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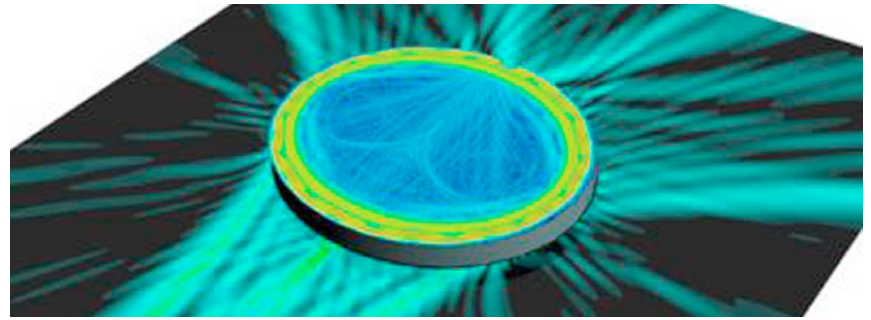
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Using a century-old phenomenon discovered in St. Paul's Cathedral, London, applied scientists at Harvard University have demonstrated highly collimated unidirectional microlasers. **5**

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Forget fab-lite, this is fab-tight

By Philip Ling

Over-cautiousness during the recent hard times may have left the semiconductor industry struggling to keep up with expected demand, according to industry analyst Malcolm Penn, CEO of Future Horizons, who has coined the phrase ‘fab-tight’ to highlight the need for more capacity across the board.

A FLAT-LINED CAPITAL EXPENDITURE curve over six quarters means many fabs have been running at close to 100% capacity for three years, a trend that is set to continue due to the missing investment, leaving little or no room for flexibility. Penn highlighted that the last quarter of last year saw a 147% increase in capital expenditure but fears it is a case of ‘too little, too late’.

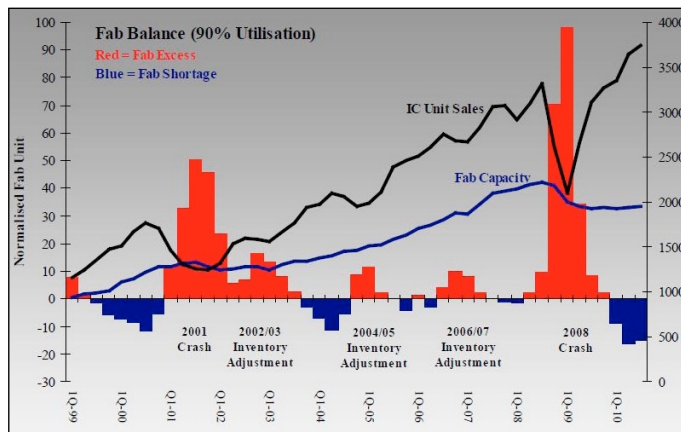
Instead of adding capacity in anticipation of demand, Penn believes that manufacturers have taken to building it in response to demand; a ‘just in time’ approach that may work well in certain supply chains, but doesn’t fit the semiconductor model. Subsequently, with a lack of sales there has been a reduction in R&D by the manufacturers of semiconductor fabrication equipment, causing an even more severe dearth of capacity and lack of cutting edge technologies to feed the now rising demand.

Behind the lack of investment is reduced confidence in the market caused by the downturn, but Penn was keen to stress that this wasn’t a classic cycle or recession; it was a ‘pause’ with a subsequent bounce back, not a boom. As a result, there will be a market correction, not to be misread as a crash, which may ultimately help reduce the stress on existing manufacturers.

His forecast is for a ‘steady’ 4 to 6% growth which some may feel is too low, however Penn believes the industry has an ability to see what it wants to see; for instance it is perceived that the average selling price (ASP) for ICs continues to fall where, in fact, it has been rising for eight quarters.

Penn points out that the perception may be founded on the lack of premium devices entering the market, which command a higher selling price, as dictated by clas-

sic economics. With a subsequent glut of ‘commodity’ parts, it may be apparent that the ASP is falling but clearly that should be something under the control of the industry,



Fab shortage versus fab shortage.

not driving it.

Likewise, the problem may stem from device manufacturers being too eager to pass savings on to their customers, as each new process node delivers more transistors per square inch, or larger wafers render a greater number of die.

Economics aside, it seems clear that an over-reliance on fabrication partners may ultimately promote the resurgence of independent device manufacturers (IDMs), if the cost of the equipment can be justified. The alternative is the ‘fab-lite’ model, which Penn feels is now defunct (and, perhaps, was never viable), or the more mainstream ‘fab-less’ solution.

The danger here is that, as technology evolves, fabless manufacturers may become more closely tied to a single fab partner, who will ultimately need to prioritise between those that offer the greatest potential, in

other words, ICs destined for high volume applications. This can only lead to the loss of innovation.

The problem may be that the real value in semiconductor manufacturing is now in the (re)packaging and distribution, which is why fabless companies are able to command the greatest – and possibly only commercially sustainable – margins.

The good news is Penn sees many new markets needing many new devices, predominantly devices that aren’t 20nm SOCs. This includes mixed signal ICs, power devices, compound semi-

conductors and display drivers; applications and devices that could offer smaller IDMs real opportunities.

Penn proposed that the industry is riding on the back of six premises that are essentially wrong; myths that are perpetuated through either a lack of understanding, confidence or vision. The first three declare that the market

has reached a level of maturity that dictates its cyclic nature is at an end and, as a result, ASPs must continue to decline. But perhaps more interesting are the ‘myths’ that state there is no strategic value in fabs and that the fabless model is a recipe for success.

These two substantiate, in Penn’s view, the ‘Wall Street’ dictate that, as it is a mature market with low growth and declining ASPs, everything should be outsourced and the focus should be on IP and branding.

Penn’s forecasts, which historically have been relatively accurate, are derived from fierce analysis and common sense; the former helps uncover the trends behind the data, while the latter helps provide the context. ■

Philip Ling is Editor for embedded electronics at **EETimes Europe** - he can be reached at phil.ling@eetimes.be

Unidirectional ‘whispering gallery’ microlasers show higher output efficiency

By Julien Happich

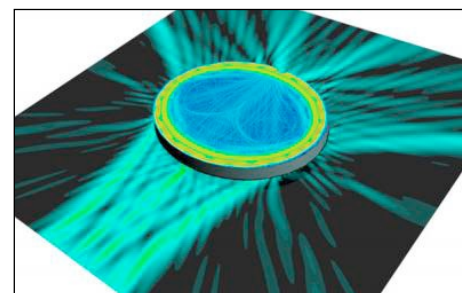
USING A CENTURY-OLD phenomenon discovered in St. Paul’s Cathedral, London, applied scientists at Harvard University have demonstrated, for the first time, highly collimated unidirectional microlasers. The result of a collaboration with researchers from Hamamatsu Photonics in Hamamatsu City, Japan, and the Institute of Theoretical Physics of the University of Magdeburg, Germany, the advance has a wide range of new applications in photonics such as sensing and communications.

The research team took advantage of a concept in physics referred to as “whispering gallery modes.” Over a century ago, British scientist Lord Rayleigh wondered how two people standing on opposite sides of the

dome in St. Paul’s Cathedral could hear each other by whispering into the circular wall. He discovered that the sound skirts along the smooth surface of the wall with negligible attenuation due to scattering or absorption. The optical analogy of whispers in a dome are light rays confined to the perimeter of tiny circular disks by multiple reflections from the boundary as they circle around. Because attenuation is minimal within the smooth disk, these resonators have already been used to make some of the world’s lowest-threshold lasers. Circular disks, however, have posed certain challenges.

“One of the crucial unsolved problems of these microlasers for practical applications has been that their emission is non-directional and their optical power output is negligible,” said team leader Federico Capasso, Robert L. Wallace Professor of Applied Physics and Vinton Hayes Senior Research Fellow in Electrical Engineering at Harvard’s School of Engineering and Applied Sciences (SEAS).

“Light gets trapped by these whispering

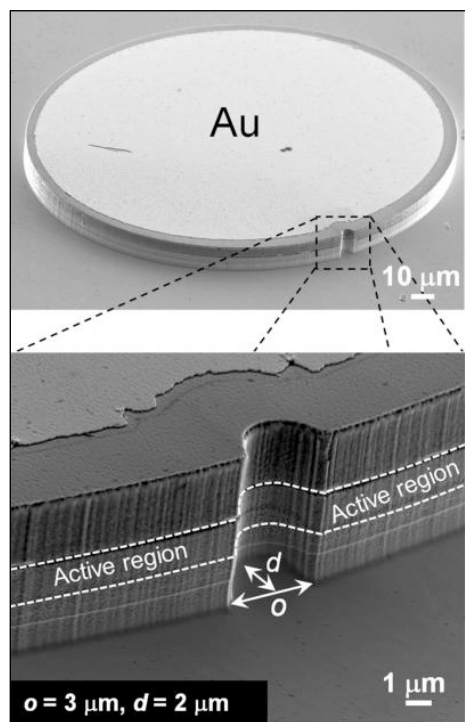


The new microlaser uses an elliptical resonator with a wavelength-sized notch (seen at top right) on the boundary to create unidirectional rays (bottom left).

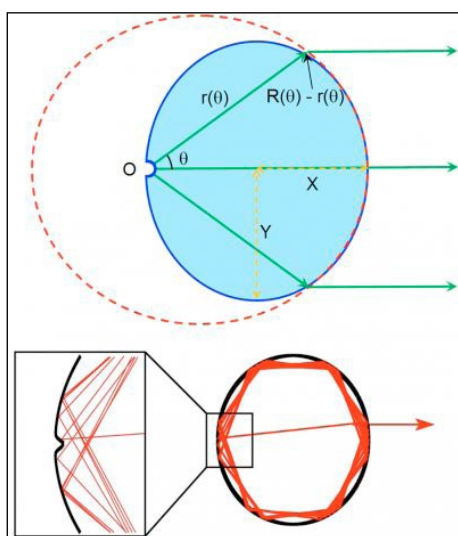
gallery modes with little chance to escape except by a faint isotropic emission. Strategies to suitably deform the disks to solve this problem have yielded disappointing results,” Capasso added.

By shaping the microlaser as an ellipse with a wavelength-size notch carved out from its edge, Capasso’s team found that the cycling whispering gallery modes scatter efficiently off the notch and emerge as nearly parallel beams from the microlaser. The prototypes are quantum cascade lasers emitting an optical power of 5 milliwatts at a wavelength of 10 microns. The microlaser performance is insensitive to the details of the notch, making this device design very robust.

“Our calculations show that the notched elliptical microlaser should have even better performance at the shorter wavelengths near 1 micron, typical of laser diodes used in optical communications, where the attenuation of whispering gallery modes is negligible,” said coauthor Jan Wiersig of the Institute of Theoretical Physics of the University of Magdeburg. “The realization of these simple-structured and robust microlasers through standard wafer-based fabrication makes small-volume directional light sources possible for many important applications such as photonic ICs with high-density chip-scale integration, optical communications, biological sensors, and lab-on-a-chip,” said coauthor Masamichi Yamanishi, Research Fellow of Central Research Laboratories at Hamamatsu. ■



Upper panel: This is a scanning electron microscope image of the notched elliptical resonator with a minor radius $X = 80 \mu\text{m}$, a major radius $Y = 96 \mu\text{m}$ and notch dimensions $o = 3 \mu\text{m}$, and $d = 2 \mu\text{m}$. Lower panel: Zoom-in view of the device showing the smooth sidewall of the laser cavity. The two white dashed lines indicate the boundaries of the active region.



Upper panel: Schematic illustration of the notched elliptical resonator. Lower panel: Ray simulation of whispering gallery mode dynamics. Credit: Courtesy of the laboratory of Federico Capasso, Harvard School of Engineering and Applied Sciences (SEAS).

ECC toolbox could extend scaling while defining a new nand Flash interface standard

By Philip Ling

THROUGH THE DEVELOPMENT of innovative scaling techniques, Micron believes it has at least a 6 month process advantage over its competitors' nand Flash technology. However, the company acknowledges it comes with a downside of reduced endurance and increased error checking and correction (ECC) requirements, which threaten to limit the density of Flash memory just as its momentum builds in mainstream applications.

The solution to this problem, put forward by Micron, is to integrate the ECC function in to multi-chip packaged Flash memory, further extending the lifetime of its process technology. This may also create the need for bespoke Flash memory, so the real challenge faced by the company is to convince the industry it has the best solution to a problem that doesn't actually exist at the moment.

The move could see the technology being adopted as a standard by JEDEC and the Open Nand Flash Interface group, ONFI, with whom Micron says it has already started discussions; Micron claims both ONFI and JEDEC have been working on an interface that 'could develop into a ClearNAND standard'.

The target market for the ClearNAND technology is developers working with 'raw' nand who are now struggling with ECC. According to Micron's Director of Strategic Marketing, NAND Product Group, Kevin Kilbuck (pictured): "Future products will rely on ClearNAND taking ECC out of the system and developing devices specifically for ClearNAND enabled memory."

Micron also announced its first SSD product line to incorporate the company's 25-nanometer nand Flash technology. Offering a broad portfolio of capacities ranging from 64 to 512GB, the drives will be available in 1.8-inch and 2.5-inch form factors. As with its

predecessor, the product line also supports the SATA 6Gb/s interface, which opens up the data path between the host processor and the SSD delivering improved overall

Micron claims the continued scaling of nand Flash is helping it displace other forms of mass storage, most notably hard disk drives. Currently the company claims it is producing devices with 25nm features and can extend this to 18nm and possible 15nm, using pitch doubling/double patterning



Kevin Kilbuck: "Future products will rely on ClearNAND taking ECC out of the system and developing devices specifically for ClearNAND enabled memory."

techniques. However, scaling beyond that will require more extreme measures such as the move to EUV technology. That puts pressure on Flash manufacturers to develop a method to extend the lifetime of existing, working processes to meet the demand from tomorrow's applications.

Micron argues that, as ECC is entirely technology-dependent and not application

specific, unlike wear levelling, it makes sense to integrate the function in to the memory device. Other memory manufacturers are believed to be working on similar solutions, although there is no evidence of this as yet.

It could mean that the first manufacturer with a proven solution will effectively set the standard with JEDEC and ONFI, although Micron's Kilbuck points out that the standard is more about the electrical interface and not the protocol used.

For manufacturers of nand controllers this may be a double-edged sword; on one side it removes the burden of ECC management, but on the other it also reduces the complexity of the controller and, therefore, its perceived value.

The next logical step may be to integrate other functions from the controller in to the Flash memory, although at the moment Micron states this isn't the intention, it admits the ClearNAND controller will 'evolve'. At the moment the controller uses around 200k logic gates but in the future this could rise to 1 million.

The technology falls in to what Micron is describing as a 'toolbox' for nand error management, which will include other firmware and signal processing algorithms, and will be used in various Micron Flash memory products.

The company's roadmap includes 'standard' and 'enhanced' ClearNAND; the latter targeting larger devices (up to 64Gbyte) and applications that more random access and less data streaming. ■



system responsiveness including faster boot times and speedier application loads. The new drives reach read speeds up to 415 megabytes/s, which

is 17 percent faster than Micron's previous generation drives, while the 512GB drive achieves up to 260 MB/second write speeds, more than 20 percent faster than

the company's fastest C300 drive. The new SSDs also provide benefits that desktops, workstations and industrial applications can take advantage of including low power consumption, lightweight construction and resistance to shock and vibration.

Micron is currently working with notebook manufacturers to qualify its new RealSSD drives under the C400 product name. Samples of the RealSSD C400 drives are available now and Micron expects mass production to begin in February.

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Ten execs to laud for 2010; ten technologies to watch in 2011

By Junko Yoshida

AFTER HUNKERING DOWN and fighting for survival in 2009, many electronics industry players—both the companies and those who lead them—have bounced back in 2010, some more emphatically than others. In many cases, those who have rebounded most dramatically have done so by acting more boldly and taking more risks than their competitors and peers. But while they weren't afraid to move aggressively, they also applied more discipline, sharpening their focus on their products, their technologies and—here's an idea—their customers.

In this issue, we have picked 10 CEOs who we believe made a real difference in 2010. Many undertook gutsy moves intended to change the game in the marketplace; some breathed new life into the stagnant cultures within their own companies.

We have also selected 10 top technologies that we think are on the verge of blossoming on the market in 2011 and beyond. Some of the choices are more obvious than others, but overall the list is intended to illustrate where companies and engineers are channeling their development efforts right now.

Sit back, scan the lists and apply your own expert analysis; then tell us your own picks at www.eetimes.com. We'd love to compare your list with ours and let you peruse other readers' selections, just to see where the discussion leads—and who gets to claim bragging rights a year from now.

— Junko Yoshida is editor in chief of EETimes

Jha rides the winds around Android

SANJAY JHA SPENT 2010 at the helm of one of the most high-profile turnaround efforts in electronics as chief executive of Motorola Mobility. Plenty of stormy seas are still ahead, but the engineer-turned-executive is making progress on a carefully plotted course.

Estimates are that Motorola will have shipped about 14 million of its new Droid smartphones this year, putting it back in the game of high-end handsets. That's significant for a company that had sprung a big leak in its financials and market share after essentially missing the emergence of the super-hot smartphone market.

In October, the company's handset business broke even for the first time in three years, a quarter ahead of plan, said Mark McKechnie, a Wall Street analyst who follows Motorola for Gleacher & Co. "I am definitely positive on what he [Jha] has done so far. Sanjay really breathed some life into the company, and runs a tight ship," often having a hand in which products make it to market, McKechnie said of the former chip set designer from Qualcomm.

Icebergs ahead include a long-rumored Apple iPhone for Verizon, which has been Moto's biggest partner and a leading Android advocate. Jha is tacking toward huge markets in sub-\$200 smartphones and China to weather that squall.

With a doctorate in electrical engineering, this CEO has no shortage of brainpower to read the changing stars. And he is not alone navigating the high seas of mobile systems. Nokia's new chief executive, Stephen Elop, has even a bigger boat to turn around.

— Rick Merritt



TI's Templeton flouts convention to win in analog

TEXAS INSTRUMENTS IS ARGUABLY the most nimble vendor in the IC business. TI focused on DRAMs when that market was hot, then exited the business when it went south. After DRAMs, the company's mantra was DSPs. It has recently focused on analog and taken the lead in that sector's revenue rankings. Now chairman, president and CEO Rich Templeton is doing what in today's outsourcing-obsessed world is seemingly unthinkable: He's expanding the company's fab capacity.

TI says its recent analog capacity additions will amount to more than \$4.5 billion of additional analog revenue per year when the fab lines are fully operational. Last year, the company began ramping up the industry's first 300-mm analog fab, in Richardson, Texas. In July, it purchased two Spansion fabs, capable of 200- and 300-mm production, in Aizu-Wakamatsu, Japan. And in October, TI acquired a 200-mm fab in Chengdu, China, from Cension Semiconductor Manufacturing Co. that had been operated by Semiconductor Manufacturing International Corp.

The added fabs in China and Japan are targeted for analog. Analysts said TI could be challenged to fill them during slow periods, but Templeton believes TI's fab strategy will bring added market share and lower costs. That worries many of its analog rivals, which use older fabs or have outsourced their production to foundries.

Under Templeton, "TI continues to execute its strategy of exploiting low-cost manufacturing advantages and growing embedded processing and analog faster than its peers," said analyst Doug Freedman



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TI's earnings for 2010 are projected to come in at \$2.52 a share on sales of \$13.9 billion, compared with \$1.16 per share on sales of \$10.4 billion in 2009, according to FBR.

— Mark LaPedus

Laub at last brings magic touch to long-suffering Atmel

NOT LONG AGO, Atmel Corp. seemed destined for oblivion. In 2006, it fired CEO George Perlegos, who subsequently attempted to regain control of the company in an ugly proxy battle. The chip maker was losing money, had too many fabs and lacked focus.

In 2007, Atmel appointed chip veteran Steven Laub president and CEO in a move to fix the mess. But the cleanup effort got sidetracked in 2008 as the company fended off hostile takeover bids by Microchip Technology Corp. and On Semiconductor Corp.

More recently, Laub has realized his vision—and more—for Atmel. The company has shed its excess fab capacity, and Laub has reshaped



Atmel into a focused, fab-lite microcontroller play.

FBR analyst Craig Berger believes Atmel hit the jackpot in 2008 when it acquired Quantum Research Group Ltd., a developer of a capacitive sensing technology for touchscreens. “We did not expect maXTouch handset volumes to ramp so meaningfully in 2010, nor did we expect very robust industrial shipments to be sustainable,” said Berger.

Analyst Doug Freedman at Gleacher & Co. acknowledged that his firm “underestimated

the magnitude of growth resulting from rapid adoption of Atmel's touch solution by high-volume players in the smartphone (Verizon's Evo, Motorola's Droid X, Samsung's Galaxy) and tablet (Samsung's Galaxy Tab)” markets.

Atmel's maXTouch sales alone have jumped from nearly zero in 2008 to \$140 million in 2010. Freedman estimates that the product could hit \$240 million in sales in 2011.

The question is whether the company can sustain that growth in the face of competition from a growing number of rivals, including Cypress, Microchip, Renesas and Synaptics.

Earnings expectations for Atmel this year are 33 cents per share on sales of \$1.6 billion, according to FBR. In 2009, Atmel lost 23 cents per share on sales of \$1.22 billion.

— Mark LaPedus

Freescale's Beyer: Mr. Congeniality doesn't shy from controversy

RICH BEYER JOINED troubled Freescale Semiconductor in 2008 and has put the company back on a healthy trajectory.

The company recorded \$1 million in income from operations in the third quarter, ended Oct. 1, compared with a loss of \$251 million

a year ago. One of the most debt-ridden chip companies in the world since its acquisition by private-equity firms in 2006, Freescale has also improved its debt structure under Beyer.

What's more, the company will likely go public in 2011.

Beyer has brought a much-needed focus to Freescale's once sprawling product and business segments. His decision to exit the mobile handset chip market was controversial, painful and emotionally taxing, especially among Freescale's veteran staff.

But a laserlike focus on the network and basestation market has allowed Freescale to seize a growing opportunity in the global telecommunications market. The company is also establishing tighter relationships with automotive manufacturers.

Many analysts agree that Freescale has done well recently on the strength of its products. Indeed, it has come far enough along to have become a formidable competitor to Texas Instruments.

Beyer's best trick might have been his foresight and leadership in building a strong and cohesive team of senior executives at Freescale.

They include Lisa Su, senior vice president and general manager for networking and multimedia; Reza Kazerounian, senior vice president and general manager for microcontroller solutions; and Tom Deitrich, senior vice president and general manager for cellular products and RF, analog and sensor solutions. Describing each executive as smart, capable and aggressive but also “congenial,” Beyer said he has high confidence in this team.

Freescale clearly needs more time before Beyer and his congenial lieutenants can heal all the wounds inflicted by the internal rivalries, political maneuvering and reorganizational turmoil of the past few years. But Beyer is determined to change the corporate culture at Freescale, and he appears to be moving in the right direction

— Junko Yoshida



ASML's Meurice: Litho outsider revives the industry's giant

BACK IN 2003, struggling ASML Holding NV lost the top spot in the lithography market to Nikon Corp. and was looking nervously over its shoulder at perennial No. 3 player Canon Inc. Desperate times called for desperate measures. In 2004, ASML went outside the industry and named little-known Eric Meurice, an executive vice president of Thomson Television Worldwide, as president, CEO and chairman.

The consumer electronics executive put the litho specialist back on the map. ASML accelerated its efforts in 193-nanometer immersion and extreme ultraviolet (EUV) lithography, and growth took off.

By 2009, according to Gartner Inc., ASML held 51 percent of the lithography market, followed by Nikon, 39 percent (Canon remained mired in third place, with 9 percent).

Barclays Capital estimates ASML's current share of the leading-edge, 193-nm immersion market at a whopping 80 percent, leaving Nikon and Canon in the dust. Nikon, which once filled 100 percent of Intel Corp.'s leading-edge lithography requirements, took another



body blow from ASML this year when the Netherlands-based vendor won half of Intel's leading-edge lithography business at the 22-nm node.

