Fairchild MOSFET BGAs deliver 40A per Phase @ 50 W/in²

Setting the new standard in packaging and performance:
- Superior parasitic source inductance (6 phi for 5.0 mm x 5.5 package)
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- Excellent thermal performance 0.5 °C/W 10K
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Across the board. Around the world.

More VRM power with fewer phases
Introducing the package destined to be the industry standard in the world of high current, high switching frequency VRMs for PCs. Fairchild’s MOSFET BGAs offer unparalleled high current densities in a package that arguably has one of the smallest footprints and pincounts in its class. So for your next VRM, design-on MOSFET BGAs and get an impressive combination of high efficiency, high power density, highly optimized board space and great time to market. MOSFET BGAs from Fairchild — setting the new standard in packaging and performance. For more information on Fairchild MOSFET BGAs, go to www.fairchildsemi.info/powerbga
Europe in the Spring

To escape from the cold European climate, Spring days are starting to peek through the clouds back home in old Germany on the Baltic Sea. It is time to take out my old Beetle being just five years older than the PCIM Europe show. Thinking about all the electronics in an automobile today I am happy that we had engineers in the past able to design a car that can stay reliable over three decades. What is with today’s automobiles? Will we have semiconductor support 30 years into the future to provide replacement and spare parts of all the electronics in modern cars.

We have faced the same problem with the steam engines in old locomotives or vessels. Here the permit for the usage of the steam engine is only given if the steam engine passes safety inspection. Different technology, same pattern. These products are now only for display in the museums.

Does this happen to events as well. The big open air festivals are gone. Rosskilde Festival in Denmark has attracted generations of Europeans including me. Did I get older and lose interest, or is it that modern times take away these events. Things which become too common lose the momentum to attract the people.

Major conferences and shows are only as stable if they have fresh blood coming in from the youngsters in engineering. We need industry to give younger engineers a start up chance. Revolutionary ideas are not developed by the grandfathers. Their wisdom is a benchmark to measure progress for future developments.

The web is the complimentary tool today to work efficiently. Power Systems Design Europe is not only in print form but available digitally on the web. This provides easy access to our magazine for world wide demand. Anyone, not just in Europe can get our magazine just by visiting our web, www.powersystemsdesign.com. We will post all issues there and you will have the freedom to travel and still get the news. Our magazine is a youngster in the publishing world but we are experienced oldies. Our average age Jim and I (not Julia) is twice as old as PCIM Europe conference that will celebrate 25 years. PCIM started originally as a conference and show in the US by Myron Miller. PCIM was taken to Europe and organized by Gerd E. Zieroth.

Gerd’s words as a publisher in 1989 in PCIM Europe magazine are: “More than ever, industrial structuring and new trends in the field of power electronics, show clearly how necessary are the communications media, in order to provide on a wide basis the right information, at the right time, to the specialist user of this technology throughout Europe. To this end, the “PCIM ’91 Conference and the PCIM Europe” magazine combined their efforts.”

As a reminder, you should mark your calendar for the last week of May to attend the most important European event in Power. My association at PCIM Europe for more than one and a half decades as a board member of the PCIM conference will provide additional fuel for our magazine and keep the focus strongly set for technology and their advanced application. See you at the podium discussions. Each day around lunchtime we will have short presentations from experts followed by an open discussion. I have selected semiconductors as the focal elements for power electronics. MOSFET’s on Tuesday, IGBT’s on Wednesday and Rectifiers on Thursday.

See you at the show in Nuremberg!

Best regards

Bodo Arlt
Bodo.Arlt@powersystemsdesign.com
Power Integrations Extends its Distributor Franchise with Unique Memec

Power Integrations (NASDAQ: POWI), announced today that it has expanded its distributor network in Germany, Austria, and Eastern Europe through Unique Memec, with whom the company already has a successful relationship in Northern and Southern Europe. “I am excited about the addition of Unique Memec to meet the needs of our customers in Central Europe,” said Ben Sutherland, Managing Director of Power Integrations Europe, Ltd. “Unique Memec has made a significant investment in switching power supply application engineers and in equipping application labs over the last 18 months. Our ongoing strategy is to train the Unique Memec field application engineers so that they are capable of assisting our customers to design power supplies in their local language.”

“We have been successful selling solutions using the Power Integrations products and are looking forward to extending our coverage to Germany, Austria and Eastern Europe. We will offer the same high level of design expertise that our dedicated team of power FAEs around Europe already provides to our power supplier customers,” said Jon Ellis, European Marketing Director at Unique Memec.

German Chapter Visits SEW-EURODRIVE

IEEE Joint IAS/PELS/GIES German Chapter had kindly been invited by SEW-EURODRIVE to hold a chapter meeting in the private company’s headquarter at Bruchsal in Germany, which took place 4-5. March 2004. After a warm welcome by owner and general manager Rainer Blickle, several technical presentations and a well organised tour through electronic and mechanical assembly lines permitted the 80 participants an impressive insight into technology, production and application specific final assembly of the company’s proprietary Eurodrives, which are decentralised drives for various applications in industry and transportation. The technical program was complemented by a scientific lecture of Prof. Dr. Budig about direct drives.

