the DDR is to maximise the total value to society that using the digital dividend may generate over time. It is not our objective to raise revenue for the Exchequer, nor is this a consideration that we can take into account, given our statutory duties.

1.6 Over the past two years, we have consulted on our strategic approach to the release of the DDR spectrum. We have concluded that we should take an approach that puts the market at the centre of decision-making, rather than the regulator.

1.7 This means that for the most part it will be users, not regulations, that decide how, for what and by whom the spectrum should be used, subject mainly to technical conditions designed to prevent harmful interference."

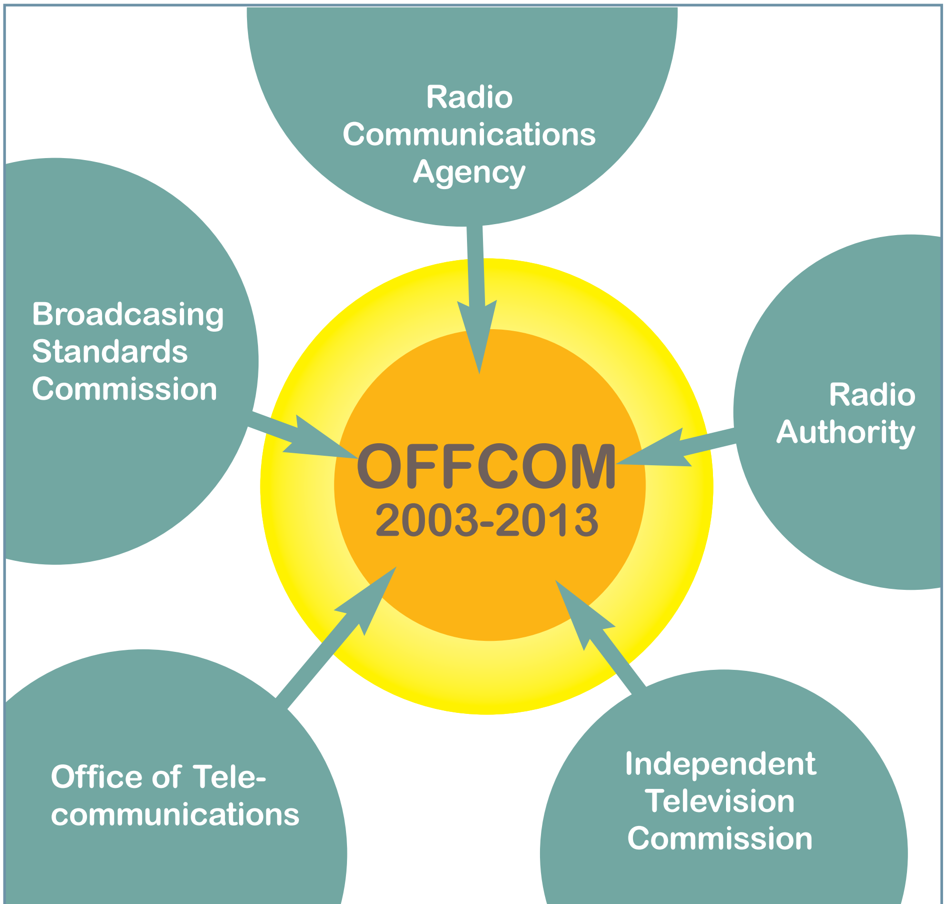
Indeed! Witness that nowhere in this DDR is there mention of the following internal OFCOM report, "*A Study into the Application of Interference Cancellation Techniques*", from April 2006 and now released on the web, which was commissioned from Roke Manor Research Ltd. This report provides, with a few notable omissions, the status of ICT circa 2006. Albeit this material relates to simulation and mathematical modelling, not actual hardware development and testing, nevertheless just what has OFCOM undertaken to facilitate or encourage this ICT development in the UK since 2006 or even Whitespace development through the DDR?

"ALTHOUGH THE UK BODY AREA NETWORK INDUSTRY IS CURRENTLY FRAGMENTED AND NOT APPRECIABLY VISIBLE, THE LATENT TECHNICAL CAPABILITY DOES EXIST FOR THE UK TO BE A MAJOR PLAYER IN THIS NEW WORLDWIDE HEALTHCARE INDUSTRY"

Consider also that in May 2008, the same year of the DDR, OFCOM published a report on its web site entitled "*Tomorrow's Wireless World*" together with an accompanying press release. A few of the key statements extracted from this material are:

"…Breakthroughs aside, we note that the general pace of technology advancement, both within industry and academia, is very strong indeed. Wireless sensor networks are moving from the military to the civilian domain, attracting a significant amount of interest within the research community. However, their widespread deployment is still some way off and we conclude that no additional spectrum or regulation is necessary at this time. In the wired domain, the technologies underpinning copper telephone networks may progressively be enhanced to achieve higher data rates."

"The healthcare sector and, therefore, the members of the public accessing healthcare services are expected to benefit from the widespread deployment of information and communications technologies. For example, a home hub could be used to analyse a patient's blood samples, dispense the correct dose of medication and link to the local GP to automatically book an appointment when needed. Body area networks could monitor vital signs and automatically change drug dosage. The use of technology could empower the individual to take more responsibility in maintaining their health, freeing up resources within the NHS for other, higher priority uses. Many of the applications could be deployed over existing local area or cellular networks, requiring no further regulatory action. In such cases the challenge relates more to the fusion and presentation of healthcare information from disparate sources, rather than the physical means to create an underlying network. However, some applications were identified that may require future investigation and, if



Historical structural predecessor organisations amalgamated into OFCOM, and projected lifespan

necessary, regulatory attention:

- Body area networks may be used to interconnect implanted medical devices. The safety critical nature of this application suggests a requirement for dedicated spectrum. Depending on the deployment of such networks, the existing allocation of spectrum at around 400MHz may need to be monitored and, if necessary, reviewed;
- Local area networks may be used to interconnect medical equipment or to bridge between diagnostic units and implanted body area networks. Conventional wireless local area network spectrum is available but safety critical data streams should be supported by dedicated spectrum. There is currently no allocation for such applications in the UK; and
- Social and emergency alarms already use dedicated spectrum. However, increased deployment in the future may lead to congestion in these bands."

Clearly the IEEE does not consider consulting OFCOM before proceeding; for in previous year, the IEEE formed Task Group 6 for Body Area Networks (IEEE 802.15). This is a very active area with the growth potential to provide much need economic benefit to the UK, as well as the capability of providing revolutionary healthcare services, not just for implanted devices, delivered through the NHS. Consequently, in the national interest, it should not be left again to the Americans to drive this technology.

Although the UK Body Area Network (BAN) industry is currently fragmented and not appreciably visible, the latent technical capability does exist for the UK to be a major player in this new worldwide healthcare industry. But its creation shall involve governments ensuring competition between the incumbent vested interests of the traditional healthcare instrumentation and service market providers, such as the Cisco's, GE's and Philip's resisting encroachment by the Mobile Network Carriers from the 3GPP with 4G technologies for new healthcare apps.

What is presently needed is the political leadership and will to drive the universal UK telecommunications coverage necessary to implement and sustain such evolving BAN systems while reorganising the NHS and healthcare delivery, especially in rural communities. It shall eventually require much more than the initial bit-rates stated in the evolving IEEE 802.15 BAN specification; for converged interoperability delivered via optical fibre, wireless and satellite coverage beyond both the inadequate 2Mbps and inappropriate national penetration coverage targets proposed by OFCOM.

Essentially, it requires a political decision because at the heart of the emerging BAN industry issue is the current political and regulatory debate, intensified around the August Google and Verizon joint proposal in the US concerning "Net Neutrality" and prioritising certain types of Internet data traffic. Unquestionably, life-critical healthcare BAN data traffic must be prioritised over the networks or dedicated spectrum provided. The issue is clear cut.

Finally, in the recent BBC adaption of the John Buchan classic "The 39 Steps", Richard Hannay states: "Do you know what is wrong with this great nation? Smugness and complacency!" Sadly, as a seasoned OFCOM observer those words appear to me to sum up OFCOM's culture. Fundamentally, that is why the new Coalition Government needs to engage, with enlightened self-interest, on this "Net Neutrality" debate in the lead up to the new Communications Act. ■

Adjacent channel and blocking

Myk Dormer

RECEIVER DATASHEETS present the specifying engineer with a bewildering scatter of parameters to worry about. The main "functional" parameters, such as sensitivity (hence range), maximum data rate, power consumption and physical size, and the "rejection" parameters, comprising selectivity, intermodulation, blocking and spurious responses. These affect the operation of the radio in the presence of other, interfering signals and, unfortunately, are frequently ignored or omitted.

While spuri (such as image, "IF/2" and clock-harmonic spuri) and multiple interferer large signal effects are important, they only impinge on the system performance when an interferer falls on a small selection of specific spot frequencies. Here we are concentrating on the simpler 'band-wide' blocking and adjacent channel parameters.

To examine these specifications in turn (note that these are normally expressed relative to the wanted carrier level, so '60dB rejection' describes a radio able to tolerate an interferer 60dB above the signal level):

Blocking is a receiver's absolute, base-line rejection parameter. It is measured against an interfering signal offset from the wanted carrier by between one and ten megahertz. In circuit terms this parameter tests the ultimate stop band of the intermediate frequency filters (and the front end filters, if these are unusually narrow) and the large signal (saturation) performance of the preceding LNA and the first mixer.

Adjacent channel represents close-in selectivity. It is the ability to reject an unwanted signal in the next channel; for a narrowband receiver this can be as little as 12.5 or 25KHz away. This parameter is defined by the shape factor and quality of the intermediate frequency and by the close-in phase noise of the local oscillator (if this too noisy a process known as 'reciprocal mixing' will degrade the adjacent channel rejection).

For wideband modules (such as the simple 433.92 or 868.3MHz ISM band designs) the blocking performance is overwhelmingly the most important rejection parameter. We do not expect multiple co-sited wideband modules to operate simultaneously (time division techniques, such as low duty-cycle methods, are commonly used), so in-band interference rejection matters much less than the ability to keep functioning in the presence of transmitters in nearby allocations (for a 433MHz radio this could be Tetra mobiles at 425MHz. An 868MHz radio faces cellular phone carriers from 880MHz upwards).

Narrowband modules require good adjacent channel performance as well, since frequency division techniques (the use of multiple, often adjacent, channels in-band) are the norm, and large in-band interferers are far more likely to be encountered on the adjacent channels

To give an idea of the levels of performance attainable, the blocking performance of an EN300-086 compliant PMR (hand-held professional radio) must exceed 84dB (and is frequently better than 90dB), while the adjacent channel must better 70dB. These figures are a compromise between what is achievable with conventional circuitry and the absolute physical requirements needed to allow multiple users to operate with any degree of success in the same band.

The performance of low power wireless modules, unfortunately, falls well short of these figures. While simple, discrete component circuitry will easily manage 80dB blocking and 60dB adjacent with no great penalties in complexity or power consumption, many wireless modules are built around completely integrated receiver architectures. In these designs the critical circuit blocks (local oscillators and filters) are implemented on-silicon and, while the resulting device will function impeccably in a single signal environment, the blocking and adjacent channel parameters are often as low as 50dB and 30dB respectively, or worse. In general, if a radio data sheet fails to mention a particular parameter, it is most likely that it is embarrassingly poor.

The obvious question remains: "Why does this matter?"

It matters on two counts: Firstly, because the lower the rejection performance is the greater the likelihood that an incidental, present-in-the-radio-environment interferer will disable the link. There is always interference present in the real world and there is a lot of luck involved as to how much. A higher performance radio simply has more chance of performing reliably.

Secondly, it matters because the ability to co-site multiple systems is influenced directly by these parameters.

Imagine a situation where multiple radio systems are to be installed on a single site. For the sake of argument, we'll assume that the link is bidirectional (transceivers at both ends) and that receiver sensitivity and transmitter power output give a nominal range of 100m (typical for a low power ISM band set-up).

Now consider the effect of another link transceiver, operating in-band. We know (from the frequently used Egli propagation model) that path loss and, hence, signal strength is proportional to approximately 40 log (distance). From this, the relationship between link range and the separation between interfering transceivers can be expressed as:

40 log (operating range) = 40 log (separation between interfering transceivers) – rejection (in dB)

(depending on frequency separation, the 'rejection' can be either blocking or adjacent channel)

Hence: separation = 10^ (40 log (range) – rejection)/40

Now, using this equation for some real numbers:

Blocking = 90dB minimum separation = 0.56m
Blocking = 45dB minimum separation = 7.5m

To relate this to a real situation: imagine that this radio link is being used to transmit commands to, and receive slow frame rate video from, a remote operated vehicle. Now consider the situation when two such vehicles are operating in the same area (this could be as frivolous as a robotics demonstration, or as serious as bomb-disposal operations).

The high performance link will not lose range until the vehicles are inside 60cm of each other. The link based on low performance radios will begin to degrade at a separation of over seven meters.

Where link reliability can be compromised, then maybe a lower specification radio can be considered, but where multiple links share the same spectrum, and when reliability is an issue, then the receiver specifications cannot be ignored. ■

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Complete Digital Pre-Distortion Platform PAVES THE WAY to Higher Efficiency

Gina Colangelo, applications engineer for the communications infrastructure segment team at Analog Devices Inc, and **John Oates**, system applications engineer in the communications infrastructure segment team at Analog Devices, discuss power efficiency of amplifiers in wireless designs

MARKET PRESSURES are forcing high-power wireless radio designs to be more cost-effective than ever before. Transmitter efficiency is a big part of this equation. A quick look at any power amplifier (PA) transfer function will show that there is a fundamental tradeoff between linearity and power efficiency.

Power efficiency of a PA transistor is highest when operating in saturation, where the linearity is poor. The nonlinearity creates spectral growth beyond the signal bandwidth which interferes with adjacent channels, degrading the ACLR performance (Adjacent Channel Leakage Ratio). Within the signal bandwidth, the amplifier nonlinearity also results in added distortion, which degrades the error vector magnitude (EVM) and increases the bit error rate (BER) at the receiver.

One way to meet the linearity and spectral requirements of the air interface is to reduce the input signal level to the power amplifier so that it operates within the linear portion of its transfer curve, resulting in poor power efficiency. This method is the simplest but adds cost to the system: to achieve the required power output, a larger, more expensive PA must be used. In a typical 3G mobile base transceiver station (BTS), the transmission efficiency is less than 10%, meaning more than 90% of the DC power is lost and turns into heat.

The more cost-effective answer to this dilemma is solved by DSP ingenuity. Using a technique called digital pre-distortion (DPD), the spectral requirements can be achieved by pre-distorting the transmit signal to effectively linearize a PA transistor which is operating in the highly efficient saturation region. DPD requires an observation receiver with a high bandwidth ADC that down-converts a coupled version of the PA output. The digital version of the transmitted waveform is compared to the received waveform and adaptive algorithms compute or update a set of coeffiecients to pre-load the next transmitted waveform.

As the adaptive algorithm converges, the transmitter output is linearized even though the PA is operating well into the nonlinear portion of the transfer function. DPD can improve transmitter efficiency from less than 10% to over 35%, depending on the algorithm and the power amplifier topology.

3G/4G-Compliant Radio Platform

Wireless radio systems that contain complex closed loop algorithms such as DPD cannot be designed in isolation. Analogue behaviours of the signal chain, as well as the electrical and thermal memory effects of the PA, are not easily modelled. The number of distortion mechanisms increase rapidly with the order of nonlinearity, meaning that the input drive level to the PA can significantly change the distortion behavior. Having a full closed loop evaluation platform is invaluable to optimizing the DPD algorithms for a given PA.

Analog Devices (ADI) has developed a 3G/4G-compliant transmit radio platform to enable wireless infrastructure equipment designers to evaluate the closed-loop performance results with a PA and digital pre-distortion techniques. This Mixed-Signal Digital Pre-Distortion (MSDPD) platform, shown in **Figure 1**, combines ADI's high performance linear and mixed-signal devices into a state-of-the-art transmitter and DPD observation receiver. Designers now have the flexibility to design, evaluate and optimize their DPD algorithm without being forced into using a pre-packaged, closed box solution.

Using their broad portfolio of RF and mixed signal ICs and rich history in communication signal processing, ADI has assembled a proven combination of these standard parts on a single development board. This allows basestation manufacturers to reduce their engineering resources and improve time to market.

This full radio evaluation platform has not only helped wireless infrastructure equipment designers evaluate DPD, but it has also opened the door for other applications that use high power amplifiers, such as cable broadcast systems, microwave point-to-point links and wireless repeaters, to quickly evaluate what DPD can do for their application. In theory, it is not only possible to compensate for high power PAs, but also for the nonlinearity of the transmit chain itself. It will be interesting to see all the future applications which can benefit from DPD technology.

The FPGA Advantage

Today, many DPD users are either using a fixed function ASIC (application-specific integrated circuit) or an FPGA (field-programmable gate array) based solution. The programmability of an FPGA provides the flexibility to optimize the solution and to adapt to future improvements in data converter and power transistor technologies.

A fixed-function ASIC does not allow designers to easily make changes to

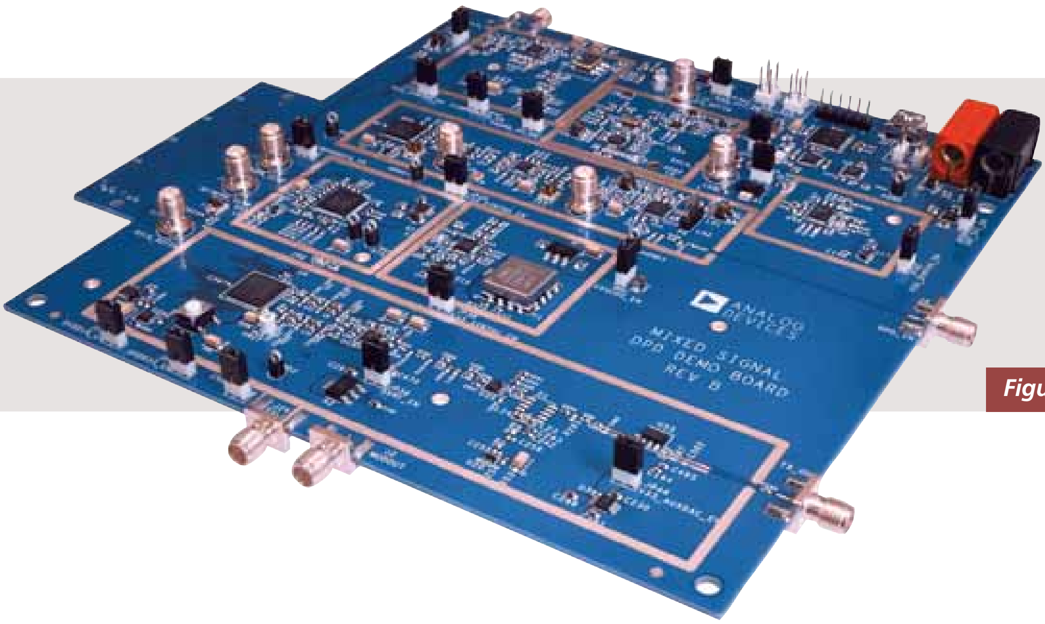


Figure 1: *MSDPD board*

algorithms or support variations in standards. The advantages provided by programmable devices will enable a faster time to market, with the flexibility to accommodate new and evolving standards cost effectively without having to wait for the next ASIC re-spin.

With advances in FPGA technology, a single FPGA device can be used to implement the whole radio modem with support for multiple standards and multiple antennas, eliminating many signal processing and connectivity ICs. This results in reduced board space and BOM costs. Also, this level of integration brings the industry a step closer to a software defined radio (SDR), enabling equipment manufacturers to quickly respond to the demands of network providers.

The MSDPD development platform is the only solution of its kind on the market that offers wireless infrastructure equipment designers the functionality of an FPGA. The MSDPD board interfaces seamlessly with several FPGA development kits: Altera's Stratix IV via an HSMC interface and Xilinx's Virtex 6 via an FMC interface. The direct interface to the FPGA presents an instant framework for designers to quickly evaluate either third party DPD algorithms or design and optimize their own algorithms in a closed-loop environment by simply reprogramming the FPGA.

Architecture Discussion

The MSDPD board was designed to provide best-in-class performance of both the transmit chain and observation receive path. The radio design is broadband and configurable at assembly to support RF bands from 800MHz to 2.7GHz. Currently, 125MHz of transmit bandwidth is supported. Depending on the DPD methods employed, this would allow for a corrected Tx bandwidth between 20 and 40MHz.

Inputs to this board include baseband digital data from the FPGA, reference clocks, observed RF output and power. Outputs from this board include the RF pre-amplified output at the desired RF carrier center frequency and an IF sampled version of the transmitter output. The board is designed to work with an external PA and RF coupling network. The transmitter and observation receiver signal chains used on the MSDPD are illustrated in **Figure 2**.

ZIF/CIF Transmitter

The MSDPD board samples baseband I and Q data from the digital processor using a 16-bit 1.2GSPS Dual DAC, which is then modulated up to the desired RF output frequency and amplified to generate up to +19dBm peak output power which can be passed to an external PA for transmit. The MSDPD board supports both zero-IF and complex-IF transmit architectures.