ASML's sales are believed to have hit \$5.99 billion in 2010, up 170 percent over 2009, according to Barclays. What's more, amid a supposed slowdown in the fab equipment market, ASML is "seeing no restraint for tool demand" heading into

2011, Meurice told analysts during a conference call to discuss the company's strong third-quarter results.

Meurice is leading the charge in the monumental task of commercializing EUV, which has spent decades in R&D. By 2012, ASML could generate sales from \$500 million to \$1 billion in EUV scanners alone, according to Barclays. But the challenge remains to make EUV a production-worthy technology, as some of the pieces—including the power source, resists and masks—are still not ready for prime time.

— Mark LaPedus

Vij mobilizes for a reenergized MIPS

WHEN A COMPANY is struggling, the dreaded CEO change is a move of last resort that doesn't guarantee a successful makeover. But MIPS Technologies' strong comeback this year in the highly competitive processor IP market traces directly to Sandeep Vij's installation at



the helm in January. MIPS' revenue grew by 50 percent, to \$22.5 million, in the September-ended fiscal first quarter compared with the year-ago period. Revenue from royalties increased 40 percent, to \$13.6 million; licensing revenue soared 71 percent, to \$8.9 million.

Developments afoot at MIPS before Vij's arrival included the company's early jump on Android, its development of the M14K core in China and its first forays into the mobile baseband and app processor markets. Work on Android began a few years back as a skunk works at MIPS; the M14K core development was initiated by a senior engineering leader who returned to Shanghai. But MIPS' move into the mobile market was still viewed as somewhat suspect.

Vij brought much-needed support to virtually every risk in the pipeline. He created a believable road map for MIPS' resurgence, not only in the digital home and networking markets but also in the mobile space, in a bid to reenergize the customer base. MIPS has identified several "mobile chip licensees"; they include Altair, Beceem, Mavrix, Sequans, Wintegra and an unidentified "anchor" licensee, based in Asia, that MIPS claims to have wooed away from ARM.

It may be a few more years before MIPS poses a real threat to ARM in mobile, but given its progress under Vij, the notion is no longer folly.

— Junko Yoshida



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Renesas Electronics' Akao goes for the bold

PERHAPS NO CHIP INDUSTRY chief did more to boost his company's fortunes in 2010 than did Yasushi Akao, president of Renesas Electronics Corp. With his plate still full from the April merger of Renesas Technology and NEC Electronics that created Renesas Electronics, Akao in July bought Nokia's wireless modem business for about \$200 million.



It was a bold move for a Japanese electronics company. Still working to combine two Japanese giants with nearly 50,000 employees worldwide into a cohesive whole, Akao now had to integrate 1,100 Finnish engineers into the operation and move Renesas into an entirely new market.

While the new company is an MCU powerhouse—Renesas and NEC were ranked No. 1 and No. 2, respectively, pre-merger—

the Nokia deal advances two key parts of the strategy Akao laid out in his "100-day" post-merger plan: growing revenue outside of microcontrollers and outside of Japan (in the latter case, to 60 percent of total sales).

Renesas has already spun much of Nokia's wireless modem business back out into a wholly owned subsidiary, Renesas Mobile Corp. The move was billed as positioning Renesas to compete in a market for cellular baseband chips that differs dramatically from the company's core microcontroller business; Akao has called Nokia's technology critical to Renesas' overall prospects.

The jury is still out on many of Akao's moves. Critics have said Renesas is getting into the cellular modem business way too late to capture meaningful share. Linley Gwennap, principal analyst of The Linley Group, said Nokia's LTE/HSPA+ technology gives Renesas the potential to be a significant player as the industry transitions from 3G to 4G, but he added that the company lacks legacy products and the kind of key relationships that its competitors already claim.

In May, Akao spoke with EE Times about the struggles of other Japanese semiconductor company mergers in recent years. To avoid repeating their mistakes, he said, "we need to make choices up front to reduce development costs and improve throughput. These are the lessons I learned from having worked at Renesas Technology over the last seven years." — Dylan McGrath

Maier keeps Linear agile, focused and out of me-too markets

LOTHAR MAIER, chief executive of analog and power management chip company Linear Technology since January 2005, executes a management strategy that emphasizes profits and margins over market breadth and growth for growth's sake. Linear can be said to have had a "good recession"; it had an even better 2010. For the September-ended quarter, the company reported record quarterly revenue of \$389 million, 25 percent above its previous best before the industry downturn. Linear continues to be highly profitable, with a profit margin of 35 percent for the recent quarter.



Maier's method is to get into targeted markets quickly and then get out before the me-too followers slash prices—and kill margins—just to get business.

Linear capitalized on its early involvement in mobile handsets but has made a deliberate move away from that market as margins have become squeezed. This year saw the company complete a clean break from consumer-oriented markets and renew its

focus on the automotive, industrial and networking sectors, where it can get full value for the innovative chips it makes.

— Peter Clarke

East ARM's for battle on Intel's turf

IN HIS NINTH YEAR as CEO of ARM Holdings, Warren East guided the processor intellectual property licensor to declare a record order backlog for its fiscal third quarter, as well as an upbeat outlook for the fourth quarter and into 2011.



Perhaps most notably, 2010 was the year that ARM—envisioning a day when its processor architecture is embedded in everything—emerged as a rival to Intel.

The IP provider rode the wave of Apple's iPad tablet computer, for which it supplies the main processor core, as the popular platform slowed the rise of the netbook—the form factor through which Intel has taken aim at ARM's mobile device hegemony. At the same time,

ARM made strides on Intel's turf, particularly in the server market. It also announced the Cortex-A15 processor core and achieved further traction with its Mali line of graphics processor units.

ARM's share price has reflected the markets' favorable opinion of East's stewardship; hovering at £1.55 (about \$2.44 at current exchange rates) on the London Stock Exchange a year ago, the stock was flirting with £4.00 (\$6.29) as this article went to press.

— Peter Clarke

Gou keeps Foxconn ahead of the newshounds

CHIEF EXECUTIVES ARE NO STRANGERS to managing through bad news cycles, especially during downturns, but in 2010 Foxconn Technology Group's Terry Tai-Ming Gou has shepherded his company through a tough year in which the bad news has had nothing to do with sales or profits.

Gou cofounded Taiwan's Hon Hai Precision Industry Co. Ltd. in 1974 to make cheap plastic parts for TVs. From that humble start, Hon Hai, whose public face is the Foxconn brand, has grown to

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become the world's largest contract electronics manufacturer (CEM), with 2010 sales expected to come in at NT\$3 trillion (\$98.4 billion), up from NT\$1.96 trillion (\$64 billion) in 2009. Hon Hai OEMs the iPhone and iPad for Apple, along with products for Dell, Hewlett-Packard, Sony and countless others.

But Foxconn is battling an image problem that surfaced in January, when a 19-year-old male employee was found dead of an apparent suicide at a Foxconn facility in Shenzhen, China. A string of suicides followed among the company's Chinese staff. On at least two occasions, Gou raised salaries sharply in China in response to criticism of the company's practices. Just last month, however, another Chinese employee was said to have committed suicide, bringing the total number of presumed suicides to 13, and workers at a Foxconn factory in the southern Chinese city of Foshan staged a massive protest over pay.

Further embarrassment was heaped on Gou's company in recent weeks when press reports surfaced that Fei Lam, a 17-year-old New York er, had made about \$130,000 by selling white housing conversion kits for black iPhones at \$279 apiece (Apple isn't due to release a white version until next year). Lam is alleged to have sourced some parts illegally from Foxconn factories in China, a claim Foxconn denies.

None of this has stalled Foxconn's growth. It recently opened a factory in Chengdu that is ramping up iPad production; according to reports, the new Chinese fab will manufacture a new version of the popular tablet.

And in 2011, Foxconn will account for 50 percent of total CEM sales worldwide, according to iSuppli.

— Mark LaPedus

Here's what we'll be talking about

EACH YEAR electronics becomes a deeper and more inextricably intertwined

part of our daily lives. And with the burgeoning service infrastructure—from wireless medical to broadcast 3-D—electronics will assume an even greater role in the coming years. Here are 10 technologies that our editors think will generate buzz, attract developers and investors, and get end users to open their wallets in 2011 and beyond.



Gesture recognition for hands-free convenience

GESTURE RECOGNITION has been a research curiosity for years, with a lot of admirable work languishing in the lab despite the seemingly obvious appeal of hands-free operation. Now PrimeSense Ltd.'s design win in Project Natal, which resulted in the Kinect hands-free controller for the Xbox 360, may have yielded the killer app field needed. The accelerometer- and gyroscope-based Wii baton piqued the public's interest in more innovative user interfaces. But moving the recognition hardware into the console, leaving the user's hands free, is (pardon the pun) a game changer. The perceived success of hands-free interfaces like Kinect will motivate companies like Canesta (recently acquired by Microsoft), Hillcrest Labs and Movea to begin offering hands-free interfaces for such other platforms as TVs and notebook computers. In fact, the next best step might be the development of a standard lexicon of "gestures for control."

— Peter Clarke

Personal power management puts you in charge

"THE GOAL OF GIVING every household and business access to timely, useful and actionable information on their energy use" was the focus of a recent open letter to President Obama from GE, Google, Intel, Honeywell, Whirlpool and 42 other companies. "By giving people the ability to monitor and manage their energy consumption, for instance, via their computers, phones or other devices... we can harness the power of millions of people to reduce green-house gas emissions—and save consumers billions of dollars," the companies told the President. Google already has a free downloadable app, the Power-Meter, that can monitor overall energy consumption in a home with an installed breaker-box add-on, such as Energy Inc.'s TED (The Energy Detective). Intel is taking the approach one step further by "personalizing" energy management as it once helped personalize computing; the company has crafted a prototype personal-energy monitor that plugs into the wall (instead of the breaker box) and uses artificial intelligence to deduce which appliances in a household are on and how much power they are using.

In 2011, a whole ecosystem of personal power management devices will be announced by Intel, its partners and competitors.

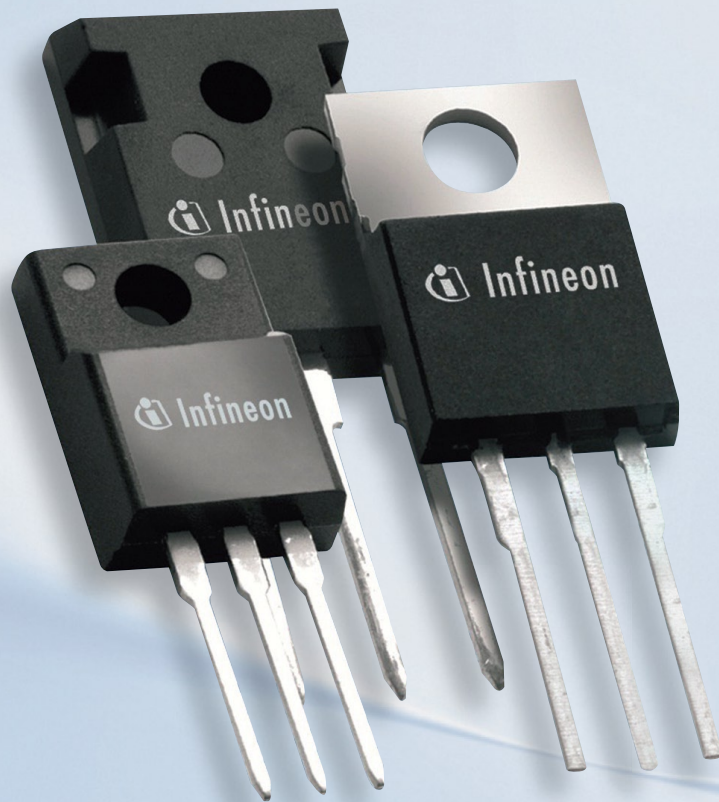
— R. Colin Johnson



Touchscreen tabs advance 'consume only' model

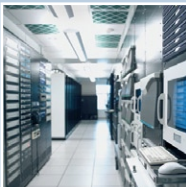
ELECTRONIC DEVICES DESIGNED exclusively to consume, rather than both consume and create, began with Apple's iPod music player, which only Microsoft's Zune has effectively challenged. Following the debut of Apple iPad, however, every major electronics producer is taking on Apple. Makers of laptops, netbooks, smartphones and, yes,





650V CoolMOS™ CFD2

Introduction of new market leading 650V CoolMOS™ technology with integrated fast body diode



With the new 650V CoolMOS™ CFD2 Infineon launches its second generation of its market leading high voltage MOSFETs with integrated fast body diode. This new outstanding product is planned to be the successor of 600V FCD with improved energy efficiency. The softer commutation behavior and therefore better EMI behavior gives this product a clear advantage in comparison with competitor parts.

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For further information please visit our website:

[www.infineon.com/coolmos]

even music players will all be marketing competing touchscreen tablets in 2011. Almost all will try to emulate the trend-setting iPad while adding some differentiator; Dell's Streak, for example, also lets you make phone calls.

Only a few vendors will try to build an ecosystem that goes head-to-head with Apple's. One is Samsung, whose Galaxy Tab matches the iPad's features, right down to a companion phone with a similar name (as the iPhone is to the iPad, the Galaxy S is to the Galaxy Tab). Others will aim for underserved markets. Hewlett-Packard's business-oriented Slate, for example, features a stylus input, suiting it for corporate clientele, such as the insurance companies that have put Slates in the hands of their adjusters in the field. Research in Motion's PlayBook, meanwhile, banks on the BlackBerry phone's reputation for superior security compared with the iPhone. Tethering the iPad-like PlayBook to a BlackBerry phone lets RIM users keep pace with iPad owners without sacrificing security.

— R. Colin Johnson

Wireless connects for health care

HOME HEALTH CARE is pegging its success on wireless technologies, which in 2011 and beyond will be crucial to delivering health maintenance and management remotely. Companies such as

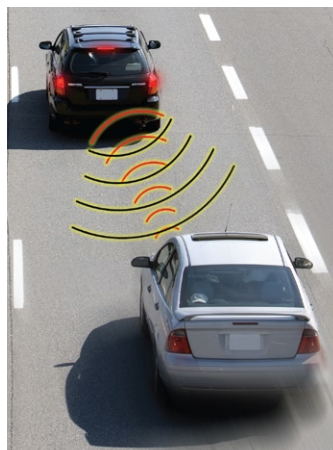


General Electric, Intel and Qualcomm are refocusing their telehealth and independent-living app development efforts on wireless connectivity. In a Qualcomm-developed illustration of the power behind wireless medical gateways as a critical part of the remote medical care solution, the data from body sensors communicates with a handheld wireless device via Bluetooth, Wi-Fi or ultralow-power BAN radios. Another company engaged in this market is MedApps, whose HealthPAL mobile health monitoring device automatically and wirelessly transmits biometric readings to a server, making patient data available for remote monitoring and review. LynuxWorks, meanwhile, has teamed with Portwell Inc. to deliver a proof-of-concept wireless sensor platform, based on Intel chips, that can monitor more than 25 Bluetooth wireless biometric sensors and graphically portray the patient sensor data for visual monitoring in the familiar Windows environment.

— Nicolas Mokhoff

Automotive radar coming to cheaper cars

RADAR TECHNOLOGY has registered on automakers' own radar for more than a decade, though the car manufacturers have proceeded with their typical caution in adopting what has been a costly technology with safety implications. But as silicon sensor costs come down and as the technology gains traction in luxury models, radar systems will begin to trickle down over the next few years to midpriced autos. Lower silicon and system prices will also encourage



more governments to mandate automotive radar.

Going into 2011, automotive radar already offers collision avoidance and mitigation in the forward-facing direction, as well as blind-spot monitoring and parking support via rear-facing radar.

Beyond 2011, the technology will eventually enable driverless free-way motoring, with smart algorithms using forward-and rear-facing radar, as well as lane detection systems, to control drive-by-wire steering, acceleration and braking systems.

— Peter Clarke

Augmented reality: Geotagging the real world



AUGMENTED REALITY, or the overlay of information on live images via a device display, has already been proved in military applications such as heads-up windscreen displays in fighter aircraft. Now consumer AR is coming to GPS-enabled camera phones.

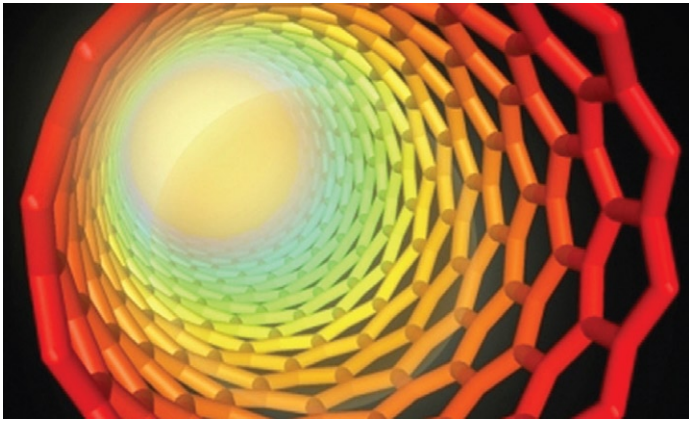
In 2011, Apple, Google and a dozen startups plan to offer apps and systems that will relay commercial information—such as what's on sale at the various stores in the mall you're visiting—AR-style. Even Intel Capital is looking to cash in on the craze by investing in Layar (Amsterdam, Netherlands), an AR platform company that offers online tools for the development community.

But social networking may be the killer AR app. Sekai Camera, for instance, lets users leave their own AR posts at points of interest. A visitor to an ice cream shop, for instance, could aim a phone's camera at the front of the shop and type a message recommending the soft-serve pistachio. Other Sekai Camera users would see the pistachio fan's posting when they aimed a camera phone at the shop.

— R. Colin Johnson

Energy storage media sought

MANY EXOTIC TECHNOLOGIES loom as long-term prospects for efficient energy storage, but to date none poses a commercially feasible alternative to lithium-ion batteries, and recent refinements to lithium-ion technology will keep it in the lead for the short haul. A123 Systems, a developer and manufacturer of advanced Li-ion batteries based on nanoscale materials that were conceived at MIT, was recently selected to develop battery packs for a 2012-model-year electric passenger car from Shanghai Automotive Industry Corp., the largest automaker in China. A123 has also signed a deal to sell 44 megawatts' worth of its batteries to AES Energy Storage, in a step toward putting solar and wind farms on the grid. While lithium-ion today is the poster child for energy storage, the technology has inherent limits in energy density and readily



available raw materials. Those restrictions, in turn, could limit the production of electric vehicles if a commercially feasible alternative to lithium-ion batteries is not found soon.

— Nicolas Mokhoff

Mobile 3-D to drive user acceptance

RETAILERS HAVE PLENTY OF 3-D TVS in stock this holiday season, but the products' acceptance has been hampered by limited content and by the need for LCD-shutter glasses that dim displays as they switch the view between eyes. User uptake has only been strong in the home theater market, for which DisplaySearch expects that 3.2

million 3-D TVs will have been shipped in 2010.

That same forecast, however, predicts that 3-D TVs will grow to over 90 million units in 2014—accounting for 41 percent of all flat-panel sets sold that year, up from just 2 percent today—as autostereoscopic displays that do not require the glasses enter the market. Toshiba, for one, is already selling glasses-free 3-D televisions in Japan.

Many of the users who

buy glasses-free 3-D TVs in 2014 will have already gained experience with autostereoscopic displays by using the ones built into their mobile devices, such as Fuji's 3-D still camera. In-Stat predicts that more than 60 million autostereoscopic 3-D displays for mobile devices will ship in 2014.

— R. Colin Johnson

Biodegradable electronics

PROGRESS HAS BEEN made in efforts to promote recycling of electronic and electrical goods, but the ultimate goal is fully biodegradable electronics.

Early biodegradable circuits being designed at Stanford University and elsewhere could find use as control circuits for drug delivery via implanted medical systems, for which the slower speed of organic electronics is not a hindrance. Nanopumps for insulin, for instance, are already being designed by a team from STMicroelectronics and



Debiotech S.A. (Lausanne, Switzerland); a biodegradable version would function for an expected lifetime of a few months and then simply dissolve away.

Success with biodegradable implants, and improved speeds for organic circuitry in general, could one day allow environmentally compostable electronics to become ubiquitous.

— Peter Clarke

3-D optical metrology measures up



OUTPUT IN 3-D from TVs, game consoles and mobile handsets will be joined by 3-D input in 2011. Called 3-D optical metrology, the technique projects stripes of light onto objects, then makes measurements of the distortions in the reflected light to deduce size and shape, thereby allowing real-world scenes to be input automatically to a 3-D model.

Generating accurate 3-D models traditionally requires either manual measurements or expensive, laser-based 3-D rangefinding systems. Now Texas In-

struments and others are downsizing their microelectromechanical system-based picoprojectors to do the same job inexpensively using structured light illumination.

SLI offers automated 3-D sensing by projecting matrices of light onto objects, the reflected distortions from which allow the objects' dimensions to be deduced automatically.

Applications range from 3-D video game development to fingerprint scanners that could identify people at a distance. Seikowave (Lexington, Ky.), for instance, is harnessing a specialized infrared MEMS picoprojector that brings SLI to medical diagnostics; the device can noninvasively monitor the rise and fall of the chest of a respiratory patient, for example, during medical testing.

— R. Colin Johnson

Software to take half of the total navigation market by 2016

By Julien Happich

THE PERCENTAGE OF new passenger cars globally shipping with factory-installed telematics will increase from less than 10% in 2010 to 62% in 2016, according to ABI Research.

ABI Research practice director Dominique Bonte comments: "Several factors are driving the uptake of OEM telematics, the most important being an automotive industry that is emerging from a painful recession and finding renewed dynamism.

"At the same time soaring interest levels in the adoption of open platforms and the integration of smartphones and telematics applications into vehicles represents nothing less than a renaissance of both the consumer and commercial telematics markets, borrowing the hugely successful application store paradigm from the mobile industry to improve time-to-market and industry innovation, and most importantly to reduce the costs of telematics services for end-users.

Initiatives such as the open source GENIVI infotainment platform and Nokia's Terminal Mode standard are creating high expectations and result in industry wide cooperation."

However, concerns still remain as to the long-term viability of a still highly fragmented telematics ecosystem, with traditional players such as Telematics Service Providers (TSPs) and automotive Tier 1 suppliers threatened with being squeezed out of the value chain by a new breed of connected navigation and software developer challengers. Other market barriers include stalling telematics legislation with both the EU's eCall and Brazil's SVT stolen vehicle tracking projects continuing to suffer from delays and indecisiveness.

Finally, despite the many benefits offered by telematics smartphone applications, they also bring new safety risks through increased driver distraction which in turn could lead to legislation limiting the use of portable devices in vehicles.

The research firm also noted in a different report that while in 2009, almost 95% of revenues came from established, hardware-based technologies such as factory-fitted navigation and unconnected PNDs, by 2014, more than 60% of the installed base will consist of software-based navigation solutions, and the off-deck location-based services

(LBS) market will be primarily funded by advertising rather than direct fees. By 2016, ABI estimates that revenues will to all intents and purposes be a 50:50 split.

"For years (world economic crash aside) the in-car navigation market has grown relatively unabated," says ABI Research senior analyst Patrick Connolly. "It was a niche within an established market that was large enough for everyone to succeed concurrently. However, with penetration rates in some regions approaching 50%, it starts to become more competitive.

The result is a clear transition away from pure hardware sales to software based-solutions and revenues."

Other pronostics from ABI Research include a fall in ASPs for in-dash applications as companies look to open up the market. Connected PNDs will become commonplace as the likes of TomTom and Garmin innovate and drive new revenue streams. The arrival of application stores and free navigation will help to drive uptake and revenue in the handset-based market. It is expected that location-based advertising will create a viable alternative to subscription services. ■

IBM, Samsung expand IC alliance

By Mark LaPedus

IBM CORP AND SAMSUNG Electronics have announced they will collaborate on basic research into new semiconductor materials, manufacturing processes and other technologies.

The agreement also renews IBM and Samsung's joint process development agreement (JDA) to multiple nodes starting at 20-nm.

For the first time, Samsung researchers will join IBM scientists in the Semiconductor Research Alliance at the Albany Nanotech Complex, Albany, N.Y.

Researchers will investigate new materials and transistor structures, as well as innovative interconnect and packaging solutions for

next-generation technology nodes.