As an additional social program SEW generously invited the participants to taste local food and wine from amiable south western German region Baden in a wine cellar. Many discussions between researchers from industry and universities during the evening have shown that the subject briefly addressed from the panel, how to develop the proven German engineering education in the European context with respect to internationalisation, actually attracts considerable attention.

Presentation of structure and research themes of Nürnberg based Engineering Center for Power Electronics—ECPE—built relationship and further networking opportunities with this newly founded organisation. The topic IEEE business has been used as platform to review the three chapter meetings of 2003, assigning awards for outstanding contributions.

Picture: Recipients of chapter awards. Dr. Miller (Intrieon AG, left), Prof. Dr. ir. R. W. de Doncker (RWTH Aachen, with induction motor trophy), Dr. H. Mittelhner (SICED GmbH), Dr.-Ing. T. Tolli (Philips Research) and Award Chairman Prof. Dr.-Ing. H. Späth (University of Karlsruhe, right)

Philips and IMEC sign agreement

Philips Electronics and IMEC signed an agreement that extends Philips access to IMEC’s advanced research facilities and expertise until the end of 2008. This new agreement, which closely follows Philips’ decision last year to become a core partner in IMEC’s sub-65nm CMOS research program.

For leading consumer electronics companies like Philips, having access to state-of-the-art semiconductor technology is the key to delivering ever richer experiences to consumers in areas such as multi-media entertainment and communications. However, in addition to the baseline CMOS processes used to produce the powerful digital chips at the heart of these applications, companies also need special semiconductor processes to produce chips that can handle associated tasks such as wireless communications, power amplification and display driving. Philips’ commitment to differentiating itself in the marketplace by providing total system solutions rather than component parts means that development of these special semiconductor processes is as important to the company as having state-of-the-art CMOS. Philips now works with IMEC on three levels—(i) as a core partner in IMEC’s sub 45nm process development within the Philips/Motorola/STMicroelectronics Crolles2 Alliance; (ii) as an individual partner with IMEC in the development of Philips-specific special process technologies; and (iii) as a valued contributor to discussions over the future direction of semiconductor research at IMEC.

Further information on IMEC can be found on: www.imec.be. News from Philips is located at: www.semiconductors.philips.com
eupec announces Chinese name to strengthen China ties

eupec displayed its advanced IGBT products and High Voltage Diodes and Thyristors at the PCIM exhibition in Shanghai. The IGBT product family enables the development of new concepts for motor drives in household appliances, air conditioning systems, and industrial applications. eupec is the only manufacturer of commercial Light Triggered Thyristors for HVDC and SVC markets. eupec semiconductor products are tuned to high energy consumption, and eupec has been working with stringent heat dissipation requirements to improve reliability. As a result, eupec's innovative product family enables the development of new applications.

Free SPICE Modeling Service

Intusoft announced that its SPICE modeling capability has been extended to users of the company’s ICAP/4 simulation software, and the overall engineering community, on a no-charge basis. Intusoft has historically augmented its simulation offering by providing a wealth of analytic models, such as resistors and capacitors. It was the decision of Larry Meares, president and founder of Intusoft, to now exclusively drive new model additions directly from the engineering community. “This is the best way to comply with today’s demand for SPICE models, by respecting the needs of the engineering tool user.”

The modeling service directs an inquirer to fill out a Model Request Form, specifying their company and contact information, and a link to the model’s datasheet, application notes and test circuitry. For those not using Intusoft’s simulation tools, the inquirer can download a free version of the ICAP/4 analog and mixed-signal SPICE software and create their own custom test circuit for the model. Tim Ghazaleh, marketing director for Intusoft, replied that the free modeling service is another key way Intusoft is strengthening its relationship marketing program to its customer base and engineering community. The program forms a communication channel to Intusoft’s marketing organization, with corresponding ties to the development team.

5A Boost Converter ≤ 2mm

LTC3425: 95% Efficient, 4-Phase Operation and up to 8MHz Switching

Generating a 5V, 5A point-of-load output from a 3.3V power rail or a single cell Li-Ion battery just got easier with the LTC3425. With 8MHz switching frequency, this 4-phase converter not only maximizes the size of external components, but also provides ultralow output ripple. With no output current limiting and true output disconnect, the LTC3425 delivers a full featured solution in a compact footprint.
The definition is your position to look at

Power management starts at the device level with controller ICs that put functions to sleep when not needed or by slowing down clock cycles to save power. Followed by the distributed power at the board or system level. Ending up in the high voltage at station class power generators and distribution.

By Bodo Ait, Power Systems Design Europe
Editor-in-Chief

Modern controllers using C-MOS logic run at extremely low voltages. You need to consider the load and its conversion to obtain the correct voltage at the proper peak current. MOSFETS are the semiconductor elements that serve that purpose today. Any ICs helping here are named “Power Management IC”.

The most frequently asked question is: what is low power and what is high power? It depends upon the application. Individuals working on automotive controllers may define 42 volts as being a high voltage, high power. Conversely, those in Europe operating at 240 volts or 420 volts, consider any value of voltage below these values as low voltage. However, this voltage region is the most commonly used in industrial and commercial electronics.

The IC manufacturers are looking to applications in communications, computer and the portable and wireless portion of that business. Here we have the strong demand to use the give energy at the best performing efficiency. IC makers like Lattice, TI and others playing in here are using complex structures to have parts of the IC put to sleep when they are not needed and have algorithms to wake them up if they have to contribute to the process.