The AD9122 1.2GSPS 16-bit Dual DAC was chosen for its best-in-class performance to target MC-GSM Class 1. The high input LVDS data rate allows for 200MHz of input bandwidth in the first generation MSDPD platform. The on-chip 32-bit NCO (numerically controlled oscillator) included on the AD9122 allows for flexible IF generation in steps less than 1Hz, helping to meet channel raster requirements that would otherwise need to be absorbed by the dividers in the RF PLL, a

Figure 2: *General layout and the actual view of the DAQ card*

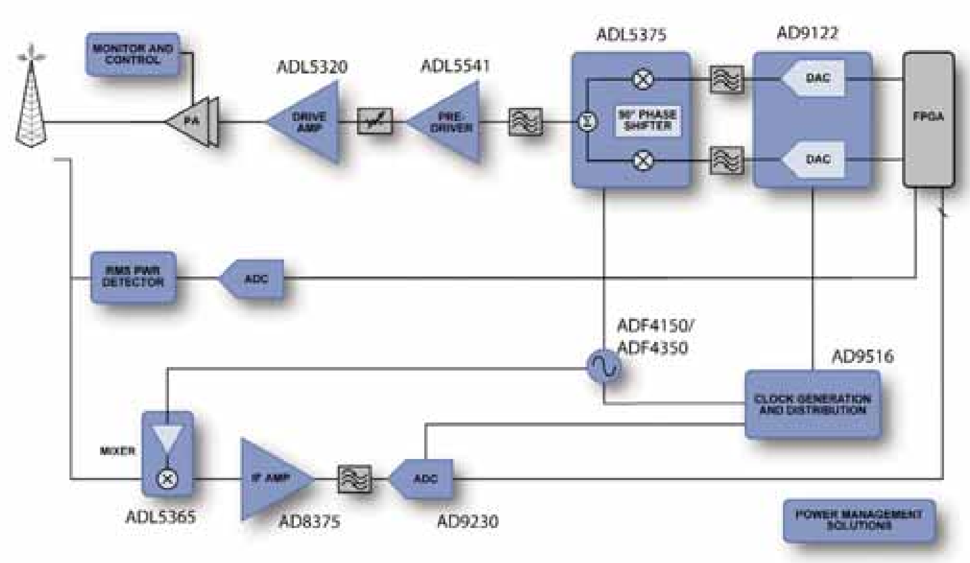


Figure 3: MSDPD setup with FPGA development platform

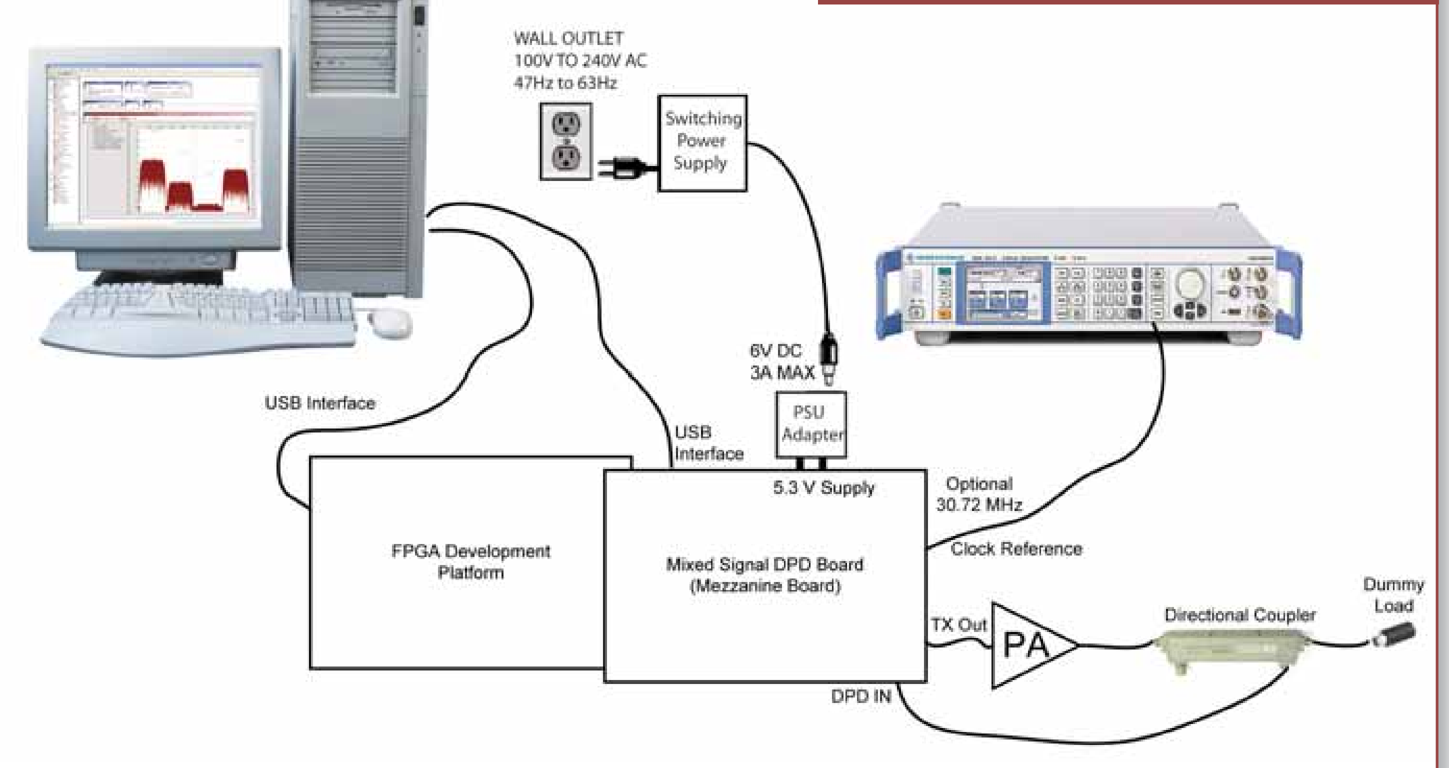
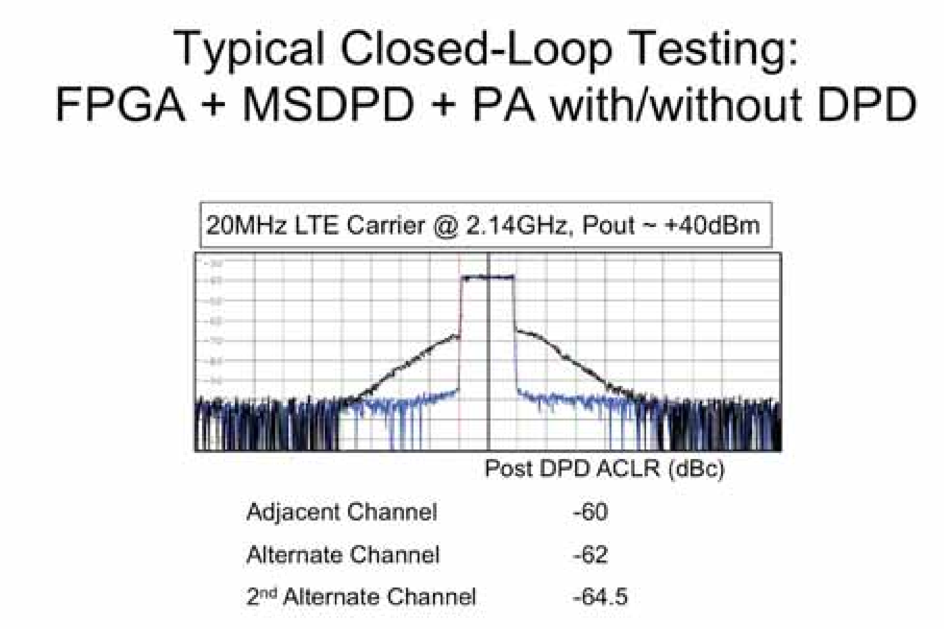


Figure 4: MSDPD closed loop performance



method that could potentially degrade spurious performance. Digital gain, phase and offset compensation are also included on chip to aid in reducing LO feedthrough and unwanted sidebands that are introduced by the analogue quadrature modulator, allowing for the minimization of RF filtering.

The dual DAC is followed by a fifth order low pass filter to remove any unwanted DAC images or clock related spurs. The filter cutoff frequency was over-designed in order to maintain flat frequency response and low group delay variation across the full transmit bandwidth. Following the filter, the analogue IF is up converted to the final RF using the ADL5375 quadrature modulator, which was selected because of its broadband nature and very low noise floor of -159dBm/Hz. The ADL5375 supports a disable function that allows the output to be disabled during the Rx portion of a TDD burst.

The local oscillator (LO) for the transmit path is generated on-board using the ADF4150 PLL with an external VCO to provide superior phase noise. One benefit of a complex-IF transmit architecture is that the LO can be shared between transmit and observation receive paths, since the observation receiver employs a high-IF sampling architecture.

The quadrature modulator is followed by an RF amplification chain. Since PAs have gain variations versus frequency and temperature, it is desirable to have some analogue gain control to equalize the transmitter. For minimum SNR (signal-to-noise ratio) degradation and optimal OIP3 (output third order intercept point) performance, it is recommended to do the bulk of the gain range adjustment between amplification stages.

The ADL5541 15dB fixed gain block followed by a PIN diode attenuator was chosen for the analogue gain control. Fixed gain blocks typically have better linearity and noise performance than VGAs (variable gain amplifiers). The ADL5320 pre-driver broadband amplifier completes the RF amplification chain on the MSDPD board and provides an additional 13dB of gain with an OIP3 of 42dBm, and a Noise Figure (NF) of 4.5dB at 2.1GHz. The cascaded RF amplification chain provides 22dB of gain, and an OP1dB = 24dBm and OIP3 = 41dBm at max gain.

Passband flatness and group delay variation across the entire DPD bandwidth are also crucial specifications for the transmitter. The digital algorithms will try to equalize the frequency response of the up-converter. This will directly impact the dynamic range of the transmitter which will be reduced by the amount of ripple or droop across the pass-band. The filter designs on the transmit path of the MSDPD board were optimized such that the passband flatness across the full BW is less than 1dB and the group delay variation is less than 0.5ns.

IF Sampling Observation Receiver

The MSDPD board contains a complete real IF-sampling observation receiver that is designed to digitize the coupled output of the PA and provide it to the DSP elements. Since the role of this receiver is to observe the characteristics of the transmit path, it should provide linearity and noise performance superior to that being monitored so it doesn't drive overall performance.

Any distortion added to the PA coupled output by the observation path cannot be distinguished from the PA distortion and will influence the effectiveness of the DPD algorithm. Filters should have a relatively flat frequency response with low group delay variation across the band of interest for best DPD performance.

The observation receiver consists of an AD5365/7 doubly balanced passive mixer that operates in the RF bands from 900-2500MHz. This highly linear mixer has an input IP3 of 36dBm with integrated RF and LO baluns and a SPDT switch enabling selection between two LO sources. The mixer down-converts the RF signal to a typical IF of 184MHz, but the IF can be changed based on application requirements. Following the mixer, 24dB of gain range is afforded by the AD8375 digitally controlled Variable Gain Amplifier (DGA) to ensure the full dynamic range of the ADC is maintained. An anti-alias filter is used to remove harmonics and broadband noise before the signal is digitized with an AD9230, 12-bit 250 MSPS ADC. Four-carrier WCDMA loopback results have measured performance at 60dB SNRFS and 77dBc Spurious Free Dynamic Range (SFDR) at the ADC output.

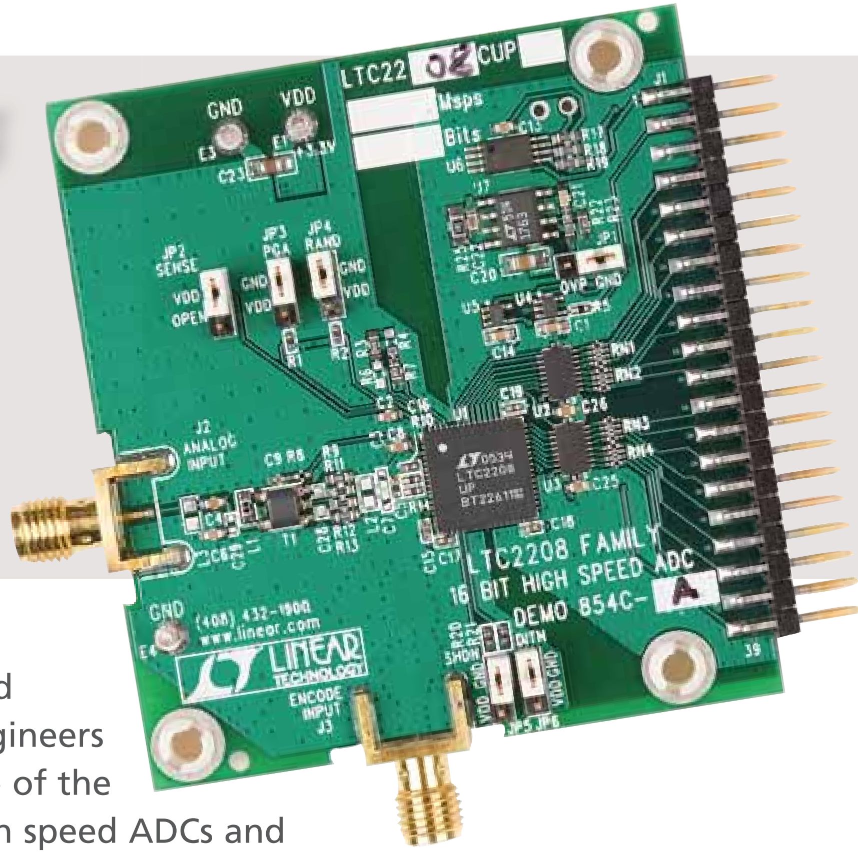
Closing the Loop

The typical setup required for closed-loop transmitter evaluation with the MSDPD board is shown in **Figure 3**. With an FPGA development kit and an MSDPD board, the only requirements to get the full evaluation system up and running are a power connection, a computer with USB and a PA stage.

Figure 4 shows typical closed loop DPD performance before and after linearization using the MSDPD board with a 20MHz wide LTE signal at 2.14GHz. These promising results allow cheaper PAs to be employed with improved power efficiency and linearity. Spectral performance can typically be improved by at least 25dB depending on the DPD algorithm.

The MSDPD board from Analog Devices is a complete toolkit for wireless companies investigating the power of DPD technology in their systems. ■

Bench Testing HIGH SPEED ANALOGUE to Digital Converters



Mark Thoren, Applications Design Manager, and **Clarence Mayott** and **Derek Redmayne**, Applications Engineers at Linear Technology highlight some of the issues with testing and applying high speed ADCs and provide some tips on how to systematically test applications

HIGH-SPEED analogue to digital converters (ADCs) are an essential part of many communications and instrumentation applications, including cellular basestations, wireless data infrastructure equipment, spectrum analyzers, software radio, medical diagnostic equipment and RFID readers. These systems can be quite complicated, with a combination of low-noise analogue signal processing and high-speed digital circuitry, often on the same board. And the place where analogue meets digital – the ADC – is a critical point that is sensitive to problems in either domain. This article highlights some of the issues with testing and applying high speed ADCs and provides some tips on how to systematically test applications.

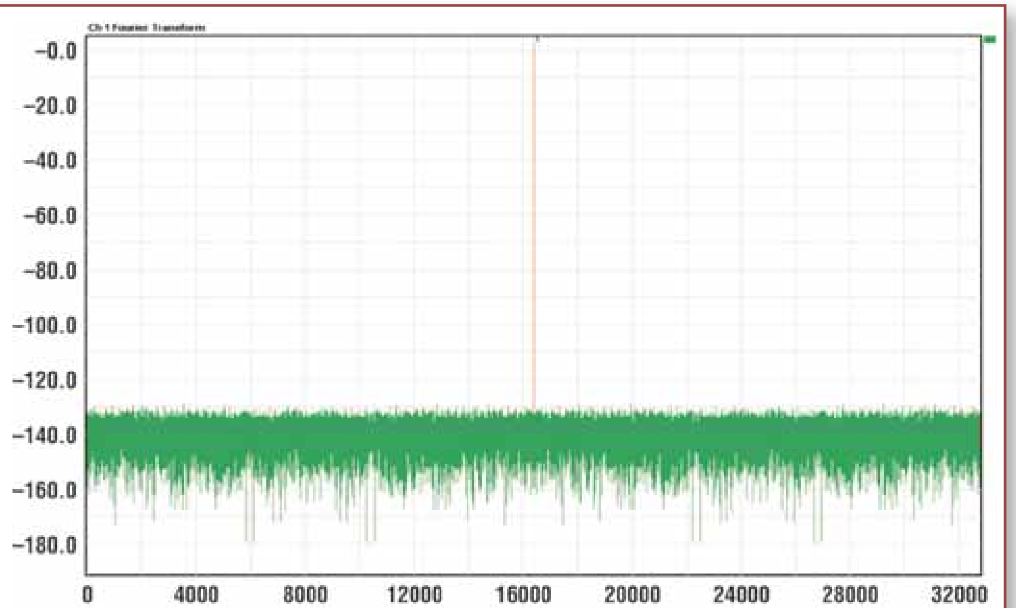


Figure 1:
Worst frequency to use for evaluating an ADC
F1 = 25MHz THD = N/A
Fs = 100MHz SFDR = N/A
SNR = 95.92dB Flor = -138.06dBFS

First Things First: Get a Reference Board

Each application has its own requirements for dynamic range, bandwidth, input frequency and sample rate. Other parameters that may be equally as important are power requirements and the type of digital interface (LVDS, single-ended CMOS and output voltage level of CMOS signals). These requirements narrow down the choices of ADC and the next step is to evaluate the ADC on the bench.

The ADC manufacturer should have a good reference board available. This is important for two reasons. First, many significant layout decisions have already been made. Simply use the reference board as a model for your layout to achieve datasheet level (or better) performance. Second, when bench testing the ADC, any test result that suggests performance far worse or far better, than the datasheet specifications usually mean that the test itself is flawed. Some test problems are subtle and methods to avoid or account for them are described below.

Basic Test Setup

With the reference board in hand, it is reassuring to power it up and see it meet the datasheet specifications for yourself. The test conditions include a sample rate (usually the maximum rated for the part) and an input frequency. Two signal generators are required for a basic test of signal to noise ratio (SNR), total harmonic distortion (THD) and the combination of these, SINAD, which is typically used as a figure of merit in calculating the "effective number of bits" that an ADC can achieve.

Depending on the signal generators available, the analogue input requires a narrowband filter such as TTE Model Q70T-25M-15P-50-720B (for a 25MHz input test frequency.) Most RF signal generators do have a sinusoidal output, but THD may be on the order of 1% (-40dB).

To effectively evaluate the ADC, the signal source must have a lower THD than the ADC itself. Use the datasheet as a guideline; if the ADC THD specification is -80dB and the generator's specification is -40dB, then the generator must be followed by a filter that attenuates the generator's second harmonic by at least 40dB. This will provide a conservative estimate because other harmonics are included in the generator's THD specification.

Distortion is not as important on the clock input – in fact many ADCs accept a square wave input. However, a narrowband filter reduces wideband phase noise, which in turn allows the measured SNR to approach the true SNR that the ADC is capable of. Jitter is the integral of phase noise and the basic relationship between jitter and the maximum SNR that can be achieved is:

$$SNR = -20*\log_{10}(2\pi*f*t_j)$$

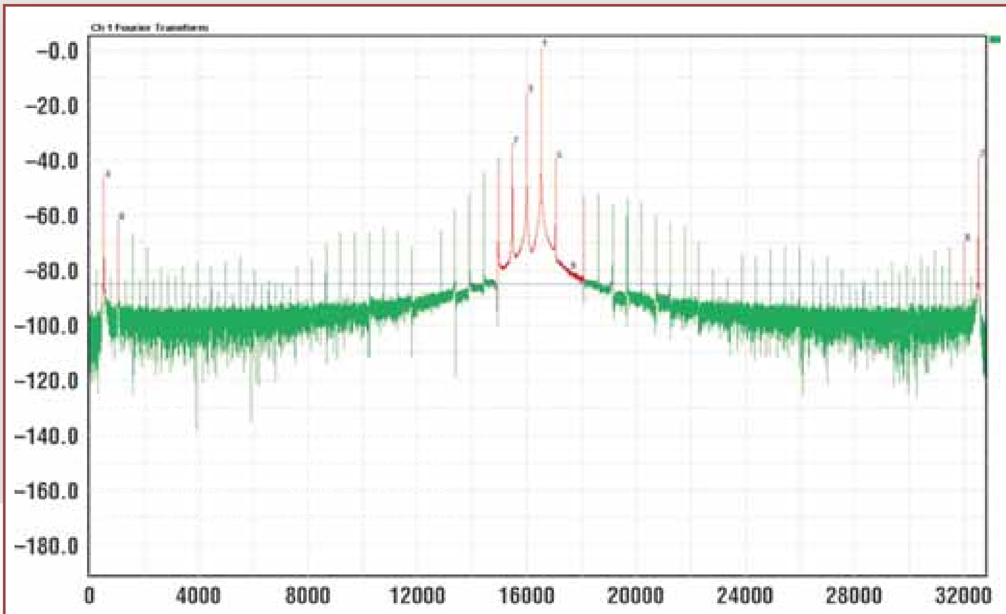


Figure 2:
Input frequency slightly higher than Fs/2
F1 = 25.2MHz THD = -16.08dB
Fs = 100MHz SFDR = 16.08dB
SNR = 41.40dB Flor = -85.16dBFS

where f is the analogue input frequency and tj is the jitter of the sampling clock expressed in seconds RMS (root-mean-square). There are several other factors that limit SNR that are properties of the ADC. These are quantization noise, electrical noise and the internal jitter of the ADC itself. The only one that you have control over is the clock jitter.