No other details were given, however. IBM, Infineon, Freescale, GlobalFoundries, Renesas, Samsung, ST, Toshiba and others are part of IBM's "fab club." The group is collaborating on process R&D.

But a question remains: Is South Korea's Samsung switching gears in high-k?

Initially, Samsung plans to roll out a gate-first, high-k technology. As previously reported, this technology will be offered at the 32- and 28-nm nodes for foundry customers, which will be rolled out this year.

The gate-first technology was developed and is now being touted by IBM's "fab club."

But at the recent 2010 IEEE International Electron Devices Meeting in San Francisco, Samsung presented a paper on a rival technology: "gate-last high-k/metal gate devices."

If so, this would be a major departure from Samsung's original position. This may have caused a rift in the "fab club," especially between IBM and Samsung. Perhaps the two companies are kissing and making up as a result of the new announcement.

The camp is still far behind Intel Corp., which has shipped 45- and 32-nm processors based on its gate-last, high-k technology. ■

Audio processing puts greater demand on DSPs

By Philip Ling

THE MIGRATION TO DIGITAL A/V is creating demand for higher performing DSPs for audio processing, particularly in post-processing. As standards begin to emerge for surround sound effects and a more convincing audio experience, the complexity and bit-rate of some audio codecs is now outpacing those for video, according to DSP IP provider, CEVA.

Using its TeakLite-III DSP core, CEVA has developed what it claims is the most powerful single-core audio DSP available today; running at 1GHz on a 40nm process, it is able to handle complex and demanding audio codecs where other existing solutions would need two DSP cores. Key to CEVA's value proposition for using the CEVA-TL3211 is that embedding two DSP cores is considerably more complex and expensive than using one.

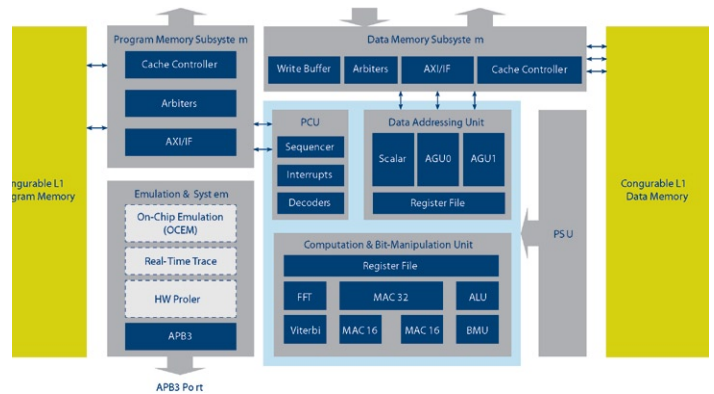
The new core, which is the second device to use the TeakLite-III core, features several improvements over its predecessor, the TL3210. Primarily, it now integrates the same power scaling unit (PSU) as used in CEVA's larger, more powerful DSP cores, this allows large areas of the core to be power-scaled through voltage and/or clock gating, saving power during inactive modes. This can equate to as much as an 80% reduction

in standby power over the CEVA-TL3210 core.

However, the company admits, the power demand during active operation remains similar to the TL3210. For this reason, CEVA believes there will still be demand for the first generation TeakLite-III core, in applications where the use-case is closely defined.

For applications where more flexibility is required, the new core should present greater benefits. The core's performance is primarily delivered through another innovation, the data cache controller, which allows the device to use slower (and therefore cheaper) external DDR RAM than competitive devices. This also creates what CEVA describes as a 'fully cached' solution, allowing greater DDR latencies and therefore reducing system cost, while delivering the DSP performance needed for highly demanding HD audio codecs such as those found in Blu-Ray DVD playback.

According to the company, post-process-



The data cache controller, PSU and AXI support are all new features for the TeakLite-III based DSP.

ing is also putting greater demand on the DSP sub-system; once representing around one tenth of the total bandwidth requirements, it can now account for as much as 25%.

The TL3211's performance comes primarily from the addition of the data cache controller, but also through the introduction of an AXI bus interface, replacing the older AHB bus as used in the TL3210. Both the PSU and AXI bus are expected to be standard features of future TeakLite-III based DSPs. The AXI bus also supports a low power mode, which helps minimise active power. CEVA stated that typically the TL3211 consumes 50uW/MHz for MP3 decode. ■

Blue Link: Hyundai's next in-vehicle telematics interface

AUTOMOTIVE

By Julien Happich

CAR MANUFACTURER HYUNDAI introduced its new global telematics brand Blue Link and other independently developed in-vehicle technologies at the 2011 Consumer Electronics Show (CES).

Blue Link, which makes its world debut in the U.S. market, is a telematics system unique to Hyundai models that offer consumers seamless connection between the office, home, smart phone and automobile with fast and reliable IT technology.

As consumers shift their lifestyles, the car maker said it aims to concentrate on providing more services focused on customers in-

stead of vehicles. In addition to turn-by-turn navigation ability, a restaurant finder and more than 30 other features, Blue Link will let Hyundai owners start their car remotely, will call emergency services if the driver cannot, will share vehicle location on social-network sites and will let drivers browse the Web, text and e-mail in a non-distracting manner. Blue Link will even let parents monitor how far and how fast their teens are driving when they borrow the family car.

Hyundai also displayed six concept in-car technologies. The Smart Connectivity System allows drivers to connect their smart

phones and tablet PCs with the vehicle; the Motion Sensor Moustick recognizes the driver's hand movements through sensors to control the car's audio and navigation system; the Intelligent Haptic System is a control system inspired by popular consumer technology; and the Dynamic Cluster combines an LCD gauge and information system that is driver-customizable.

The Car Browser System and Web Platform deliver a fully functional Internet terminal; the Multifunctional Safety Vision System completes the list, supporting a four-camera, 360-degree view around the vehicle. ■

Nanoscoops' could spark new generation of electric automobile batteries

By Julien Happich

AN ENTIRELY NEW TYPE of nanomaterial developed at Rensselaer Polytechnic Institute could enable the next generation of high-power rechargeable lithium (Li)-ion batteries for electric automobiles, as well as batteries for laptop computers, mobile phones, and other portable devices.

The new material, dubbed a “nanoscoop” because its shape resembles a cone with a scoop of ice cream on top, can withstand extremely high rates of charge and discharge that would cause conventional electrodes used in today’s Li-ion batteries to rapidly deteriorate and fail.

The nanoscoop’s success lies in its unique material composition, structure, and size. The Rensselaer research team, led by Professor Nikhil Koratkar, demonstrated how a nanoscoop electrode could be charged and discharged at a rate 40 to 60 times faster than conventional battery anodes, while maintaining a comparable energy density. This stellar performance, which was achieved over 100 continuous charge/discharge cycles, has the team confident that their new technology holds significant potential for the design and realization of high-power, high-capacity Li-ion rechargeable batteries.

“Charging my laptop or cell phone in a few minutes, rather than an hour, sounds pretty good to me,” said Koratkar, a professor in the Department of Mechanical, Aerospace, and Nuclear Engineering at Rensselaer. “By using our nanoscoops as the anode architecture for Li-ion rechargeable batteries, this is a very real prospect. Moreover, this technology could potentially be ramped up to suit the demanding needs of batteries for electric automobiles.

Researchers at Rensselaer Polytechnic Institute developed an entirely new type of nanomaterial that could enable the next generation of high-power rechargeable lithium (Li)-ion batteries for electric automobiles, laptop computers, mobile...

Batteries for all-electric vehicles must deliver high power densities in addition to high energy densities, Koratkar said. These vehicles today use supercapacitors to perform power-intensive functions, such as

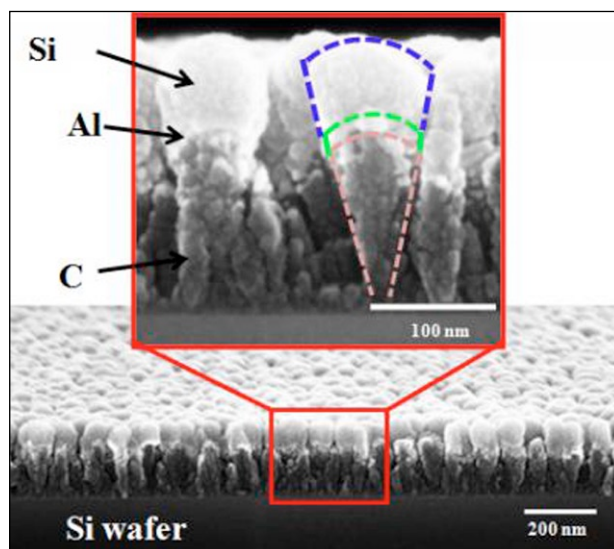
starting the vehicle and rapid acceleration, in conjunction with conventional batteries that deliver high energy density for normal cruise driving and other operations. Koratkar said the invention of nanoscoops may enable these two separate systems to be combined into a single, more efficient battery unit.

The anode structure of a Li-ion battery physically grows and shrinks as the battery charges or discharges. When charging, the addition of Li ions increases the volume of the anode, while discharging has the opposite effect. These volume changes result in a buildup of stress in the anode. Too great a stress that builds up too quickly, as in the case of a battery charging or discharging at high speeds, can cause the battery to fail prematurely. This is why most batteries in today’s portable electronic devices like cell phones and laptops charge very slowly – the slow charge rate is intentional and designed to protect the battery from stress-induced damage.

The Rensselaer team’s nanoscoop, however, was engineered to withstand this buildup of stress. Made from a carbon (C) nanorod base topped with a thin layer of nanoscale aluminum (Al) and a “scoop” of nanoscale silicon (Si), the structures are flexible and able to quickly accept and discharge Li ions at extremely fast rates without sustaining significant damage.

The segmented structure of the nanoscoop allows the strain to be gradually transferred from the C base to the Al layer, and finally to the Si scoop. This natural strain gradation provides for a less abrupt transition in stress across the material interfaces, leading to improved structural integrity of the electrode.

The nanoscale size of the scoop is also vital since nanostructures are less prone to cracking than bulk materials, according



The new material, dubbed a “nanoscoop” because its shape resembles a cone with a scoop of ice cream on top, can withstand extremely high rates of charge and discharge that would cause conventional electrodes used in today’s Li-ion batteries to rapidly deteriorate and fail.

to Koratkar. “Due to their nanoscale size, our nanoscoops can soak and release Li at high rates far more effectively than the macroscale anodes used in today’s Li-ion batteries,” he said. “This means our nanoscoop may be the solution to a critical problem facing auto companies and other battery manufacturers, how can you increase the power density of a battery while still keeping the energy density high?”

A limitation of the nanoscoop architecture is the relatively low total mass of the electrode, Koratkar said. To solve this, the team’s next steps are to try growing longer scoops with greater mass, or develop a method for stacking layers of nanoscoops on top of each other.

Another possibility the team is exploring includes growing the nanoscoops on large flexible substrates that can be rolled or shaped to fit along the contours or chassis of the automobile.

Published in the journal *Nano Letters*, this study was supported by the National Science Foundation (NSF) and the New York State Energy Research and Development Authority (NYSERDA). ■

Measuring the resistivity of bulk materials

By Mary Anne Tupta

ACCURATE RESISTIVITY measurements are critical when characterizing materials, but they are not always easy to make and different material types require different instrumentation and techniques. This article addresses best practices for making resistivity measurements.

Electrical resistivity is a basic property that defines how well a material conducts current. It's determined by measuring the resistance of a material sample, then factoring in its geometry. The three basic types of bulk materials—metals, insulators, and semiconductors—can be described by their resistivity:

- Metals are good conductors of current with typical resistivities of about 10^{-6} ohm-cm.
- Insulators are poor conductors with typical resistivities from about 10^9 to 10^{20} ohm-cm.
- Semiconductors conduct current better than insulators but not as well as metals; they may fall anywhere from about 10^3 to 10^7 ohm-cm.

Measuring the resistivity of metals and other good conductors

Characterizing a metal's resistivity demands measuring very low resistances (and therefore, low voltages) accurately. Many techniques used for metals are applicable to other applications that involve measuring small voltages, such as the resistance of superconductors, nanowires, graphene (a one-atom-thick form of carbon), and other nanomaterials in which the applied power must be kept low to prevent device self-heating.

Figure 1 illustrates a system for determining the resistivity of a metal bar or rod. A current source is connected to both ends of the sample and voltmeter leads are placed a known distance apart on its surface (L). The resistivity of conductive materials is typi-

cally found by sourcing a known current (I), measuring the voltage drop (V), then calculating the resistivity (ρ) from the measured voltage, the magnitude of the source current, the cross-sectional area ($A=wt$), and the distance between the voltmeter leads, using this equation:

$$\rho = \frac{V}{I} \frac{wt}{L}$$

For conductive materials like metals, this voltage drop is usually just microvolts or nanovolts, so precise measurements are crucial. Potential error sources include test lead resistance, thermoelectric voltages, low frequency noise, external noise sources, Johnson noise, and the use of a voltmeter with insufficient sensitivity. Fortunately, special techniques can reduce the impact of these errors. For example, using the four-wire method, in which one set of leads are used to source the current and another set are used to measure the voltage drop across the sample, will eliminate the effects of lead resistance.

Thermoelectric voltages are a common source of error when making low voltage and low resistance measurements. These voltages are generated when different metals

in the circuit are at different temperatures. To reduce thermoelectric voltages construct test circuits using the same materials for interconnects. Minimize temperature gradients within the test circuit and allow the test equipment to warm up and reach thermal equilibrium. Finally, use an offset compensation method to overcome these unwanted offsets, such as a current-reversal method or the delta mode offset compensation technique.

The delta mode technique for removing offsets and low frequency noise involves applying a current and measuring the voltage, then reversing the current and re-measuring the voltage. The difference between the two measurements divided by two is the voltage response of the sample to the applied current level. Repeating the process and using averaging reduces the noise bandwidth and therefore the noise. Although this was once a manual technique, which limited the reversal speed to less than 1Hz, newer instruments now automate the technique, increasing the reversal speed. The reversal speed sets the frequency that dominates the noise. Higher reversal speeds remove low frequency noise and thermal drift better because these noise sources have lower power at higher frequencies. Keithley's Model 2182A Nanovoltmeter and Model 6220 or 6221 Current Sources, which include software to automate these measurements, are appropriate for a wide range of resistances.

External noise sources are interferences created by motors, computer screens, or other electrical equipment. They can be controlled by shielding and filtering or simply by eliminating the noise source. Because these noise sources are often at the power line frequency, avoid test frequencies that are exact multiples or fractions of 60Hz or 50Hz. When using DC instruments and reversal methods, the same result can be achieved simply by integrating each measurement for an integer number of power line cycles.

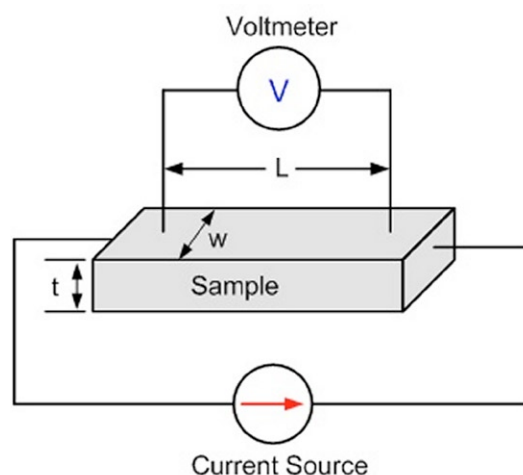


Figure 1: Determining the resistivity of a metal bar or rod.

In any resistance, thermal energy produces the motion of charged particles. This charge movement results in Johnson noise. Johnson noise may be reduced by reducing the bandwidth by analog or digital filtering or by reducing the temperature of the device.

Most digital multimeters can't measure microvolt- or nanovolt-level voltage drops accurately, so a sensitive voltmeter, such as Keithley's Model 2182A Nanovoltmeter, which has 1nV resolution, is a better choice.

Measuring the resistivity of insulators

The techniques used to measure the resistivity of insulators such as paper, rubber, and plastics are very different from those used for conductors. The resistivity of an insulator is determined by applying a voltage to the sample for a specified period of time, measuring the resulting current with an electrometer or picoammeter, then calculating the resistivity based on Ohm's law and geometric considerations.

Both volume and surface resistivity measurements can be made on insulators. Volume resistivity is a measure of the leakage current directly through the insulator. Electrodes are placed on the top and bottom of the sample to be tested (see figure 2). The high terminal of the ammeter is placed on one side of the sample; the high terminal of the voltage source is placed on the other. A potential difference is placed between the two electrodes. Although the magnitude of the applied voltage usually depends on the material under test, it is often 500V DC (per ASTM D257). After a specified electrification

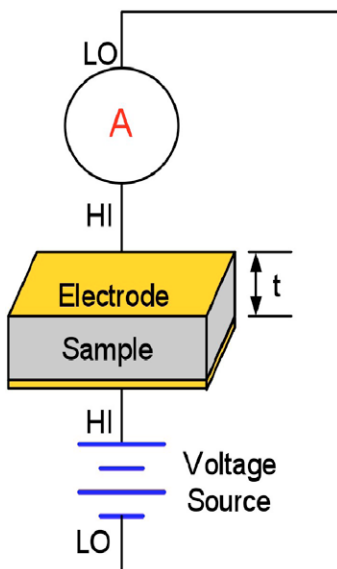


Figure 2: Determining the resistivity of an insulator.

time, usually 60 seconds, the current is measured using an ammeter capable of measuring nanoamps or lower. Volume resistivity is calculated based on the area (A) of the electrodes and the thickness of the sample (t):

$$\rho = \frac{V A}{I t}$$

Figure 3 illustrates the test configuration for measuring surface resistivity (s), that is, the electrical resistance on the sample's surface. Two electrodes are placed on the surface of the sample a known distance apart. The ammeter's high terminal is placed on one electrode; the voltage source's high terminal is placed on the other. A potential difference is applied for a known period of time and the ammeter measures the resulting current. The surface resistivity σ is calculated by factoring in the width of the sample (w) and the distance between the electrodes (L):

$$\sigma = \frac{V w}{I L}$$

Potential error sources when characterizing an insulator's resistivity include choosing an ammeter without sufficient sensitivity, using an inappropriate electrification time or test voltage, electrostatic interference, and background currents due to charge stored in the material, static or triboelectric charge, or piezoelectric effects.

Electrostatic interference occurs when an electrically charged object is brought near an uncharged object. High resistance materials do not allow the charge to decay quickly and unstable measurements may result. Electrostatic shielding will help to minimize these effects. Shield the material by using a conductive shielded enclosure and connecting the low terminal of the ammeter to the shield.

An alternating polarity technique can be employed to counter the effects of background currents, which can equal or exceed the current stimulated by the applied voltage. In this technique, a bias voltage of positive polarity is applied, then the current is measured after a specified

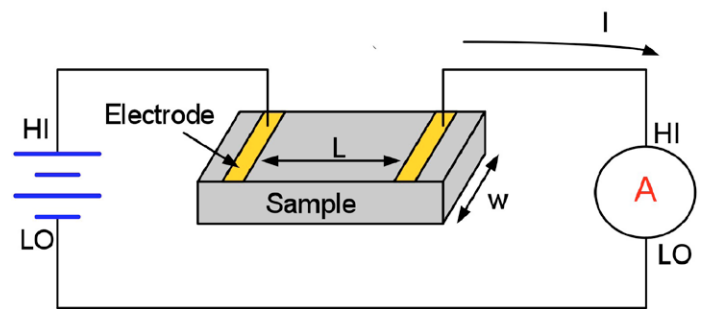


Figure 3: Test configuration for measuring surface resistivity (σ).

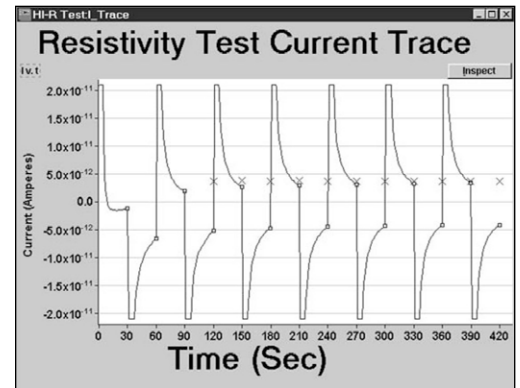


Figure 4: Resistivity test current trace.

delay. Next, the polarity is reversed and the current is re-measured using the same delay. This process can be repeated any number of times. The resistance is calculated based on a weighted average of the most recent current measurements. The Xs on the graph in Figure 4 represent the calculated current based on a weighted average of the last few measurements, which cancels out the background current. Keithley's Model 6517B Electrometer includes a built-in test sequence that automates this alternating polarity technique.

A high-quality electrode system that provides good contact to the test sample is essential. Conductive rubber on these electrodes enables good contacts to the sample, especially if the sample is a rigid material. Avoid electrodes that will add appreciable resistance to the measurement circuit or could contaminate the sample. Choose an electrode configuration that supports calculating the resistivity from the measured resistance, which several of the commercial systems now available provide, including Keithley's Model 8009 Resistivity Test Chamber.

Measuring the resistivity of semiconductors

The four-point collinear probe technique is the most common way of measuring the resistivity of semiconductor materials; it involves bringing four equally spaced probes

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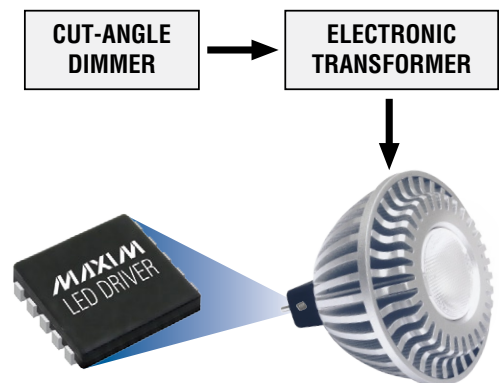
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in contact with a material of unknown resistance (Figure 5). The outer probes (1 and 4) source current; the inner probes (2 and 3) measure the resulting voltage drop across the sample's surface. The volume resistivity is calculated thus:

$$\rho = \frac{\pi}{\ln 2} \frac{V}{I} tk$$

where ρ = volume resistivity (ohm-cm), V = voltage measured between 2 and 3 (V), I = source current (A), t = sample thickness (cm), and k = a correction factor based on the ratio of the probe to wafer diameter and on the ratio of wafer thickness to probe separation. Using four probes eliminates measurement errors due to the probe and lead resistance, the spreading resistance under each probe, and the contact resistance between each metal probe and the semiconductor material.

Another method for measuring the resistivity of semiconductors is the van der Pauw method (Figure 6), which involves applying a current and measuring voltage using four small contacts on the circumference of a flat, arbitrarily shaped sample of uniform thickness. The current is forced to two adjacent terminals of the sample. The voltage is measured on the opposite pair of terminals. This method is particularly useful for measuring very small samples because the dimensions of the sample and the spacing of the contacts

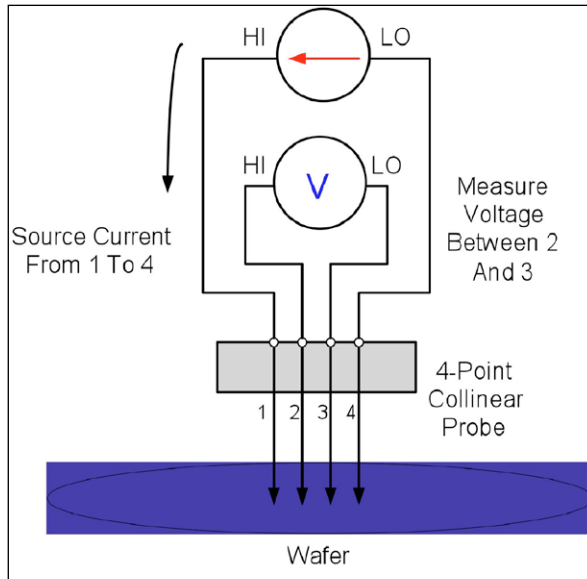


Figure 5: The four-point collinear probe technique for semiconductor materials.

are unimportant. It requires making eight measurements around the periphery of the sample to compensate for offsets and geometric considerations; these measurements are combined mathematically to compute the resistivity. A switch matrix is often used to switch the current source and voltmeter to all sides of the sample to automate these measurements. Typical sources of error for van der Pauw measurements include voltage drops due to lead and contact resistances, voltage offsets, and incorrect instrumentation choices.