As all that places in the voltage range below 5Volts as the controllers with increasing clock cycle are moving to more dense structures and lower voltages. The challenging subject here, is the MOSFET working efficient in the low voltage arena.

The peak power demands are going up and point of load converters are the ones delivering the power right up to the micro-controller IC. Multi phase convert- ers are the tools to fulfill the support.

Based on what kind of volume application is in focus the semiconductor manufactures for the power management ICs and the discrete MOSFETS are working close with the Intel and AMD people to have the right solution for the motherboards of next generation computers. It does not matter if it is desktop or laptop, both need optimized solutions as at the end the stand by time for laptops is important if you are of the supply. But also the heat is something that needs to be extracted from the total design.

Worst case is the junction temperature to not exceed the max junction temperature before the device is destroyed. Companies like Ansoft and Intuos have design and simulation software to be ahead of hardware test to see how performance can be optimized.

Simulation has made a significant contribution to system performance. Nowadays we have the product virtually ready to go for production with very close to the final product. The more and more advanced software and the extraction of data from devices in semi-conductors and passives including thermal details prepares the platform to work straight ahead. The simulation starts on semiconductor design level and goes step for step up and includes the mechanics as well as the electric motors to simulate total drive systems.

Any thing in technology can be applied for simulation.

The computers of today have increased calculation speed together with ‘unlimited memory space’. Working with these tools today has much more detailed information to describe all elements more complex and have much more accuracy in the model. That includes today thermal behavior, something in the past that needed the engineers educated guess to feel if he was right or wrong. In a lot of cases the safety margin was too much. Or in some cases not enough and the actual device test showed the gaps.

So we have had our Eye on low and lower, now we take a look into automotive. In the sixties of last century the automobile designs. Fairchild now understand what they got from Harris to serve is very good for the market in automotive. Here power management jumps from electronically control to combustion efficiency, still power management.

Moving up in voltage gets us to the line voltage we have in Europe 240 AC as the US has 110 AC. Looking into the three phase we are up at 420 volts in Europe. Anywhere we are in an area where the MOSFETS start to have problems solving the needs. The on resistance is the major drawback to fight against.

The right switch of choice at line voltage and frequencies from a few hertz up to about 100KHz has become the IGBT. Introduced as the switch of choice for motion applications in 1982 by Mr. Becke and Weatherly from RCA. They called the device COMFET and got the first IGBT patent from the US patent office in December 1982. So what, the IGBTs are the semiconductor switches preferred when dealing with applications requiring 600 to 1200 volt capability. These areas are the house hold equipment and industrial areas. Here we have a lot of applications going up to drive applications in the 2 KW range handled by discrete IGBTs in a combined version with the free-wheeling diode.

Most popular applications are the variable speed electrical motor drives. To get them to the level of efficiency we see today power management is the tool doing it. The inverter system is powered from the supply voltages for the air or magnetic bearings in the motor can be part of the power management philosophy to reduce the waste of energy.

Above these power values, the applications include power distribution at station class and traction. The preferred solid-state device is the GTO and Thyristor. Guess what is considered to be low voltage, low power in these applications? It depends upon your perspective! And again the “Power Management” is used as a terminology here. Regenerative breaking is a standard in traction.

Will also become important in the automobile by hybrid systems storing energy while braking into super capacitors or batteries.

We are covering in our Power Systems Design Magazine the entire gamut of applications in order to supply the power designer with up to date crucial information that can help to facilitate the design being considered.

Power management is so wide in understanding and everyone sees it in his own view like when the boss named the secretary a big white bird. What do you believe their thoughts are? She thinks about a wonderful swan and the boss thinks about a turkey both have their imagination to see things a different way. An old joke from my childhood.
Many questioned our sanity 23 years ago when we founded a new semiconductor company to focus strictly on analog ICs. For this was the beginning of the digital revolution, and industry pundits claimed, “analog is dead.” Were they ever wrong.

In fact, growth in digital electronics has created an even greater need for analog ICs. Since our world is still analog in nature, conversion between the analog world and digital processors will always be needed. Today’s explosion in functionality in portable electronic products means even more analog ICs are needed. Consider all the analog functions needed to support a modern cellular phone with a color display, digital still camera, video camera and MP3 player. This growth in functionality also fuels the need for an increasing number of power management ICs.

Every new product generation seems to require more power supply rails than the one before. Consequently, it’s no surprise that power management ICs are one of the fastest growing segments in the analog IC industry. But there’s more going on than just increased use of regulators—we’re witnessing a dramatic shift from simple linear regulators to more sophisticated switching regulators in nearly all applications. There are several key reasons for this movement.

The combination of reduced power supply voltages and increasing load currents makes linear regulators impractical in many applications. Linear regulators often generate considerable heat, requiring significant PCB area and heat sinks. In battery-powered products, their inefficiency translates directly to reduced run-time. Just during the last couple years we have seen a dramatic shift from the use of linear regulators to very tiny megahertz switching regulators in cellular phones in order to maximize battery life.