Often clock sources and signal generators have unspecified or underspecified phase noise and any device that the clock signal passes through has the potential to add jitter. In addition, the manner in which jitter or phase noise is specified may not be useful in terms of the end application.

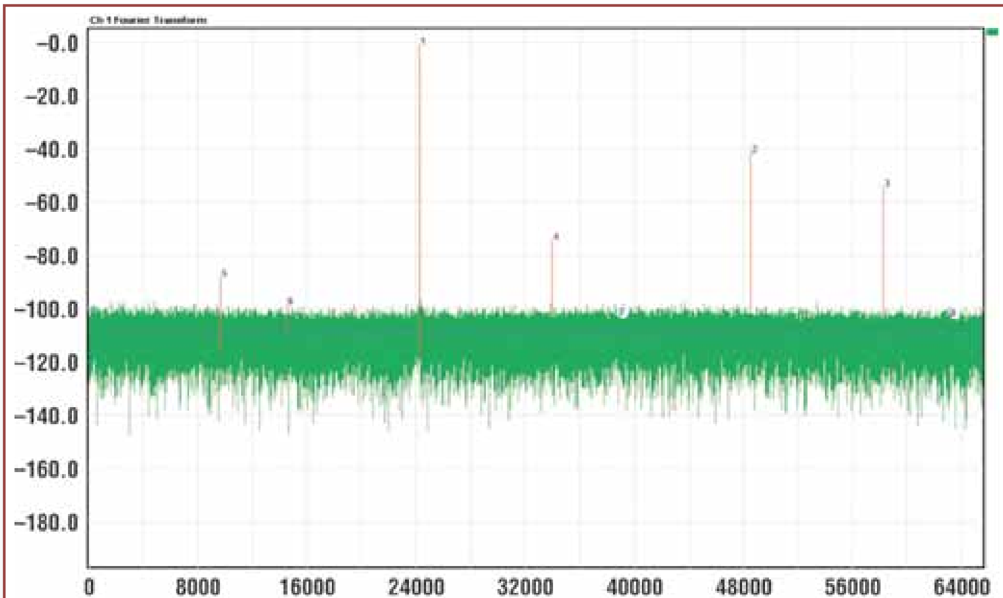


Figure 3:
Unfiltered clock, unfiltered input
F1= 24.999389648MHz THD = -40.19dB
Fs = 135MHz SFDR = 40.41dB
SNR = 59.03dB Flor = -108.18dBFS

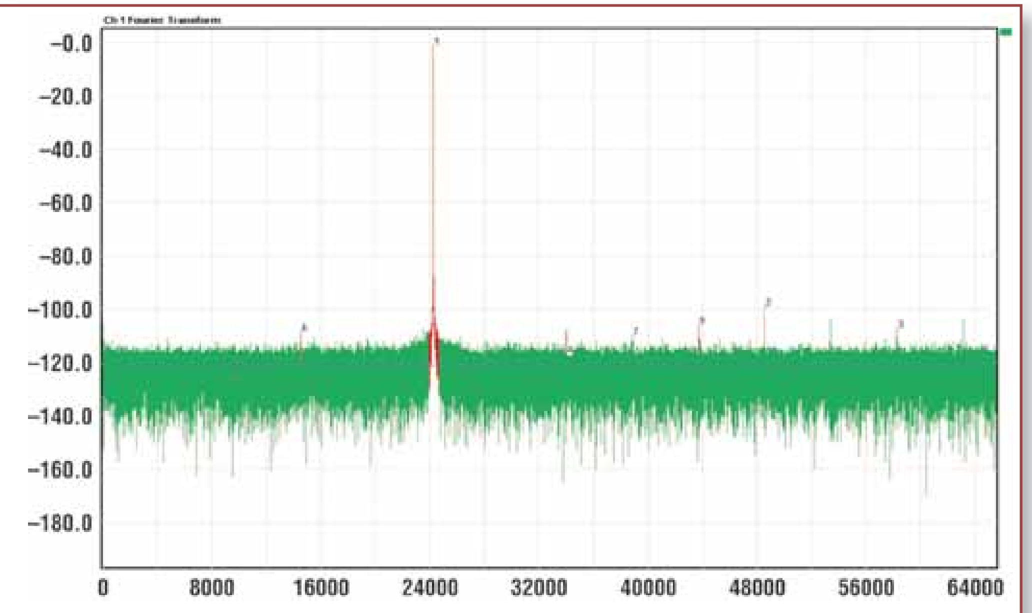


Figure 4:
Filter added to analogue input
F1 = 24.999389648MHz THD = -96.82dB
Fs = 135MHz SFDR = 98.05dB
SNR = 72.04dB Flor = -121.24dBFS

The reference board is the best way to verify the specifications of your clock source and that it is adequate for your application. It is even better than jitter analysis equipment as it provides an unequivocal demonstration of how the clock source will compromise ADC performance.

The Worst Frequency to Use for a Test Signal

The datasheet test conditions are usually a good starting point when choosing sample rates and input frequencies. It may not be possible to do this if the proper filters or generators are not available and, of course, the ADC should also be tested under conditions as close to those of the end application as possible. However there is one condition that is not suitable for testing any ADC. This is when the test frequency (F1) at the analogue input is exactly ¼ of the sample rate (Fs), or any other frequency that aliases to ¼ of the sample rate ($Fs * (2N+1)/4$, N = 0,1,2,3…). This puts the fundamental frequency in the centre of an FFT spectrum plot – which sounds like a good idea at first – but note that all of the harmonics fall into one of three locations – DC, on top of the fundamental and at exactly Fs/2! Thus it is impossible to separate the fundamental from the odd harmonics, rendering any THD calculations meaningless.

In addition, if the input is overdriven (clipping) large odd harmonics result that only add to the fundamental. This makes SNR and THD measurements appear better and better as the input is overdriven more and more.

Figure 1 is an 8192-point FFT of the 16-bit LTC2208 ADC data. The sample rate is 100Msps and the input frequency is exactly 25MHz. No distortion components are visible and the 95.9dB SNR is far better than the typical 77.6dB SNR for this part, which seems too good to be true. The only hint that anything is wrong is that the amplitude of the fundamental frequency is greater than 0dB and inspection of the raw data shows that the minimum and maximum codes are the minimum and maximum that the ADC can produce. **Figure 2** shows more truthful results when the input frequency is moved slightly higher to 25.2MHz.

A Practical Example

Figure 3 shows an 8192-point FFT of the LTC2208 output data. Two HP8642A RF generators provide the clock input and analogue input signals directly with no filtering. Clearly this does not meet the datasheet specifications. However it's not time to call the ADC manufacturer yet. **Figure 4** adds a TTE Q70T-25M-15P-50-720B filter on the input, which reduces the distortion to a more plausible level.

The visible "skirt" just visible around the

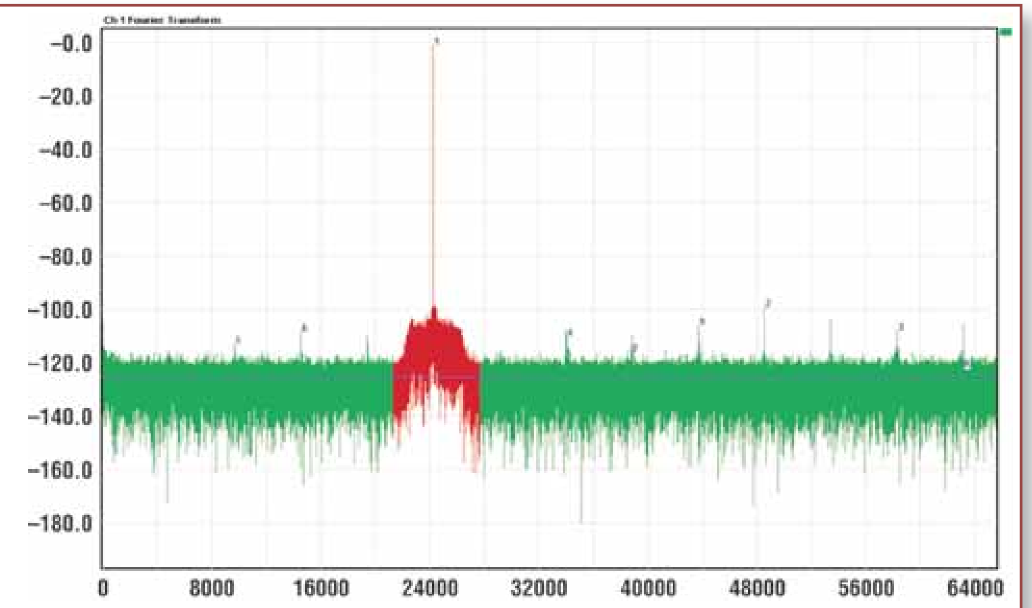


Figure 5:
Filter added to clock
F1 = 24.999389648MHz THD = -97.52dB
Fs = 135MHz SFDR = 98.45dB
SNR = 77.37dB Flor = -125.63dBFS

fundamental is the passband of the filter and clearly shows another property of the signal generator, which is its wideband noise. This noise can safely be excluded from the SNR calculation if it is a small portion of the total spectrum and if the rest of the noise floor is relatively flat. Linear Technology's evaluation software allows masking noise in this region (shown in red). The masked region is replaced with the average of the rest of the noise floor for SNR and SIND calculations.

Figure 5 includes a TTE KC7T-135M-5P-50-720B bandpass filter to the clock input, greatly improving SNR. The input filter passband is much more prominent and a larger region is masked from the SNR calculation. This test approaches datasheet numbers, but there is one more subtle effect at work. The direct sampling front-end of this ADC produces a small spike of current at every sample. This is not a problem when the source is purely resistive and less than 100 ohms or so, however the narrowband filter has a very high Q and is reactive outside of its passband. Thus it "rings" in response to sampling glitches, producing distortion.

Figure 6 includes a 100MHz absorptive lowpass filter that presents a 50 ohm resistive impedance to the ADC at high frequencies. This prevents ringing in the filter and decreases the THD by 6dB and allows the test setup to achieve full performance. The absorptive filter schematic is shown in **Figure 7**.

This just scratches the surface of the possible tests that may be used to characterize an ADC for a given application. Another useful measurement is a two-tone intermodulation test, which is a measure of an ADC's ability to handle multiple signals simultaneously. An extension of this test is Adjacent Channel Power Ratio or Adjacent Channel Leakage Ratio in which the test signal is a band of pseudo-random noise.

Integrating the ADC into a New Design

With the performance of the ADC reference board validated, the next step is integrating it into a new design. While the end applications for high-speed ADCs are highly diverse, there are a few design principles that apply universally.

First, copy the reference board layout as closely as possible. Pay particular attention to placement of bypass capacitors, reference compensation capacitors, ground planes and the separation of the conversion clock, input signal and data lines. The conversion clock must be treated as an analogue signal, even though it may have the appearance of a square wave. In addition, any logic devices that the conversion clock passes through must be treated as analogue components.

If an FPGA or DSP is used as a clock divider, the divided signal must be retimed with a flip-flop that is clocked by a low-jitter source. The retiming flip-flop is now an analogue component and must be powered from a clean, analogue supply.

Finally, include some features to make testing and troubleshooting easier. For instance, break the analogue signal path in a few places to allow a test signal to be injected. Also include the ability to capture a set of data from the ADC directly, with no digital signal processing. A communications infrastructure board may never see any signal as simple as a single sinewave, but testing the ADC in the same way as it is specified in its datasheet will aid significantly in finding any problems that may come up. ■

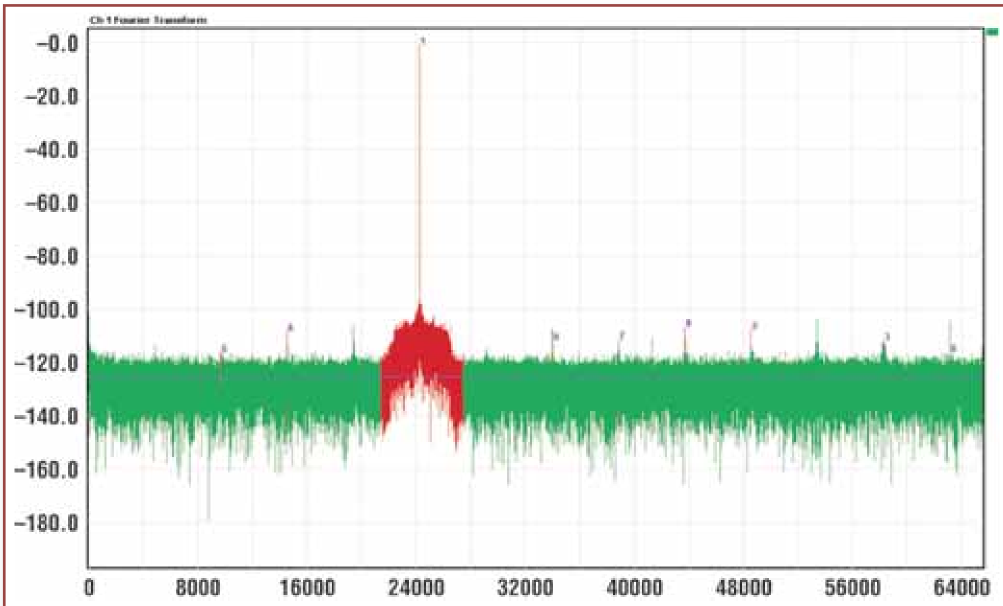


Figure 6:
Absorptive lowpass added to input
F1 = 24.999389648MHz THD = -103.54dB
Fs = 135MHz SFDR = 105.88dB
SNR = 77.41dB Flor = -125.58dBFS

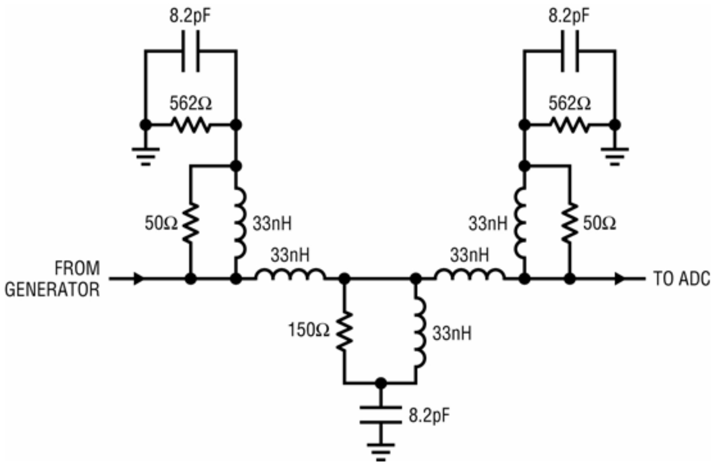


***Figure 7:** Absorptive lowpass filter schematic*

Channel Coding, Decoding and Processing used in MOBILE SATELLITE COMMUNICATIONS Part 1

In a series of three articles **Stojce Dimov Ilcev** of Mangosuthu University of Technology in Durban, South Africa, reviews the basic and state-of-art channel coding, decoding and error correction techniques as well as channel processing used in Mobile Satellite Communications

VOICE, VIDEO AND data information used in Mobile Satellite Communications (MSC) are transmitted in digital form through a channel that can cause degradation of these transmission signals. The noise, interference, fading and other obstacle factors experienced during transmission could increase the probability of bit error at the receiver of Mobile Earth Station (MES). The coding process uses redundant bits, which contain no information to assist in the detection and correction of errors.

The subject of coding emerged following the fundamental concepts of information theory laid down by Shannon in 1948, which is the relationship between communication channel and the rate at which information can be transmitted over it; the theorems laying down the fundamental limits on the amount of information flow through a channel are given.

As is known, satellite communication systems are generally limited by the available power and bandwidth. Thus, it is of interest if the signal power can be reduced while maintaining the same grade of service or bit error rate (BER). As mentioned, this can be achieved by adding extra or redundant bits to the information content by using a channel coder. Otherwise, excepting several main classes of channel coder, the three most widely used in MSC are block, cyclic and convolutional encoders.

Block Codes

Binary linear block codes are expressed in the (n, k) form, where (k) is the information bits number that is converted into (n) code word bits (see **Figure 1**). There are (n, k) party bits in each encoded block, where the difference between (n) and (k) bits are added by the coder as a number of redundancy bits (r). In the other words, a coded block comprising (n) bits consists in (k) information and (r) redundant bits expressed as follows:

$$n = k + r$$

Such a code is designated as a (n, k) code, where the code rate or code efficiency is given by the ratio of (k/n). Mapping between message sequences and code words can be achieved using look-up tables; although as the size of the code block increases such an approach becomes impractical. This is not such a problem as linear code words can be generated using some form of linear transformation of the message sequence. Thus, a code sequence (c) comprising of the row vector elements ($c_1, c_2, \ldots, c_n$) is generated from a message sequence (m), comprising the row vector elements ($m_1, m_2, \ldots, m_k$) by a linear operation:

$$c = m\,G$$

where G = generator matrix. Thus, in general, all (c) code bits are generated from linear combinations of the (k) message bits.

A special category known as a systematic code occurs when the first (k) digits of the code are the same as the first (k) message bits, namely if input message bits appear as part of the output code bits. The remaining n-k code bits are then generated from the (k) message bits using a form of linear combination, and they are termed the party data bits.

The generator matrix for a linear block code is one of the bases of the vector space of valid codewords. The generator matrix defines the length of each codeword (n), the number of information bits (k) in each codeword and the type of redundancy that is added; the code is completely defined by its generator matrix.

The generator matrix is a (k · n) matrix that is the row space of V_k. Thus, one possible generator matrix for a typical (7, 4) linear block code has to be presented in four rows as blocks: G = 1101000/ 0110100/1110010/1010001. Thus, the distance between two coded words (for example, first 2 and second 2 digits) in a block is defined as the number of bits in which the words differ and is called the Hamming distance (d_h).

***Figure 1:** The information and the parity bits of block code*

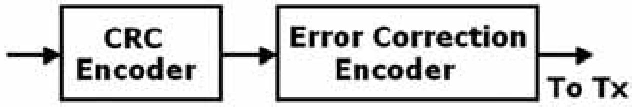
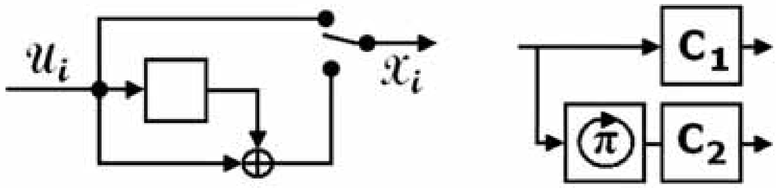


***Figure 2:** The cyclic code solution*

***Figure 3:** Convolutional encoder (left) and turbo encoder (right)*



The Hamming distance has the capability to detect all coded words having errors (e_d), where $e_d < (d_h - 1)$; to detect and correct (e_{dc}) bits, where $e_{dc} = (d_h - 1)/2$ and to correct t and detect (e) errors, where the Hamming distance as a minimum space between two coded blocks is given by:

$$d_h = t + e + 1$$

In the detection process, two coded words separated by (d_h) are most likely to be mistaken for each other. The extended Golay code offers superior performance to Hamming Codes but at a cost of increased receiver complexity. In practice, code words are conveniently generated using a series of simple shift registers and modulo-2 adders.

Cyclic Codes

These code methods are a subclass of linear codes, where a code word is generated simply by performing a cyclic shift of its predecessor. In other words, each bit in a code sequence generation is shifted by one place to the right and the end bit is fed back to the start of the sequence, hence the term cyclic. Both the linear Hamming and extended Golay codes have equivalent cyclic code generators. Thus, non-systematic cyclic codes are generated using a unique generator polynomial g(p) and message polynomials in the forms as follows:

$$g(p) = p^{n-k} + g_{n-k}p^{k-1} + \dots g_1 p + 1$$

$$m(p) = m_{k-1}p^{k-1} + m_{k-2}p^{k-2} + \dots + m_1 p + m_0$$

where the generator polynomial is a factor of p^{n+1} and the value ($m_{k-1} \dots m_0$). When this is multiplied by the generator polynomial, it results in the generation of a code word by:

$$c(p) = (m_{k-1}p^{k-1} + m_{k-2}p^{k-2} + \dots + m_1 p + m_0)\, g(p)$$

Thus, an alternative to this approach is to generate systematic cyclic codes, which can be generated in three steps, involving the use of feedback shift register:

a) The message polynomial is multiplied by p^{n-k}, which is equivalent to shifting the message sequence by (n – k) bits. This is necessary to make space for the insertion of the party bits.

b) The product of step 1, $p^{n-k}m(p)$ is divided by the generator polynomial, g(p).

c) The remainder from step 2 is the party bit sequence, which is then added to the message sequence prior to transmissions.

The cyclic codes scheme has two methods used in MSC: Bose-Chadhury-Hocquenghem (BCH) and Reed-Solomon (RS).

BCH Codes – The BCH codes are the most powerful of all cyclic codes with a large range of block length, code rates, alphabets and error correction capability. These codes have been found to be superior in performance to all other codes of similar block length and code rate. See **Figure 2**.

Most commonly used BCH codes have a code word block length as $n = 2^m - 1$, where (m = 3, 4 …). For instance, the Inmarsat standard-A uses 57 bits plus 6 party bits encoded with BCH (63, 57 code in TDM channels and for the return request channel burst employs Aloha BPSK (BCH) 4800b/s.

RS Codes – The RS codes are a subset of the BCH codes specially suited for correcting the effect of the burst errors. The latter consideration is particularly important in the context of the MSC channels and hence, RS codes are usually incorporated into the system design.