Special considerations must be taken into account when measuring semiconductor

materials with resistances of hundreds of kilo-ohms or higher: use a 4-point collinear probe that has excellent isolation between the probes to avoid leakage current errors.

- Choose a current source with high output impedance (τE^{14}) to avoid loading errors and a built-in guard to reduce the effects of shunt capacitance. Use voltmeters with high input impedance ($\tau E14$ ohms).
- Always shield the DUT and all sensitive circuitry and use shielded cabling to prevent errors due to electrostatic interference. Connect the shield to the system's low terminal.
- To avoid common mode current issues, use differential voltage measurement techniques. ■

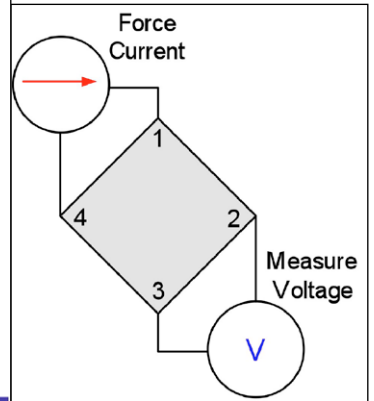


Figure 6: The van der Pauw method for determining the resistivity of semiconductor materials.

Radar measurement comparison - swept and FFT-based signal analyzers

By John S. Hansen

MODERN PULSED radar systems use advanced waveform and modulation characteristics to obtain greater range resolution, enhanced clutter suppression and superior target recognition. Specifically, performance improvements are achieved using radar signals with wide bandwidths, low duty-cycles, high linearity and sophisticated modulation. The nature of these waveforms makes them difficult to measure and synthesize.

Understanding how different types of instruments respond to these radar signals

is crucial when designing high-performance and cost-effective radar systems. This article will review several measurement approaches for characterizing the spectral content of low duty-cycle, wideband radar signals.

The basic tool for characterizing radar signals is the spectrum analyzer or signal analyzer, which measures the power content of radar signals as a function of frequency. This capability is important because an incorrect spectral profile indicates a number of problems that result in wasted power and emission of undesired signals. Traditional spectrum analyzers use a swept-tuned architecture to achieve high dynamic range and

wide frequency measurement ranges [1].

Advances in digital signal processing have resulted in two significant technological developments: 1) the inclusion of digital IFs in traditional swept-tuned spectrum analyzers, and 2) the emergence of Fast Fourier Transform (FFT)-based analyzers as an alternative to the traditional spectrum analyzer architecture. The inclusion of digital IFs in traditional spectrum analyzers has greatly enhanced the accuracy, repeatability and speed of these instruments. FFT-based signal analyzers provide unprecedented modulation analysis capability and can result in much faster measurements in

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some cases, but much slower measurements where many FFT segments are stitched together to form a display. Selecting the optimal measurement approach requires some knowledge of the instrument capabilities and signal under test. To understand how the instrument's architecture affects the displayed frequency response, measurement speed and dynamic range, the spectral responses of a wideband low duty-cycle radar waveform will be compared using swept-tuned and FFT-based analysis techniques. Fortunately, some signal analyzers, such as the Agilent N9030A PXA, contain both swept and FFT capabilities allowing a direct comparison of these two techniques within the same instrument. In addition, some signal analyzers can also be used as a vector signal analyzer for measurement of phase profiles, modulation, transient analysis and spectrograms.

Chirped radar signals

A pulsed radar transmits a periodic sequence of narrow pulses and receives target echoes

between the pulses during the transmitter-off time. Pulse compression techniques using linear frequency modulated (LFM) or "chirped" waveforms can improve range resolution with a relatively higher average transmitted power as compared to narrow pulsed waveforms operating with a similar operating bandwidth [2].

Whether accomplished by implementing pulsed or chirped waveforms, increasing the range resolution and unambiguous range requires wide bandwidth and low duty-cycle waveforms respectively. The combination of wide bandwidths and low duty-cycle creates unique measurement challenges, as there is a lower probability of intercepting these signal types during a typical measurement.

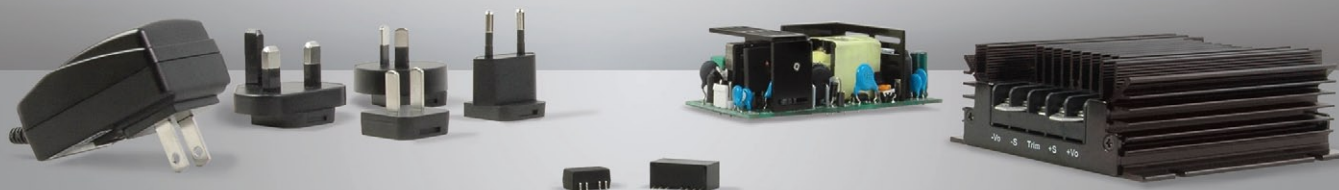
Wideband chirped radar measurements using swept-tuned analyzers

As an example, figure 1 shows the measured frequency responses of a wideband chirped signal for an 80 MHz frequency deviation with a 2-microsecond pulse width and a 20-microsecond period, although today's signal

analyzers can easily analyze 1 GHz chirp radar signals. The two measurements shown in this figure were captured using a swept-tuned analyzer configured with different sweep times in order to compare the effects of instrument configuration on low duty-cycle waveforms. The measurement on the left was captured using an analyzer configured with a sweep time automatically set to 1-millisecond. In this case, the analyzer's sweep time is too fast to capture all of the spectral energy in the waveform. Spectral energy is captured every 20-microsecond during the sweep, but nothing is captured as the sweep advances between pulses. As swept-tuned analyzers continuously measure the signal during a sweep, these periodic pulses appear as individual frequency energy components with equal spacing. These are often referred to as pulse repetition frequency (PRF) lines. Note that these signals have no specific frequency domain meaning and will move around with each sweep [2]. To measure the complete spectral content of the chirped waveform, slow the analyzer's sweep time

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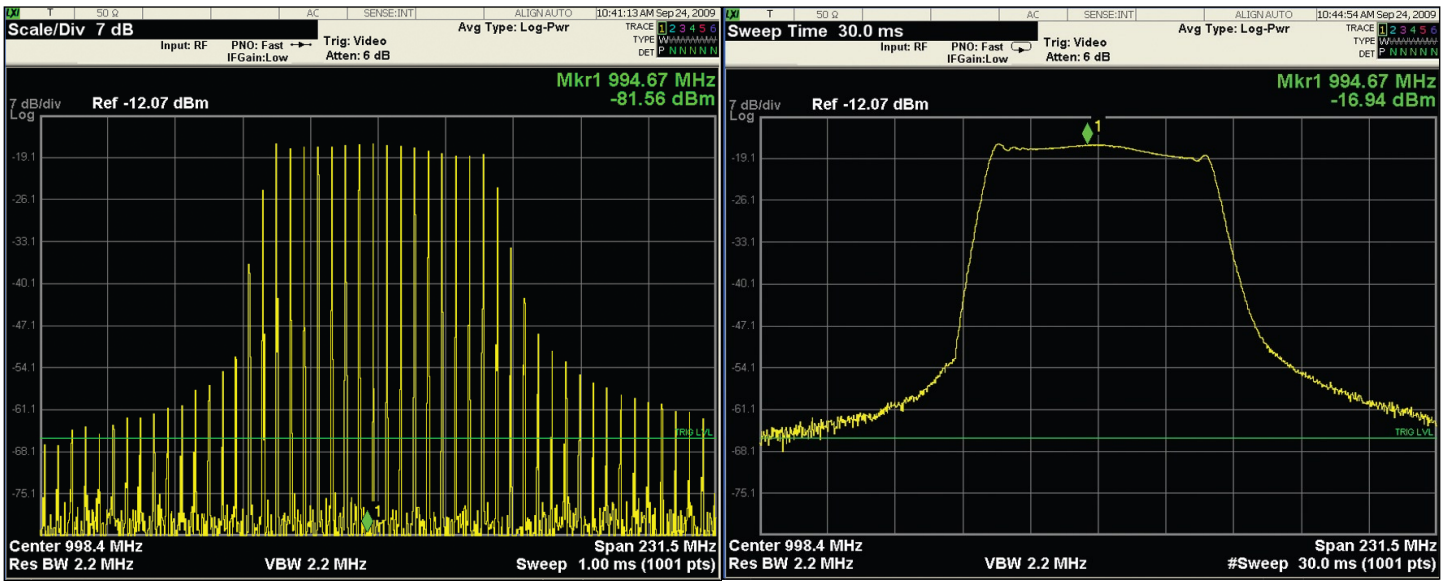


Figure 1: 80 MHz chirped radar signal measured as a function of sweep time on the Agilent PSA spectrum analyzer in swept mode. The resolution bandwidth (RBW) was 3 MHz in both measurements.

so that a pulse occurs in each measurement bucket or point of the sweep. In this example, peak detection was turned on and the sweep time was increased to 100-milliseconds. The desired chirped spectrum is the result as shown in figure 1.

Wideband chirped radar measurements using FFT-based spectrum analyzers

Measuring this same chirp with an FFT-based spectrum analyzer is less optimal. The reasons for this have to do with how the FFT-based spectrum analyzer “sweeps” or measures across spans greater than the FFT analysis bandwidth of the instrument. Essentially, the analyzer must measure the spectrum a section at a time and then concatenate or “stitch” the results. For wide

analysis bandwidths this can also be fast. This approach works reasonably well for continuous signals but is less effective for pulsed signals – due to measurement efficiency. The time required by the analyzer to retune between each segment of the desired spectrum is long relative to the short time data is sampled for each FFT computation. The result is a low probability of intercepting the signal, especially for signals with low duty cycles.

In the swept analyzer example, the sweep time was slowed to increase the number of times the pulsed energy was intercepted during the sweep. This resulted in a better view of the signal as shown in figure 1. However this approach will not work with an FFT-based spectrum analyzer as it may not even have a sweep time control. If it does its

function is not the same even though it may simulate a conventional sweep control. An alternate approach of improving a pulsed RF measurement that does work with an FFT-based spectrum analyzer is to reduce the RBW setting. As the RBW is reduced, the measurement slows increasing the probability of intercept. If the RBW is reduced enough, missing the signal is no longer an issue because the analyzer sees the spectral components of the signal as continuous waveforms, the sum of which forms the pulsed signal.

With a narrow RBW setting the FFT-based spectrum analyzer actually becomes more efficient at measuring spectrum than a swept analyzer with an equivalent narrow RBW setting, despite the fact that the analyzer still must “stitch” together the spectrum from

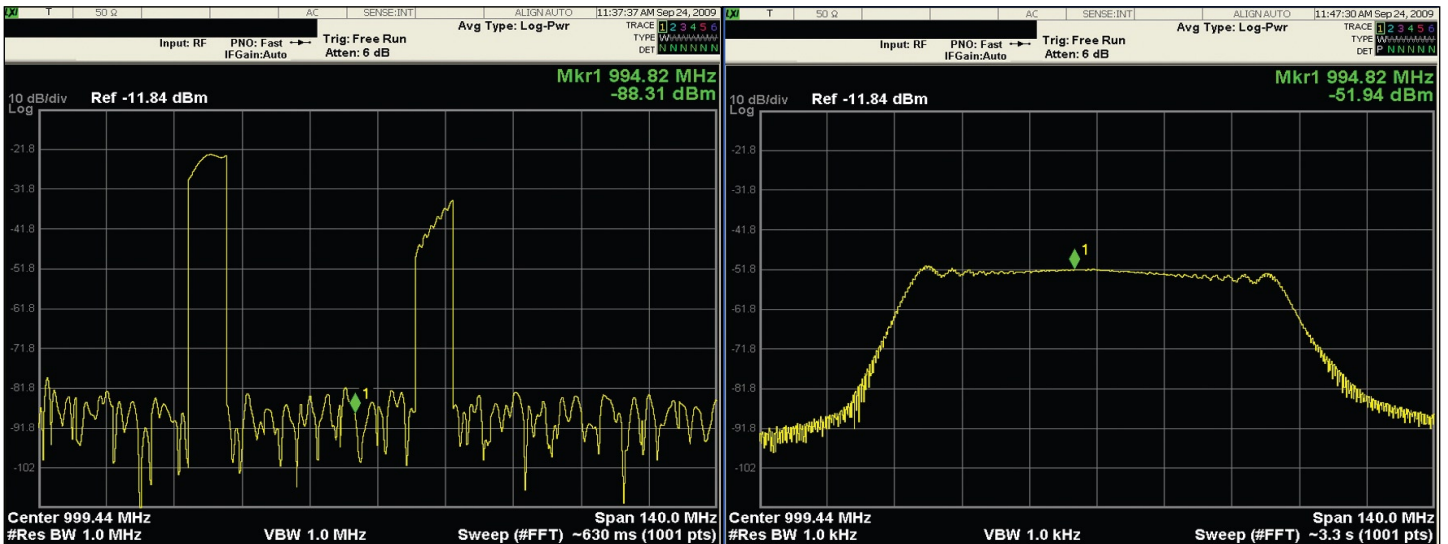


Figure 2: 80 MHz chirped radar signal measured on the Agilent PSA in FFT mode as a function of instrument RBW. Sweep time control is not available in FFT mode.

SPECIAL FOCUS: TEST & MEASUREMENT

several computed FFT segments. For example, the time required to measure 140 MHz of spectrum with 1 kHz RBW is 3.3 s on the PXA in FFT mode. Nonetheless, reducing the RBW to measure a pulsed RF signal has its costs in both measurement speed and dynamic range. Figure 2 shows a measurement of the same chirped radar as measured in figure 1, this time using the FFT mode of the Agilent PXA spectrum analyzer and different RBW settings. With the default RBW of 3 MHz, the measurement is sporadic. By decreasing the RBW to 1 kHz we are able to measure the spectrum. However, the measurement now takes 3.3 seconds versus the 30 ms for the swept mode shown in figure 1. In addition, reducing the RBW also increases the amount of pulse desensitization resulting in less dynamic range. Comparing the figures, the swept mode achieves about 15 dB more dynamic range for this example. An explanation of pulse desensitization can be found in the Agilent Radar Measurements Application Note [2].

Chirped radar measurements using a vector signal analyzer

As shown in the previous examples, an FFT-based analyzer has limits when the span and/or signal of interest extends beyond the analysis bandwidth (FFT bandwidth) of the analyzer. However, for signals within the instruments analysis bandwidth, an FFT-based signal analyzer can provide rich analysis when implemented as a vector signal analyzer.

Modulation analysis is possible because a vector signal analyzer measures both the magnitude and phase of the signal over time and frequency. Figure 3 shows the amplitude, phase and frequency responses for a radar chirp as a function of time measured simultaneously using the Agilent 89601A VSA software connected to the Agilent PSA spectrum analyzer.

A vector signal analyzer's performance is determined largely by the capacity of its digitizer [2]. For instance the Agilent PXA uses a 400 MSa/s digitizer with 14 bits of resolution for 140 MHz of analysis bandwidth and 75 dBc distortion-free dynamic range.

Wider bandwidths can be achieved using an ultra-wideband (UWB) vector signal analyzer such as the Agilent Infiniium DSO9000A Series oscilloscope-based VSA. The DSO9000A analyzer samples at 40 GSa/s with 8 bits of resolution and is therefore capable of analysis bandwidths up to 13 GHz (though with less dynamic range than the PXA). This can be very useful for analyzing wideband chirps such as the 1-GHz chirp shown in the previous examples. In this case, the oscilloscope uses the same VSA software as used by the PXA. Because the oscilloscope is sampling at 40 GSa/s, it can measure this X-Band radar signal directly without requiring down conversion (see figure 4).

Conclusion

Signal analyzers use different approaches to measuring a signal's spectrum. Each approach has its advantages and limitations. These differences are most apparent and critical when measuring wide-band pulsed signals such as radar. The pros and cons are summarized in Table 1. Instruments that perform as swept, FFT and vector signal analyzers, such as the Agilent PSA, PXA and MXA signal analyzers, provide optimal performance and capability regardless of the characteristics of the signal being measured.

Additional information concerning measurements for radar can be found in Agilent's Radar Measurements Application note mentioned previously. This application note can be ordered from www.agilent.com/find/radarprogram or downloaded from www.agilent.com/find/ad.

References

- [1] Agilent Application Note 150, "Spectrum Analyzer Basics", Literature number 5952-0292.
- [2] Agilent Application Note, "Radar Measurements", Literature number 5989-7575EN.
- [3] Agilent PSA Series High Performance Spectrum Analyzers, Literature number 5980-1283E.
- [4] Agilent Application Note 150-2, "Spectrum Analysis – Pulsed RF", Literature number 5952-1039.

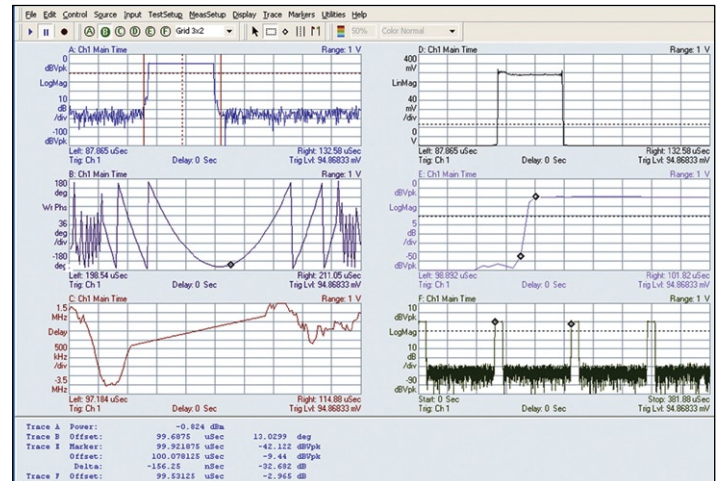


Figure 3: Frequency, time, and phase measurements using the Agilent VSA software and PSA spectrum analyzer.

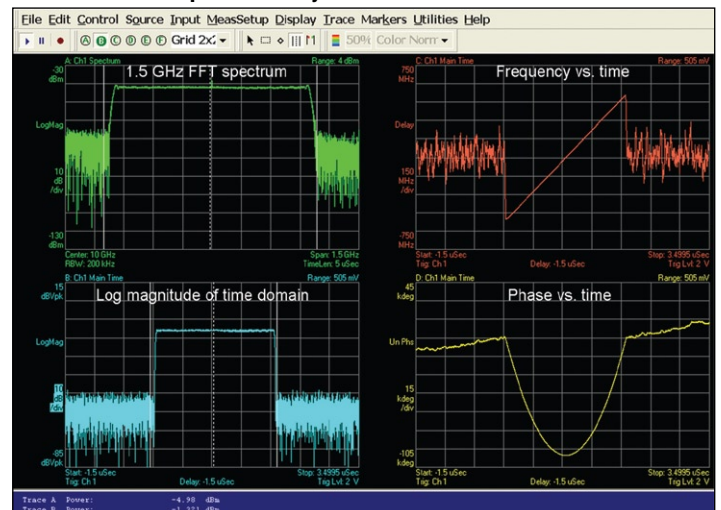


Figure 4: Frequency, time, and phase measurements of a 1-GHz radar chirp using Agilent VSA software and DSO9000A Series oscilloscope.

	Swept-tuned Spectrum Analyzer	FFT-based Spectrum Analyzer (Signal Bandwidth < Analyzer FFT Bandwidth)	FFT-based Spectrum Analyzer (Signal Bandwidth > Analyzer FFT Bandwidth)
Dynamic Range	Excellent	Good to fair (Dependent on digitizer)	Good
Speed			
Wide RBW	Excellent	Excellent	Poor
Narrow RBW	Fair	Excellent	Excellent
Modulation Analysis	Optional	Excellent (with VSA software)	Not available
Transient Analysis	Zero-span	Excellent	Not available

Table 1: Summary table comparing performance and capability of swept versus FFT-based signal analyzers.

Optical power measurement and resolution

By Daniel van Brechtá

THE MODERN OPTICAL SPECTRUM analyzer (OSA) is a powerful tool for carrying out a variety of measurements, but many users do not appreciate some of its potential applications. In this article, the relationship between power measurement and resolution will be discussed, with the aim of showing users how understanding the technical principles of the OSA will allow them to get the most out of the instrument.

The particular type of OSA described in this article is based on a Czerny–Turner monochromator. In this type of monochromator, the different wavelengths of input light are spatially separated by a diffraction grating. By rotating the grating, a spectrum of wavelengths is swept across a narrow slit, allowing passage of only a narrow bandwidth of light (see figure 1).

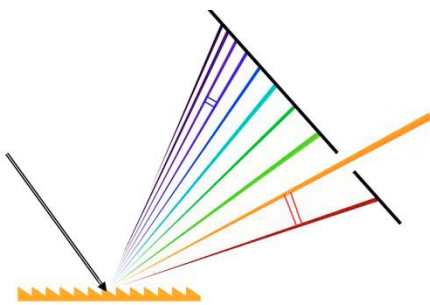


Figure 1: The wavelengths that are diffracted from the grating are not evenly distributed.

Effective resolution

It is important to understand that the separation between the diffracted wavelengths is not evenly distributed. In fact, at long wavelengths, the separation between the diffracted wavelengths is larger than at short wavelengths.

In the monochromator, almost all of the diffracted wavelengths are blocked. Only a narrow portion of the light passes through

the slit and reaches the surface of a photodetector. Here, the slit acts as a bandpass filter. The narrow spectrum that passes through the slit is often referred to as “resolution bandwidth”. Owing to the uneven distribu-

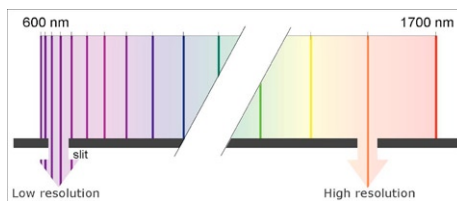


Figure 2: The same slit provides a different resolution for different wavelengths

tion of wavelengths, the bandwidth that is selected by the filter depends on the selected wavelength (see figure 2). Whereas many wavelengths fit through the slit (i.e. low resolution) at short wavelengths, the same slit allows passing of only few wavelengths (i.e. high resolution) at long wavelengths. This means that the bandwidth of this filter



Figure 3: At 1550nm, the OSA has a stored value for the effective resolution of 17 pm, i.e. higher resolution than the selected 20pm

(effective resolution) is often quite different from the selected resolution setting on the instrument (see figure 3).

The effective resolution vs. wavelength curve is determined and stored during factory calibration of the OSA.

Absolute power display

Assume an OSA that records the output of a lamp with a perfectly flat spectral power distribution, so that within each 1 nm bandwidth the lamp offers the same amount of radiant power. One might expect



Figure 4: The recorded spectrum of a perfectly flat spectrum is dropping towards longer wavelengths

that the OSA (with its power/wavelength display) will produce the same perfectly flat spectrum. However, this is not the case (see figure 4). In fact, the increasing effective resolution towards longer wavelengths causes the recorded trace to drop. At short wavelengths, the slit allows passing of more wavelengths (i.e. more power reaches the photodetector). On the other hand, at long wavelengths the same slit offers higher resolution and less power reaches the photodetector. The spectrum is shown in an absolute power display, which plots power (PdBm) against wavelength.

Dividing the recorded power at each point by the local effective resolution again produces the flat spectrum. Now the spectrum is shown in the power density display, which plots power per nanometre (PdBm/nm) as a function of wavelength (see figure

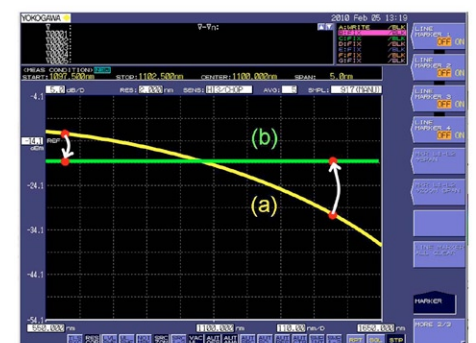


Figure 5: Recorded OSA trace (a) is converted to the power density spectrum (b) by dividing the measured power by the local effective resolution

5). The OSA does this automatically when the user selects dBm/nm instead of dBm for the power level scale. For the calculation, the OSA uses values for the effective resolution that are determined during factory calibration.