Ten years ago Linear Technology introduced the first switching regulators featuring Burst Mode® operation to deliver excellent light-load efficiency. DC/DC converters in handheld products now consume as little as 10 μA quiescent current, increasing run-time in standby mode. Even in automotive applications, standby current is critical with over 100 microcontrollers in a modern high-end car. Unless each of these subsystems has low standby current, the car battery may be dead after parking just two weeks at the airport. Modern high-voltage switching regulators such as Linear Technology’s LT1976 provide a breakthrough by consuming only 100 μA during standby.

Newer highly integrated switching regulators have become simple enough for analog-challenged designers to use successfully. Some low-power switching regulators require only three external components, making them almost as easy to use as the familiar linear regulator.

Looking ahead, we will continue integrating new features into switching regulators to improve performance and simplify use. Several recently introduced products incorporate spread spectrum switching to modulate switching frequency by a pseudo-random number sequence. Instead of concentrating switching noise into narrow harmonics, noise is spread across the frequency spectrum to minimize interference with sensitive receiver circuitry. Tracking and sequencing features are also being integrated into switching regulators to address the needs of multi-supply systems.

The maturation of the power management IC industry has also resulted in application-specific parts for almost every need. Linear Technology now manufactures over 3,000 standard power management ICs, addressing a wide range of general-purpose applications, as well as very specific needs such as multi-display white LED drivers and Thermoelectric Cooler Controllers. Linear Technology will continue to lead the power management IC industry by setting new performance standards, and developing new architectures to meet evolving system requirements.

By David B. Bell, President, Linear Technology Corporation

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www.linear.com
Power management in automatic brightness control applications

An Intel study on “Optimizing Mobile Power Delivery” reveals that display backlights represent 33% of the total battery drain in notebook computers. Thus, finding ways to manage backlight brightness—and the power consumed to achieve it—offers high potential for significant power conservation. Automatic brightness control is one such solution.

By Bruce Ferguson, Sr. Systems Engineer, Microsemi Corporation

Our eyes may hardly notice a 50% reduction in ambient lighting, but if we control display brightness and power consumption by that same 50% we can provide a dramatic impact on battery runtime in any portable device—and offer significant reductions in power consumption for stationary applications as well.

While many appliances include a manual capability for adjusting display brightness, few users employ it. Automatic control of backlight brightness is therefore essential to effective power management in all types of display-based devices. It is also a critical factor for ergonomic satisfaction, as displays are often viewed under varying ambient lighting conditions.

Portable devices such as notebook computers and cell phones roam between locations with vastly different ambient lighting—from daylight and well-lit offices to the dimly lit cabin of an international flight. In automotive applications, displays must operate over the entire visual brightness range from a moonless night to a sunny day. Even wall-mounted LCD TVs must function in bright environments or over-illuminate their displays in dimmer light conditions.

What users need is a closed loop system that allows them to set display brightness to their personal comfort level once, and that will automatically adjust brightness thereafter as dictated by changes in ambient light, optimizing the display and conserving power.

A complicating factor concerning light control involves the necessity of ignoring the effects of infrared light that is detected by conventional light sensors, but not by our eyes. Sunlight and incandescent light have large concentrations of infrared content, as do some heat sources. Beyond ergonomics, avoiding “over-bright” displays not only reduces power consumption, it also reduces stress on the LEDs or CCFL lamps that illuminate the display. Many LCD display specifications show lamp life is improved by as much as three times, when the CCFL lamps are run at 50% of maximum brightness; this translates into longer product lifetimes for notebook computers, LCD monitors, and LCD TVs, where the lamps are not intended to be user replaceable items.

Implementing Automatic Brightness Control

In brightness control applications, two design parameters can be used to quantify the effect of ambient light that tends to wash out information on a display. Eq.(1) below represents the Pixel...
Contrast Ratio (PCR)—essentially the brightness of one pixel (typically fully on) divided by the brightness of another pixel (typically off). The PCR is a function of the display relative to the surrounding ambient. This can be a little more difficult to quantify for a portable device, because it depends on where you are using it. For the general case:

\[
PCR = \frac{(T_L \times BL) + (R_L \times A)}{(T_H \times BL) + (R_H \times A)} \tag{Equation 1}
\]

Where:
- \(T\) = Light transmittance of a pixel as determined by the liquid crystal drive
- \(BL\) = Brightness of the LCD backlight
- \(R\) = Reflectivity of the display surface at a pixel location
- \(A\) = Ambient light incident on the display (illumination)

Equation (1) can be reduced to Eq.(2) as below:

\[
BL = \frac{(R_L \times PCR \times R_H)}{PCR \times T_H - T_L} \times A \tag{Equation 2}
\]

Since the goal of any brightness control system is to keep the Pixel Contrast Ratio (or PCR) constant for the user in a varying ambient, we can set PCR equal to a constant. The transmittance and reflectivity of the display can also be assumed constants for a given set of displayed content. This allows equation 2 to be reduced to:

\[
BL = K \times A \tag{Equation 3}
\]

This relationship clearly indicates that Pixel luminance or backlight brightness can and should be scaled directly to the external ambient to maintain display readability. Assuming the pixel brightness is proportional to the dimming control signal amplitude, this implies that a signal from a light sensor can be used to directly adjust the backlight controller and provide automatic brightness control that keeps the display readable in all ranges of ambient conditions.

Such an automatic brightness control strategy would also certainly improve display readability in a hybrid system, where users manually select the initial display PCR that satisfied their visual needs, and the automatic brightness control system maintained that level with varying ambient lighting conditions.