This set of codes has the largest possible code minimum distance of any linear code with the same encoder input and output block length.

Thus, the RS codes are specified using the convention RS (n, k), where n = number of code symbols word length per block; k = data symbols encoded and the difference between (n) and (k) is the number of parity symbols added to the data. The code minimum distance is given by:

$$d_{min} = n - k + 1$$

The code is capable of correcting errors such as: $e = 1/2\,(d_{min} - 1)$ and $e = (n - k)/2$, or to use an alphabet of 2^m symbols with: $n = 2^m - 1$ and $k = 2^m - 1 - 2e$, where m = 2,3 … and so on. The advantage of RS codes is the reduction in the number of words (n) symbols, which are code words, producing a possibly large value of minimum distance (d_{min}).

Convolutional Codes

The second family of commonly used codes is known as convolution codes. Unlike block codes, which operate on each block independently, these codes retain several previous bits in memory, which are all used in the coding process. They are generated by a typed-shift register and two or more modulo-2 adders connected to particular stage of the register.

The number of bits stored in the shift register is termed the constraint length (K). Bits within the register are shifted by (k) input bits. Each new input generates (n) output bits, which are obtained by sampling the outputs of the modulo-2 adders. The ratio of (k) to

(n) is known as the code rate. These codes are usually classified according to the following convention: (n, k, K), for example (2, 1, 7), refers to a half-rate encoder of constraint length 7. It is important to know what sequence of output code bits will be generated for a particular input stream. There are several techniques available to assist with this question, the most popular being connection pictorial, state diagram, tree diagram and trellis diagram.

However, to illustrate how these methods are applied, the simple example of half-rate (1/2) encoder will be considered with constraint length k = 3. The system has two modulo-2 adders, so that the code rate is 1/2. The input bit (m) placed into the first of the shift register causes the bits in the register to be moved one place to the right.

The output switch samples the output of each modulo-2 adder, one after the other, to form a bit pair for the bit just entered. The connections from the register to the adders could be one, two or three interfaces for either adder. The choice depends on the requirement to produce a code with good distance properties. A similar encoder used by the Inmarsat standard-A is a half-rate convolutional encoder. Therefore, in terms of connections to the modulo-2, adders can be defined using generator polynomials in the encoder configuration. The polynomial for the generating arm (n) of the encoder $g_n(p)$ and the generator polynomials representing encoder $g_1(p)$ can have the following relations:

$$g_n(p) = g_0(p) + g_1 p^1 + \dots g_n p^n$$

$$g_1(p) = 1 + p + p^2 = 1 + p^2$$

where the value of g_1 takes on the value of 0 or 1 and a 1 is used to indicate that there is a connection between a particular element of the shift register and the modulo-2 adder. Thus, to provide a simple representation of the encoder, generator polynomials are used to predict the output coded message sequences for a given input sequences. For instance, the input sequence 10110 can be represented by the polynomial relation:

$$m(p) = 1 + p^2 + p^3$$

Combining this with the respective generator polynomials and using the rules of module-2 arithmetic results in the following:

$$m(p)g_1(p) = (1 + p^2 + p^3)(1 + p + p^2) = 1 + p + p^5$$

$$m(p)g_2(p) = (1 + p^2 + p^3)(1 + p^2) = 1 + p^3 + p^4 + p^5$$

The output code sequence c(p) obtains by interleaving the above two products as follows:

$$c(p) = [1,1]p^0 + [1,0]p^1 + [0,0]p^2 + [0,1]p^3 + [0,1]p^4 + [1,1]p^5$$

Here, the number between brackets represents the output code sequence.

The Inmarsat analogue standard-A uses a HSD channel encoding configuration for the information data stream at 56Kb/s. The scrambling sequence on the input data stream shall be provided by the scrambler before the convolutional encoder described in CCITT Recommendation V.35 scheme. A convolutional encoder is described in **Figure 3**.

The data stream then passes differential encoder state stage 1 followed by 1/2 (half) convolutional encoding with constant length k = 7. The half (1/2) rate convolutional encoder can provide two data streams to the QPSK modulator using two generator polynomials rates as follows: $G_1 = 1 + x^2 + x^3 + x^5 + x^6$ and $G_2 = 1 + x + x^2 + x^3 + x^6$. The encoder provides two parallel data streams to the modulator: I and Q, while (Q) should lag (I) by 90° in the modulator.

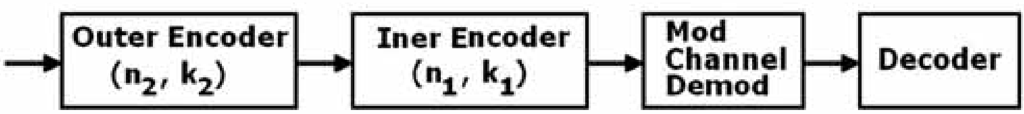
The Inmarsat digital standard-B for transmission and out-of-band signalling channels uses digital modulation and FEC in order to efficiently utilize satellite power and bandwidth.

The basic modulation and coding techniques are filtered by 60% roll-off O-QPSK and 40% roll-off BPSK, both with convolutional coding at either rate: 1/2 or 3/4 FEC and 8-level soft decision Viterbi decoding (constraint length = 7).

Hence, punctured coding is used to derive 3/4 and 1/2 rates. All BPSK channels are differentially encoded outside the FEC. The Inmarsat standard-M for all transmissions, with the exception of those fields carrying digitally coded voice, employs FEC with convolutional encoding of constraint length k = 7 and 8-level soft decision Viterbi decoding.

There are two generator polynomials rates: G_1 (133 octal) and G_2 (171 octal). The transmitted bit is nominated by 1 and deleted by 0.

Figure 4: *Concatenated coded system*



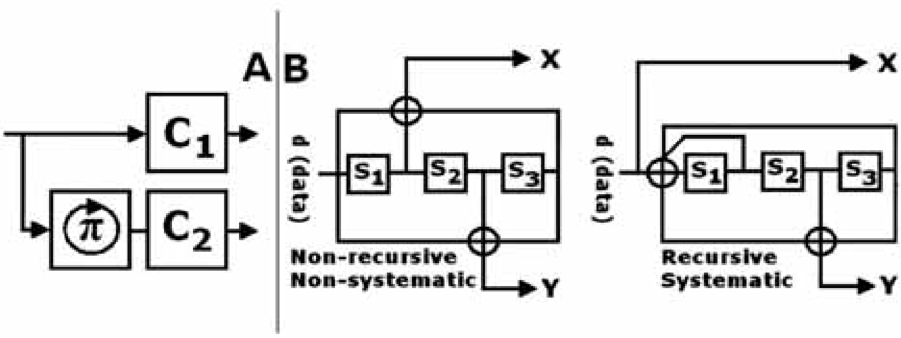


Figure 5: *The two forms of convolutional encoders*

However, the first bit in each transmission frame is the output from the G_1 polynomial and all bits are transmitted at the rate of 1/2 code. The output data from the bit selector are punctured coded data of 3/4 rate.

Concatenated and Turbo Codes

The concatenated codes were originally developed for deep space communications and occur when two separate coding techniques are combined to form a large code (see a concatenated code system in **Figure 4**). The inner decoder is used to correct most of the errors introduced by the channel, the output of which is then fed into the outer decoder, which further reduces the bit error rate to the target level. That is to say, a typical concatenated coding scheme would employ half-rate convolutional encoding of constraint length 7 (2, 1, 7) – Viterbi decoding as the inner scheme and RS (255, 223) block encoding and decoding as the outer scheme. Interleaving between the inner and outer coders can be used to further improve the performance.

Turbo codes are a new class of error correction codes that were introduced in 1993 by a group of researchers from France, along with a practical decoding algorithm. The major importance of these codes is that they enable reliable transmission with power efficiencies close to the theoretical limit predicted by Claude Shannon. Two types of encoder are shown in **Figure 5** (**a** and **b**).

Since their introduction, turbo codes have been proposed for low-power applications such as deep space and satellite communications, as well as for interference limited applications such as third generation cellular or personal telecommunication services. Due to the use of a pseudo-random interleaver, turbo codes appear randomly to the channel, yet possess enough structure so that decoding can be physically realized.

Thus, developed for deep space and satellite communication applications, turbo codes offer a performance significantly better than concatenated codes. They are generated using two or more recursive systematic convolutional code generators concatenated in parallel. Here, the term recursive implies that some of the output bits of the convolutional encoder are fed back and applied to the input bit sequence. The first encoder takes the information bits as input.

The key to the turbo code generation is the presence of a permuter, which performs a function similar to an interleaver; with the only difference that here the output sequence is pseudo-random. The permuter takes a block of information bits, which should be large to increase performance, for example more than 1000 bits and produces a random, delayed sequence of output bits, which is then fed into the second encoder. In such a manner, the outputs of the two encoders are partly bits transmitted along with the original information bits. Hence, in order to reduce the number of transmitted bits, the party bits are punctured prior to transmission.

From various simulation results it is recognized that turbo codes are capable of achieving an arbitrarily low BER of 10-5 at an Eb/No ratio of just 0.7dB. For instance, in order to achieve this level of performance, large block sizes of 65,532 data bits are required. Because of this prohibitively enlarged block size, an original turbo code is not well suited for real time telecommunication systems such as the IS-95 CDMA cellular standard. For that reason, the work on this problem has focused on the design of short block length codes, compatible with IS-95 standard.

Basic and State-of-Art Coding

In this article we have reviewed basic and state-of-art coding, decoding and error correction techniques for MSC. Those techniques have been used extensively in digital MSC, because they are providing cost-effective solutions in achieving efficient and reliable digital transmissions.

Coding now plays an important role in the design of modern MSC and forthcoming generations of technology are expected to continue this trend with development more complicated, but more economic coding schemes.

Future Mobile and Fixed Satellite Communication Systems cannot be totally separated from development of terrestrial broadband and broadcast communication systems. In this perspective, development of new satellite systems and techniques tends to align with that of terrestrial communications and to provide full integration between two networks, which will allow high data rates and high quality of service, anytime and anywhere.

Looking at this framework will be necessary to highlight some of fundamentals of coding, decoding and error correction technologies, developments and their evolution. In particular, communication links and modelling of channels for MSC need design and implementation of modern coding and interference cancellation techniques.

In this innovative age of ICT it is becoming essential to provide communications of information to people on the move at sea, on the ground and in the air, having sometimes difficulties to locate some of them precisely. Therefore, the deployment of channel coding and interleaving will enhance the bit-error performance of MSC links addressed for digital speech and data transmissions. ■

The End of Electric Charge and ELECTRIC CURRENT as We Know Them – Part 2

Ivor Catt, an engineer and a scientist, presents a two-part article on the matters of electrical charge and current. This is the second part

"IT DOESN'T MAKE any difference how smart you are, who made the guess, or what his name is – if it disagrees with real-life results, it is wrong. That's all there is to it!" Richard Feynman, Nobel Prize winner.

" ...Scientists tend not to ask themselves questions until they see the rudiments of an answer in their minds. Embarrassing questions tend to remain unasked or, if asked, to be answered rudely." – P B Medawar, "The Future of Man" [BBC Reith Lectures 1959], pub. Basic Books Inc., N.Y., 1960, p62.

Last month, a narrow voltage spike was injected into a printed circuit conductor above a ground plane (**Figure 1**) in the presence of a parallel passive line (**Figure 2**). Further down the lines, it separated out into the faster Odd Mode and the slower Even Mode. Last month, I proved mathematically that the earliest, first traces were not permissible under Faraday's Law.

Does Mathematics Distinguish Between Cause and Effect?

Electromagnetic theory grew out of the perusal of such things as magnets, electrically-charged bodies and the rest. This led to such concepts as electric charge and electric current, and to static electric field and static magnetic field. Faraday (thought he) discovered that a slowly changing magnetic field generated electric current. Much later, dubious mathematics was applied to such steady state things by Maxwell, extending to slowly changing fields, "electric currents" and, thence, to displacement current. According to Heaviside, displacement current derived from theoretical problems with the way electric current through a capacitor caused magnetic field.

Maxwell's invention of displacement current led to the idea that sunlight was electromagnetic. (Incidentally, my article "Displacement Current" in Wireless World, December 1978, pointed out that Maxwell and all lecturers and textbook writers up to today, overlook the electric current spreading out across the capacitor plates, which throws into question the reasoning leading to displacement current.)

During this development of electromagnetic theory, there were no rapidly changing fields and no electromagnetism travelling very fast, at the speed of light. Later, in around 1880, Oliver Heaviside first addressed fast travelling electromagnetism in a sophisticated way.

Maxwell started with magnets, electrically charged bodies and the like,

Figure 1: *Signal on active left surface line*

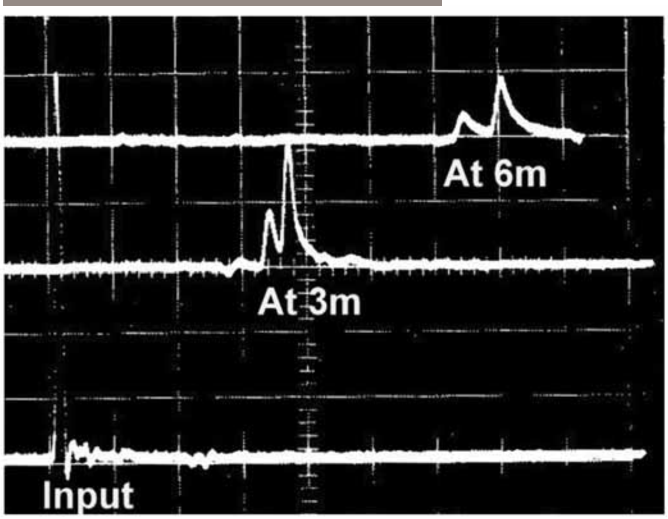
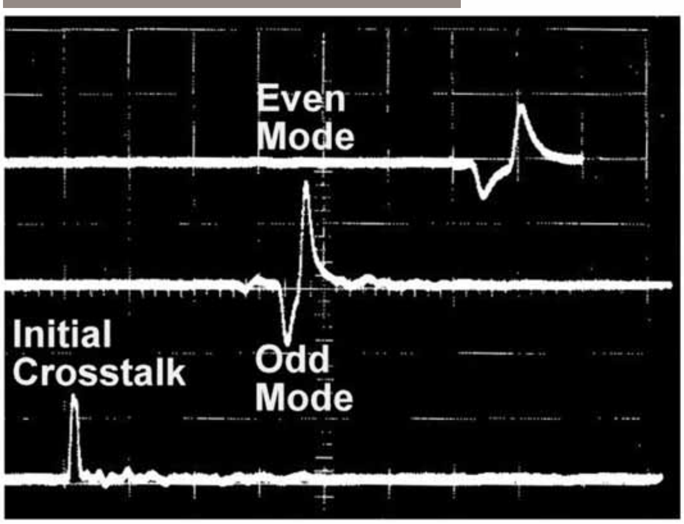


Figure 2: *Signal on passive right surface line*



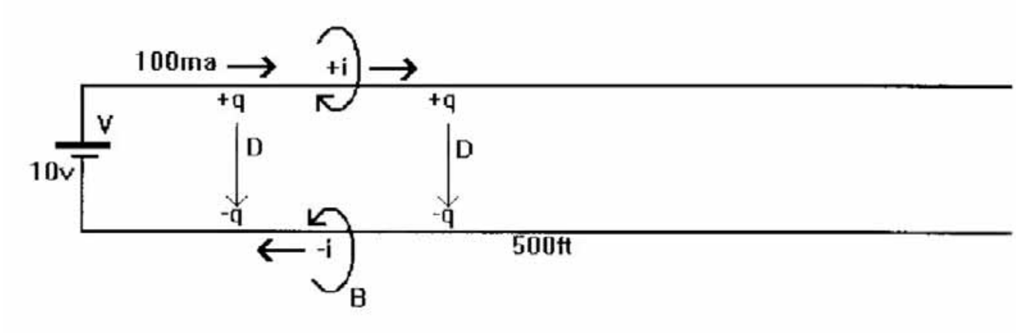


Figure 3: Features of a voltage step travelling from battery to resistor

then much mathematical manipulation led to the Transverse Electromagnetic (TEM) Wave and light.

Now, supposing that we had started with sunlight, which we have always known about, instead of with static fields and devices such as magnets. Had we had the appropriate instruments, we would have found out that light was two-dimensional energy density and travelled in the third dimension at the speed of light.

Now, all this mathematical manipulation starting from electricity and fields and leading to light is reversible, since mathematics ignores causality, and direction, in its equations. It is strange that the softer subject – chemistry – uses the more rigorous arrow in place of the ambiguous 'equals' sign used in our subject.

Since we know about sunlight, it is equally legitimate to start with sunlight or the TEM Wave (which sunlight is), and work backwards using the same mathematics towards electric field, magnetic field, electric charge and electric current. Only a historical accident caused us to progress in the traditional direction.

If we accept Occam's Razor, each of the items we then derive mathematically has to justify its existence as physically real, rather than merely the results of mathematical manipulation of things which are physically real. It turns out that, in electromagnetic theory, electric charge and electric current remain merely mathematical manipulations of what went before from our starting point with light, or the TEM Wave.

In the case of a battery connected by two wires to a resistor or lamp, they have no function. This is proved by "The Catt Question" (Electronics World, May 2009, p16) because of the dubious, contradictory "answers" by leading experts over where the charge comes from. We see that electricity is not fit for purpose, not quick enough to do the job in hand. This can only be done by the original sunlight, or TEM Wave, which has the necessary speed to get the energy from battery to lamp, since it travels at the speed of light, which an electron cannot do.

Although a cloud cannot exist without edges, the edges of a cloud do not exist. They have no width, volume, mass or materiality. However, the edges of a cloud can be drawn. Their shapes can be manipulated graphically and mathematically. The same is true of the so-called "electric charge" and "electric current". Maxwell's Equations show us that they are always on the edge of an electric or magnetic field. It was the alleged mass of electric charge which put it on a collision course with "The Catt Question".

I excluded electric charge and electric current in 1976 and published "The Death of Electric Current" in Wireless World in December 1980. I relegated them to merely being mathematical manipulations of the electric field and magnetic field (or more accurately, of the electromagnetic field). There is a difference. For instance, the gradient in electric field density (which equals electric charge) does not have mass, whereas electric charge does have.

Concept of 'Electricity'

It is pretty clear that the concept of "electricity" as perceived today started its life in the above role, of helping a battery to heat a resistor or light a lamp. Rubbing a glass rod with cat's fur played a subsidiary role in the origins of electricity. What are the other, surviving roles for electricity in today's science? I can think of the Bohr atom, the cathode ray tube and the diode.

Figure 4: Features of a voltage step travelling from battery to resistor

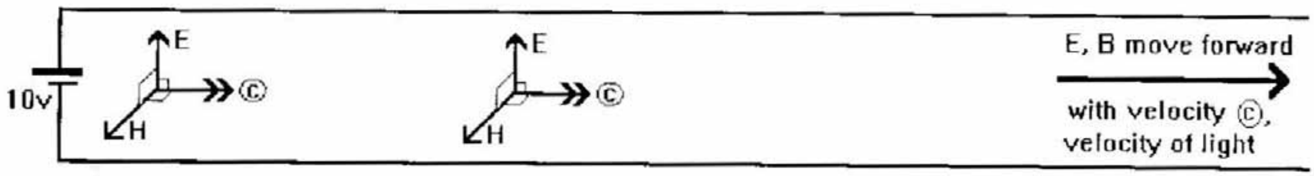
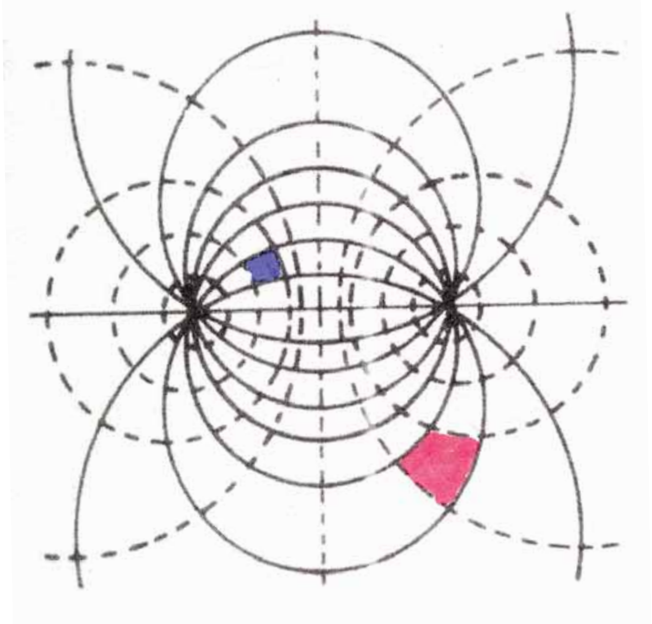


Figure 5: *Curvilinear Squares for a TEM Wave travelling between parallel lines, identical for other electromagnetic fields*



The Bohr atom: Part of its role is to supply the "electrons" which expedite the flow of "electricity" from battery to lamp. But this role is discredited by "The Catt Question" and by the earliest, first traces in Figures 1 and 2, and all the traces in Figures 5 and 6 in the last month's article (Part 1). We see that electrons hop along from atom to atom down the passive wire in both directions at once, passing each other on their journey. However, surely other roles remain today for the "electrons".

The Cathode Ray Tube: First, a digression. I asked my co-author, the late Dr Arnold Lynch, why he was chosen to give the keynote speech in the IEE (now IET) to celebrate the centenary of J J Thomson's discovery of the electron. He replied: "Because JJ told me about it."