Because of the opto-mechanical nature

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of the OSA, the stored values for the effective resolution will deviate slightly from the true value. This will cause a small error in the calculation of the power density display. These errors are kept to a minimum by regular calibration of the instrument, but the absolute power display will always offer slightly better level accuracy.

Power density display

In contrast to the absolute power display, the power density display can immediately be read and understood. This is the display used for publication of results. There is no need to know the effective resolution at each point in the spectrum for interpretation of the power level. This means that power levels at different wavelengths can be compared in a single view, and the power inside a peak is easily calculated by integrating the trace over the desired bandwidth. If the recorded spectrum is extremely narrowband (i.e. less than the effective resolution bandwidth), the absolute power is independent of the effective resolution. Here, the recorded peak level equals the total power inside the spectral peak. ■

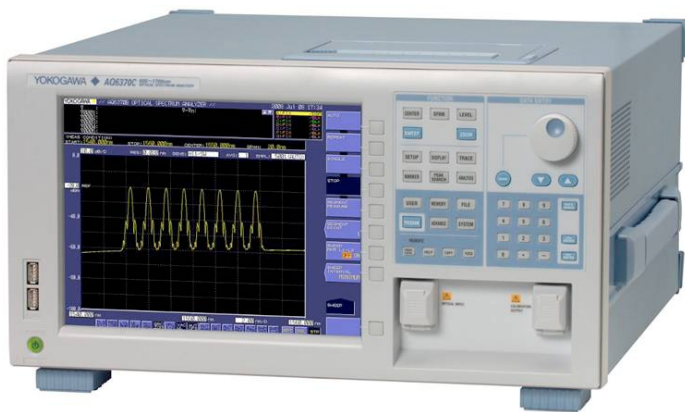


Figure 6: The Yokogawa AQ6370C optical spectrum analyser

High bandwidth probes in a compact and lightweight housing

Pico Technology announced two high bandwidth Tetris probes in a compact and lightweight housing, for testing densely-packed high-speed circuits. With their active circuitry, these probes deliver a significant performance improvement over passive probes.

While the input capacitance of a passive probe loads the signal source even at frequencies below 1MHz, causing distortion, the Tetris probes maintain a high input impedance

into the GHz range. This enables the accurate display of pulses with sub-nanosecond rise times. The Tetris probes are compatible with all standard high-bandwidth oscilloscopes with 50-ohm BNC inputs, such as the PicoScope 6000 Series. The Tetris 1000 has a probe bandwidth of 1 GHz, while the Tetris 1500 is rated at 1.5 GHz. Other specifications are: input impedance 1 megohm in parallel with 0.9 pF; measuring range +/-8 V; attenu-

ation 10:1 +/- 5%; cable length 1.3 m; weight (probe only) 96 g. The probe heads have a T-shaped cross-section that allows them to be stacked side by side, closely enough to probe adjacent pins of a 0.1 inch IC package. The probes



are supplied with a comprehensive accessory pack consisting of: low-inductance ground blade, assorted ground leads, L-In adapter, Z-Ground, 2 adhesive copper pads, two pico hooks, replacement solid and sprung tips, 0.8 mm socket adapter, and coloured cable markers. A universal mains power supply is also included.

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LeCroy enhances LogicStudio

to include Tektronix and Agilent oscilloscope connectivity

LeCroy Corporation has announced the latest version of its LogicStudio software that enhances the oscilloscope connectivity of the LogicStudio 16 providing support for not only the LeCroy WaveJet oscilloscope but also several popular oscilloscopes from Tektronix and Agilent. This software adds an unprecedented level of flexibility to the LogicStudio, letting users of a wide range of oscilloscopes from 40 MHz up to 1 GHz turn their PCs into mixed signal oscilloscopes. The 16 digital channels, 1 GS/s sample rate, 3.75 ns glitch capture, and serial protocol analysis (I2C, SPI, UART) of LogicStudio can now combine with the analog channels from a wide range of oscilloscopes, including the LeCroy WaveJet, six Tektronix product lines, or three Agilent product lines. The lively, dynamic waveform display with a smart, intuitive user-interface is now more powerful than ever, providing a deep toolset for digital, serial and analog debug. Like most logic analyzers, LogicStudio can capture and display digital and serial signals. However, the software goes a step further and provides a communication link to a wide range of oscilloscopes turning the PC into a true mixed signal debug environment. The communication from the LogicStudio software to the oscilloscope will allow for configuring the trigger and transferring data, presenting all the digital, serial and analog data in a single display. Analog waveforms from the

oscilloscope are displayed alongside digital and serial signals from the digital channel enabling quick and easy mixed signal measurements. With support for ten different oscilloscope series from three different manufacturers, the LogicStudio is a versatile, time saving tool for embedded system design and debug. LogicStudio provides a wide range of tools for digital debug including timing cursors, unique zooming and panning of waveforms, a persistence display and a history mode which can replay old data captures. Additionally, protocol analysis for I2C, SPI and UART is included to decode waveforms as they are captured and provide the ability to trigger on specific address or data packets on the bus.

Data is captured and displayed at a high rate, which when combined with the persistence tool and history mode can quickly help identify glitches or problems. A magnifier tool will let the user search longer captures for more details without changing the scale of the main acquisition. For timing measurements, activate a pair of cursors anywhere on the display or snap them right to an edge of one of the waveforms for precise measurements. Triggering can be operated in Auto, Normal or Single modes just like a modern oscilloscope.

LeCroy Corporation

www.lecroy.com

16G fibre channel

analyzer blade option

JDSU announced the Xgig 16G fibre channel analyzer, what the company claims to be the industry's first FC testing solution to enable storage equipment manufacturers to complete the development of storage equipment compatible with advanced 16G technology. 16G FC continues to evolve as a high-speed, high-capacity technology critical for storage area networks (SANs) to handle more data at greater speeds using fewer links. The JDSU Xgig 16G fibre channel analyzer provides accurate, fast and comprehensive analysis of 16G fibre channel links to quickly identify and fix mission-critical errors, ensure quality data transmission, and improve overall equipment and network performance. The instrument provides network equipment manufacturers with a solution to validate crucial development, integration and interoperability functions that are in compliance with the 16G fibre channel specification. For end users, the advantages of 16G storage equipment include increased bandwidth for the network, lower power consumption (at least 25% compared to 8G FC), as well as lower cost of associated equipment by reducing the number of cables, ports and devices required. The new Xgig 16G fiber channel analyzer comes as a blade option that fits into the JDSU Xgig 5000 chassis.

JDSU

www.jdsu.com

Modulation domain analyzer software package

for precise frequency analysis and visualization

The Pendulum TimeView modulation domain analyzer software package launched by Spectracom is designed to support critical test functions for precise signal frequency analysis. TimeView 3 turns the Pendulum CNT-91 timer/counter into an advanced, real time measurement analyser claims the company. Applications include analysis of pulsed RF in radar equipment, real time monitoring of short-term stability in synthesizers and test of frequency control components. This enhanced version also emulates the behavior of Agilent's

discontinued model 53310A. An MDA (Modulation Domain Analyzer) can visualize frequency variations over time, just as oscilloscopes show voltage variations over time. Spectracom's MDA solution consists of two parts: the CNT-91 frequency analyzer, as fast sampling front end and the TimeView 3 MDA software, running on a PC. TimeView 3 builds on the features available in the existing version 2.1, but has an even more user-friendly graphical interface and more automated settings to meet user requirements.



As well as the Agilent 53310A emulation mode, new features include precise FM calibration, new post-processing functions including wander metrics (MTIE

and TDEV), and improved pulsed RF visualization.

Spectracom

www.spectracomcorp.com

Automated test software

for PCI Express 3.0 transmitter compliance

Agilent Technologies announced an automated compliance test package for PCI Express (PCIe) 3.0 physical-layer transmitter compliance testing that includes measurement support for the new PCIe 8-GT/s interface. The Agilent N5393C compliance test software for Infiniium 90000 Series oscilloscopes performs a wide range of oscilloscope-based tests for the PCIe 1.x, 2.x, and 3.0 standards. It also provides early 8-GT/s physical layer transmitter measurements for customers designing to the requirements of the PCIe 3.0 specification. The N5393C PCIe compliance test software provides design and validation engineers with a fast and easy way to verify physical layer transmitter compliance

for PCIe 2.5-GT/s, 5-GT/s end point, root complex systems and devices and for 8.0-GT/s chipsets. The software provides automated compliance test support for the BASE and CEM measurement points supporting PCIe 1.x and 2.x standards, as well as BASE specification support for the PCIe 3.0 standard; it supports de-embedding of test fixtures and cables to help improve voltage and jitter margin measurements when used with the optional Agilent N5465A Infinii-Sim waveform transformation toolset. It displays the results in a flexible report format and provides a margin analysis.

Agilent Technologies

www.agilent.com

In-system emulation technology

with dedicated model library for the TigerSHARC DSPs

Goepel electronic has developed a dedicated model library for the TigerSHARC series of Digital Signal Processors (DSP) from Analog Devices to enable the use of VarioTAP emulation technology. VarioTAP's functional range goes from programming of external Flash devices, interlaced bus emulation tests (BET) up to emulation tests on system level. It is based on processor specific library models in software IP form. The VarioTAP IP models for TigerSHARC DSP has been developed in close cooperation with the Estonian Company Testonica, and enables Flash programming as well as numerous emulation test functions. The adaptive streaming technology of the TAP signals allows

emulation tests to be carried out in parallel or interactively to Boundary Scan tests within a test program. The number of Taps' is effectively unlimited by utilising the hardware platform Scanflex for instance, up to eight Taps' can be controlled independently from and simultaneously to other I/O resources. In addition to dynamic tests of externally connected components such as RAM or I/O resources, the IP functions for bus emulation and system emulation enable the functional testing of on-chip resources as well as the execution of program codes defined by the customer.

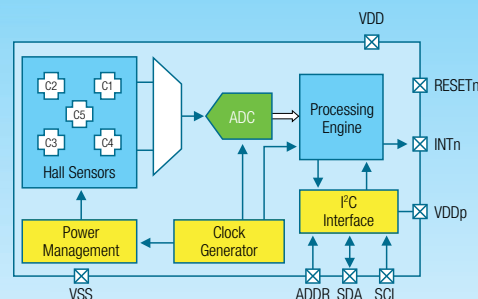
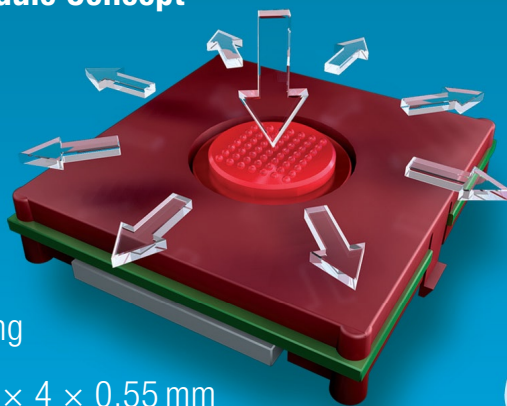
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Automotive Ethernet diagnostics and beyond!

By Mike Jones

ETHERNET HAS now been widely accepted by carmakers as the interface of their On-Board-Diagnostics (OBD) for the next generation of cars. This adoption will be accelerated with the introduction of standardised IP Diagnostics interface, as specified in ISO 13400, using Ethernet as the physical layer.

Download times are reduced from hours to minutes from the increased speed of 100Mbps Ethernet (or 1000Mbps Gigabit Ethernet), full duplex bandwidth available by the network. Costs are also reduced by seamlessly interfacing the car directly to a service centre network or remote laptop. Micrel has led the way by offering the first AECQ-100 qualified Ethernet devices, deployed in the market since 2008. However, Ethernet is unlikely to just stop at OBD interface applications. It's low cost of ownership, open standard and ample bandwidth makes it attractive to many other applications in the car, including infotainment and camera networks.

Ethernet offers complete flexibility when designing a multi-node network, allowing topologies of ring, star or a hybrid of both. Traditional networks in the car like MOST are restricted to only ring topology, which although can ease cabling logistics, is very bandwidth inefficient. Ethernet configured in a star topology will provide full 100Mbps, full duplex (or 1000Mbps) point-to-point for each node, unlike a ring where this bandwidth is shared across all nodes.

One of the major growth applications in the car today is the camera, both as image and sensor. Increasing the ease of driving and safety in cars is becoming not just popular but mandatory. Enhanced picture image and sensor resolutions needed to support such applications such as, lane departure, sign / traffic light recognition and collision avoidance requires increased bandwidths. Ethernet can deliver this performance in the most cost effective manner and becoming the choice across the industry.

Figure 1 below shows the flexibility of Ethernet to provide a simple hybrid network for these applications. Cabling costs are also reduced for Ethernet compared to other spe-

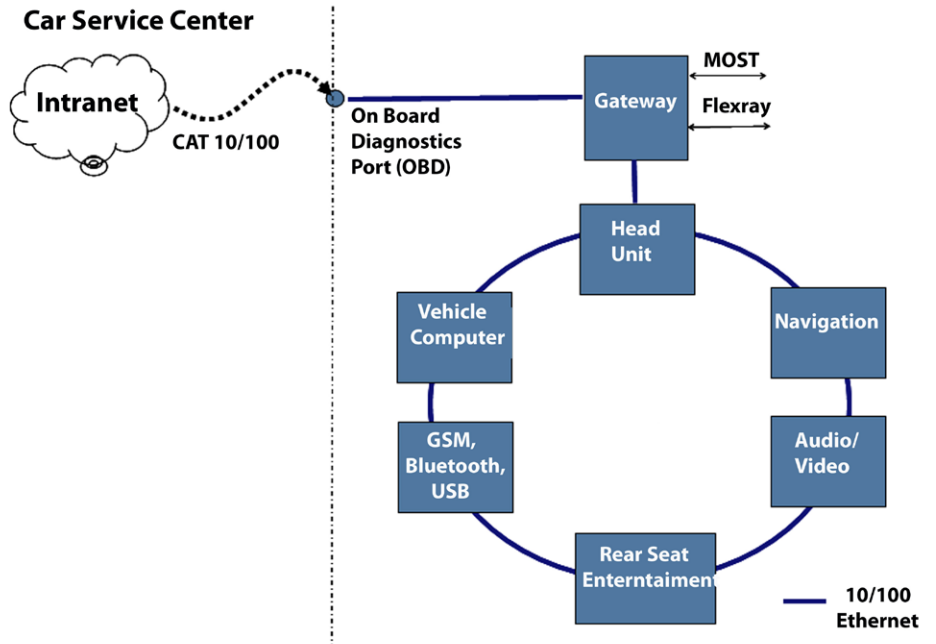


Fig. 1: Example Ethernet car network.

cific media like POF (Plastic Optical fibre) by running over common Unshielded Twisted Pair copper.

Ethernet audio/video bridging

To guarantee an Ethernet quality of service for timing critical services, for example audio / video in home; professional environments, such as recording studios and concert halls; car infotainment, the IEEE has formed an Audio/Video Bridging (AVB) task

group as part of 802.1. The original work on the AVB specification migrated from the Residential Ethernet Study Group investigating next generation Digital Home Networking. Interestingly, it is this AVB standard that is attracting a keen interest not only from the consumer multimedia market but also the automotive sector. By leveraging the technology and volumes of scale from the Digital Home the automotive market will crucially have the ability to offer latest

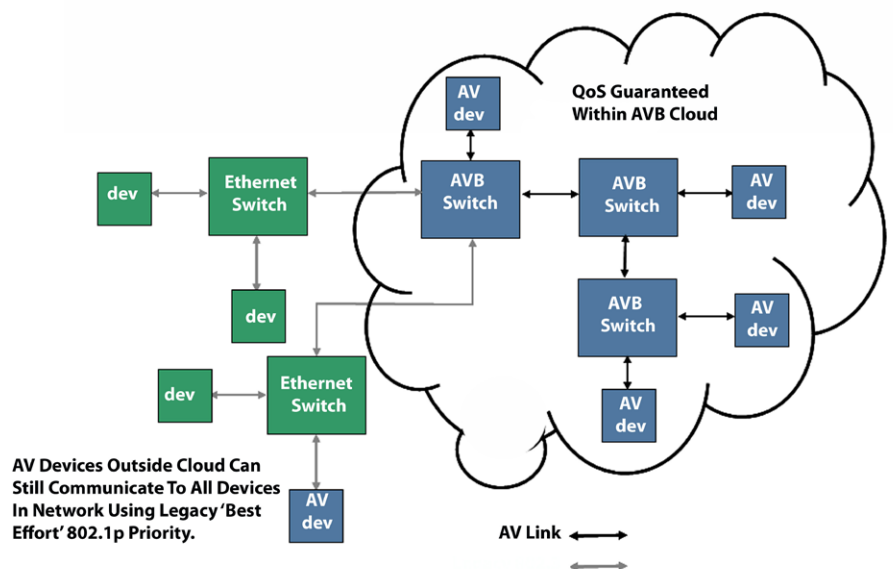


Fig. 2: The AVB cloud.

Mike Jones is Senior FAE at Micrel – www.micrel.com

digital multimedia services at the lowest cost point possible.

The AV Bridging system is based on three specifications; IEEE 802.1as Time Synchronization; IEEE 802.1Qat Stream Reservation; and IEEE 802.1Qav Queuing & Forwarding for AV Bridges.

Using these standards allows a single standard Ethernet (802.3 and 802.3) network to carry multimedia applications as well as non-time critical traffic (data) by establishing an 'AVB cloud' within the network.

Time critical traffic is bounded to within the AVB cloud, where all devices must support AVB capability, as shown in Figure 2. To establish a link between two AVB devices, an enhanced LLDP (Link Layer Discovery Protocol) is run, following auto-negotiation completion, to ensure both devices support AVB. Then the 802.1, as Precision Time Protocol (PTP), is used to ensure that the link delay is less than 2us.

IEEE 802.1as time synchronization

802.1as is based upon the IEEE 1588 Time Synchronisation specification that utilizes UDP (User Datagram Protocol) packets over IP to synchronization the network by providing a common 8kHz clock source. Figure 3 shows a typical Hardware implementation of the IEEE 802.1as/1588 functionality. To achieve synchronization with the rest of the network each node must determine which clocking source it should use. All nodes perform the 'Best Master Clock' algorithm to select timing. If the node is to be a master to many of the nodes in the ring then a high precision source, such as GPS, is used. If the node is not designated as a master then it will extract timing from the network using the 1588 protocol. Failure to extract timing from the network will result in using the

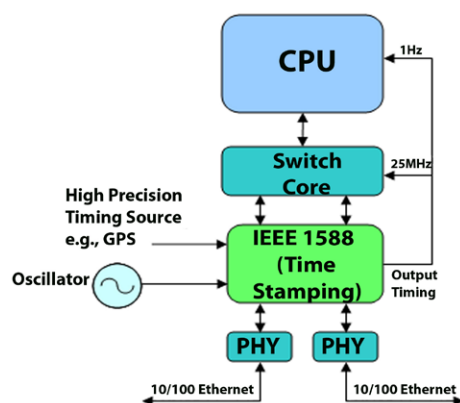


Fig. 3: Hardware implementation of IEEE 1588/802.1as.

on-board local oscillator. The master is responsible for providing all the slaves in the network with an advertisement of its position. If the slave does not receive any advertisement from the master then it will designate itself as the master.

To synchronize the master and slaves 1588 operates PTP (Precise Time Protocol) based on IP multicasting. The switch needs to identify PTP packets and timestamp

the ingress and egress PTP packets. In the ingress direction the switch will forward the incoming PTP packets directly to the processor port.

The synchronization process is divided into two phases. First, the offset time between the master and slave is calculated and corrected. To perform this function the master continuously transmits a unique message to the slave at defined intervals, usually ev-

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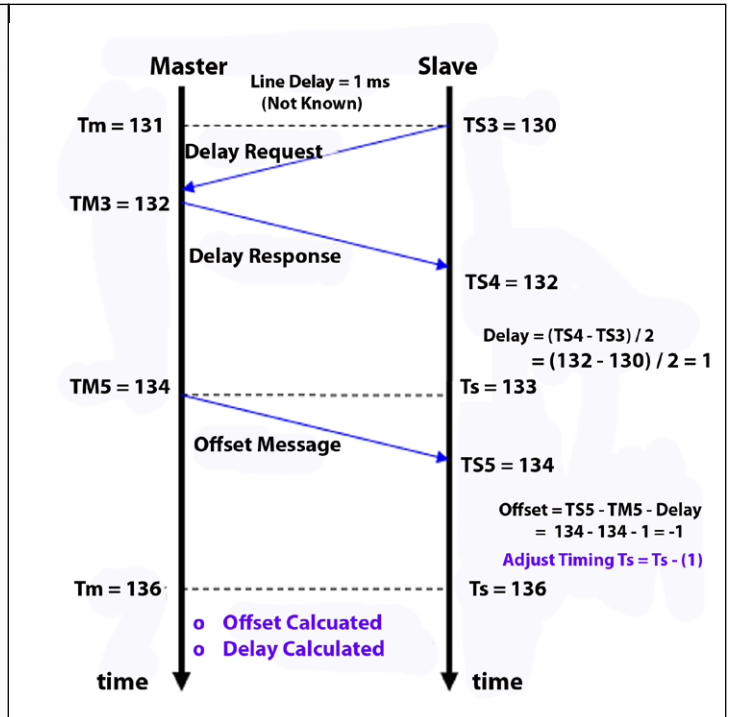
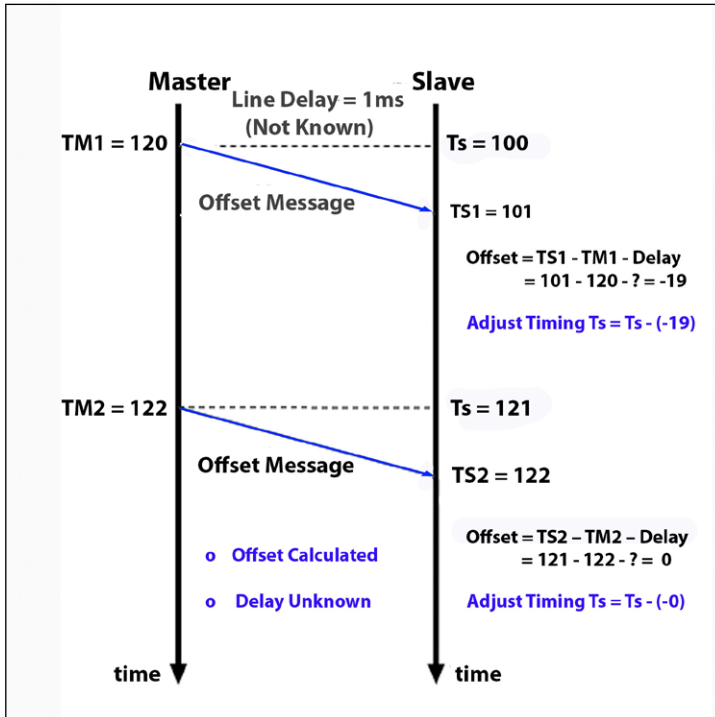


Fig. 4a: Example of PTP synchronization - offset calculation

Fig. 4b: Example of PTP synchronization - delay calculation.

ery roms. The second phase of the synchronization process is the delay measurement. The slave will send a 'delay request' to the master that is returned and the round trip delay calculated using the timestamps. The assumption here is that the delay between master and slave is always symmetrical.

Figures 4a and 4b provide an example of the Offset and Delay phases of the PTP synchronizations process. To achieve the required latency jitter, the maximum drift allowed is around 4ppm, equivalent to a 4ns drift every 10ms synchronization cycle.

listener, for example listener B in Figure 5, subscribes to a stream already being forwarded by the bridge, the bridge will act as a proxy and generate a reserve message.

SRP usually limits the maximum total allocated bandwidth to around 75 percent to reserve sufficient bandwidth for any future high priority traffic. De-registration will occur in the same manner as reservation, in this case freeing up the reserved resource as the leave message propagates through the bridges.