Traditional light sensor technology

With ergonomic factors clearly dictating that display brightness be automatically tailored to the ambient conditions encountered by the user, the selection of a light sensor to accurately detect ambient conditions becomes the critical factor in implementing the control system. The most common light sensors in use today are phototransistors and PIN diodes. Both types of sensor generate signals that vary with incident ambient light intensity, but each has significant drawbacks in a number of brightness control applications.

The photodiode or PIN diode offers a very linear response to incident light intensity, producing a current proportional to the ambient lighting. The output current from the photodiode is very small (typically nanoamps) so some sort of signal amplification is needed. In addition, the spectral response of a photodiode is most sensitive in the infrared area so it typically requires the additional expense of an infrared filter to ignore light outside the visible spectrum (Figure 1). In fact, contributions from both the infrared and ultraviolet regions of the spectrum tend to increase the detector signal far beyond the ambient level sensed by a user’s eye.

Phototransistors have a response similar to a typical bipolar transistor with a photodiode driving the base. The transistor Beta provides the necessary current gain, which amplifies the weak signal of the photodiode input. Unfortunately, the transistor beta is not a particularly stable parameter so the gain of the phototransistor circuit varies with supply voltage, with temperature and with manufacturing process tolerance; this means the phototransistor has limited usefulness as a calibrated linear light sensor and is not recommended for automatic ambient tracking systems.

In many portable applications, designers have tended to accommodate or mask the broad spectral response of PIN diodes in their brightness control strategies. But in several new brightness control application areas, like LCD TVs and automotive mirrors, responses to light outside the visible spectrum can cause severe performance problems.

For example, almost all remote controls for TVs use infrared signals to change channels or adjust volume. These signals can actually be sensed as incident ambient light by a light sensor controlling the TV display brightness, resulting in a significant change in brightness of the TV screen without an apparent cause visible to the user.

---

**Figure 1: PIN photodiode and Human Eye Spectral Response.**

**Figure 2: Thermal Clad lets you Build Capacity Not Size.**

**Increase power load capacity.**

Innovation in motor control is driven by market demand for power in smaller packages, extended motor life and improved power outputs. Kerrtek, a motor control manufacturer known for the most advanced motor drives in the industry understands these market drivers: Kerrtek came to Bergquist with their latest design, looking for ideas on how to improve the thermal and mechanical design of the power board section in the motor control. Bergquist suggested Thermal Clad® in an insulated metal substrate, as a substitution for their FR-4 heat sink, through-hole component design.

The new Thermal Clad design for Kerrtek resulted in a reduction of assembly hardware from 130 to 18, a highly automated surface mount assembly, an increase in power capacity of 30% and a lower overall profile.

**Proven materials and flexible designs.**

Thermal Clad® substrates provide the electrical isolation needed to meet operating parameters and agency test requirements: Thermal Clad® has the ability to be fabricated in a wide variety of form factors, including curves, holes and 3-D elements. Thermal Clad® is available in either aluminum or copper based substrates, in a variety of different thicknesses.

With Thermal Clad®, overload capacity is increased and power cycle life is extended. You’ll find it easy to reduce the profile of your motor control design while at the same time increasing power load capacity, all on Thermal Clad. Contact us today for your FREE thermal Clad® Selection Guide!
As an added benefit, the quiescent current of these sensors is typically negligible and the devices are useful at extremely low light levels. When such a device—like one of Microsemi’s LX1970 family—is used with an appropriate controller for LEDs or CCFL, the signal from the sensor can be employed to directly control display brightness for ambient variations perceived by the human eye.

The LX1970 visible light sensor has two outputs that produce currents that are proportional to the intensity of light that reaches the sensor. The SRC output is designed to source current into a resistor wired to ground. The SNK output is designed to sink current from a resistor wired to a high potential such as the VCC. When only one output is used, the other output is left unconnected to reduce power consumption.

The value of the current source i-to-V conversion resistor can be used to scale the voltage produced at the LX1970 output within limits. The upper limit is determined by the short circuit saturation current of the LX1970, which occurs at approximately 100µA of output current: 1000µA flows at approximately 2500 lux for the LX1970. Attenuating the light allowed to reach the sensor can extend the upper range of the sensor at the system integration level. This can be done using a gray filter or reducing the aperture of the hole in the cover above the light sensor to let in less light.

The lower limit is determined by the dark current of the device which for the LX1970 occurs around 1 lux. The supply voltage used will impose a maximum voltage limit termed the compliance voltage of the LX1970 current source. The current source needs about 300mV of headroom. If a large resistor is used, the current source may run out of headroom and essentially clamp the output voltage such that further increases in light have no effect; in this case, lowering the value of resistor can extend the range. Normally the output compliance voltage is strategically used to limit the maximum output voltage since most light control systems have a peak brightness limitation that can be programmed in this way.

One precaution regarding the use of the visible light sensors like the LX1970 is response time. Typically, the LX1970 is much faster than the human eye. Most light sources produce light that varies considerably over a 60Hz cycle and the LX1970 can track this signal if given user adjustment level (or fixed PWM duty cycle). To avoid this variation affecting sensitive downstream circuitry, we recommend putting a capacitor across the resistor to set the time constant to around one second.