The "electron", with its debilitating mass, which prevents it from keeping up with a TEM Wave, is only one hundred years old. Now in Heaviside's "Energy Current" approach to electromagnetic theory, the energy current, or TEM Wave, delivered at the speed of light by the HT power supply, approaches the CRT sideways between anode and cathode, or in the case of the signal input, between grid and cathode. The movement is at right angles to the alleged movement of the electron. Now the interaction between the TEM Wave arriving as "HT" and the TEM Wave arriving as "signal" is complex. However, since they collide at 180 degrees, their collision should be handled to some degree by the discussion in my 1995 book. However, the detail still has to be worked out.

When we address the electron, apparently travelling in the wrong direction at the wrong speed, it is useful to consider a wave in the sea approaching us. White foam on top of the wave appears to travel at a lower speed at right angles to the approaching wave.

The Diode: The TEM Wave of Energy Current enters sideways, directly into the interface between the P region and the N region. "The diode as an energy-controlled, not a charge-controlled, device" is discussed in Electronics and Wireless World, September 1983, p903 and in my 1995 book.

Tradition

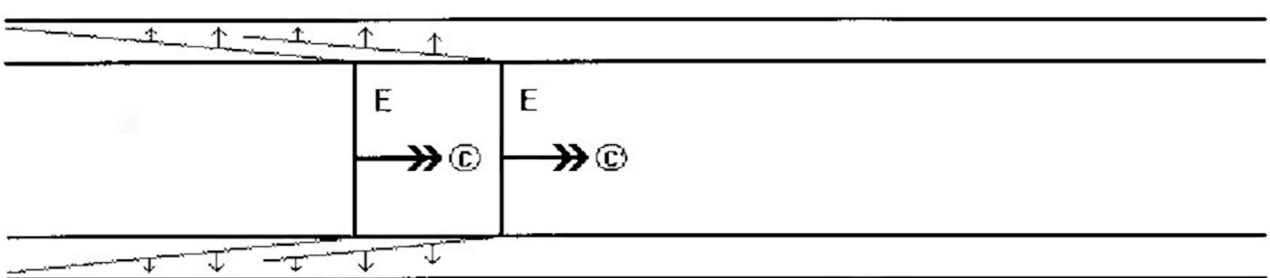
In case it should be feared that the transition described above moves us from a secure foundation to uncertainty, an analysis of the slovenly way in which the journey from "electricity" and fields to the TEM Wave and light was made, is called for. This is to be found in my articles "Maxwell's Equations Revisited" (Wireless World, March 1980) and "The Hidden Message in Maxwell's Equations" (Electronics & Wireless World, November 1985). My article "The Heaviside Signal" (Wireless World, July 1979) discusses how academia cleave to two mutually contradictory versions of the TEM Wave (or light), mostly, with Einstein, keeping to the false "Rolling Wave", where E causes H causes E. The flaw in "The Rolling Wave" is concealed by general ignorance about the relative phases of E and H, which is not mentioned in text books. If we accept the truth, that they are in phase, "The Rolling Wave" collapses. E and H cannot cause each other if they are in phase.

The Figures

Figures 3 and **4** show a TEM Wave's four features: i, q, E and H. Figures 1 and 2 here, and Figures 3 through 8 last month, only proved the existence of E, and we deduced the rest. We were right to deduce H, (or B), but wrong to give physical reality to i and q.

These conventional concepts broke down in the case of the earliest, bottom trace in Figure 2, the right-hand passive conductor. Here, Even and Odd Mode spikes were superposed, so opposite electric currents flowed through each other and there were both positive and negative charges together on the surface of the conductor, each terminating its own independent electric flux. At the least, electric charge and electric current have to be redefined. Preferably they need to be removed from electromagnetic theory. As Maxwell's Equations show, they are the result of mathematical manipulation of electric and magnetic field, for instance $\nabla \cdot \mathbf{D} = \rho_f$.

Figure 6: *A TEM Step travelling between parallel lines*



The link between electric charge and electric field is the easiest to see. If electric field comes to an abrupt stop, the edge is called "electric charge". The ExH in the **Figure 6** penetrates into the conductors as well as advancing to the right. However, the dielectric constant of a conductor approaches infinity, which means that the velocity of penetration approaches zero, leading to a sharp edge in the electric field, which we traditionally call "electric charge".

Why can a TEM Wave (Energy Current) only travel in a balanced mode, Even or Odd, when guided by four conductors? The answer lies buried in the concept of "Curvilinear Squares", **Figure 5**. This single, extremely important field pattern, which applies to many situations in electromagnetism, was only drawn in one text book during the 20th century, presumably because the other authors and lecturers did not know it. When energy travels at the speed of light guided by two conductors, the same amount of energy travels through the red square and the blue square. The impedance of each square is 377 ohms if the dielectric is vacuum, or air.

It is best to think of the two conductors in Figure 6 as flat. As a wafer of energy current, like the voltage spike in Figures 1 and 2, travels along at the speed of light, it does not know what is ahead of it or behind it. It sees ahead not only the space shown ahead, but also the new segment of conductors to its left and right, where a 377 ohm rectangle (very long and thin because of the copper's great permittivity) will receive the same amount of energy as a small square ahead, this energy moving sideways into the conductors very slowly. However, since a square (of copper) has a very high permittivity and therefore very low Zo, each 377 ohm rectangle must be elongated into a very long rectangle. Now because the velocity of the energy current is slower in the copper, the distance advanced to left and right into the copper is far smaller than the distance travelled forwards.

The angle of the sloping lines reduces towards horizontal as the permittivity is increased and, therefore, as the velocity into the copper reduces. As we approach the infinite permittivity of copper, the sloping lines become horizontal and we have a right angle between the forward travelling energy current and the surface of the conductor. This probably explains why a stable TEM Wave guided by four conductors must have its curvilinear squares, (or its electric field) at right angles to the surface of the conductor, limiting the permissible wave fronts guided by our four conductors to Even Mode and Odd Mode, which are the only possible wave fronts which are symmetrical.

Einstein's Error

"The special theory of relativity owes its origin to Maxwell's equations of the electromagnetic field." – Einstein.

The observed and photographed phenomenon, Figures 1 and 2, and Figures 5 and 6 from last month, contradicts the starting point of Einstein's theory of relativity.

In Figures 1 and 2 the spikes continue unchanged (after first separating out). When discussing the origins of Relativity, Einstein dismissed such a possibility as absurd: "... If I pursue a beam of light with the velocity c (velocity of light in a vacuum), I should observe such a beam of light as a spatially oscillatory electromagnetic field at rest. However, there seems to be no such thing, either on the basis of experience or according to Maxwell's equations."

Now in Figures 1 and 2 the spike could be a brief flash of monochromatic, sinusoidal light travelling between the two conductors, unchanged, just like the spike. In trace 2, then 1, each spike appears as a "spatially oscillatory electromagnetic field at rest [unchanging]", which Einstein dismisses as absurd.

Notice that in addition to my observing and photographing such a "spatially oscillatory electromagnetic field at rest", my calculations towards the same conclusion last month were based only on Maxwell's equations. Of course, Einstein never used a high-speed sampling oscilloscope. It is less clear why he avoided the imperatives of Maxwell's equations.

Einstein teaches 'The Rolling Wave'; the idea that in a TEM Wave E causes H causes E, which breaks down for each spike in Figures 1 and 2 (see Albert Einstein and Leopold Infeld's 'The Evolution of Physics') where it is written: "...What kind of changes are now spreading in the case of an electromagnetic wave? Just the changes of an electromagnetic field! Every change of an electric field produces a magnetic field; every change of this magnetic field produces an electric field; every change of ...., and so on. As field represents energy, all these changes spreading out in space, with a definite velocity, produce a wave. The electric and magnetic lines of force always lie, as deduced from the theory, on planes perpendicular to the direction of propagation. The wave produced is, therefore, transverse."

In contrast, on page 6 of volume 3 of his "Electromagnetic Theory", Heaviside stands firmly for "The Heaviside Signal". For instance he says: "...the whole slab moves bodily to the right at speed v, ... It carries all its properties with it unchanged," which is a clear statement of the Heaviside signal. He mentions the slab elsewhere in his writings. One does not conceive of slabs rolling, or of one part of the slab causing another part. Almost by definition, a slab, like a slab of heavy granite, moves forward unchanged at constant velocity, like Figures 1 and 2.

Blindness

We can learn a lot from my failure to notice the key point of this article for 43 years. When I published my article in 1967 I was excited about the fact that in the case of crosstalk (interference) between two parallel conductors, two velocities were involved, which was not previously known, and that crosstalk could reach 50% however far apart they were separated. This caused me to overlook the historic point discussed in this two part article.

However, there was a much more important reason for my failing to see the obvious. This was that I was socialised into respecting the reigning theory, along with its mathematical baggage. I was also impressed by the mathematical clutter that I created, reproduced last month. Thus, when I showed that only two modes were legitimate, it did not occur to me that the obvious third mode seen in the earliest trace in Figures 1 and 2 contradicted the limit of two modes deduced by the mathematics. Given my conventional education, there was no possibility that I would notice that the mathematics, and with it Faraday's Law, were being disproved before my eyes.

But did Figures 1 and 2 contradict the mathematics as well as contradicting Faraday's Law? Here we see how inadequate mathematics is as a language, because it is indifferent to questions of superposition and so was neither proved nor disproved by the photographs. Mathematics is indifferent to many other features of the physical world. This is why today's hijacking of the physical world by the limitations of mere mathematical analysis is disastrous.

If you missed Part 1 of this article you can now order it by going online at ***www.electronicsworld.co.uk***

LCD Television DEMYSTIFIED Part 2

Fawzi Ibrahim, former lecturer and author of several books, gives a practical overview of LCD television receivers. In this part, Ibrahim takes the back off an LCV TV receiver to have a look at the board architecture

IT IS ONE of the mysteries of retail conventions that when one buys a car one is entitled – in fact enticed – to look under the bonnet to examine the engine, even though they might not be able to tell a fan belt from a seat belt.

Try and do this when buying a television receiver and you will encounter incredulous looks. It is, of course, as important to ensure good workmanship in a car as it is in an electronic product. The grounds for refusing to take the back off a television receiver are the risks that these products are supposed to pose.

This would have been true in the case of the old CRT-type televisions which, even when the mains are disconnected, the tube can still retain a voltage high and powerful enough to deliver a nasty shock. However, this is not the case with modern LCD receivers. Provided normal common sense is observed, the same common sense utilised in changing a light bulb, namely, disconnect the item from the mains and don't go round poking your fingers or metal objects all over the place, then removing the back cover of an LCD receiver poses little risk to the person or the television receiver.

In part one of this article in the last issue of Electronics World, we looked at the board schematic of a typical LCD television, explained the function of each board and, more importantly, in the context of fault-finding, their inter-relationship and identified the main and most recognizable elements of each board. In this second instalment, we take the back off the receiver to have a look at the actual board architecture of a typical LCD television. We will identify each board, name their most recognisable features, outline their functions and explain their inter-connections. We will then proceed to put together some diagnostic pointers avoiding the stultifying rigidity of the flowchart.

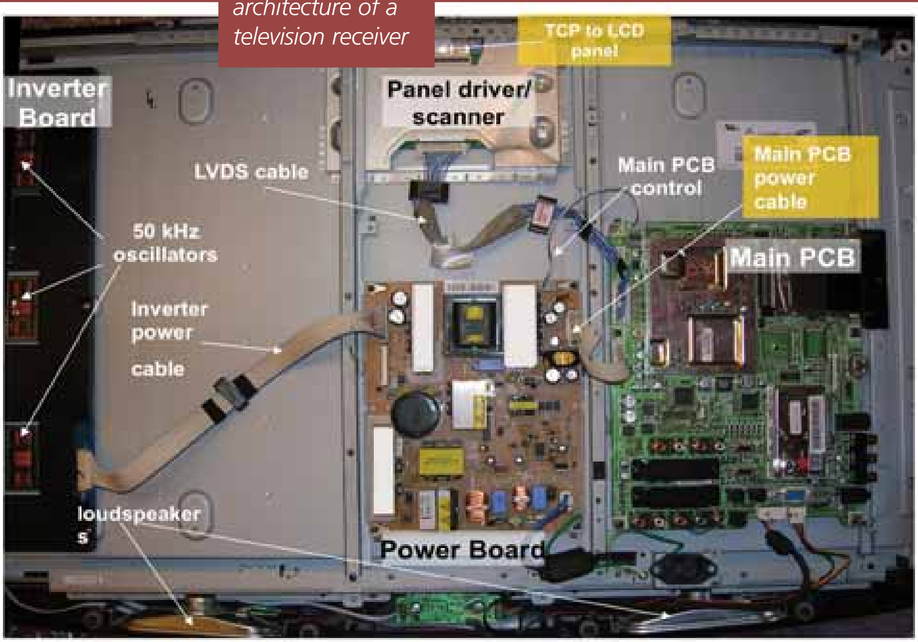


Figure 1: *Board architecture of a television receiver*

Practical Approach

Before taking the cover off the back, place the receiver face down on a foamed or cushioned table, a layer or two of bubble wrap will do, to avoid any scratches let alone cracking the reasonably delicate screen. First remove the stand by undoing four screws identified by the letter S. The cover is held by a number of screws identified by arrows that must be removed to lift the back cover off and reveal the board architecture shown in **Figure 1**. For a closer look at the principal boards refer to **Figures 2a** and **2b**.

As explained in Part 1 of this series, there are two principle PCBs: the video/audio/control main PCB (also known as Small Signal Board, SSB) and the power supply board. They are connected by two cables: the main PCB power cable and the power control cable. The inverter board on the left is fed with DC (24V) as well as control signals 'INV ON' (inverter on) and 'Bri/dim' from the main PCB via the power board. The remaining PCB, the driver/scanner (T-Con) is fed with digitised audiovisual signals together with as DC and control signals via the LVDS cable.

For each frame, the T-con decodes the video signals, converts them to a DC representation of the cell's brightness and feeds them down the data columns to the cells as the screen is scanned line by line. This is then repeated for next frame and so on.

The actual cable arrangements between the main PCB and power board as to which cable carries which signals differ depend on the make and model of the receiver.

Fault-Finding Pointers

As was explained in the previous part, board-level fault-finding is more or less all that can be achieved in modern television receivers. Component-level fault-finding, especially without a schematic diagram, is limited to

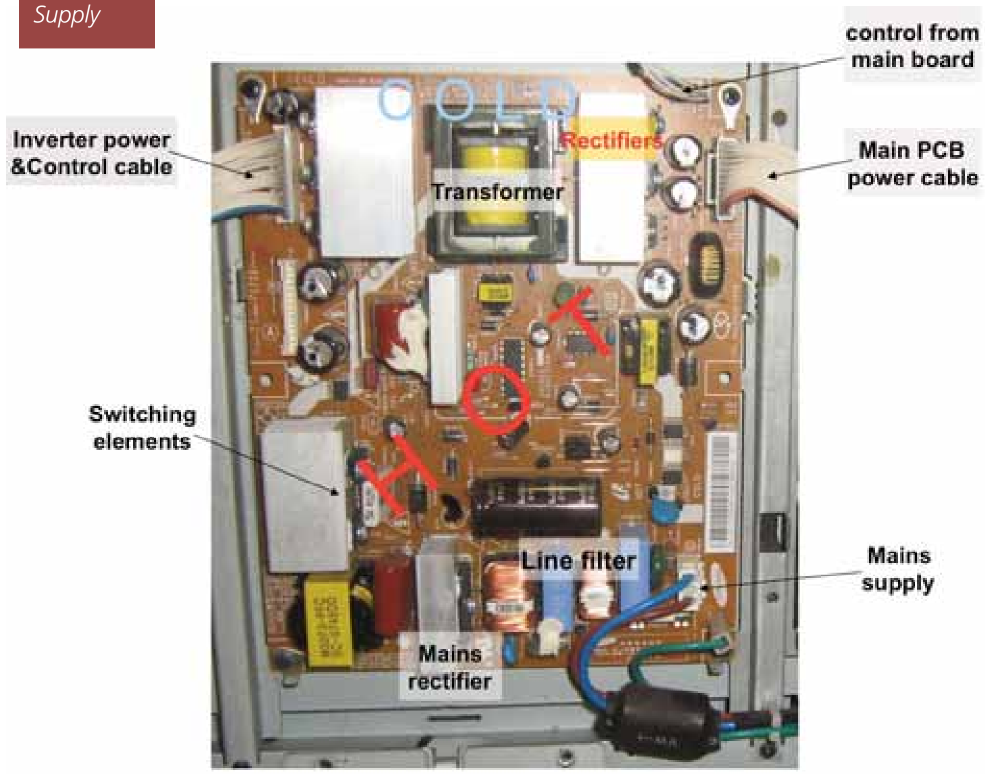


Figure 2a: *Power Supply*

speculative substitution of the usual suspects. Even if say a malfunctioning chip is identified, in the majority of cases, something more sophisticated than a soldering iron is necessary for de-soldering and substitution. For all these reasons, we are limiting ourselves to board-level fault identification, which after all is the first step in any fault-finding procedure. I use the word 'identification' loosely since, in the majority of cases, until the board is replaced, we are talking about suspecting a board to be defective rather than a definite identification. However, in most cases, a robust diagnosis may be made.

The output features of a television receiver are picture and sound. In LCD-type flat panel receivers, there is a third feature, namely the backlight. The state of each of these is the starting point, the symptoms. If sound is present, one may assume the main PCB to be in working order even if there is no picture. The absence of video on the screen may be due to a fault in the backlight assembly including the inverter board or a faulty T-Con board, or for that matter a malfunctioning screen. It is of course possible that the absence of a picture is due to a fault in the video chain within the main board.

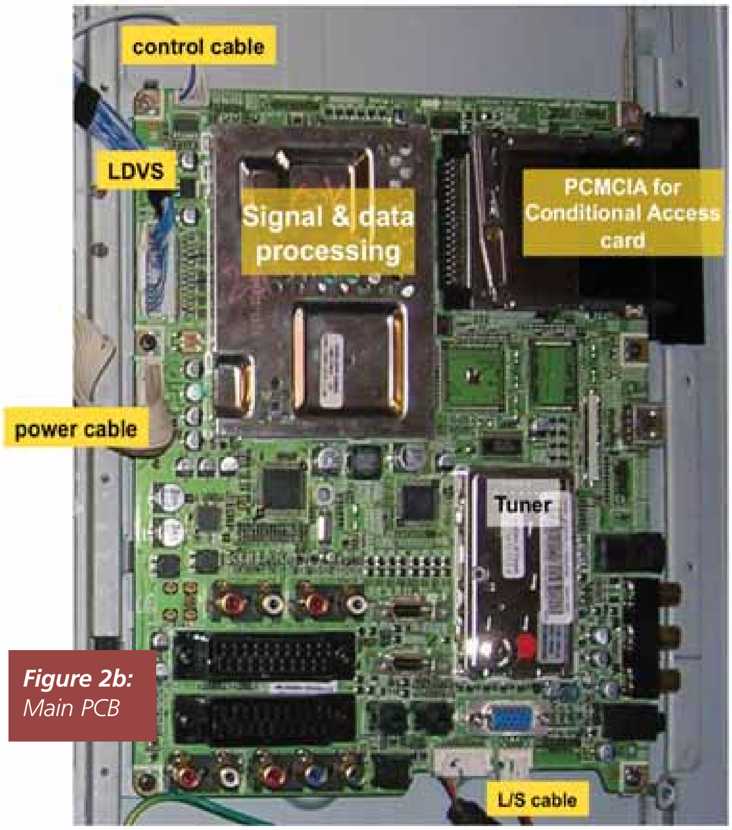


Figure 2b: *Main PCB*

In cases where a picture is not visible, it is useful to ascertain if the backlight is on before removing the back cover with the 'pressure test'. The LCD panel is of the 'normally-dark' type in which the cells are set in the off position when there is no video signal present. However, if a bit of pressure is applied to the screen by say pressing it gently with a finger, then if the backlight is on, a bright smudge will momentarily appear.

Beware, however, the absence of such a smudge does not mean that the backlight assembly is faulty. A further useful test before the back cover is removed is the 'Menu test': check if the Menu appears on the screen. If it does, then the backlight assembly, the T-Con and the screen itself are healthy and the fault is somewhere in the video chain before the signal/data processing unit. This is because the text for the menu is generated by the micro controller and fed directly to the processing chip.

Ultimately, the back cover has to be removed. Tests may now be carried out, but care must be taken not to touch any part of the circuits directly or by any metal object. Initial tests on the COLD SIDE include measuring the various DC lines generated by the power supply using a DVM. The best place to access these voltage lines is on the header boards. The pin-out of each header board is normally indicated on the PCB of most leading brands as illustrated in **Figure 3**. The first voltage to be measured is the STB voltage which should be around 5V, depending on the make and model. This

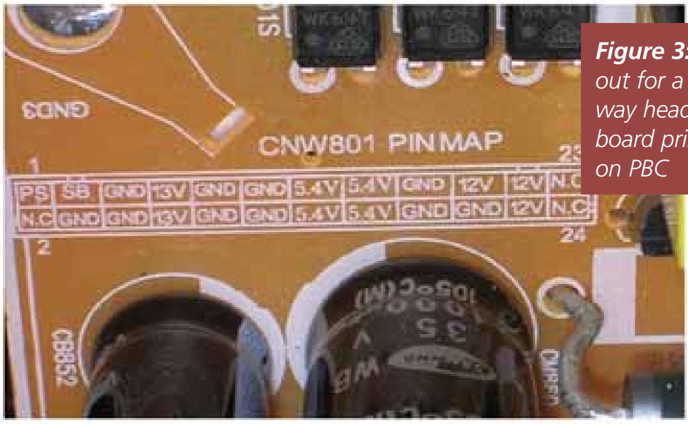


***Figure 3:** Pin-out for a 24-way header board printed on PBC*

result in no picture on the television screen. However, in this case, sound should be normal. Once again, the opposite is not necessarily true, namely a 'no video, sound OK' symptom does not necessarily point to a faulty T-Con. The 'no video' part of the symptom could be due to the absence of a backlight.

voltage should be present so long as the receiver is connected to the mains.