IEEE 802.1Qat stream reservation

The 802.1Qat allows network bandwidth and buffer resources to be reserved for specific traffic schemes using SRP (Stream Reservation Protocol). SRP is conducted in two parts, registration and reservation; listeners register for a stream and sources reserve the required resource to provide the stream. Figure 5 shows a simple example of the SRP process. A listener will initially send a registration message which will propagate through the bridges in the ARP cloud until it reaches the talker. If the talker's identity is unknown by any of the bridge along the route they will broadcast the message to all ports. As well as forwarding the registration messages, each bridge will make a temporary entry in its database to forward the associated reservation message reply back from the source. If another

IEEE 802.1Qav queuing & forwarding

Queuing and Forwarding methods are based on segregating traffic into isochronous (time critical) and asynchronous (non-time critical) packets and prioritising during a time cycle provided by the 8kHz synchronized 802.1as clock source. Traffic segregation is achieved using the priority class defined in 802.1p (see Priority and QoS). Egress port buffers are then separated into two or more queues, each allocated to a specific priority class. Isochronous packets will be given the highest priority, while asynchronous packet the lowest.

A number of priority forwarding algorithms exist for the queues, including credit-based and weighted round robin. Both methods are preferred over simple strict priority, which could starve low priority traffic in cases where high priority traffic rate is high.

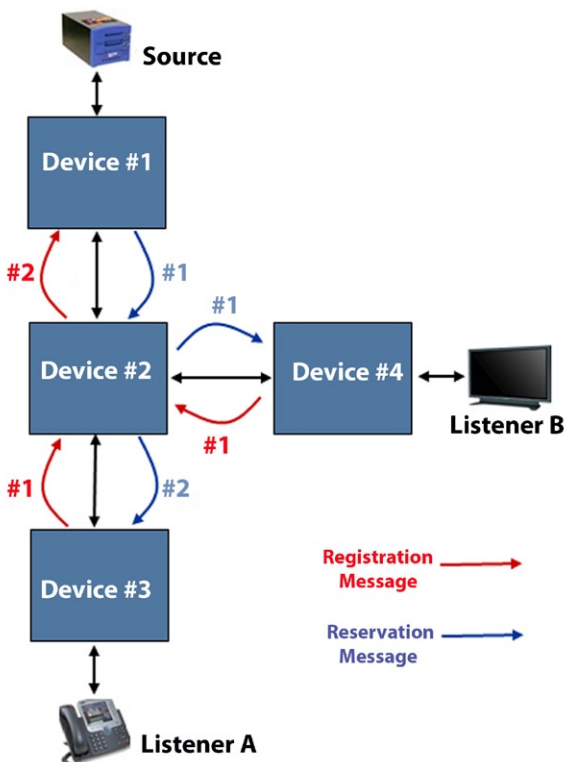


Fig. 5: IEEE 802.1Qat Stream Reservation.

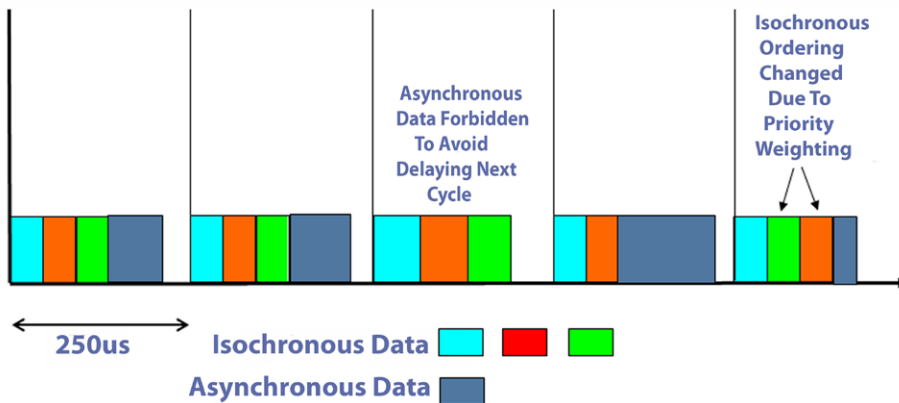


Fig. 6: Example of IEEE 802.1Qav Forwarding & Queuing.

Real time performance is achieved by time multiplexing the communication within the networks AVB cloud. 802.1as provides a synchronized 8kHz clock to each node that is used to create a 250µs (2x 8kHz clock period) frame. Critical isochronous data transfer is performed at the start of the time slot, followed by non-critical TCP-IP traffic, if it is not going to delay the start of the next frame. A frame of 250µs, rather than a single 125µs clock period, is used since the largest permissible Ethernet packets (1518 bytes) introduce themselves more than 120µs forwarding delay. AVB streaming will usually fragment traffic into a number of smaller packets every cycle rather than using fewer large packets which results in an undesirable bursty traffic flow. Latency jitter performance is reduced to a minimum using this method of time slot multiplexing. Any jitter caused by queue delay in a cycle is removed by re-scheduling during the following cycle. An example of 802.1Qav Forwarding and Queuing of isochronous and asynchronous traffic is shown in Figure 6. It is usual to limit isochronous traffic allocation to no more than around three quarters of the available bandwidth as not to starve the network of asynchronous traffic. This is essential to ensure that an AVB cloud can operate transparently and seamlessly within an 802.3 Ethernet network, without any noticeable degradation in the standard TCP/IP traffic data.

To provide interoperability with standard non-AVB Ethernet switches, AVB packets are normal 802.3 Ethernet frames identified by using a special type field. The AVB packet is encapsulated within the Ethernet data field. The AVB packet, defined in IEEE 1722 (AVB Layer 2 Protocol Specification), consists of a header with type, 802.1Qat streaming reservation information and 802.1as time-stamp

followed by payload data. An example of the standard 802.3 Ethernet frame with AVB encapsulation is shown in Figure 7 below.

AVB automotive profile

The automotive environment has distinct differences to other adopters of the AVB standard in the fact that it is generally well defined. Unlike digital home applications, where the specification has to provide a guaranteed service when 'anyone' can connect 'anything' to 'anywhere' at 'any time', a car network is fixed during assembly with relatively limited additional user connec-

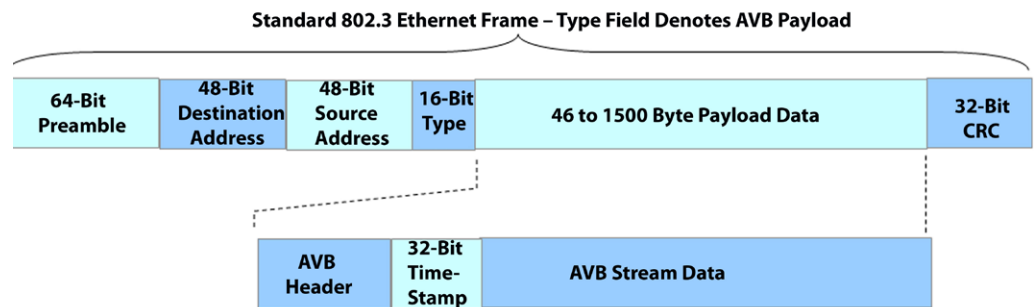


Fig. 7: AVB encapsulation within IEEE 802.3 frame.

tivity. By utilising these observations it can be argued that automotive applications do not actually require support of the full specification to deliver the required QoS. The need for IEEE802.1Qat Stream Reservation is debatable. By optimising the Ethernet AVB specification to automotive needs then a low cost, high performance solution

is possible. BMW have themselves recently published a White Paper discussing this very subject, 'Audio/Video Transmission in Cars using Ethernet'. The paper suggests that only a subset of the AVB specification is needed, which they refer to as AVA (Audio Video Bridging for Automotive). Here they recommend a solution consisting of the following parts from AVB: IEEE 1722 AVB Packet and the PTPv2 Time Synchronisation (IEEE 802.1as).

Conclusion

Today, Ethernet has already emerged inside the car to provide an IP-based standard interface for diagnostics and software downloading. However, the growth of Ethernet in the car has not stopped there. Ethernet can be considered to form the backbone of the next generation automotive multi-media networks, carrying 'live' traffic.

New standards such as IEEE 802.3AVB (Audi-Video Bridging) initially defined for Digital AV Home networking are being adapted to support the same real-time services in the car. Following this the ultimate goal would be to converge other bus systems inside the car into a single common bus; Ethernet. ■

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Automotive connectors evolve to meet complex demands and EV challenges

By Ted Worroll

CONSUMER DEMANDS drive many trends in the dynamic automotive industry, whether it is cost, comfort, style, safety, reliability, functionality, or any number of other factors. These customer demands, combined with consistent technology advancements, performance enhancements, and the requirement for smaller, lighter systems and components, have shaped the evolution of the automotive connector.

Historically, many automotive connectors were developed based on industrial connector designs. The original industrial designs were developed to address many of the same environmental factors that are found in the automotive environment, including high temperatures, vibration, shock, and fluid exposure. Engineers adapted the industrial designs to meet automotive requirements; however, the increasing complexity of automotive electronics, particularly control systems and sensors, has created demands for interconnect solutions that vary greatly from the traditional pin-and-socket connectors, and can adapt to electric and hybrid vehicles.

Designers using the latest electronic technologies to enhance systems such as safety features, user interfaces, and electric vehicle charging must implement high-performance connectors. In addition to meeting quality and reliability standards, connector requirements in today's vehicles include increased I/O counts, higher densities, small PCB footprints, and lower costs. Although these requirements may appear incompatible with lowering costs, connector suppliers are responding by developing new solutions that challenge traditional parameters in regard to both technology and cost.

Reliability and durability

One of the biggest challenges in the evolution of the automotive connector is meeting reliability and durability standards. Today's vehicles rely heavily on electronics to control critical systems, including steering,

brakes, airbags, and GPS navigation which means that electronic components used in key electronic systems must be ultra-reliable and durable. Failures in any critical system could have disastrous results.

While today's electronic systems have demonstrated reliability, they cannot be visually inspected and physically tested like traditional rod-and-gear mechanics. As electronic designs continue to replace mechanical control systems, connectors must evolve to eliminate the reliability concerns.

The automotive challenges

Temperature: under-the-hood applications must perform on both ends of the temperature spectrum, from sub-freezing temperatures prior to ignition, to high operating temperatures when an engine is running. Temperature stresses are common in automotive applications, and these stresses require connectors that can operate at temperatures between -55 and 125°C, but these aren't the only concerns. Current electronic fabrication processes require connectors withstand processing temperatures for RoHS compliance up to 260°C.

This elevated processing temperature requirement has emerged in response to the European initiatives that eliminated lead from soldering operations, thus elevating the processing temperatures during electronics fabrication.

Shock and vibration: interconnects for automotive electronics have incorporated much experience from industrial applications with regard to shock and vibration. It can be challenging to find interconnect solutions that are able to withstand both low and high frequency vibrations typical of automotive applications, hence, the critical need to find an interconnect partner with the ability to work on a project from the beginning to ensure that a reliable solution ends up in the finished product.

Examples of vibration range include low frequency sources, caused by out of balance



Electric vehicle charging plug.

wheels on a vehicle, to high frequency vibration caused by engine turbochargers. Shock loads vary, with some extreme, undamped shocks resulting in 100s of Gs of force on impact surfaces.

Sealing: many electronics traditionally used in automotive applications were developed for environments not typically subjected to moisture and chemicals. Fortunately, some manufacturers have been able to use their industrial experience to implement sealing techniques designed to meet IP65 (splash), IP67 (submersion) and IP69 (spray) specifications. Manufacturers have employed anti-corrosive materials to ensure connectors survive in wet and corrosive environments for applications found on vehicle engines, batteries, and systems exposed to the external environment.

Quality

Beyond the performance and environmental exposure issues for connectors, there are important quality concerns as well. Conditions, such as bent pins from connector misalignment during assembly are an old problem, one that not only affects reliability, but assembly costs and production delays as well. However, even this issue is being addressed through the latest plug-only landed contact designs, which minimize these types of quality issues. There has been a tremendous move away from traditional pin and socket connectors to pressure contacts that can be better controlled in under-hood environments.

Ted Worroll is Product Manager at
ITT Interconnect Solutions - www.ittcannon.com

These plug-only landed contact systems include pressure contacts designed to mate directly to pads on a PCB, yet able to withstand the thermal shock, vibration, and hostile environments common in automotive applications. In these systems, all of the contacts are in a plug-side connector so OEMs can have receptacles integrated into their housing with essentially no connectors and no contacts. The advantages for this approach include a cost-reduction from the removal of contacts, an increased density, due to requiring only a pad on the PCB, and the simplification of the connection in the plug-side. New connector designs provide a plug-only solution that is scalable and sealed, which increases density, reduces PCB space, and cuts total installed costs.

Innovations

With recent environmental concerns and the rising cost of oil, the automotive industry has once again seen a shift, as consumers are demanding more compact, fuel-efficient vehicles. Technological advancements have enabled automobile manufacturers to address the demands of its customers with the mass-production of environmentally friendly vehicles, such as hybrid and electric cars.

Since the introduction of electric vehicles, a primary concern from many skeptical consumers has been the reliability of the charging solution. Not only is the operating life of the rechargeable lithium-ion battery being questioned, but also the lengthy battery recharging process is an issue. These obstacles have undoubtedly delayed the mass-production of electric vehicles by major automotive manufacturers. With recent interconnect technology advancements, the charging of a lithium-ion battery can be significantly reduced from the standard eight hours down to four hours.



Backshells, flange gaskets, and mounting plates

With the release of the SAE Electric Vehicle J1772 charging specification in January 2010 (a standard adopted in both the U.S. and Japan for Level 1 and Level 2 electric vehicle charging), the automotive market demanded a robust coupler capable of passing the stringent UL 2251 certification. In addition, the application required a high amperage charging solution that could provide fast, easy, and safe charging of any electric vehicle. Manufacturers have addressed the needs for a high amperage solution and have reduced the Level 2 charge time by 50%. With a single inlet design that allows for Level 1 and Level 2 charging, this advanced interconnect system has proven its ability to meet both electrical and mechanical UL specifications.

The design features high efficiency power contact technology to provide flexible functionality, with minimal modifications, across a power curve ranging from a low of 15A/120V to a high of 75A/240V. The interconnect solution utilizes standard ITT VEAM CIR series backshells, flange gaskets, and mounting plates, providing for an enhanced cable management system that incorporates robust and proven techno and ground pin contacts on the inlet side. Freeze-preventing drain holes enable outdoor use in extreme environments.

As manufacturers adapt designs to be on the front end of consumer trends, engineers must continuously develop reliable, durable, and scalable connector designs with high-density packaging that take up less space while reducing costs. ■

Bus-powered USB-to-CAN adapters

enable an easy connection of CAN devices to PCs

EasySYNC has announced two new USB-to-CAN adapters that provide a fast and easy way to connect CAN bus devices to a PC via USB. The USB2-F-7001 is a non-isolated adapter, while the USB2-F-7101 features built-in digital isolation. Both devices are powered directly from the USB connection eliminating the need for an independent power supply. The new adapters are built into a tough plastic enclosure capable of operating throughout the industrial temperature range from -40°C to +85°C. Flexible mounting allows use in a variety of applications, including as a portable adapter accompanying a laptop



or for permanent installation in industrial and commercial locations. The enclosure features a standard USB type-B socket, allowing the adapter to be connected to a Host type-A socket.

Each device integrates a USB-to-FIFO interface IC, CAN controller and CAN bus transceiver, and is compatible with USB1.1 and USB2.0

Host and Hub ports for easy plug-and-play installation. The CAN bus signals are output to an industry-standard DE-9P connector conforming to the CiA DS102-2 pin-out. Maximum CAN bus data rate is 1Mbps.

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TROOSTWIJK
www.TroostwijkAuctions.com

IO-Link analog plug

converts analog signals into IO-Link signals

Until now it has been costly to connect and incorporate analog input/output signals, even though they generally only make up less than 10% of the signals used in a system. The reasons include the use of shielded cable on the installation side and expensive multi-channel input modules on the controller side. Balluff has launched IO-Link analog plugs with a high resolution of 14 bits designed for systems with limited instances of analog signals. With an IP 67 enclosure rating, the plugs feature a space-saving housing, are connected directly to the sensor and convert the analog signals into IO-Link signals before transmission. In this way

they provide significant savings potential. In place of expensive shielded cables, simple unshielded, 3-conductor cable is used. The signal neutrality of the IO-Link ports on the IO-Link Master module in combination with the IO-Link plugs ensures maximum signal variance. Mixing of different input, output, current and voltage signals can be mixed on one module. Versions are available with a current input of 4-20 mA, voltage from 0-10 V or PT 100, a current output of 4-20 mA and a voltage output of 0-10 V.



Balluff

www.balluff.co.uk

Smart managed switches

with two diagnostics-capable POF interfaces

In addition to six RJ-45-ports, the FL switch SMN 6TX/2POF-PN from Phoenix Contact also offer two diagnostics-capable POF interfaces, in a narrow control cabinet-friendly housing. Both polymer and HCS fibers can be connected via the fiber-optic interfaces with SCRJ connections. These optical fibers facilitate user-friendly and easy assembly in the field. Combining this switch with the new field assembly-capable HCS fibers with gradient index FL FOC PN-C-HCS-GI-200/230 enables transmission distances of up to 250 meters to be achieved. The fiber-optic cable connectors are assembled on site in less than two minutes. Complex crimping, gluing and polishing are no longer required. Using the integrated fiber-optic diagnostics, the switch supports users when troubleshooting faults, whereby

the received power is continually measured and the optical system reserve is displayed in the Web-based management system using an SNMP object or Profinet communication. The switch can be used as a Profinet IO device with a PDEV function and can be utilized in redundant Ethernet networks with RSTP Fast Ring Detection or in an MRP environment. For Ethernet/IP networks, it has multicast filtering with an IGMP snooping function. A connection to high performance switches in the backbone area, e.g. to the Gigabit Modular Switch FL Switch GHS 12G/8 from Phoenix Contact, can be established not just via copper interfaces but also via POF-SCRJ interfaces using GIHCS fiber-optic cable.



Phoenix Contact

www.phoenixcontact.de

IP67 sealed DIN valve connector

external thread for consistent torque

Molex augments its range of externally-threaded Brad mPm DIN valve connectors with the addition of Form C and Form Micro housings, combining IP67 sealing properties with an external-thread design. The mPm DIN valve connector range provides superior cable retention for increased performance and reliability, simplifies the manufacturing process and reduces overall applied costs for hydraulic, pneumatic and electromagnetic drive systems. The external nut on the new generation mPm DIN valve connector provides greater and consistent torque, which ensures good cable retention and high reliability. The Molex mPm DIN connectors achieve a sealing performance from dust and water to IP67. Cable retention force is

increased by up to 115%, when compared to traditional internal nut designs. The new design reduces the number of components in the connector, making customer assembly and secure mounting, easier and quicker. The Brad mPm range of DIN valve connectors conform to Industry Standard EN 175301-803.



The connectors can accommodate PG9 and PG11 cable and up to 9mm cable outer diameter. Standard circuitry options available include light-emitting diode and bi-polar LED indicators, blocking diodes to protect against over voltage or peaks when switching off and voltage-dependent resistors (VDR) to protect supply and switch.

Molex

www.connector.com

Low-profile DC jack

raises only 4.4mm above the PCB

For applications that face particularly tight space restraints, Suyin has developed the two-pin type 040068FR right-angle DC power jack connector. Rated for a maximum of 6.3V DC and 2.0A DC, this THT jack is equipped with a spring-loaded switch contact and a centre pin with a diameter of 1.65 mm. It accepts a cylindrical DC connector with an outer diameter of 4.0mm. The jack's extremely low height of just 4.4mm above the printed circuit board is achieved through two clever design tricks: first, the jack housing is partially open towards the top. Secondly, its underside can be mounted in

a way that is partially counter-sunk into the board by 0.9 mm. The jack's underside, which is designed for in-board mounting, has a cross shape. As a result, after mounting, it is able to withstand the strongest removal forces in all horizontal directions. The number of guaranteed mating cycles is specified at 5,000, the contact resistance at 20mΩ (initial) and the insulation resistance is 100 MΩ. A Capton film on top of the jack ensures trouble-free automatic pick & place assembly using a vacuum-assisted pipette.



Suyin

www.suyin-europe.com

Miniature rectangular connectors

qualified to ESA, save up to 60% in weight

Souriau obtained the qualification of the European Space Agency (ESA) for its rectangular miniature microComp range of connectors, offering a smaller footprint replacement for ESA/ESCC D-Sub connectors, which is widely used today in satellite payloads. The microComp allows a space saving up to 40% and a weight reduction down to 60%.

Connectors currently used on equipment and harnesses of telecommunication satellites or scientific missions are of the same type as those on laptop and home computers. Reliability is the key word in the space industry, for both launchers and satellites. All the mounted components have



to be qualified and are subject to an extensive manufacturing follow-up with full traceability. This traceability permits the identification of the batch of raw material in case of failure in order to isolate the potentially defective components.

The complete shell for this

rectangular microComp range is made of composite materials, then metalized to ensure an effective electrical

continuity between the plug, the receptacle, the backshells and the harness braid. The electrical crimp contacts are removable and allow users to wire and unwire their equipment.

Souriau

www.souriau.com

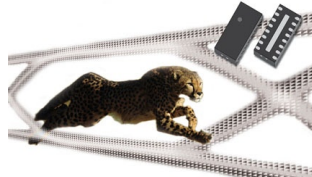
low footprint 8-channel ESD diode array

offers all-in-one protection for HD display ports

STMicroelectronics has developed what it calls virtually invisible protection for high-definition connections. The 8-channel ESD diode array delivers all-in-one protection for HDMI, DisplayPort, DiiVA, SATA, USB3.0 interconnects, and minimizes loading on ultra-high-speed data lines. These interconnects combine several multi-gigabit data channels to achieve total

data rates in excess of 10 Gbit/s in the case of HDMI 1.4 and up to 13.5 Gbit/s for DiiVA. The high per-channel data rates of advanced multimedia connections increase the demands on devices protecting internal circuitry as the equipment is connected and disconnected. ST says it is responding to this challenge by expanding its HSP high-speed

protection IC family to save part count and PCB space, and enable high-definition equipment to maintain ultra-high data rates. With ultra-low capacitance per line and extremely close matching between capacitance values, the 3.3x1.5x0.6mm HSP061-8M16 also minimizes slowing



of data edges and prevents signal skew between adjacent lines. This prevents communication

errors that ultimately can produce glitches in played-back HD images or audio. The HSP061-8M16 offers 15kV ESD protection, has 100 Ohm differential impedance, 0.6 pF input/output capacitance and support a 6.3GHz bandwidth.

STMicroelectronics

www.st.com

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Inside Bluetooth low-energy technology

By Kjartan Furset

BUT THERE IS ONE critical difference: Bluetooth low-energy technology was designed from the outset to be an “ultra-low power” (ULP) wireless technology whereas Classic Bluetooth technology forms a “low power” wireless connection.

Classic Bluetooth technology is a “connection oriented” radio with a fixed connection interval ideal for high activity connections like mobile phones linking with wireless headsets. In contrast, Bluetooth low-energy technology employs a variable connection interval that can be set from a few milliseconds to several seconds depending on the application. In addition, because it features a very rapid connection, Bluetooth low-energy technology can normally be in a “not connected” state (saving power) where the two ends of a link are aware of each other, but only link up when absolutely necessary and then for as short a time as possible.

The operational mode of Bluetooth low-energy technology ideally suits transmission of data from compact wireless sensors (exchanging data every half second) or other peripherals like remote controls where fully asynchronous communication can be used. These devices send low volumes of data (i.e. a few bytes) infrequently (for example, a few times per second to once every minute or more seldom).

A tale of two chips

There are two types of chips that together form Bluetooth low energy architecture: single mode and dual mode. A single mode device is a Bluetooth low energy-only chip that’s brand new to the Bluetooth specification – it’s the part of the technology optimized for ULP operation.