When the dimming control is done manually, the user will normally change the intensity of the LCD each time the room ambient changes. With an automatic light control system, the user makes an initial “one time” adjustment to their preference, and as the ambient lighting changes, the display brightness adjusts to make the display appear to stay consistent at the same perceived level. Figure 3 illustrates how a light sensor control system can be designed to interact with user preferences to provide various brightness contours over a limited range of ambient lighting conditions.

In Figure 3, it can be seen that at any ambient light level, with the LX1970 prescribed dimming control, the user can adjust the Dimming output from “off” (0% Duty) to an ambient specific maximum level (100% Duty). Furthermore, by adjusting user dimming level (or fixed PWM duty cycle), the Dimming signal will increase (decrease) as the ambient light increases (decreases). The design parameters are the two corners on the maximum brightness setting contour: the percent full-scale brightness at 0 lux, and the ambient level that produces a full-scale output. These two points will be programmed to give the desired response.

The best approach to designing the brightness control system is as follows: Determine the level of display brightness desired in total darkness (at full-scale dimming setting) and the light source dimming control voltage that corresponds to this display brightness. Design dark level brightness control bias. Determine how the sensor will be mounted and create a mockup to determine the sensor sensitivity in your application.

For further assistance in calculating resistor values, consult Microsemi for application information.

Figure 2: LX1970 and Human Eye Spectral Responsiveness.

Similar out-of-visible-spectrum illumination effects have plagued the development of brightness controls for automotive mirrors and/or headlamps, which are becoming increasingly necessary with the use of new high intensity discharge head-lights and LED tail-lights. The sensitivity of commonly used sensors to the red area of the spectrum like that emitted by tail lights can produce faulty control signals, dimming the mirror reflectivity or lamp brightness at very inconvenient times.

New integrated circuit visible light detectors

A new class of integrated circuit visible light detectors is just emerging on the market. These devices typically consist of an array of PIN diodes on a single substrate, with individual diode characteristics wirelessly array controlled in such a way as to match its overall spectral response very closely to that of the human eye (Figure 2).

With PIN diodes it’s possible to filter out the response to visible light. When the response of an infrared sensitive PIN is subtracted from an otherwise matched full-spectrum PIN, the result is a diode that is sensitive only to visible light. Using current mirrors, it is possible to accurately amplify the PIN diode current by adjusting the physical size characteristic of the current mirror transistors (which is straightforward on an integrated circuit). This way, the good temperature coefficient and linearity of the PIN diode is reflected in the sensor output.

As an added benefit, the quiescent current of these sensors is typically negligible and the devices are useful at extremely low light levels. When such a device—like one of Microsemi’s LX1970 family—is used with an appropriate controller for LEDs or CCFL, the signal from the sensor can be employed to directly control display brightness for ambient variations perceived by the human eye.

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One precaution regarding the use of the visible light sensors like the LX1970 is response time. Typically, the LX1970 is much faster than the human eye. Most light sources produce light that varies considerably over a 60Hz cycle and the LX1970 can track this signal if given user adjustment level (or fixed PWM duty cycle). To avoid this variation affecting sensitive downstream circuitry, we recommend putting a capacitor across the resistor to set the time constant to around one second.

When the dimming control is done manually, the user will normally change the intensity of the LCD each time the room ambient changes. With an automatic light control system, the user makes an initial “one time” adjustment to their preference, and as the ambient lighting changes, the display brightness adjusts to make the display appear to stay consistent at the same perceived level. Figure 3 illustrates how a light sensor control system can be designed to interact with user preferences to provide various brightness contours over a limited range of ambient lighting conditions.

In Figure 3, it can be seen that at any ambient light level, with the LX1970 prescribed dimming control, the user can adjust the Dimming output from “off” (0% Duty) to an ambient specific maximum level (100% Duty). Furthermore, by adjusting user dimming level (or fixed PWM duty cycle), the Dimming signal will increase (decrease) as the ambient light increases (decreases). The design parameters are the two corners on the maximum brightness setting contour: the percent full-scale brightness at 0 lux, and the ambient level that produces a full-scale output. These two points will be programmed to give the desired response.

The best approach to designing the brightness control system is as follows: Determine the level of display brightness desired in total darkness (at full-scale dimming setting) and the light source dimming control voltage that corresponds to this display brightness. Design dark level brightness control bias. Determine how the sensor will be mounted and create a mockup to determine the sensor sensitivity in your application.

For further assistance in calculating resistor values, consult Microsemi for application information.

PVM Dimming Interface Conversion

The majority of applications for the LX1970 involve using it in conjunction with a lighting control system that is dimmed using a PWM signal from a microprocessor; usually the resultant brightness of the controlled light source is a function of the duty cycle of the PVM signal. In this type of system the light sensor is best integrated by creating a resultant dimming signal that is the product of the light sensor output multiplied by the PWM duty cycle.

Typically there is a minimum level of brightness required in total darkness, so there is some control from the PWM signal that must get through when the light sensor output is zero (which wouldn’t happen if they were truly a product function only). The circuit used to perform this function is illustrated below in Figure 4. This circuit supports two modes of operation, an auto mode, which allows the user to adjust their brightness contour and works in conjunction with the light sensor and a non-auto or manual dimming mode where the user directly controls dimming and the sensor influence is removed.