The other DC voltages may also be measured: typically, 3.3V, 5V and 12V available on the main PCB power cable and 24V which can be picked up on the inverter cable (refer to Figure 2a). Their presence confirms a healthy power supply. The converse unfortunately is not necessarily true; the absence of DC voltages does not prove a breakdown in the power supply. A faulty main PCB would render the power supply powerless so to speak. This is because the power supply will normally generate these DC voltages only if enabled by a control signal from the main PCB. This signal is normally referred to as 'PS ON' which in most brands is active High.

A further control signal, 'INV ON' is required to generate the inverter's 24V and/or enable the backlight. An intermediate position is also possible, namely the power supply could cycle between the 'on' and 'off' positions. Such cycling, again does not necessarily point to a malfunction in the power unit; it could well be a fault in the main PCB. The temptation to isolate the power supply from main PCB by unplugging the connecting cables should be resisted because it achieves nothing. Apart from the standby voltage, for most brands, the other voltages will be permanently off. This is the reason why the power supply board cannot be tested in isolation from the main television chassis frame, away from the main board. The only way to examine the power supply unilaterally is to use a main PCB simulator described later.

The backlight should normally turn on after the DC rails have been established which may be confirmed by a glow that can observed through a few holes in the backlight metal cover. Failure for the backlight to turn on may be a result of faulty power supply, a malfunctioning main PCB, or a defective inverter board.

A breakdown in the T-Con board would

Main Board Simulator

An effective aid to board-level fault diagnosis of an LCD television receiver displaying such fatal symptoms as 'dead set', 'no video, no sound', 'stuck on standby', 'flickering red LED', 'cycling' etc, is the TV Diagnostika (see inset). The TV Diagnostika is a simulator which plugs into the power supply in place of the main board providing a facility for unequivocal board-level diagnostics. On another level, the TV Diagnostika allows individual testing of the power board. As we have seen earlier, in current LCD TV architecture, the main board and the power unit are linked together like conjoined twins; the one cannot function without the other.

Even the simplest of tests, measuring one DC line for instance, requires laying the set face down on a spacious bench using appropriate foam cushions. TV Diagnostika changes all that. It liberates the power supply from the confines of the television's metal frame.

Non-Fatal Faults

So far, only fatal faults, (dead set, no video-no sound, flashing red LED, etc) have been considered. Non-fatal faults, cover a multitude of symptoms: picture faults including picture distortion, disorganisation or fading; horizontal and vertical lines or bands, colour distortion and pixel defects and sound faults, including no sound and sound distortion. Pixel defects, single or multiple vertical or horizontal lines, screen burn and negative picture point to a defective LCD panel.

Vertical or horizontal bands may point to a faulty T-Con or a defective LCD panel. Multiple pictures, and/or dismembered pictures point to a faulty main board; a 'Video OK – No Sound' symptom also point to a malfunctioning main board, albeit, only the sound decoding/amplifying section. ■

TV DIAGNOSTIKA

The TV Diagnostika is a main board simulator. It generates the control signals which the main board sends to the power supply unit. In the inter-relation between the power supply and the main board, two control signals may be identified:

- 'PS-ON' (Power Supply On), also known as PCON
- 'BL-ON' (backlight on) , also known as 'Inverter On' or 'SW_inverter'

The first instructs the power supply to generate the DC voltages destined for the main board and the second enables the inverter's 24V to be established and with it the backlight to turn on. In some brands, the 24V rail is established when the PS-ON control is enabled but the backlight's florescent tubes only turn on when BL-ON is enabled.

The TV Diagnostika is a passive diagnostics tool requiring no external DC source of any kind. It utilises the standby voltage generated by the power supply itself to generate the appropriate control signals. It works on two different levels: in-situ to indentify a faulty board or independently away from the TV receiver to test the power unit.

For in-situ testing, simply disconnect the main board from the power supply and plug in the Diagnostika instead. The power supply will be turned on regardless of the main board. The presence or otherwise of the DC voltages is indicated by a number of LEDs. If the DC rails are present and correct, then the power supply is healthy. The inverter can then be enabled by a switch to turn on the backlight on confirming that the latter is not defective either. Incorrect voltage readings unequivocally confirm a faulty power unit. Similarly, with a healthy power unit, failure for the backlight to turn on confirms a malfunctioning backlight assembly.

For the first time, using the TV Diagnostika, the power unit may be tested individually and independently, away from the confines of the television metal frame. The power board may be taken out altogether and, by plugging in the simulator, it can be fully tested. Not only component-level diagnosis can take place away from the cumbersome television set, but, and more importantly, once suspected components have been replaced, confirmation that the power unit is functioning properly can be made before it is inserted back in the TV receiver.

If you missed the first part of this article, you can order it online at ***www.electronicsworld.co.uk***

Embedded World Exhibition

EMBEDDED TECHNOLOGIES are seen everywhere: from the car, communications systems and industrial and consumer electronics to military systems and aerospace technologies. So, the Embedded World Exhibition & Conference has built a reputation as one of world's biggest exhibitions of its kind and the meeting place of the international embedded community working on such applications. In 2010, there were some 730 exhibitors from 30 countries that showed 18,350 visitors the full range of products for embedded technologies in hardware, software, tools, services and lots more.

This year the show is heading for a record with new exhibitor registrations up by 12%.

"It is already obvious that Embedded World 2011 is heading for a record. Last year's area has already been topped and the number of exhibiting companies from all over the world will grow considerably again. We assume that we can welcome more than 750 exhibitors in Nürnberg," says Alexander Mattausch, Exhibition Director of Embedded World at NürnbergMesse.

This year, products on display are expected to include:

- Hardware: Components – Modules – Systems for various applications
- Tools: Hardware – Software
- Application-Software
- Real-time operating systems – Visualization software – Internet browsers – Test and verification software
- Services: System development – Electronic manufacturing – Consulting – Training – Trade literature

EMBEDDED WORLD CONFERENCE 2011

Design&Elektronik presents the Embedded World Conference again in 2011. This conference is the leading European event for the embedded industry and covers all fields of embedded system development.

The steering board of the 'Embedded World Conference' has reacted to the enormously increased number of papers submitted for the ninth edition of this event by appointing a much larger selection panel. The expertise of the panel members ensures the high quality expected of the conference papers by all concerned.

In his keynote lecture, Dr Yrjö Neuvo, Helsinki University of Technology, outlines the challenges confronting developers of future embedded systems. He shows how the constantly increasing networking and interaction between systems will cause the embedded world to expand appreciably.

In the rest of the lecture programme too, outstanding experts from the embedded community provide answers to the most urgent questions and make embedded system developers fit for tomorrow's challenges.

The key topics of the conference include ARM Cortex architecture, multicore, networking, security, libraries and Open Source. This year's conference is focused compactly on the major topic blocks, which makes it an unequalled opportunity to meet the industry's thought leaders for jointly developing the most innovative embedded systems.

The main topics are in line with the subject of the "Embedded World Technology Report" prepared by the "Embedded World Expert Board", which comprises experts from twelve companies. In 2011, the board deals with the subject of "Energy-efficient internal and external communication".

With 20 sessions and 13 classes, the Embedded World Conference programme again promises an interesting and lively conference tailored exactly to the requirements of development engineers.

Embedded specialists from the Fraunhofer Institute for Integrated Circuits (IIS) and the Fraunhofer Institute for Computer Architecture and Software Technology (FIRST) chair the individual conference sessions again in 2011. More information about the programme for the Embedded World Conference 2011 and online registration is available at www.embedded-world.de.

OVERVIEW OF TOPICS AT THE EMBEDDED WORLD CONFERENCE 2011

SESSIONS:

Open Source Projects/Embedded Linux
Test & Verification
Networking
Automotive
RTOS
Metering
Management of Embedded System Projects
ESI – Embedded Systems in Automation
Cortex-Cores
Software Development Methods
Multicore
Model based Design/Debugging Methods
Embedded System Architecture
CPLD, FPGA and ASICs/Reconfigurable Systems
Wireless Technologies
Development Tool
Software Development in High Level Languages
Cryptography/Security
Safety & Software Quality
M2M/Internet Technology

CLASSES AND HANDS-ON:

Architectural Design of Software for Multicore Systems
Cryptography and Embedded Security
New Cortex-M4 implementations
Architectural Design of Device Drivers
GNU/Linux for Safety related Systems
Modeling Behavior with UML: Interactions and Statecharts
Fault Tolerant Systems Design
Safety-Critical Systems Design
Floss for Safety related Systems
Cortex-inside
DSP Processing with Cortex-M4
Cortex M3
Embedding USB

and Conference *March 2011*

ELECTRONIC DISPLAYS CONFERENCE 2011

The electronic displays conference presents an event of a high professional standard again this year. Prof. Dr. Karlheinz Blankenbach of Pforzheim University of Applied Sciences, Chairman of the Conference Committee, is looking forward to the fifth edition of this highly specialized conference:

"The electronic displays conference has improved again this year. The participants can look forward to a variety of top lectures. The conference is regarded as one of the most important sources of information for the industrial displays industry. We also received a very large number of excellent papers this year for compiling the programme."

A total of over 45 lectures will be presented on the two days of the conference. This year's speakers come from countries all over the world, such as Taiwan, England, the US, France and China.

As a special highlight, there will be three keynotes at the electronic displays conference for the first time, covering the segments of OLED, LCD and industrial prospects:

***David Woodward**, President Sharp Microelectronics*
***Prof. Dr. Karl Leo**, Technical University of Dresden, Fraunhofer IPMS*
***Dr. Heckmeier**, MERCK Senior Vice President of Liquid Crystals Research and Development*

Among the sessions and topics to be presented are the display markets; display technologies such as LCD, OLED, E-Paper; display systems for automotive, touch and E-signage among others; display interfaces; 3D displays and so on.

In addition to the conference, 14 national and international companies will present their products in the electronic displays area in Hall 9. More information about the programme for the electronic displays Conference 2011 and online registration is available at **www.electronic-displays.de**.

INFORMATION AND FREE ONLINE REGISTRATION

Use the opportunity for online registration for a free visit in advance and ensure even faster admission to Embedded World 2011 in Nürnberg. The latest lists of exhibitors and products, floor plans, detailed conference programmes, travel tips and lots more information on Embedded World 2011 are available at www.embedded-world.de.

MANPOWER – JOB MARKET ONLINE IN JANUARY 2011

"We want the job market to offer real added value for embedded world visitors. The first job vacancies will go online in January 2011," said Mattausch. Jobs will also be shown on displays in prominent positions in all exhibition halls.

MACHINE-TO-MACHINE AREA AT EMBEDDED WORLD

The M2M Area is presented for the third time with companies from the segment of direct wireless communication from machine-to-machine. Exhibiting in the theme pavilion or on a stand in the M2M area is worthwhile for suppliers of communication modules for terminal equipment, terminals with such communication modules integrated, system integrators for implementation of remote maintenance solutions, Internet service platforms offering users a secure dial-in connection over Internet accesses and telecommunication companies wanting to develop the M2M and remote maintenance markets.

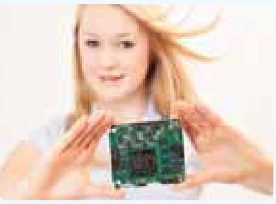
M2M communication is also discussed at the embedded world Conference. This part of the conference is organized by the magazine Computer&Automation in cooperation with the M2M Alliance.

Conference Programmes Online

Attendees of Embedded World Exhibition & Conference can also look forward again to the informative and top-calibre Embedded World Conference and electronic displays conference. The conference programmes are already online.

"The embedded community fully supports its exhibition. The event is the top worldwide platform for the industry to exchange ideas and source information at a high level – it is a permanent feature in the embedded community's exhibition calendar," said Mattausch. ■

CONSTANT TECHNOLOGY INNOVATIONS



After presenting highly interesting innovations for the embedded market with its FPGA initiative in November last year, Kontron's product announcements now move to the Embedded World Exhibition & Conference. Kontron is presenting new platforms based around the new Intel Core i3/i5/i7 technology, as well as boards and modules with AMD G series. In addition, software service innovations will also be presented.

HALL 12, STAND 404

GREEN HILLS SOFTWARE TO SHOWCASE WORLD'S FASTEST TRACE PROBE

Green Hills Software will demonstrate its integrated development suite (IDE), MULTI, its safety and security certified INTEGRITY real-time operating system (RTOS), its INTEGRITY Secure Visualization (ISV) and its wide portfolio of secure networking protocols on the industry's leading multicore microprocessors at Embedded World. The event will also be the first public European showing of the company's SuperTrace Probe v3, the fastest trace probe with the largest storage capacity ever built.

HALL 10, STAND 319

TOSHIBA'S ANNOUNCES FIRST ARM CORTEX MCUS WITH ON-CHIP USB DEVICE

Toshiba Electronics Europe will be using Embedded World 2010 to showcase its wide range of 32-bit ARM Cortex-M3 microcontrollers (MCUs), including the first members of its ARM Cortex-M3 family to feature on-chip full-speed (12Mbps) USB-device connectivity.

Ideal for applications ranging from industrial control to office automation, the new TMPM366 devices are supported by hardware and software tools that will help embedded system designers to speed development and prototyping.

HALL 12, STAND 568

PROTECT DATA IN EXTREME CONDITIONS WITH APACER'S INDUSTRIAL SECURE DIGITAL (SD) CARD

To satisfy the needs of embedded systems, Apacer Technology has released the next generation industrial SD card. Apacer's industrial SD card greatly improves data transfer rate and is the best storage solution for medical, surveillance, car navigator, industrial automation and POS applications.

Designed to meet the strict requirements of industrial system, Apacer's Industrial SD card can withstand extreme temperatures range of -40 to 85°C and is exceptionally resistance for shock, vibration and dust.

HALL 9, STAND 580

The µ-Follower

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

IN 1995 Mr Morgan Jones published his book on 'Valve Amplifiers'. Although he mentioned that "there is nothing new under the sun", the high gain/low output resistance gain stage called µ-Follower (sometimes mu-follower) was absolutely new for me. An article in Wireless World (1962, p. 553ff, 'Bootstrap DC Amplifier') looks as one of the early references on a µ-Follower type of valve gain stage (**www.janbell.ukfsn.org/WW**).

When thinking of a typical modern amplifier gain stage, the µ-Follower's high-Z input and low-Z output look charming. They look a bit like a SRPP too (see Part 5 of this series).

However, the additional resistor R2 in **Figure 1** between the anode of the lower valve V1 and the cold end of the V2 cathode resistor R5 has a great influence on the gain G and output resistance R_o of this type of gain stage. R4 works to bias V2 and C2 works as small-signal short-cut between V2 grid and V1 anode, as long as it has a value that does not hurt a flat frequency and phase response in B_{20k} ($C2 = 1\mu F \approx (2*\pi*0.2Hz*1M\Omega)^{-1}$). Figure 1 shows a typical µ-Follower gain stage. With R_{a1} = R2||R4 and R_{c1}, R_{c2} = R3, R5 **Figure 2** is the equivalent circuit of Figure 1.

As function of the output load R_L, with r_{g1} and r_{g2} = infinite and an un-bypassed ($_u$) resistor R_{c1}, the general gain equation for the µ-Follower with two different triodes (driven by the same anode current I_a) becomes:

$$G_u(R_L) = \frac{v_o}{v_i} = -\mu_1 \frac{r_{a2}+\mu_2(R_{c2}+R_{a1})}{r_{a1}+r_{a2}+(1+\mu_1)R_{c1}+(1+\mu_2)(R_{c2}+R_{a1})+F} \quad (1)$$

$$F = \frac{r_{a2}\left[r_{a1}+R_{c2}+R_{a1}+(1+\mu_1)R_{c1}\right]}{R_L}$$

and the general and un-bypassed case of R_o can be derived as:

$$R_{o.u} = r_{a2}\frac{r_{a1}+(1+\mu_1)R_{c1}+R_{c2}+R_{a1}}{r_{a1}+r_{a2}+(1+\mu_1)R_{c1}+(1+\mu_2)(R_{c2}+R_{a1})} \quad (2)$$

Setting $R_{c1} = 0\Omega$ leads to the respective equations for the bypassed gain $G_b(R_L)$ and output resistance $R_{o.b}$.

With $r_a = r_{a1} = r_{a2}$, $\mu = \mu_1 = \mu_2$ and $R_c = R_{c1} = R_{c2}$ a double-triode operation will generate less extensive equations. Hence, the two R_L dependent gains reduce to:

$$G_u(R_L) = -\mu\frac{r_a+\mu(R_c+R_{a1})}{2r_a+(1+\mu)(2R_c+R_{a1})+\frac{r_a}{R_L}\left[r_a+R_{a1}+(1+\mu)R_c\right]} \quad (3)$$

$$G_b(R_L) = -\mu\frac{r_a+\mu(R_c+R_{a1})}{2r_a+(1+\mu)(R_c+R_{a1})+\frac{r_a}{R_L}(r_a+R_c+R_{a1})} \quad (4)$$

and the respective output resistances R_o at the cathode of V2 reduce to:

$$R_{o.u} = r_a\frac{r_a+(2+\mu)R_c+R_{a1}}{2r_a+(1+\mu)(2R_c+R_{a1})} \quad (5)$$

Figure 1: *µ-Follower circuit*

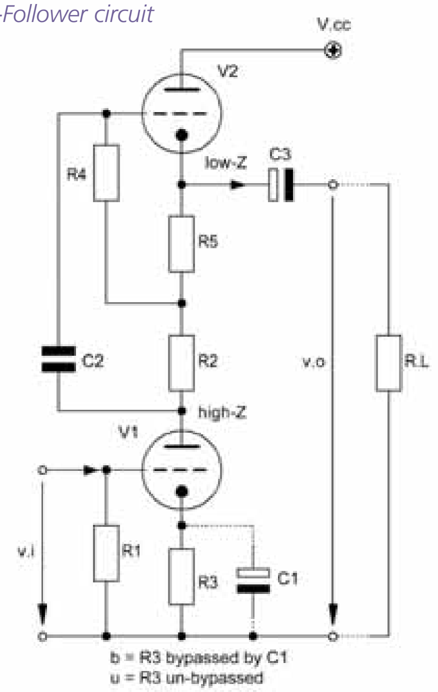
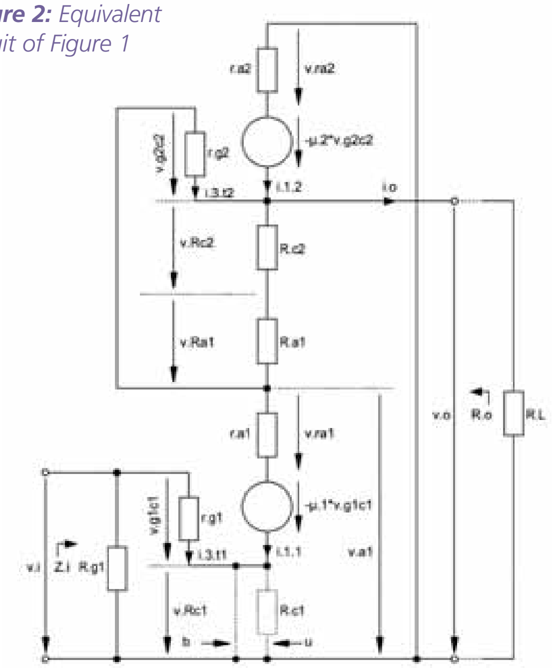


Figure 2: *Equivalent circuit of Figure 1*



$$R_{o.b} = r_a \frac{r_a + R_c + R_{a1}}{2r_a + (1+\mu)(R_c + R_{a1})} \qquad (6)$$

It's only the inclusion of R_{a1} into the above given equations that make the difference between these results and the respective ones of the SRPP of Part 5. Thus, with $R_{a1} = 0\Omega$, the SRPP becomes the special case of a μ-Follower (respective gain and R_o values see **Figures 6** and **7** at $R_{a1} = 0\Omega$).

Concerning the calculation of the input impedance Z_i and the input capacitance C_i and concentrated on V1 alone we can take Equations 7, 8 9 from Part 2. However, we have to integrate into these equations the gains from above.

To calculate the right value of C_{c1} the following equation shows the output resistance $R_{c.v1}$ at the cathode of V1:

$$R_{c.v1}(R_L) = \left[\frac{1+\mu_1}{r_{a1} + \left(r_{a2}^{-1} + R_L^{-1}\right)^{-1} + (1+\mu_2)R_{c2} + R_{a1}} + \frac{1}{R_{c1}}\right]^{-1} \qquad (7)$$

and with f_c << 20Hz C_{c1} becomes:

$$C_{c1} = \left(2\pi f_c R_{c.v1}\right)^{-1} \qquad (8)$$

With constant DC values $V_{a1} = V_{a2}$ = 90V and R4 = 1MΩ for the Figure 1 circuit, we can plot the graphs in Figures 3-7 for an E188CC/7308 example double-triode ("$_k$" indicates the number of the ten I_a values from 1mA to 20mA).