Single mode chips can communicate with other single mode chips and dual-mode chips when the latter are using the Bluetooth low-energy technology part of their architecture to transmit and receive. (See figure 1). Dual-Mode Chips will also have the capability of communication with Classic Bluetooth technology and other dual-mode

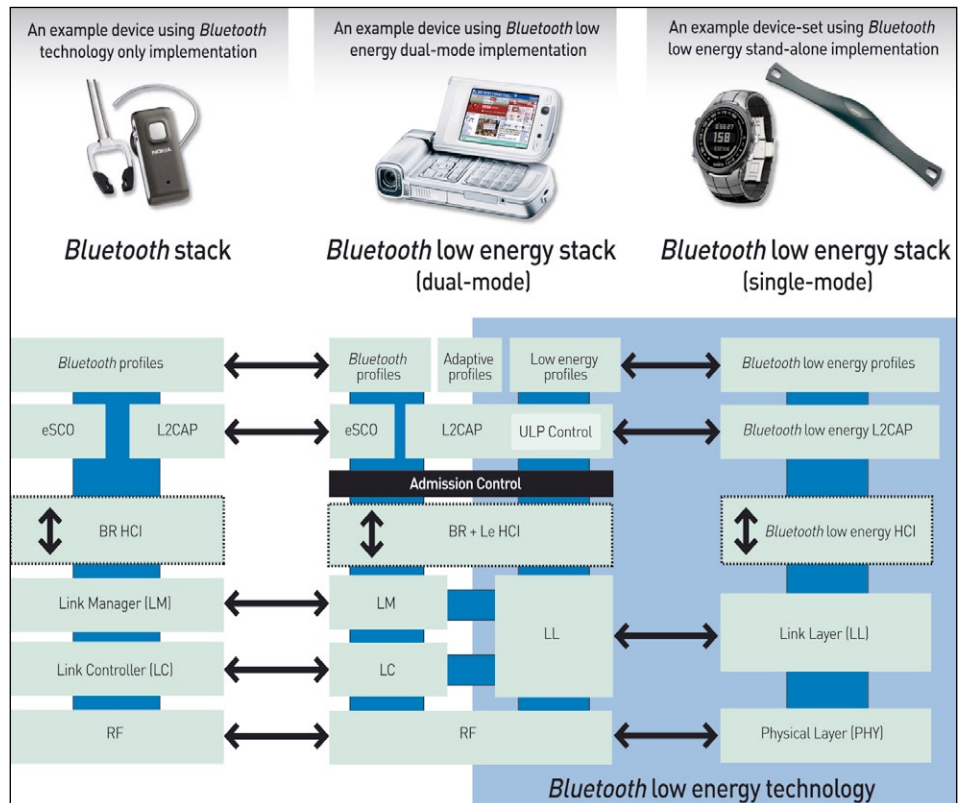


Figure 1: Dual mode chips will use the Bluetooth low energy part of their architecture to communicate with single mode devices

chips using their conventional Bluetooth architecture. Dual-Mode Chips will be used anywhere a Classic Bluetooth chip is used today. The consequence is that cell phones, PCs, Personal Navigation Devices (PNDs) or other applications fitted with a dual-mode chip will be capable of communicating with all the legacy Classic Bluetooth devices already on the market as well as all future Bluetooth low energy devices. However, because they are required to perform Classic Bluetooth and Bluetooth low energy duties, dual-mode chips are not optimized for ULP operation to the same degree as single-mode devices.

Single-mode chips can operate for long periods (months or even years) from a coin cell battery such as a 3V, 220mAh CR2032. In contrast, Classic Bluetooth technology (and Bluetooth low energy dual mode devices) typically requires the capacity of at least two AAA cells (which have 10 to 12 times the capacity of a coin cell and much higher peak current tolerance), and often more, to power them for days or weeks at most (depending on the application). (Note: There are some

highly specialized Classic Bluetooth applications that can run on batteries with a lower capacity than AAA cells.)

The technology of ultra-low power wireless

There are three characteristics of Bluetooth low-energy technology that underlie its ULP performance: maximized standby time, fast connection, and low peak transmit/receive power.

Switching the radio “on” for anything other than very brief periods dramatically reduces battery life, so any transmitting or receiving that has to be done needs to be done quickly. The first trick Bluetooth low-energy technology uses to minimize time on air is to employ only three “advertising” channels to search for other devices or promote its own presence to devices that might be looking to make a connection. In comparison, Classic Bluetooth technology uses 32 channels.

This means Bluetooth low-energy technology has to switch “on” for just 0.6 to 1.2ms to scan for other devices, while Classic

Kjartan Furset is Senior Applications Engineer at Nordic Semiconductor - www.nordicsemi.com

Bluetooth technology requires 22.5ms to scan its 32 channels. Consequently, Bluetooth low-energy technology uses 10 to 20 times less power than Classic Bluetooth technology to locate other radios.

Note that the use of three advertising channels is a slight compromise: it's a trade between "on" time (and hence power) and robustness in what is a very crowded part of the spectrum (with fewer advertising channels there is a greater chance of another radio broadcasting on one of the chosen frequencies and corrupting the signal). The specification's designers are confident they have balanced this compromise – they have, for example, chosen the advertising channels such that they don't clash with Wi-Fi's default channels (see figure 2).

Once connected, Bluetooth low-energy technology switches to one of its 37 data channels. During the short data transmission period the radio switches between channels in a pseudo-random pattern using the Adaptive Frequency Hopping (AFH) technology pioneered by Classic Bluetooth technol-

ogy (although Classic Bluetooth technology uses 79 data channels).

Another reason why Bluetooth low-energy technology spends minimal time on air is because it features a raw data bandwidth of 1Mbps – greater bandwidth allows more information to be sent in less time. An alternative technology that features a bandwidth of 250kbps, for example, has to be "on" for eight times as long (using more battery energy) to send the same amount of information.

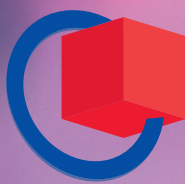
Bluetooth low-energy technology can "complete" a connection (i.e. scan for other devices, link, send data, authenticate, and "gracefully" terminate) in just 3ms. With Classic Bluetooth technology, a similar connection cycle is measured in hundreds of milliseconds. Remember, more time on air requires more energy from the battery.

Bluetooth low-energy technology also keeps a lid on peak power in two other ways: by employing more "relaxed" RF parameters than its big brother, and by sending very short packets. Both technologies use a Gaussian Frequency Shift Keying (GFSK)

Frequency (MHz)	Bluetooth low energy Advertising channel	Bluetooth low energy Data channel	Wi-Fi Channel
2480	39		
2478		36	
2476		35	
2474		34	
2472		33	11
2470		32	11
2468		31	11
2466		30	11
2464		29	11
2462		28	11
2460		27	11
2458		26	11
2456		25	11
2454		24	11
2452		23	11
2450		22	
2448		21	6
2446		20	6
2444		19	6
2442		18	6
2440		17	6
2438		16	6
2436		15	6
2434		14	6
2432		13	6
2430		12	6
2428		11	6
2426	38		
2424		10	
2422		9	1
2420		8	1
2418		7	1
2416		6	1
2414		5	1
2412		4	1
2410		3	1
2408		2	1
2406		1	1
2404		0	1
2402	37		

Figure 2: Bluetooth low energy technology's advertising channels have been carefully chosen to avoid clashes with Wi-Fi.

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modulation, however, Bluetooth low-energy technology uses a modulation index of 0.5 compared to Classic Bluetooth technology 0.35. An index of 0.5 is close to a Gaussian Minimum Shift Keying (GMSK) scheme and lowers the radio's power requirements (the reasons for this are complex and beyond the scope of this article). Two beneficial side effects of the lower modulation index are increased range and enhanced robustness.

Classic Bluetooth technology uses a long packet length. When these longer packets are transmitted the radio has to remain in a relatively high power state for a longer duration, heating the silicon. This changes the material's physical characteristics and would alter the transmission frequency (breaking the link) unless the radio was constantly recalibrated. Recalibration costs power (and requires a closed-loop architecture, making the radio more complex and pushing up the device's price).

In contrast, Bluetooth low-energy technology uses very short packets - which keeps the silicon cool. Consequently, a Bluetooth low energy transceiver doesn't require power consuming recalibration and a closed-loop architecture.

Extending the Bluetooth ecosystem

Bluetooth low-energy technology was designed for applications where Classic Bluetooth technology is not viable because of severe power restraints. This is the first time a ULP wireless technology with guaranteed interoperability has been available to electronics designers and promises to kick start hundreds of new applications.

A clue to some of the likely early applications is provided by the Bluetooth SIG's intention to follow up the December 2009 publication of Bluetooth Version 4.0 Core Specification (which includes Bluetooth low energy) with the release of the first Profiles: these Profiles optimize a generic Bluetooth low energy chip for a specific application such as Personal User Interface Devices (PUIID) (such as watches), Remote Control, Proximity Alarm, Battery Status and Heart Rate Monitor. Other health and fitness monitoring profiles such as blood-glucose and -pressure, cycle cadence, and cycle crank power will follow (see figure 3).

Let's take a look at how Bluetooth low-energy technology will be used in just two potential applications: Proximity Alarm and Indoor Location (sometimes referred to as "Indoor GPS"). Dual-Mode chips are being adopted by cell phone and portable PC mak-

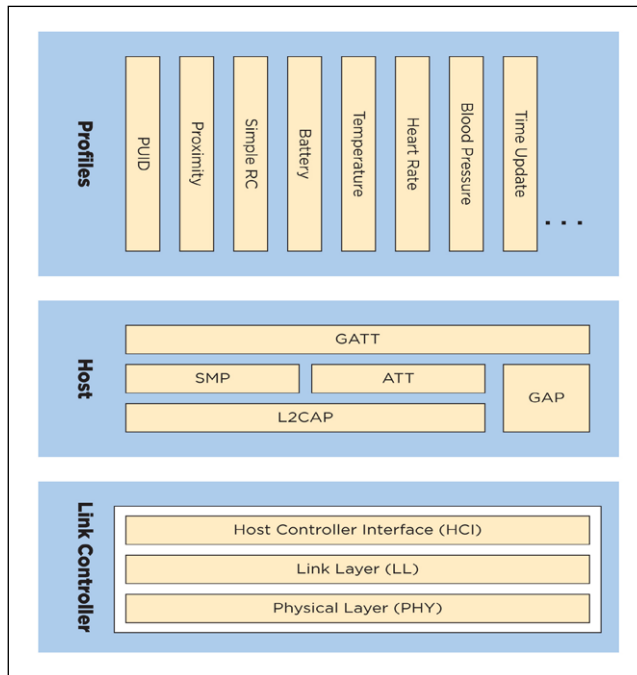


Figure 3: Bluetooth Core Specification Version 4.0 defines Bluetooth low energy technology's architecture. Profiles are due for imminent release.

ers because they'll cost only very slightly more than Classic Bluetooth technology yet offer so much more functionality. This will allow cell phone makers to offer a security device comprising a Bluetooth low energy powered watch that periodically communicates with the cell phone. If the cell phone moves out of range - and hence can't contact the watch worn by the user - it would automatically lock and the watch would emit an alarm. This would prevent the cell phone being accidentally left behind and prove a major deterrent for any would-be thief.

The proximity alarm application could be extended to a portable PC that locks when the user moves out of range (and perhaps unlocks to be ready for use when the approaching user presses a button on their watch). The application could also be used as a child safety device where the child's watch communicates with a parent's while they remain in range with an alarm sounding if the child wanders away.

The low cost and low maintenance (because batteries require only infrequent changes) of Bluetooth low energy sensors will encourage widespread use in public places. One key application could be indoor location (where there is no GPS signal)

whereby sensors around a large public building (such as an airport or rail station) constantly broadcast information about their location. A Bluetooth low energy equipped cell phone passing within range could then display that information to its owner.

Sensors could transmit other information such as flight times and gates, location of amenities, or special offers from nearby shops.

Final step

Several silicon vendors are well advanced in the design of Bluetooth low-energy chips, and have released samples and development kits to selected customers. The current specification for

Bluetooth Version 4.0 allows these companies to qualify their silicon to the Bluetooth low energy specification.

Nordic, for example, offers sample availability of its μ Blue ("MicroBlue") Bluetooth low energy chips (and a μ Blue Prototype Kit for key customers). The first product in the μ Blue family is the nRF8001 - a single mode peripheral solution in a 32-pin 5 by 5mm QFN package incorporating a fully embedded radio, link controller, and host subsystem - suitable for watches, sensors, and remote controls among other applications (see figure 4).

The final piece of the Bluetooth low-energy puzzle is imminent. The Bluetooth SIG says the first profiles - such as Proximity Alarm - will start appearing within months. That means electronics designers will get their hands on fully qualified chips to begin their actual product development towards the end of the year.

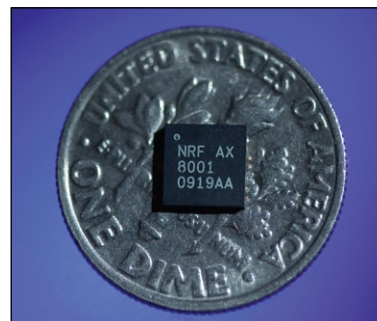


Figure 4: Nordic Semiconductor's μ Blue nRF8001 will be one of the first Bluetooth low energy chips on the market.

Once the fully qualified silicon reaches the market, expect a tsunami of Bluetooth low energy products to follow. Analyst IMS estimates that by 2013, a billion Bluetooth low energy devices will be sold every year. That represents the fastest adoption of any wireless technology by far. ■

High thermal conductivity laminates

target high frequency circuits

Rogers Advanced Circuits Materials Division (ACM) is introducing two laminates to the market. The company's latest XT/duroid 8000 series high performance thermoplastic laminate materials include the XT/duroid 8000 laminates for simpler multilayer designs (less than 6 layers) and XT/duroid 8100 laminates for constructions consisting of six or more layers. Highly reliable and halogen-free flame retardant, XT/duroid laminates are thermally and chemically robust with melting points higher than PTFE materials and an estimated maximum Relative Thermal Index (RTI) greater than 210°C, making them well suited for rugged military and aerospace applications. XT/duroid 8000 laminates feature a z-axis dielectric constant of 3.23 ±0.05 at 10GHz and a dissipation factor of 0.0035 or less at 10 GHz. They deliver stable electrical performance over wide frequency ranges, with a low thermal coefficient of dielectric constant of +7 ppm/°C from -50 to +150°C. For complex multilayer circuit

constructions requiring excellent stability, XT/duroid 8100 laminates have a reinforced woven-glass resin system for added dimensional stability. That makes them capable of supporting multilayer circuits while providing them thermal and chemical ruggedness, as well as outstanding electrical performance. XT/duroid 8100 laminates feature z-axis dielectric constants of 3.54 ±0.05 and 3.32 ±0.05 at 10GHz and dissipation factors of 0.0049 (0.0508 mm) and 0.0038 (0.1016 mm) at 10 GHz. They deliver stable electrical performance over wide frequency ranges, with a low thermal coefficient of dielectric constant of +9 ppm/°C from -50 to +150°C. Both laminates are available with a dielectric thickness of 0.0508 mm with low profile reverse treated electrodeposited copper foil cladding. XT/duroid 8100 is also available with dielectric thickness of 0.1016 mm.

Rogers Advanced Circuits Materials

www.rogerscorp.com

TI releases tools and chipset

for wireless power charging

Texas Instruments has introduced what it says is the industry's first Qi-certified wireless power development kit, which enables design engineers to speed the integration of wireless power technology in consumer electronics, such as digital cameras, smartphones, MP3 players and global positioning systems, along with infrastructure applications such as furniture and cars. The bqTESLA development kit includes a single-channel transmitter, a direct-charge receiver and associ-



ated magnetics for applications requiring 5 watts of power or less. The company states that no additional software development is required, offering true plug-and-play functionality.

The kit contains bq500110 wireless power transmitter manager, bq25046 single-input, 5-V power supply IC and MSP430bq1010 wireless power control and communications

Texas Instruments

www.ti.com/bqTESLA100LP-preu

Microwave power divider

handles 250W at up to 2.5 GHz

The Model 2372A-2 now available from Link Microtek is a two-way power divider which operates over microwave frequencies from 500 MHz to 2.5 GHz and can handle an input power of up to 250 W CW or 2 kW peak. Manufactured by Narda, the device can also be used as a non-coherent 125 W-per-signal power combiner and is suitable for a variety of applications in telecommunications infrastructure. It incorporates proprietary high-power, thin-film resistors to ensure broadband impedance matching and high isolation between inputs when used as a combiner. These resistors are



directly attached to the housing to optimise thermal transfer so that the film temperature remains stable throughout the unit's operating temperature range. Featuring an insertion

loss of less than 0.6 dB, the 2372A-2 provides exceptional phase and amplitude balance of ±5 degrees and ±0.25 dB respectively. VSWR is less than 1.5:1, and isolation is specified as at least 13 dB up to 700 MHz, rising to 18 dB at 2.5 GHz.

Employing N-type female connectors, the power divider is finished with tri-alloy plating and measures 88.9x63.5x25.4 mm.

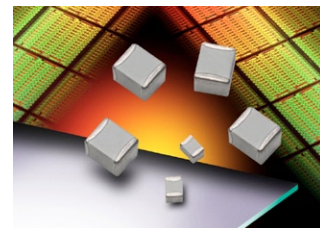
Link Microtek

www.linkmicrotek.com

RF ceramic capacitor

includes non-magnetic terminations for MRI use

AVX Corporation has expanded its porcelain and ceramic dielectric multilayer capacitor (MLC) chip product offering to include non-magnetic termination versions. Designated the SQ Series, the RF capacitor series is rated at 50 VDC to 500 VDC with capacitance values ranging from 0.1 pF to 1000 pF. Ideal for medical



devices such as MRI coils, the SQ Series offers low ESR, high Q, high current and high self-resonance frequency values. "The SQ Series capacitors' porcelain and ceramic multilayer construction features palladium internal electrodes as well as fine-grained, high density, high purity dielectric materials to keep moisture out. This advanced design allows for as much as 40 percent lower

equivalent series resistance than other MLC versions," said Larry Eisenberger, senior field applications engineer, at AVX. With these high performance materials and design, along with its

high current carrying capabilities and high quality factors, the SQ Series capacitors offer superior stability under the stresses of

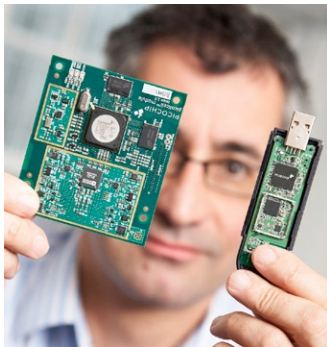
changing voltage, frequency, time and temperature. The SQ Series capacitors are rated for operation between -55 °C to 125 °C and features P90 and NPO characteristics as well as a 100 percent tin finish. The SQ Series capacitors are available in 0603, 0605, 0805 and 1210 case sizes.

AVX Corporation

www.avx.com

Picochip shares femtocell roadmap to enable 3G basestations on a USB dongle

Picochip unveiled its vision for next-generation femtocells, including picoXcell technology that will allow its customers to create an entire 3G cellular basestation in an ultra-small form factor such as a USB dongle. The concept of a basestation on a USB dongle is one of several Picochip developments in the spotlight at CES 2011. Others include enabling technology for small form factor



public access HSPA+ femtocells (sometimes known as picocells or microcells); picoArray technology that is already delivering 4G services around the world and enabling LTE trials today; and the company's new platform for dual mode (LTE and HSPA+) small cells. The availability of ultra-small femtocells will allow operators to easily add HSPA+ home-basestation capabilities to appliances such as residential

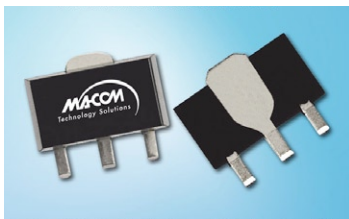
gateways, cable modems and set-top boxes, simply by plugging in a USB key. A "private cellsite" solution like this will solve consumer problems of 'not-spots' or coverage holes, deliver far faster data services than on a conventional cell, improve battery life and enable a variety of innovative "home zone" services. For public access products, Picochip's dual-mode LTE / HSPA+ solution is the only optimized platform

for designers of 'small cell' basestations that provide both LTE and HSPA+ cellular services. It enables operators to deploy LTE in an evolutionary manner. The development builds on Picochip's optimized range of silicon and software products for high-volume manufacturers of residential HSPA+ femtocells, **Picochip**

www.picochip.com

250 to 4000 MHz RF driver amplifier surface mount device exhibits high linearity

M/A-COM Technology Solutions has introduced the MAAM-009560, an HBT driver amplifier for cellular and WiMAX infrastructure applications. This driver amplifier covers a broad frequency range of 250 to 4000 MHz with excellent linearity of 42 dBm OIP₃ over a greater than 20 dB



input power range, as well as features a typical gain of 15 dB. The lead-free SOT-89 surface mount plastic package is RoHS compliant and compatible with solder

reflow temperatures up to 260°C. The ESD susceptibility achieves a class 2 ESD rating. The versatile MAAM-009560 HBT driver amplifier delivers high linearity performance while consuming low power, providing a highly efficient driver amplifier solution for cellular and WiMAX base stations. Engineering samples,

sample boards and production devices are available now.

M/A-COM Technology Solutions

www.macomtech.com

4G/LTE broadband connectivity supports robust in-vehicle telematics

Harman and Sierra Wireless have underlined their commitment to bring automotive customers the first 4G broadband connectivity. HARMAN will support Sierra Wireless AirPrime intelligent embedded modules for LTE networks to offer robust in-vehicle wireless connectivity enabling high bandwidth telematics, navigation, and online infotainment applications. The AirPrime modules also leverage broadly adopted applications programming interfaces (APIs) to encourage a growing ecosystem of software providers' solutions for connectivity, location, and manageability. The solution should provide wireless data access at download speeds of up to 100Mbps and upload speeds up to 50Mbps on LTE networks, providing a multi-faceted media, office and online experience within the vehicle.

Service expected include driver enhancements, such as real-time mapping and traffic updates, to dynamic loaded applications, content, gaming, streaming video and full internet access that can be shared among multiple devices. According to automotive researchers Strategy Analytics, 70% of vehicles produced globally in 2009 have some form of connectivity solution and the number is expected to increase to 95% by 2012. It comes at a time when consumers are rapidly adapting to lifestyles where multi-featured smart-phones and handsets are the norm, believes Harman, who is working on solutions to address vehicle-centric demand for wirelessly-enabled, mobile broadband solutions.

Sierra Wireless

www.sierrawireless.com

HSPA+ M2M module supports 2G and 3G networks and bridges to LTE

Cinterion announced the PH8, an M2M grade, fully ruggedized, high bandwidth module for global markets, designed to deliver high-speed wireless connectivity on both 2G and 3G networks as well as offering a bridge to evolving 4G networks such as LTE. The PH8 module makes it easier to integrate data rich M2M applications like streaming video on outdoor billboards, mobile medical monitoring applications, video surveillance solutions and Industrial PDAs. The robust, single-sided design leads to superior heat dissipation, allowing PH8 to outperform power-consuming PCIe devices, says the manufacturer. Full type approval and pre-approval by major global mobile network



operators helps ensure a fast and cost effective road to market. Using the latest 45 nanometer chipset from Qualcomm's long-life program, PH8 provides a future proof, dependable bridge to LTE. The HSPA+ module offers reliable M2M grade functionality with speeds up to 14.4 Mbps for downloads and 5.76 Mbps for uploads and it is compatible with Quad-Band GSM/GPRS, EDGE and five UMTS bands for true global

roaming and worldwide support. Full voice support including analog audio processing enables quick and easy audio implementation for OEMs and developers.

Cinterion

www.cinterion.com/ph8

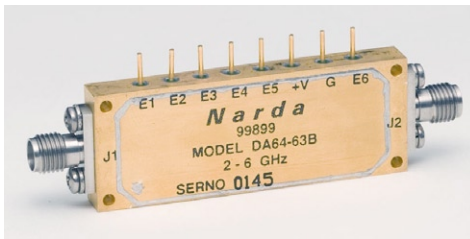
SPECIAL FOCUS: RF&WIRELESS

Switched-bit 63-dB attenuator

operates from 2 to 6GHz, 30ns switching speed

Narda has introduced the Model DA64-63B switched-bit attenuator, which offers the high level of performance required in electronic warfare and radar systems as well as precision automated test equipment. The Model DA64-63B is a 6-bit device that provides attenuation of 0 to 63 dB in 1-dB steps, and operates from 2 to 6 GHz with a switching speed of 30 ns (50 percent TTL to 90 percent RF) and rise and fall times of 10 ns. It has an insertion loss of 4.3 dB or less, VSWR of less than 2:1, and attenuation flatness of ± 0.5 dB to 31 dB and ± 1 dB to 63 dB. The Model DA64-63B will handle up to +23 dBm RF input power, operates from +5 VDC at 350 mA, and measures 25.4x19.1x6.1mm. Control is provided by TTL. Like all models in Narda's DA Series of switched-

bit attenuators, the attenuation values of the DA64-63B are guaranteed to be monotonic, and the unit is hermetically sealed. It operates over a temperature range of -54 to $+95^{\circ}\text{C}$, meets MIL-STD-202F for humidity (95 h at 95 percent), shock (76 G



for 6 ms), altitude (50,000 feet), vibration (0.06 inches double amplitude or 15 G), and thermal shock (5 cycles). Its SMA female connectors are removable, making the attenuator suitable for drop-in mounting.