Figure 4: Adding a visible light sensor to a PWM dimming system.
These trends form the motivation to develop new concepts in the field of energy conversion systems on board ships. Although the performance range for naval applications is very wide, i.e. from kW up to several MW, fuel cells have the potential to meet these requirements. The motivation mentioned above and the potential of fuel cell technology resulted in several maritime fuel cell projects. HDW already uses fuel cells as a series product on board submarines. On 20th March 2002, the first AIP (Air-independent Propulsion) submarine was christened at HDW in Kiel (Figure 1). The foundation of its subsidiary HDW - Fuel Cell Systems GmbH (HFCS) now gives the HDW shipyard the opportunity to use its specific naval fuel cell knowledge for fuel cell applications on surface ships.

Customer value for naval surface ships

Today, the naval shipbuilding industry has to face new demands. Environmental regulations are becoming stricter and comfort becomes more and more important in order to win new customers. Naval ships are designed to reach the highest standards of stealth technology. The customer value is the driving force to employ a new technology. The well-known specific properties of fuel cells and fuel cell systems, such as very low toxic emissions, low noise and vibrations, modular design and high efficiency (especially with partial load) lead to a higher customer value for shipowners:

- very low toxic emissions
- low fuel consumption
- high comfort
- low signatures
- high resistance and combat strength

Performance of maritime applications

The performance ranges for fuel cell systems used on board ships are described in Table 1. Due to the high power demand on board ships, the supply of individual consumers and/or a support of the ship’s mains supply would be a first realistic application. Since the performance levels of fuel cell systems on hybrid submarines only range between 200 and 400 kW, they are considerably lower than performance levels required for surface ships.

In the maritime sector, environmental requirements are constantly increasing. In addition to that, increased comfort is required for passenger ships, while low signatures as well as increased combat strength and resistance are essential for naval ships.

Stefan Krummrich, HDW-Fuel Cell Systems GmbH

Figure 1: Christening ceremony of the first AIP submarine at HDW in Kiel.

CT-Concept Technology Ltd. is the technology leader in the domain of intelligent driver components for medium and high-voltage IGBT, application-specific driver boards and Integrated circuits (ASICs).

As an idea factory, we set new standards with respect to gate driving devices up to 15 kW per channel, short transit times of less than 100 ns, plug and play functionality and unmatched field-proven reliability. In recent years we have developed a series of customized products which are unbeatable in terms of today’s technological feasibility.

Our success is based on years of experience, our outstanding know-how as well as the will and motivation of our employees to attain optimum levels of performance and quality. For genuine innovations, CT-Concept has won numerous technology competitions and awards, e.g. the “Swiss Technology Award” for exceptional achievements in the sector of research and technology, and the special prize from ABB Switzerland for the best project in power electronics. This underscores the company’s leadership in the sector of power electronics.

More Information: www.IGBT-Driver.com/go/2SD315A1
Maritime fuel cell applications on submarines
After 20 years of development HDW today is able to commercially offer an air-independent propulsion for submarines as a series product on the basis of PEM fuel cells. This includes the equipment of new submarines as well as the retrofit of already existing submarines.

The most important advantages of fuel cells on board submarines are:
• high efficiency
• silent energy generation process
• lowest IR signatures
• low maintenance

Today’s submarine plants consist of the components described in Figure 2.

The Siemens FC modules are the heart of the fuel cell systems shown above. Hydrogen is stored on board the submarine in metal hydride cylinders, oxygen is carried in liquid form in tanks. So far, 6 submarines of Class 212 have been contracted. This type was developed in accordance with the requirements of the German Navy. Besides the 4 submarines for the German Navy, Italy ordered 2 of these boats which are built on the basis of HDW documents at the Italian shipyard Fincantieri. In addition to that, HDW has developed an export version with its Class 214 submarine which has already been ordered by the navies of Greece and South Korea.

Fuel cells on commercial ships
The advantages of fuel cells on commercial ships are clear: high fuel-saving potential, reduced toxic emissions, low operating costs, noiseless and clean propulsion.

In 1995, HDW together with Ballard already investigated the use of fuel cells on board commercial ships incl. suitable fuels in a joint study. According to this study, fuel cells are particularly suited for:
• emergency power supply
• e.g. passenger ships, ferries
• energy generation, in particular environmentally friendly in highly polluted ports

• e.g. container ships
• energy generation / driving power for ships with specific noise reduction requirements
• e.g. passenger ships, research vessels
• driving power on ships with hydrogen or methane “boil off”
• e.g. LH2 carriers, LNG carriers

Fuels cells on naval surface vessels
In the field of naval surface vessels the investigations in Europe as well as in the US and Canada essentially focus on the “All electric ship” (AES). AES represents a ship with integrated electrical energy generation and a distribution system for propulsion, sensors, weapons and general on-board electricity supply.

The integrated all-electric propulsion system, however, is not likely to become generally accepted on board frigates and other large naval ships before the next generation.

Apart from their advantages in the commercial sector, in the naval sector fuel cells are especially distinguished by:
• low signatures (acoustically, IR)
• high resistance and combat strength

While in Europe and Canada primarily PEMFC and Diesel reformers are planned to be used as optional energy generation units, US considerations focus on direct MCFC of Fuel Cell Energy.