Coming in the next issue is Part 10 and end of series::
'The differential gain stage'

If you missed any of the previous parts, you can order them online by going to Electronics World's website at
www.electronicsworld.co.uk

Figure 5: *μF output resistances $R_{o.u}$ and $R_{o.b}$ vs. anode current I_a (R2 = 10kΩ)*

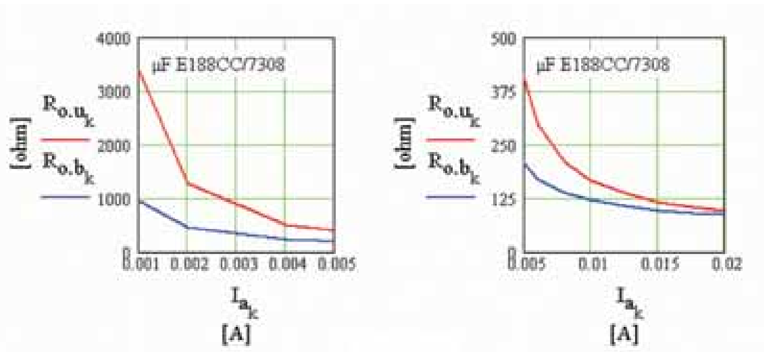


Figure 3: *μF gains G_u and G_b vs. anode current I_a (R_L = 100kΩ, R2 = 10kΩ)*

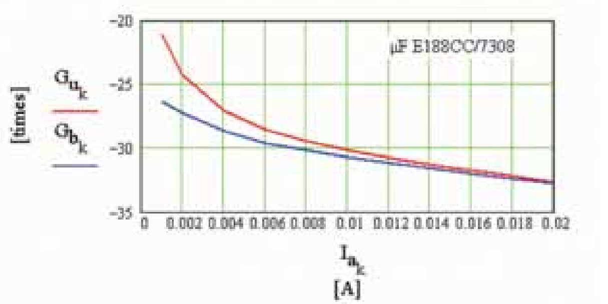


Figure 6: *μF gains G_u and G_b vs. R_{a1} = R2||R4 (I_a = 2mA, R_L = 100kΩ)*

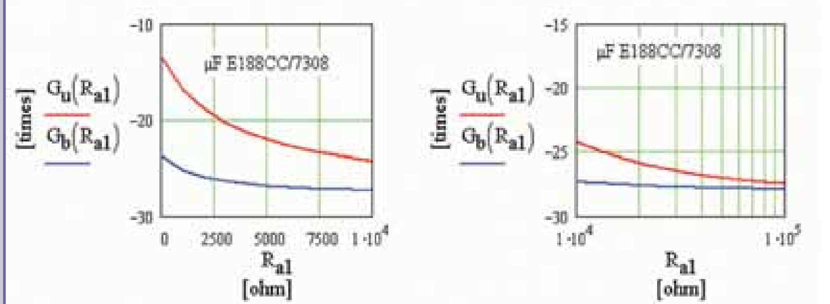


Figure 4: *μF gains G_u and G_b vs. output load R_L (I_a = 2mA, R2 = 10kΩ)*

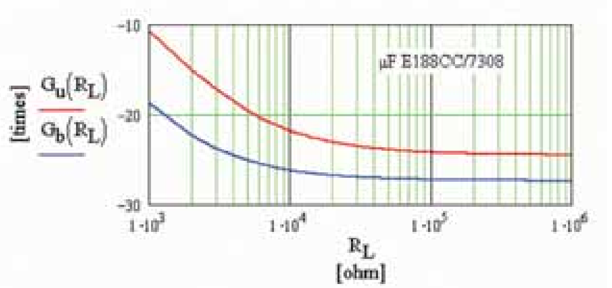
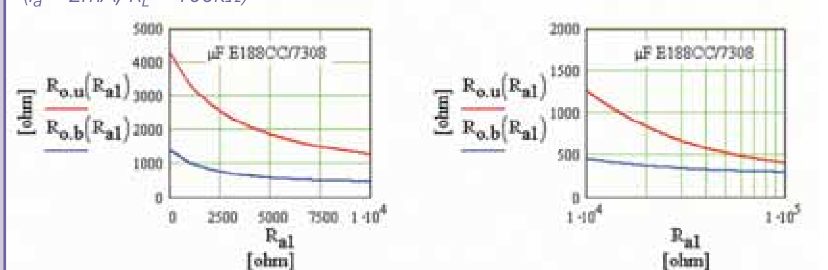


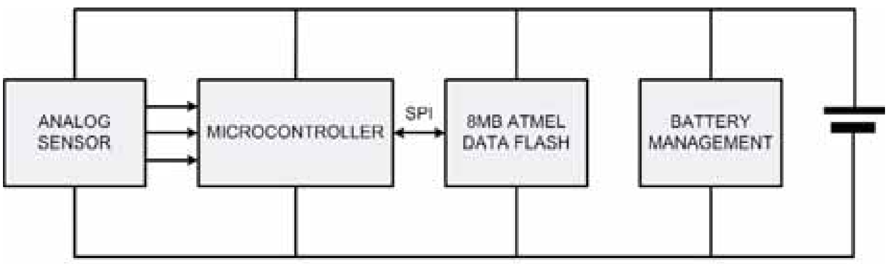
Figure 7: *μF output resistances $R_{o.u}$ and $R_{o.b}$ vs. R_{a1} = R2||R4 (I_a = 2mA, R_L = 100kΩ)*



Connecting to More Capable Devices USING USB

John Hyde from Future Technology Devices International (FTDI) will implement a series of USB projects over the course of the following editions of Electronics World

Figure 1: Block diagram of data collection pod



IN THE FIRST part of this series of articles we learnt how to implement USB into legacy serial and parallel devices. In this part we turn our attention to more complex systems – showing how to implement high-speed synchronous serial IO via USB. By way of a commonly used example I have chosen a traditional data logging application.

Figure 1 illustrates a data collection pod typical of a data logger. It is battery-powered and is both physically small and light to enable it to collect data from a wide range of moving sources. Once enabled, the microcontroller collects data from three analogue sensors and stores it in an 8MByte Atmel AT45DB642D DataFlash component. At the end of the data collection period, pods are connected to a PC for extracting data and recharging.

There are many applications that have a block diagram similar to Figure 1. In this particular case data is being collected but, with transducers rather than sensors, the block diagram could conversely form a data distribution system.

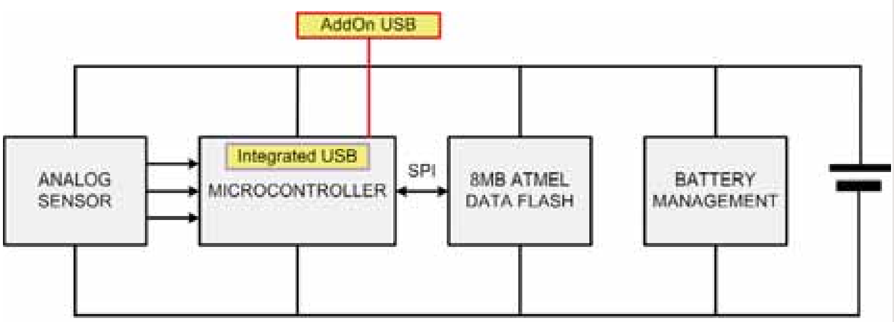
The obvious method of connecting the pod to a PC is via USB. This will mean choosing a microcontroller variant with a USB interface or by adding a USB peripheral interface component (see **Figure 2**). Since we have a lot of data to move, perhaps high-speed USB should be considered. Both options increase the cost, complexity, size, weight and current consumption of the pod, so we should look for a more creative solution.

Figure 3 describes an optimized solution that partitions the design into a USB docking station and lower-cost pods. The pods connect into the docking station using an SPI connection on a set of PCB gold fingers – thus saving the size, weight and cost of a connector. Furthermore, the battery management IC has been moved out of the data pod and into the docking station since it is only needed during charging. Data transfer and control is handled by the PC so the microcontroller code is also simplified.

The FT2232H can support two USB-to-SPI channels and run them both at 30MHz. There are also enough additional IO lines to manage two battery management ICs, support a series of buttons and LEDs, plus a 4 line by 20 character display that can give the user instructions or sales messages. This means that the docking station could be a remote peripheral. So, for an embedded PC in which there isn't a traditional keyboard or display screen, the USB docking station becomes the human interface.

This example has been broken up into a set of easy-to-adapt building blocks and an example PC application is available for download. **Figure 4** shows a more detailed block diagram of the IO connections to the FT2232H channel A, which will be set up in MPSSE (Multi-Protocol Serial Synchronous Engine) mode. Channel B is similar but has buttons and LEDs in place of the display. For prototyping the FT2232H mini module, shown in **Figure 5**, can be readily wired to the other components.

Figure 2: Options for adding USB



SPI Interface

In MPSSE mode, command bytes are intermingled with data bytes within the RX FIFO and the MPSSE processor decodes these command bytes and operates on any data bytes; this can be a little confusing at first so we will step through this SPI example in detail.

The MPSSE command structure enables data to be strobed out of the RX FIFO at a bit or byte level on the rising or falling edge of the clock. Data can also be strobed into the TX FIFO with

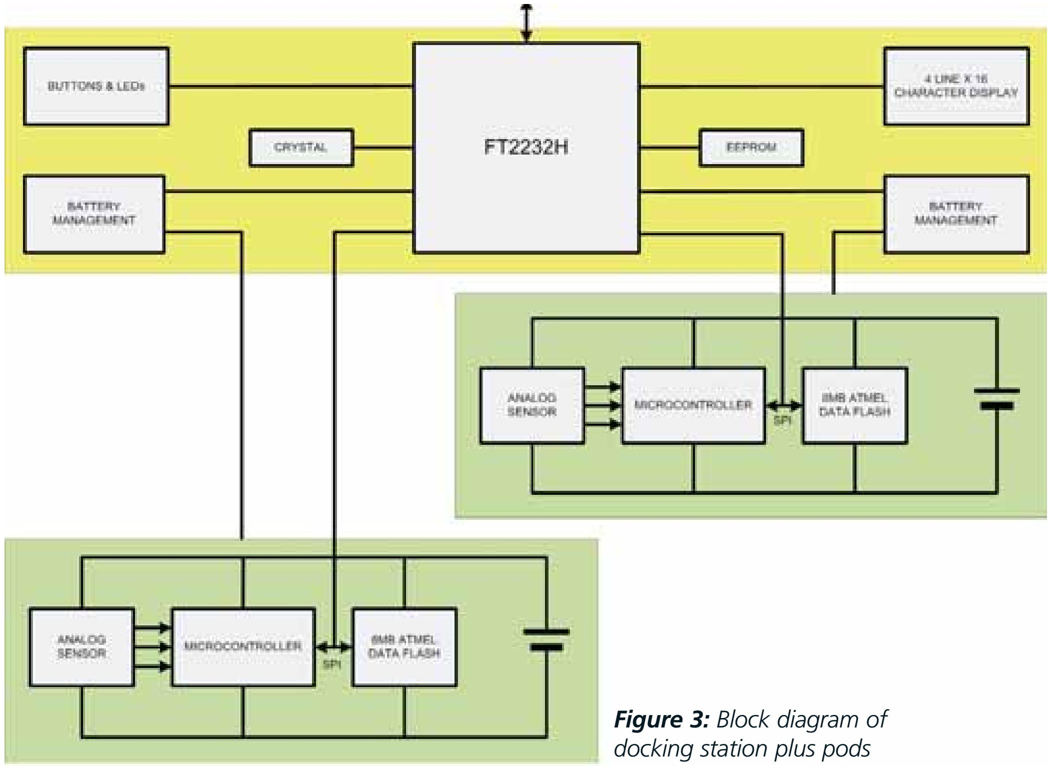


Figure 3: *Block diagram of docking station plus pods*

similar control. Our first task then is to choose a signalling method that is compatible with the Atmel DataFlash device.

Referring to the AT45DB642D data sheet we note that in SPI mode 0 SI data is latched on the rising edge of SCK and SO data is driven on the falling edge of SCK. We, therefore, set up MPSSE to drive byte data out on the falling edge of SCK and to read data on the rising edge of SCK. The DataFlash requires CS to toggle to initiate commands and in our example we will use SetDataLow commands to drive CS low and high. Let's first read the device ID from the DataFlash. After driving CS low we need to send a command byte, 0x9F. We then read in 2 bytes and finally drive CS high. This sequence is shown at the left hand side of **Figure 6**.

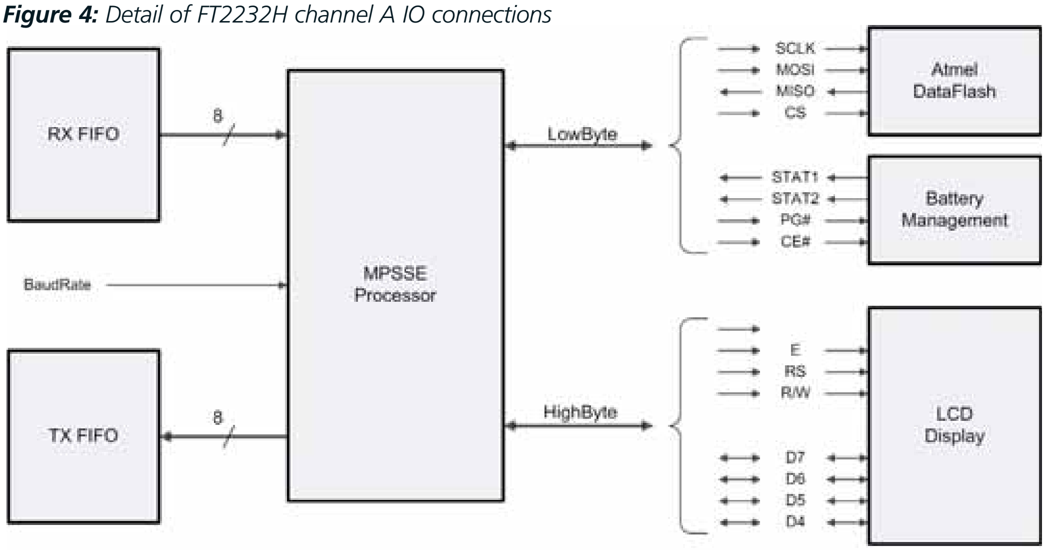
A 3-byte sequence is needed to drive CS low and this is shown on the right-hand side of Figure 6; this SetLowByte sequence can set up to 8 bits. Three bytes are needed to send the SPI command byte – bytes 2 and 3 are a count of the following data bytes and, in this example, there is only a single byte (0x0000 = 1 byte). This may appear to be a large overhead, but the PC is running very fast and the FIFOs are large so we need not be overly concerned about this. Since count can be up to 64,536, the overhead is less for larger data transfers.

Three bytes are needed to set up the read of the response from the DataFlash. Finally three bytes are needed to drive CS high which will return the SPI bus to its idle state. So, we load the RX FIFO with 13 bytes and execution of these commands by the MPSSE engine will result in two bytes being written into the TX FIFO. **Figure 7** shows the resulting SPI traffic captured with an USBee DX logic analyzer.

LCD Interface

Most 2- and 4-line character displays use the same parallel interface consisting of three control lines (E, R/W and RS) and an 8-bit data bus that can be operated in 4-bit mode. In this application only eight data lines available (called GPIOH0…7 when in MPSSE mode) so the data transfer is implemented in 4-bit mode. The waveforms needed to write and read the display are shown in **Figure 8**. A series of SetByteHigh commands have been set to create this custom waveform.

Figure 4: *Detail of FT2232H channel A IO connections*



Sending a command to the display takes about 1µs and then the display needs at least 40µs to implement the command. Some commands take much longer.

Understanding the latencies involved with USB transfers is very important. Sending data to

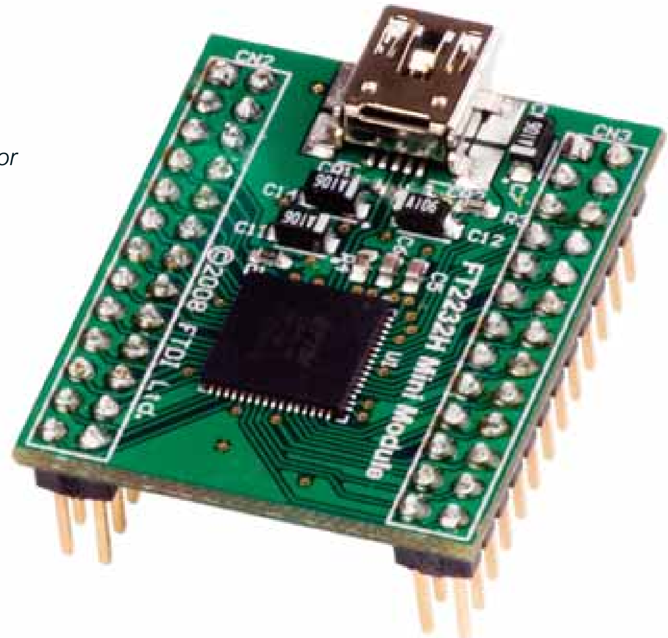


Figure 5: *FT2232H mini module used for prototyping*

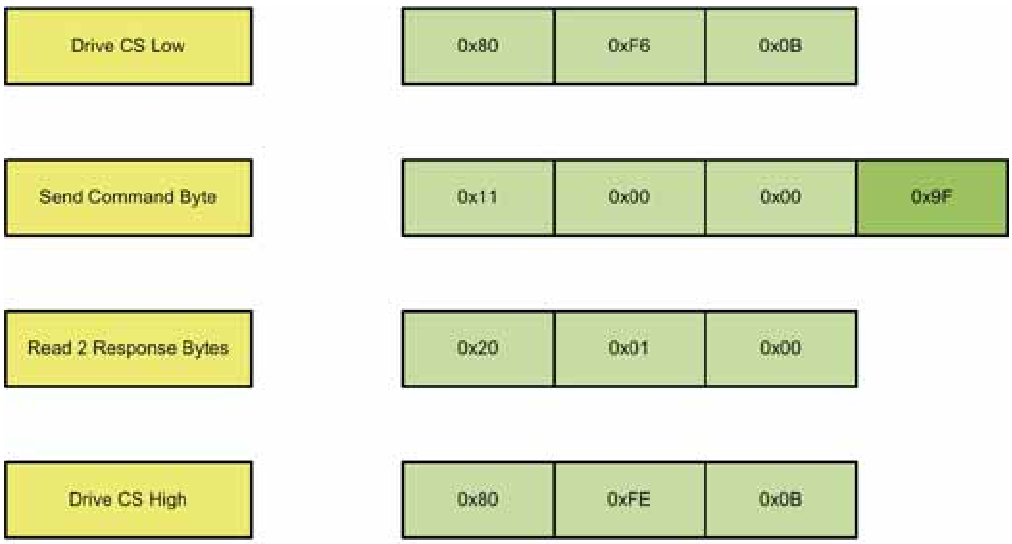
the RX FIFO involves an FT_Write command and reading from the TX FIFO involves an FT_Read command.

If two commands are initiated (two FT_Writes or FT_Write + FT_read) then the OS will schedule these in separate USB frames. In other words, they will be at least 1ms apart. So it is not sensible to poll for a 40µs signal since it will take 1ms to do the poll.

It is also a good idea to send as many bytes as possible in a single buffer; otherwise the separate FT_WRITEs will be 1ms apart. The FT2232H has a 4kByte RX FIFO and can, therefore, queue up a large number of commands/data for the MPSSE engine. In this example the system is idle for 40µs between most LCD commands using the MPSSE command 0x8F, 0x38, 0x00.