Narda

www.nardamicrowave.com

2.4GHz RF and ANT products

soon available in 2.6x2.7mm WLCSF options

Nordic Semiconductor said it will expand its 2.4GHz RF and ANT product range with the addition of a brand new line-up of wafer level chip scale package (WLCSF) options as small as 2.6x2.7mm in size and occupying up to 5x less footprint area. Sampling in Q1 2011 and available for volume orders in Q2 2011 will be the nRF24AP2 (1- and 8-channel) WLCSF and nRF24LE1 WLCSF (Flash or OTP) options. The products will be designed to meet the highly space-constrained needs of both existing

and emerging sports, fitness and health applications such as wireless watches, bike computers, sensors, hearing aids and



other devices designed to be worn on or near the body. The new nRF24LE1 WLCSF option (Flash or OTP) will be a 400 μm (regular array) 32-ball pitch

BGA measuring 2.7x2.7mm in footprint area for the Flash version and 2.6x2.7mm for the OTP version. Both devices are 0.5mm in thickness.

Nordic Semiconductor

www.nordicsemi.com

Analog-to-wireless network converter

extends machine-to-machine options

The growing penetration of DSL and Cable networks and the growing popularity of the mobile phone as a replacement for fixed line phones has resulted in less and less availability of fixed phone lines that are compatible with traditional analog modems. The WireX converter solves this problem by allowing legacy equipment with embedded analog modems to immediately be switched from connecting



through the traditional phone line to connecting through a cellular GSM / GPRS wireless network. According to manufacturer eDevice, WireX is the first analog-to-wireless converter designed for self-installation by the end-user: it does not require any changes on the existing legacy device, the user only needs to disconnect the phone cable from the wall and plug it into the WireX dial-up connector. The data previously transferred over the phone link is then automatically

transmitted using phone line emulation over a GPRS or GSM data cellular network.

In the home, the WireX can be used with different types of already-in-the-field devices equipped with analog modems.

In the case of SOHO and small shops, WireX can be used to immediately and smoothly convert point-of-sale equipment, energy metering systems, and access control devices to cellular. WireX allows wireless carriers to gain market share in the "Connected Device" category that encompasses home-based Machine-to-Machine (M2M) applications. End-users can then take advantage of subscriptions adapted to M2M data usage levels and also enjoy mobility outside the home including internationally with worldwide cellular coverage.

eDevice

www.edevice.com

Hirschmann foil antennas

can be integrated into the vehicle's body

For vehicles predominantly made of plastic materials such as campers, caravans or license-free light vehicles, Hirschmann Car Communications has developed a foil antenna that can be integrated into windcreens and even into the body structure.

Through their flexibility, foil antennas offer high degree of design freedom at minimum space requirements, the company promises. The antenna do away with rod aerials and enable designers to integrate the antenna in virtually all kind of structures as long as they are not made of metal. In

a patented process, Hirschmann prints the conducting antenna structures onto a carrier foil. The antenna is glued or laminated into place. It is then integrated invisibly into the skin. Drill holes and complex earth connections are no longer needed.



The antennas are available for radio and DVB-T TV reception, with or without integrated preamplifier. The vendor adapts

the antenna individually to the respective vehicle design.

Hirschmann

www.hirschmann-car.com

High-current inductors

with 1-MHz maximum frequency and low DCR

Vishay Intertechnology has launched two new IHLP low-profile, high-current inductors in the 1212 case size. The compact IHLP-1212AB-11 and IHLP-1212AE-11 offer a 3.0x3.6mm footprint with ultra-low profiles of 1.2 and 1.5mm respectively. With a high maximum 1 MHz frequency and standard inductance values from 0.22µH through 1.0 µH, IHLP-1212AB-11 and IHLP-1212AE-11 serve as high-performing, space- and power-saving solutions for voltage regulator module (VRM) and DC/DC converter applications. The IHLP-1212AB-11 offers an inductance range from 0.22 µH to 0.56 µH, a saturation current range from 6.7 A to 9.3 A, typical DCR from 9.5 mΩ to 18.7 mΩ, and maximum DCR

from 11.4 mΩ to 22.0 mΩ. The IHLP-1212AE-11 offers an inductance range from 0.22 µH to 1.0 µH, a saturation current range from 5.3 A to 9.0 A, typical DCR from 9.5 mΩ to 29.5 mΩ, and maximum DCR from 11.4 mΩ to 33.0 mΩ. The new inductors handle high transient current spikes without hard saturation. Packaged in an RoHS-compliant, 100% lead (Pb)-free shielded, composite construction that reduces buzz noise to low levels, the new devices are specified for an operating temperature range of -55 to +125 °C, with high resistance to thermal shock, moisture, mechanical shock, and vibration.

Vishay Intertechnology

www.vishay.com

USB audio system development kit

full range speaker drivers in sealed enclosures

HiWave Technologies launched the DyadUSB kit for rapid development of USB-powered consumer audio systems. The DyadUSB Development Kit comprises two 12W RMS balanced mode radiator (BMR), full-range speaker drivers in tuned and sealed enclosures, plus a DyadUSB amplifier module featuring HiWave's ultra-efficient Audium amplifier chip.

The module is configured to deliver 15W per channel burst audio from a host USB port's 2.5W of electrical power. The DyadUSB module is mounted on a break-out printed circuit board that enables easy connection of the speakers and USB cable. Software is supplied to enable engineers to programme the Audium amplifier chip with equalization (EQ) settings in order to evaluate voicing options and

audio effects. The developers' kit allows each element of HiWave's patented audio technology to be assessed, including enclosure design and tuning. It enables designers to build up their own implementations by integrating DvadUSB components into their

products. Design engineers will learn the benefits of combining HiWave's electronic and transducer technologies to create

stunning sound quality from very small speakers, powered by a computer's USB port. The solution is aimed at high-end desktop and portable audio applications. The Audium amplifier chip employs dynamic rail switching and on-chip voltage boost, it also features on-board digital signal processing for equalisation.

HiWave Technologies

www.hi-wave.com



5W LED lamp reference kit

10 on offer, complete with PFC and flicker-free dimming capability



This month, Power Integrations gives away ten of its RDK-251 reference designs for 5W LED lamps. The reference design includes flicker-free TRIAC dimming and single-stage power factor correction (PFC), based on the company's LNK457DG, a member of the LinkSwitch-PL family of LED driver ICs optimized for compact, non-isolated installations. The reference design provides a single constant-current output of 350mA at



a nominal LED string voltage of 15V. The output current can be reduced using a standard AC mains TRIAC dimmer down to 1% (3 mA) without instability or flickering of the LED array. The supply is compatible with both low-cost, leading-edge dim-

mers and more sophisticated trailing-edge dimmers. It operates over the universal AC input range (85 VAC to 265 VAC, 47 Hz to 63 Hz) and can withstand an input range of 0 VAC to 300 VAC. Power factor is high (>0.9) and input current total harmonic distortion (THD) is low (<10%

at 115 VAC and <15% at 230 VAC), enabling a single universal input design to be used worldwide. The board fits inside a pear-shaped A19 LED replacement lamp with an E26/27 base. The RDK-251 package contains full power supply specifications, schematic, bill of materials, transformer documentation, PCB layout, and performance data.

Power Integration

Check the reader offer online at www.electronics-eetimes.com
www.powerint.com

FAT32 for Android, Linux

includes FAT, FAT32, exFAT and NTFS drivers

Tuxera, a provider of computer files systems that are compatible with the Windows operating system, has announced a GPL-compliant FAT32 replacement package for Android- and Linux-based systems. FAT32 is a file allocation table system developed by Microsoft for use with disk drives. GPL is the general public license promoted by open-source advocates. The package from Tuxera (Helsinki, Finland) includes FAT, FAT32, exFAT and NTFS drivers that work with all Android and Linux kernel versions. "Companies who have licensed FAT patents from Microsoft cannot use the publicly available GPL-licensed VFAT implementation," noted Mikko Valimaki, CEO of Tuxera, in a statement. "If you don't license Microsoft patents, you risk a patent lawsuit. If you license the

the GPL software in Linux, or you risk a copyright lawsuit." Tuxera, founded in 2008, works with operating system vendors to take care of IP issues and legal compliance and Tuxera was the first file system vendor to license exFAT patents and source code from Microsoft in 2009. "Both exFAT and NTFS lift the 4-Gbyte file size limit, which seriously compromises the use of FAT32 in HD video applications," said Szabolcs Szakacsits, Tuxera president and CTO. "exFAT is required for the next-generation SDXC memory card support. NTFS is needed for universal PC compatibility because NTFS has been the default Windows file system from the mid-1990s to Windows 7 and beyond."

Tuxera

www.tuxera.com

Freescale magnetometer shrinks e-compass

with magnetic field compensation and digitization ASIC

Electronic compasses can now be built with a magnetometer that Freescale Semiconductor claims is smaller and less power-hungry than competing devices. The Xtrinsic MAG3110 is a three-axis device that can determine headings for navigation, dead-reckoning indoors and a range of emerging location-based services (LBSes) for smartphones and other mobile devices. The device is four times smaller than the most

commonly used magnetometer today, and draws only 25µA says the company. Using a magnetometer together with GPS services allows smartphones, touchscreen tablets and other mobile devices to determine heading even when a GPS signal and, for that matter cell phone service is unavailable.

Freescale

www.freescale.com

Dual 600-W power supply

delivers up to 80V or up to 50A on each 600W output

The QPX600D from Aim-TTI is a dual-output 1.2 kW power supply using the company's latest PowerFlex+ regulation technology to provide up to



80 V or up to 50 A on each 600 W 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.

Aim-TTI

www.aimtti.co.uk

Embedded firewall source code

with dynamic filtering to protect medical devices

Icon Labs, provider of embedded networking and security technology, launched the Floodgate-Packet Filter, an embedded firewall that allows networked devices to control the packets they process. Floodgate protects against potentially malicious attacks by filtering packets before they are processed by an embedded device. Floodgate provides both threshold-based filtering and rules-based filtering.

Threshold-based filtering protects against denial of service attacks, broadcast storms and other conditions that result in a flood of unwanted packets. Rules-based filtering allows white-listing and black-listing based on criteria such as port number, protocol or source IP address.

Icon Labs

www.icon-labs.com

Vented DC-DC variable differential transducers

for high-pressure environments

Pewatron's DC-DC LVDT Series 240 of precision linear displacement transducers from Trans-Tek is widened with a specially designed model for high-pressure applications. When exposed to a non-conductive and non-corrosive fluid or gas up to 350bar (5000psi), a vented housing allows for equal pressure in and around the LVDT. As with the standard Series 240 line, working ranges from +/-1.3mm to +/-100mm are available and integral signal conditioning provides



direct DC-in/DC-out operation in a single package.

Simple power requirements include a single-ended 6 to 30VDC regulated. Non-linearity is specified as +/-0.5% maximum full scale (+/-0.25% available).

Pewatron

www.pewatron.com

PICO

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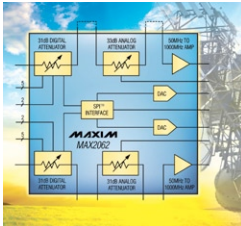
Multistate variable-gain amplifier

fully programmable, dual analog & digital device

With the MAX2062, Maxim Integrated Products launched what the company claims to be the industry's only fully programmable, multistate, dual-channel, analog + digital IF/RF

variable-gain amplifier (VGA). The device delivers an unparalleled combination of VGA performance, programmability, and component inte-

gration. As with its predecessor, the single-channel MAX2065, the MAX2062 provides unique "rapid-fire" gain selection for four customized attenuation states per path, fast 25ns digital switching, and very low digital VGA amplitude overshoot/undershoot. The MAX2062 also provides the convenience of SPI control for its two analog attenuators through its on-chip 8-bit DACs. It is an ideal choice for the "fast-attack" automatic gain control (AGC) circuits found in all 2.5G/3G/4G wireless infrastructure transceivers, including GSM/EDGE, CDMA, WCDMA, LTE, and WiMAX applications. The MAX2062 can serve as either



an IF or RF all-purpose VGA, interfacing directly with 50ohm systems operating over the 50MHz to 1000MHz frequency range. Since the stages within each path have their own RF

input and RF output, the MAX2062 can be configured to optimize either noise figure (amplifier configured first within the cascade) or linearity (amplifier configured

last). Alternately, it can be configured to provide a compromise between the two parameters (amplifier configured second). In its typical configuration (digital attenuator to analog attenuator to driver amplifier), the cascade yields a total gain range of 64dB, a maximum gain of 19.4dB, and a noise figure of 7.3dB. The cascaded linearity is equally impressive with +41dBm of OIP3, +56dBm of OIP2, and +19dBm of OP1dB performance. The MAX2062 incorporates nine unique circuit functions into a single, compact monolithic device.

Maxim Integrated Products

www.maxim-ic.com

1-W DC/DC converter

offers high efficiency and tighter load regulation

Aimtec Inc. is broadening the company's product line with the addition of the AM1D-RZ series of 1-W power supplies featuring 80 models with efficiency rates as high as 89 percent and load regulation of 6 percent. Input voltages of 5, 12, 24 and 48 VDC convert to single and dual output voltages of (±)5, (±)9, (±)12 and (±)15 VDC with momentary(1 sec) short circuit protection. Operating within an ambient temperature range of -40 to +85 °C at full load



without derating, the AM1D-RZ series is designed for versatility and can be integrated into a multitude of applications.

Designed in a compact SIP7 package (19.50x6.00x9.50 mm), the AM1D-RZ is offered with I/O isolation of 1000 VDC or 3000 VDC with load regulation of 6 percent and low ripple and noise of typically 50 mV p-p.

Aimtec

www.aimtec.com

Home networking chips

compliant with the ITU G.hn standard

Lantiq has rolled out the industry's second family of home networking chips compliant with the new ITU G.hn standard to drive data over powerline, coax or twisted pair networks. The Lantiq XWAY HNX chips support data rates up to a Gbit/second using a 100 MHz channel. The Lantiq products are part of a growing trend to hybrid home networks to enable connecting any systems to any service. The devices come with drivers for other Lantiq chips, including gateway processors and controllers for 802.11n, DECT, VoIP and analog voice. Sigma Devices rolled out the first G.hn chips late last year. Companies such as Atheros have debuted hybrid home network designs

supporting Wi-Fi and HomePlug powerline nets. The company claims its quality-of-service features operate over G.hn, Wi-Fi, Ethernet, DSL and passive optical networks. The chips provide real-time diagnostics, automatically select the optimal network to avoid noise and support spectrum management features. The HNX 156 and HNX 176 transceivers support the 25, 50 and 100 MHz band plans defined in the G.hn standard. They include a MIPS core, Gigabit Ethernet PHY and switch and PCI Express interface.

A G.hn powerline networking evaluation kit is available now.

Lantiq

www.lantiq.com

Triple-axis inertial sensor

measures both angular rate and acceleration

Temperature-compensated, calibrated and universally usable, the SD746 combo sensor from SensorDynamics combines inertial, acceleration and gyroscopic functions in a single package. Key features of the inertial sensor are three measurement axes each for angular rate and acceleration as well as a wide measurement range of up to ±2048°/s for angular rate and ±8g for acceleration. The maximum offset error at room temperature is ±5°/s for the gyroscope signal and ±0.1g for the accelerometer signal. Sensitivity error at room temperature is ±2% for the gyroscope and acceleration signal, respectively. Additional features of the SD746 include a special power-off mode in which no power is consumed, but the SPI interface remains high-

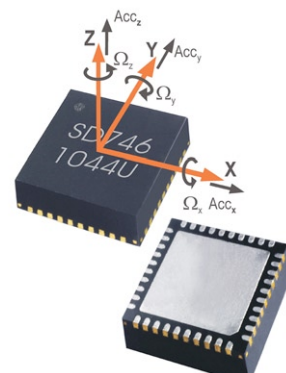
impedance and a continuously running self-test. The micromechanical combo sensor is now available from Gleichmann Electronics and is provided in a compact QFN40 package designed for an operating voltage of 2.55 V to 3.6 V and an operating temperature range of -40°C

to +85°C. The typical power consumption is 6.5mA. Its low power consumption and small-scale package are said to make the SD746 combo sensor suitable for use both in battery-

powered consumer applications and sophisticated industrial instrumentation & control applications.

SensorDynamics

www.sensordynamics.cc



TCXOs include power management

with programmable ASIC to enable low power standby modes

The Charon is a SPI controlled high accuracy TCXO with embedded timer and alarm function. The 7x5mm SMD digitally controlled temperature controlled crystal oscillator is designed and specified to bring together the highest stability TCXO performance with digital frequency control, separate low frequency output, timer and alarm functionality. A low frequency timing pulse is derived from a programmable division ratio of the high stability oscillator. This drives



the on-board 32-bit timer, which coupled to a 32-bit programmable comparator and alarm circuitry, enables a system to enter a low power standby mode and be woken at a precise time. All digital control is via a standard 4-wire SPI interface. The oscillator operates from 2.5 to 5.5V and draws 2 to 6mA in a frequency range from 3 to 40MHz.

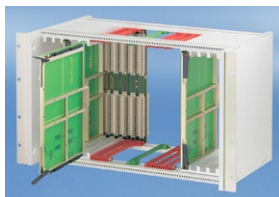
Rakon

www.rakon.com

Ruggedised 19" subrack

with enhanced shock and vibration resistance

Electronics packaging specialist Schroff has extended its europacPRO range of modular subracks with a new version designed for use in demanding environments such as military systems, on aircraft, close to rotating machinery or in power generation applications. A standard subrack consists of two side panels and at least four horizontal rails. By using stronger side panels, reinforced horizontal rails, 19" brackets and corner profiles, the new subrack is able to achieve a shock resistance up to 25 g. Standard guide rails can be used in the ruggedised subrack, and where necessary these can be bolted to the horizontal rails. There are also ductings to accept Card-Loks



or clamshells in 0.8in. intervals, and special cover plates reduce noise caused by vibration. All front surfaces of the subrack parts are anodised, giving a functional, scratch-resistant and visually attractive finish. Yellow chromated finishes are also available on request. Available in heights from 3 to 12U and widths from 21 to 84HP, the europacPRO subracks are designed to satisfy the requirements of IEC 60297-3-100 to

IEC 60297-3-105 and IEEE 1101.1, 1101.10 and 1101.11. They can be supplied in kit form or fully assembled.

Schroff

www.schroff.co.uk

Outdoor thermoelectric cooler series

with bi-polar thermostatic control

Laird Technologies has released its outdoor thermoelectric cooler series with bi-polar thermostatic control. The AA outdoor cooler series is a ruggedised air-air thermoelectric assembly (TEA) that uses impingement flow to transfer heat. It offers dependable, compact performance by cooling or heating enclosures via convection. A bi-polar thermostatic controller with predetermined set points is integrated inside the TEA to maintain its tight form factor. The unit is available in two of Laird Technologies' most popular set point configurations. The LK-81 is programmed to cool when the internal of the enclosure exceeds 25 °C and heat when it drops below 10 °C. Products in this series are offered in four models: 150 W

capacity operating at 24 V or 48 V and 200 W capacity operating at 24 V or 48 V. The LE-80 is programmed to cool when the internal temperature of the enclosure exceeds 35 °C and heat when it drops below 5 °C. Products in this series are also offered in four models: 150 W capacity operating at 24 V or 48 V and 200 W capacity operating at 24 V or 48 V. This product series has been designed to pass rigorous Telcordia test requirements conducted by Laird Technologies' customers, such as earthquake resistance, salt fog, wind-driven rain, high temperature exposure and dust contaminants.

Laird Technologies

www.lairdtech.com

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High Voltage

MINIATURE

DC-DC CONVERTERS



Over 2500 SURFACE MOUNT and THRU-HOLE Std. Models
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HIGH POWER

Up to 350 VDC Outputs

(Units up to 150 Watts)

Regulated

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Don't be an easy catch: test your products before deployment

By Juha-Matti Tirilä

Bugs are more than a nuisance; they are a hole in your security through which hackers can access your systems. The number one security threat is not a malicious attacker, but poorly managed development processes.

THE LATER TESTING is carried out, the more difficult it is to find the problem. And, the later you test, the more expensive and less thorough the fixes are. So, to test effectively, test proactively.

It is not always clear what you need to do to be properly prepared for security threats – with the growing market of add-on security products aiming at making us pay for the comforting feeling of being secured, one should be aware that the biggest danger lies within. It is not that systems are purposefully left insecure, with the intention of adding security armour around the product afterwards, but rather; they accidentally and invariably turn out that way. Companies offering software-operated products must understand that security is something that has to be built into the product from the ground up; the most common source of exploitable vulnerabilities is the ever-abounding population of software bugs. Yes, just the programming mistakes, that many think of just as development-phase nuisances or quality issues at worst, are the ones that leave the back door open for intruders.

Understanding the nature of built-in vulnerabilities is also the key to understanding why off-the-shelf add-on security solutions can not truly secure systems from attackers. What makes those hiding bugs so dangerous is that they are frequently only discovered after product deployment and delivery. In contrast to flaws discovered before release, vendors are unaware of these unknown bugs, and are therefore not prepared to provide fixes for them. Attackers are constantly looking for such holes. When discovered

by hackers, these vulnerabilities are used in exploits that are invariably able to bypass intrusion detection and prevention systems by virtue of their novel nature – their characteristics are unknown to security mechanisms so there is no one to stop them. Such a suddenly emerging threat is called a Zero Day Vulnerability, and what companies

Understanding the nature of built-in vulnerabilities is also the key to understanding why off-the-shelf add-on security solutions can not truly secure systems from attackers.

practicing solid and well managed security measures at all phases of production, aim for it that day 'o' should never dawn!

It is important to understand that the bug peril not only affects companies building software, but also the next layers in the food chain, reaching out to end customers. As soon as buggy software hits the mass market, the time bomb is ticking: when someone or something makes the flaw surface, the race is on between the vendors and attackers. Exploitation implies cost, and this is enough of an incitement for attackers. Vendors, being well aware of this race, have to rush with writing and deploying fixes, and this process subjects involved parties to many dangers. What follows may be downtime, impaired QoS, exposure of confidential material, or in-

complete and hard-to-employ patches that, in the worst case, also introduce new attack angles in the form of new bugs! The list goes on. And, this cost is not only inflicted upon the vendor who provided the software, but also on their customers using the programs.

It really is this simple: the earlier vulnerabilities are discovered, the easier and cheaper they are to fix. With pure software products, the difference in the price of a bug found during development and a bug found only after the release is already significant, however, the more complex the product in which the software is used, the bigger the price difference. Just think about the recent car recall programs as an example. New security processes should not be frowned upon as an extra cost, but rather welcomed as cost savers. Proactive testing is an investment that will pay for itself. By testing your systems proactively, you can avoid security related issues later on during the software life-cycle.

While robust security testing, immediately before deployment, does prevent vulnerabilities from being delivered to the market, it is just the first step in the right direction. Whether the product is pure software or a hardware system relying on software components, robustness testing should be an integral part of development as early as possible. Production phase processes, as such, have dramatically improved over the years.

However, instead of just looking at the product life cycle from a feature oriented perspective, the developers must also consider products' security life-spans, and perform the appropriate security and robustness checks at each phase. Therefore, security testing procedures must not be seen to live in a domain separate from product development, but should be considered an integral component therein. So, don't ignore those annoying little bugs. That way only the hackers win.

By testing your software proactively, you are able to produce better, safer software making your customers, and ultimately you, the winner. ■

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