For this data collection pod example, the FT2232H serves as a dual USB-to-SPI adaptor with 24 additional, configurable IO

Figure 6: *MPSSE commands used to drive SPI*



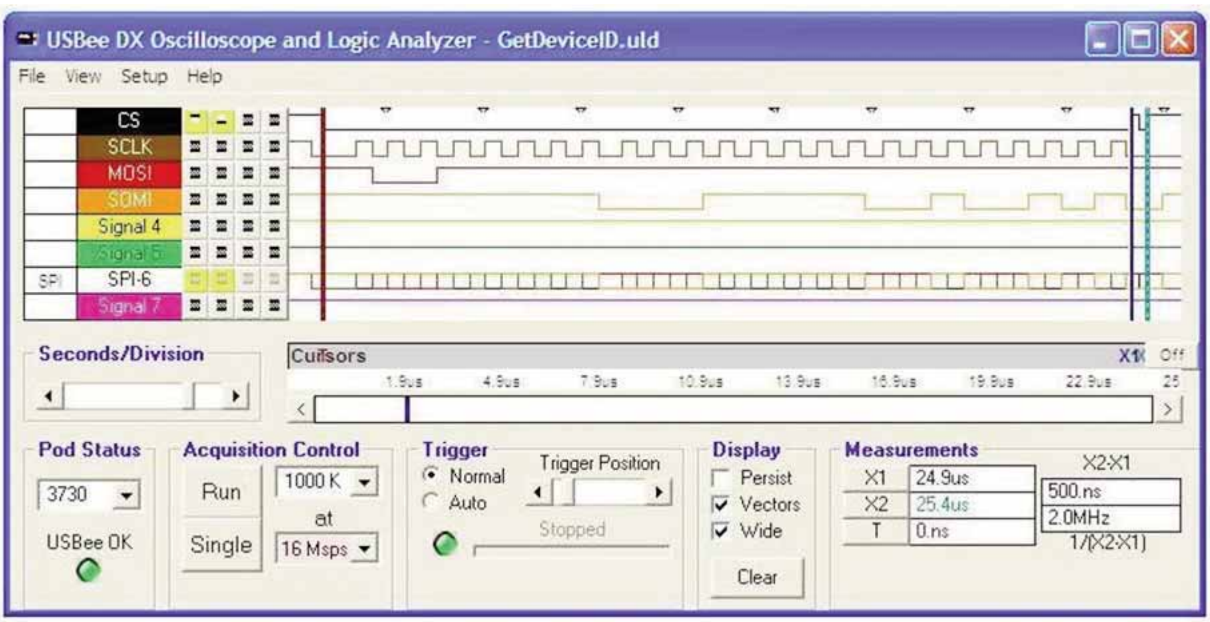


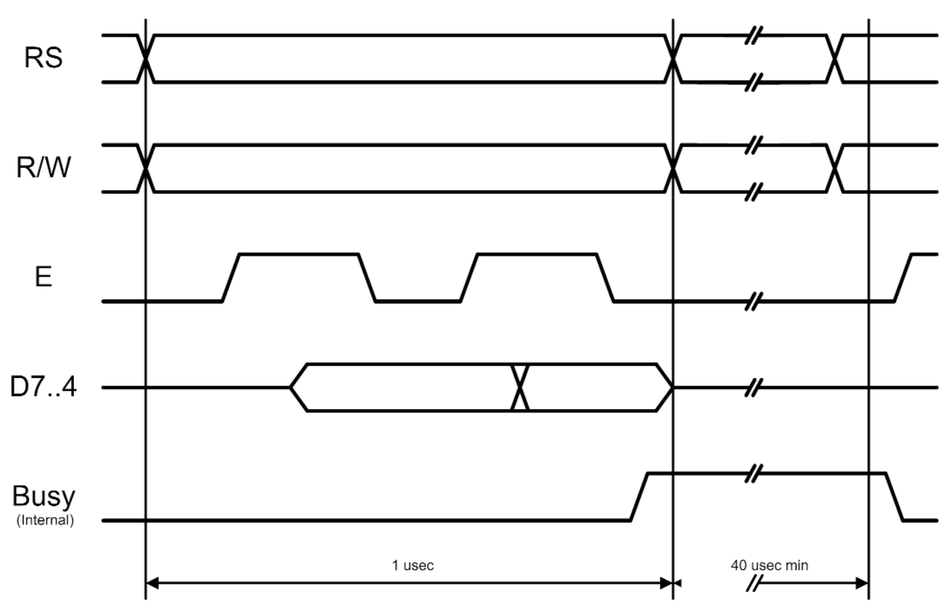
Figure 7: *USBee trace of GetDeviceID SPI command*

lines controlling the battery management ICs, LCD display, buttons and LEDs. This hardware is controlled by a PC application that can be changed to match your specific requirements.

Other Examples

The FT2232H's MPSSE mode supports SPI, I2C, JTAG and custom parallel protocols on both channels. It also supports several serial modes and protocols, making it an extremely versatile component suitable for many interfacing projects. For more information you can refer to FTDI's applications note AN_108.
http://www.ftdichip.com/Support/Documents/AppNotes/AN_108_Command_Processor_for_MPSSE_and_ MCU_Host_Bus_Emulation_Modes.pdf

Figure 8: *Control signals used by most LCD character displays*



This series continues in the next issue of Electronics World magazine. If you missed the first article in the series, you can order it by going on line at ***www.electronicsworld.co.uk***

CONDUCTIVE ELASTOMERS FOR RFI/EMI SHIELDING

Kemtron manufacture a range of conductive Elastomers as gaskets and gasket strip for EMI shielding of electronic devices. The base Elastomer is silicone for normal environments and Fluorosilicone for fuel and oil resistance, both offer a wide temperature range of -40 deg Celsius to +160 deg Celsius and up to +200 deg Celsius for some grades.

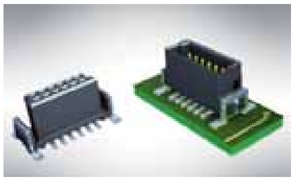
The manufacture of a conductive Elastomer is a balance of conductive particle loading and distribution throughout the silicone base, the distribution must be sufficient to ensure that the particles are in contact with each other to ensure a good conductive path through the Elastomer but the loading must not be so great to cause the silicone to lose its elastomeric properties.

In general the conductive Elastomer will have a shore A hardness of between 60 and 75 depending on grade and still maintain good tensile strength; this will ensure the gasket will deflect sufficiently when under compression giving a good EMI and environmental seal.

www.kemtron.co.uk

SPACE-SAVING PCB CONNECTORS ARE RUGGED AND FLEXIBLE

Harting's new har-flex connector series is a space-saving, rugged and flexible PCB connector for the widest range of board-to-board and board-to-cable applications.



The har-flex product family includes a number of straight connector models as well as compatible insulation displacement connectors and angled models.

Har-flex is designed to offer PCB designers the greatest possible flexibility in the use of increasingly size-sensitive and cost-intensive PCB resources. Based on a 1.27mm grid, the har-flex product family offers customers all even-numbered models from 6 to 100 pins.

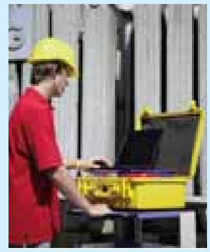
For mezzanine applications, the series has straight models in four different stack heights that allow parallel PCB distances between 8 and 13.8mm to be bridged.

For surface-mount applications, the har-flex connector family is delivered in tape-and-reel packaging. All devices undergo 100% coplanarity testing, and are designed for standard fitting with 'pick & place' pads to guarantee a simple, fully automatic and reliable assembly process.

www.harting.com

OMICRON'S DIRANA ACCURATELY DETERMINES INSULATION MOISTURE CONTENT

DIRANA (DIelectric Response ANAlyzer) from Omicron determines in a simple and efficient way the moisture content of liquid filled transformers. Accurate knowledge of the moisture content is a crucial factor in the condition assessment of power transformers. High moisture levels accelerate insulation decomposition, decrease dielectric strength and may cause bubbles to form at elevated temperatures.



Additionally, the condition (water content) of the oil is determined.

The DIRANA is also applicable to the condition assessment of bushings, instrument transformers, cables and rotating machines. Other applications include verification of proper drying for a new transformer at the factory or confirmation that the transformer is properly dried out after field assembly, repairs or oil processing.

Unique to DIRANA is the combination of the two measurement techniques: Polarization Current Measurement (PDC) and the Frequency Domain Spectroscopy (FDS). This allows for accelerated measurements, even in the very low frequency ranges which are often required for measurements on transformers that are new, cold and dry.

www.omicron.at

HIGH-EFFICIENCY, FAULT-TOLERANT LED DRIVER

The new A8515 from Allegro MicroSystems Europe is a multi-output white LED driver for LCD backlighting in consumer and industrial displays.

The device can operate from a single power supply over a wide input voltage range (from 5 to 40V) and incorporates advanced protection features to provide a high degree of fault tolerance for optimised viewing.

The A8515 integrates a current-mode boost converter with internal power switch and two current sinks that can drive up to 24 LEDs at 120mA. The two LED current sinks can also be paralleled together to achieve LED currents up to 240mA. The low 720mV regulation voltage on LED current sources reduces power loss and improves efficiency.

An external pulse-width modulation (PWM) signal applied to the PWM dimming input pin is used to control the LED intensity. The device also integrates a driver for an optional external input disconnect switch.

www.allegromicro.com

EXTREMELY LOW-POWER DACS PROLONG BATTERY LIFE

Maxim Integrated Products introduces the MAX5214 (14-bit) and MAX5216 (16-bit) digital-to-analogue converters (DACs). With power consumption less than 80µA IQ, these DACs prolong battery life in portable applications.

Best-in-class accuracy, a small package size and the low current consumption and make these devices equally attractive in 2-wire sensors where low current levels must be measured and power efficiency is important.

While the MAX5214/MAX5216 single-channel DACs already have extremely low power consumption, programmability adds flexibility and efficiency to power usage. Power consumption can be reduced further by writing the power-down sequence into the device registers. This makes the devices applicable for systems with limited power budgets such as portable glucose meters. In these cases, the devices can be powered-on to perform the required tasks with 80µA of current consumption in operation mode and then powered down to reduce the electrical current consumption to 0.4µA. Additionally, on power-up, the MAX5214/MAX5216 reset the DAC output to zero, providing extra safety for applications that drive valves or other transducers that need to be off on power-up.

www.maxim-ic.com

APACER LAUNCHES ULTRA-SLIM PROFILE SATA 7-PIN SSD SERIES

As terminal products go portable and mobile, small form-factor storage is also following this trend. Apacer Technology launches its 17mm ultra-slim profile SATA Disk Module. With its width exactly matching the SATA ports, customers have more flexibility for motherboard space design and multiple storage devices, which can be installed for expanded capacity. The SDM3 boast a patented 7-pin SATA connector, which is equipped a built-in power circuit design. This innovative design improves airflow direction and prolonged lifespan.

Available in capacities from 512MB to 4GB, Apacer's SDM3 series for industrial SSDs uses SLC chip to take the advantage of higher stability and speed. It can work at extended temperatures (-40°C ~ 85°C) under harsh operating environment.

Apacer simultaneously launches SDM3-M series using MLC chip. Available from 4GB to 16GB, SDM3 boasts the industry-leading 28-bit ECC function, which can further strengthen the auto-detection and correct the errors for increased reliability and stability.

http://eu.apacer.com/business/industrial-ssd

NEXT GENERATION AVIONICS CONNECTOR INSERTS FROM ITT ICS

Global connector manufacturer and supplier, ITT Interconnect Solutions, has announced a new Applications Note detailing the use of its ARINC 600 next generation connector inserts for aircraft flight control avionics.

Increased data transmission rates are required by the latest data communications and aircraft landing systems and ITT ICS engineers have met this challenge by designing a new series of robust, compact inserts to which allow signal, power, Ethernet and fibre optic data transmission functions to be combined into a single interconnect. These weight and space-saving inserts suit many aerospace applications, including instrument landing systems, GPS landing systems, flight navigation systems, avionic common data network systems, integrated surveillance systems and backbone Ethernet network modules.

Three new interconnect inserts have been developed – 30Q2, 13Q2 and 17Q2 – which can all also be combined with existing signal, power and quadrax inserts to develop an infinite combination of connector layouts which will meet future bandwidth requirements.

www.ittcannon.com

NEW WIZARD FOR THE SERIES HMS FROM HAMEG

The HMS series 1GHz/3GHz spectrum analyzers from Hameg, which were highly successfully introduced to the market, due to their outstanding features which are unique in their price range, like numerous filter bandwidths, high dynamic measuring range, practical AM/FM demodulators, were upgraded by adding further helpful functions.

In order to increase operational comfort and to prevent errors, users of instruments with a tracking generator are now aided by a wizard if they use a VSWR measuring bridge. Time-consuming settings in the trace menu are obviated. There is also a semi-automatic pass/fail test included, based on levels, which will be very much appreciated in test sites and for series tests. All improvements are also available for instruments already in use by downloading from:

www.hameg.com/HMS3010

NEW PLASTIC CONNECTOR FROM FOREMOST

Foremost Electronics announces the addition of the Binder 713 series M12 plastic connector to its extensive range of high quality industrial connectors.

The Binder 713 series female socket is a reliable, low-cost, direct replacement for metal-bodied versions. Its plastic housing is manufactured from rugged polyamide and has exactly the same dimensions as industry standard metal versions.

Front and rear mounted versions are available in 4, 5 and 8-pole formats with either PG9 or M16 locking threads. Protected to IP67, the 713 series has solder contacts for wires up to $0.25mm^2$ and the housing can accommodate cable sizes from 3.5 to 5.0mm. Contacts are gold-plated bronze with a current rating of 2 to 4A and solder bucket and dip solder versions are available. The new plastic 713 series connector has a minimum mating cycle of 100 cycles.

Typical applications for the new Binder 713 series include industrial controls, drives, sensors and automation equipment.

www.4most.co.uk

DUAL 600W POWER SUPPLY OFFERS OUTPUTS OF 80V AND 50A

The new QPX600D from Aim-TTi is a dual-output 1.2kW power supply using the company's latest PowerFlex+ regulation technology to provide up to 80V or up to 50A on each 600W output.

Whereas a conventional power-supply unit has a fixed current limit giving a power capability that decreases directly in proportion with the output voltage, the PowerFlex+ design of the QPX600D enables higher currents to be generated at lower voltages within an overall power limit envelope.

Each output can provide more than six times the current of a conventional supply of the same maximum voltage and power. Examples of voltage/current combinations include 80V/7.5A, 60V/10A, 40V/15A, 28V/20A, 18V/30A and 10V/50A.

The QPX600D can be operated as two entirely independent and isolated power supplies, each with its own comprehensive graphic LCD display. Alternatively, multiple isolated tracking modes are available, including some intended for series and parallel operation with metering of total voltage or total current, respectively.

www.aimtti.co.uk

EP RELAYS FOR RELIABLE SWITCHING OF HIGH CAPACITY DC LOADS

The innovative New EP series relays from Panasonic Electric Works allows a new dimension of high current levels up to 300A to be reliably switched.

Normally open versions with switching capacities of 80A/1000V DC and 300A/1000V DC are available. Normally open versions with switching capacities of 20A/1000V DC, 20A/1000V DC and 200A/1000V DC are planned for the near future.

The EP relay (80A) is particularly well suited as a cut-off relay on the DC side of an inverter in which it replaces the manual rotary switch, enabling remote control. Even currents of up to 2500A can be reliably cut off.

The design of the EP relay guarantees an optimum contact gap is maintained throughout the life of the relay. A permanent magnet ensures that when the contacts are opened the resulting arc is drawn within a chamber containing a hydrogen gas mix, for a reliable and stable contact.

www.panasonic-electric-works.co.uk

DIFFERENTIAL PRESSURE SENSOR FOR MEDICAL VENTILATION

Sensirion is launching the SDP2108-R as a high-quality sensor solution for measuring air flows in medical ventilation applications. The new differential pressure sensor in the popular SDPx108 family combines high speed and high accuracy with an extended measuring range of 0 to 3500Pa.

The SDP2108-R is based on the proven SDP1108-R, which covers a smaller measuring range of 0 to 500Pa, and it has similar mechanical, electrical and physical characteristics. The SDP2108-R differential pressure sensor is fully calibrated and temperature compensated. It also features a very fast response time of 8ms and provides an analogue output signal with a range of 0-4V. The root square output enables very accurate measurements at small differential pressure levels, while at the same time allowing the sensor to cover a wide dynamic measuring range.

The sensor utilizes the principle of thermal flow measurement to achieve outstanding sensitivity and accuracy even with extremely small differential pressures.

www.sensirion.com

LAMBDA PHOTOMETRICS OFFERS A NEW 4GHZ RF SIGNAL GENERATOR

Lambda Photometrics is announcing the immediate availability of the SG384, a new 4GHz RF signal generator from Stanford Research Systems (SRS). Adding to Lambda Photo's growing portfolio of affordable high specification test and measurement systems, the SG384 offers the following key specifications: DC to 4GHz frequency range with 1mHz resolution; AM, FM, phase and pulse modulation; -116dBc/Hz phase noise at 20kHz offset from 1GHz; full octave frequency sweeps; OXCO timebase; standard RS232, GPIB & Ethernet interfaces; and options that include clock outputs, analogue I/Q inputs, Rubidium timebase among others.

Using a unique and innovative frequency synthesis technique, SRS has been able to deliver a 4GHz RF signal generator with exceptional frequency resolution, excellent phase noise and versatile modulation capabilities. This approach dispenses with the YIG oscillator used in other designs, significantly reducing cost. The SG384 is the first in a line of new RF test and measurement products from SRS.

www.lambdaphoto.co.uk

MOUSER HONOURED AS BOURNS EUROPEAN CATALOGUE DISTRIBUTOR OF THE YEAR

Mouser Electronics, known for its rapid introduction of the newest electronic components and technologies, has been honoured with the Bourns 2010 European Catalogue Distributor of the Year Award for exceptional European sales growth and high demand creation.

"In Mouser, we have seen both significant growths in sales and new customer count," said Thierry Op de Beeck, Bourns's Distribution Manager, EMEA. "We view Mouser as an integral part of our demand-creation strategy with their focus on our new products, speed to market and commitment to providing local international support being a major contributing factor in their success."

The award was presented to Mouser President and CEO, Glenn Smith, at the recent Electronica Show in Munich, Germany, the world's leading trade fair for electronic components, systems and applications.

"It's a great honour for us to receive this distinction in Europe," said Smith. "Mouser opened its first office in Europe in 2008 and in just two years we've grown to be one of the top distributors in EMEA with design engineers."

www.mouser.com

£2M FUNDING TO STIMULATE **SPACE INNOVATION**

The Technology Strategy Board and the South East England Development Agency (SEEDA) are launching a £2m funding competition to stimulate innovation across the space industry.

The Feasibility Studies for Innovation in Space funding competition aims to accelerate the development of new innovative commercial opportunities in the space sector and is aimed at innovative businesses in the UK, with investment of up to £25,000 available for each feasibility study. The key criteria for assessment of project proposals from companies will be market potential, commercial impact and potential for success in the next steps of development.

Project proposals must relate to one or more the following market areas: Satellite Telecommunications; Sensing, Position, Navigation & Timing, Robotics & Exploration and Access to Space.

The competition opens on 10 January 2011 and closes on 10 February 2011. For full information about the competition visit: **http://www.innovateuk.org/_assets/pdf/competition-documents/briefs/tsb_feasibilitystudiesforinnovationinspace.pdf**

Our panel of commentators says the following on this development:

IVOR CATT, ENGINEER AND SCIENTIST, UK:
Compared with below the sea, space is empty!

My friend the late Heinz Lipschutz, in my view the albest inventor of the 20th century, promoted his "Uplane" for fifty years without success. He published about his frustrations in "*Wireless World*".

The potential for his heavier-than-water submarine which 'flies' through the water, as a heavier-than-air aircraft flies through the air, is enormous. There is so much of great interest a mile or two below the surface, possibly liquid methane which can be scooped up to solve our energy problems.

Unfortunately, as there once was with heavier-than-air aircraft, there is a mental block against heavier-than-water submarines, in Heinz's case made out of concrete. All attention is in the other direction, out to space, where we will not discover new sources of fuel, or much else.

BURKHARD VOGEL, MANAGING DIRECTOR, GERMANY:
This is really good news, especially in times of cutting down expenses.

However, I miss additional data that might create a more intensive stimulation of the competition among the EU companies on that market; for example in 2010 Germany's government spends EUR 1.2bn for space technology – how much money comes from the governments of France, Italy, UK (in total for space technology)?

Competition pushes creativity and motivates more instead of simply giving money!

PROFESSOR DR DOGAN IBRAHIM FROM THE NEAR EAST UNIVERSITY IN NICOSIA, CYPRUS:
It is great news to see that the British government is investing money and putting efforts into space technology research. I am glad to see the initiative set up by the Technology Board and the South East England Development Agency to support the research and development in space innovation.

The investment to be provided for single projects (up to £25,000) should enable many small or joint companies to carry out research in important space-related fields, such as satellite telecommunications, sensing, navigation & timing, robotics and so on. With a total grant of £2m, I expect that many companies will be motivated to submit their project proposals and carry out feasibility studies, and hopefully contribute to the space innovation.

I believe that the UK companies are capable of carrying out innovative research and increase their efficiencies and competitiveness, and become one of the major players in the space technology.

BARRY MCKEOWN, RF AND MICROWAVE ENGINEER IN THE DEFENCE INDUSTRY, AND DIRECTOR OF DATOD LTD, UK:
The NASA budget is currently $18.69bn. Its management structure is stable and has been since 1958. In the UK we are going through another exercise rearranging of the deckchairs of how investment in civil space should be utilised industrially. This latest feasibility stage competition is just another window dressing exercise.

Over three years ago I looked seriously at the signal processing algorithms for Autonomous Receivers for deep space applications independent of earth control. Just to test these algorithms shall eventually cost greater than £300K. So what would you do? – Go partner with JPL/NASA or some nobody UK group?

MAURIZIO DI PAOLO EMILIO, TELECOMMUNICATIONS ENGINEER, INFN – LABORATORI NAZIONALI DEL GRAN SASSO, ITALY:
This competition will focus on feasibility studies that accelerate the development of innovative commercial technologies for space and lead to new services which exploit data gained from space-based systems. It is important to review the scopes of concurrent feasibility studies competitions in technology-inspired innovation, digital services and nanoscale technologies, to assess the most relevant competition in the case of cross-cutting technologies.

Innovations studies are concerned with the nature and dynamics of innovation processes and pays particular attention to the capacities of innovations to bring about socio-economic transformation.

The goal of invention is positive change, to make someone or something better. Invention and introduction of it that leads to increased productivity is the fundamental source of increasing wealth in an economy.

Project proposals in the field of satellite telecommunications, sensing, position etc, will represent a positive change in the space technology.

If you'd like to comment on this subject or want to become a member of our panel, please write to the Editor at Svetlana.josifovska@stjohnpatrick.com

Power Your Connected Graphics Solution With The PIC32 Microcontroller

Connectivity and graphical user interfaces are essential in today's applications. You're challenged to deliver intuitive, high impact, connected solutions while maintaining flexibility to support several different product options. Microchip's PIC32 series of 32-bit microcontrollers offer the right performance, memory size and peripherals to help achieve your goals.

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