Fuel cell plant for maritime applications (FCMA)
In order to demonstrate the possible applications of the fuel cell technology on board ships, HFCS is going to launch its own maritime fuel cell plant with a power output of 160 kWel soon. For this, existing Siemens fuel cells are converted for the maritime application following the requirements of the classification societies. Our partners are Siemens as fuel cell supplier and Germanischer Lloyd for the safety-related concepts and acceptance of the complete plant.

The FCMA has been integrated into a 20 ft. standard container so that it can be installed easily on board ships. Figure 3 shows a model of the plant.

Besides four fuel cell modules of 40 kW each which are operated with hydrogen the container also includes all the processing and electrical engineering systems for control and monitoring, as well as an inverter which permits the generated electrical energy to be fed into the ship’s mains. The electrical engineering systems have been designed flexibly so that it is possible to use the ship’s mains in order to operate the plant with different voltages and line frequencies. It is also possible to operate the container ashore and feed the energy into the local mains network (e.g. for port power supply).

Supply of fuel cells on board ships
The generation of hydrogen and/or the storage of a sufficient quantity of hydrogen is one of the most important challenges for using fuel cells (especially PEM) on board ships. Figure 4 shows that in the case of a fuel cell plant operated with hydrogen there is a fourfold (LH2) and/or tenfold (CGH2 350 bar) increase in the volume of the tank compared to conventional diesel fuels. Here, a storage in metal hydride cylinders is not taken into account because of the weight and high costs. The low volumetric energy density of hydrogen and the high power demand on ships prevent a wide-spread economic use of pure hydrogen as energy carrier. Besides the problem of a large tank volume, the lack of a hydrogen infrastructure also impedes the use of fuel cells on board ships, especially on commercial ships. The use of fuel cells on the basis of hydrogen will therefore be reduced to limited applications in naval engineering. Ferry line traffic, for instance, would be conceivable.

The diesel reformer represents one key component for a wide-spread application of fuel cell technology on board ships. It combines the advantages of the fuel cell with the advantages of the high volumetric energy density of liquid diesel fuel. HFCS participates in various projects which are developing reformer components at present.

The different stages of diesel reforming on the basis of steam reforming are shown in Figure 5.

It is necessary to desulphurize the diesel in order to protect the catalysts, included in the following process stages, and the fuel cell against damage. Sulphur-free fuels can be used alternately. In the pre-reformer diesel is converted into methane and hydrogen. The following stages of the process, such as steam reformer, temperature shifts and selective oxidation are also contained in plants for the steam reforming of natural gas. Alternatives to steam reforming are autothermal reforming or partial oxidation.

For applications on board ships the development of the components desulphurization and pre-reformer is given priority since they are exclusively required for reforming diesel. The development of all other components is also carried out in other fields of application, e.g. residential power generation and distributed combined heat and power. Therefore, it is not necessary to develop an application for naval engineering only.
The use of pure hydrogen as energy carrier is only conceivable in particular cases because of the low volumetric energy density of hydrogen and the high power demand on board ships. The diesel reformer represents one key component for the wide-spread application of fuel cell technology on board of ships.

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Many applications in the field of industry and traction markets need current sensors that are able to measure both AC and DC high level currents (> 2 kA), with galvanic isolation and without power and heat dissipation.

Georges Bustos, ABB Entrelec

Our new current sensor “NCS” fulfills this requirement and is intended to be implemented inside systems like UPS, windmills, welding, electrolysis, sub-stations... Up to now, the current sensor technology being used on this typical industrial or traction applications are listed below:

• Shunt with insulation conditioner, with the main disadvantage of heat dissipation, difficult installation and limitation on the over-current measurement.
• Current transformer or Rogowski coil, only working in AC condition, and requiring necessarily an integration function.
• Open loop or closed loop current sensor, presenting limitation on over-current and immunity against magnetic perturbation.

Depending on customer applications, it is possible to use the NCS current sensors in the place of each of this current measurement technologies, with the main advantages of galvanic isolation, and wide continuous measuring range without any over-heating.

Description of the technology
The functioning principle is based on the full application of the “Ampère’s Theorem”: the integration of the magnetic field vector \( \mathbf{H} \) on a closed contour (C) leads to the primary current I.

\[
\oint_C \mathbf{H} \cdot d\mathbf{l} = I
\]

In the air: \( \mathbf{B} = \mu_0 \mathbf{H} \); the magnetic field and there is no saturation level, eddy currents and hysteresis losses,

The question is now to select the right number of probes with the correct gain and with the convenient geometry, in order to achieve the level of accuracy being awaited by the customer application.

www.hdw.de/hfcs
On this purpose, we implemented a finite elements 3D simulation tool, which can calculate the distribution of magnetic field around each Hall effect probe, and can provide the expected level of accuracy of the complete current sensor.

The simulation tool is giving results in DC and AC conditions, taking into account specific shapes of the primary bar and skin effect on the inrush current, with high level of magnetic perturbation around the current sensor.

In a first step, we checked the right correlation between simulation and experiment results, in order to quantify the level of accuracy of the simulation tool. Then we used the modelization during development phases.

**Simulation tool**

The following pictures give a comparison between simulation and experimental results on the global sensor accuracy, in AC and DC conditions, and give an overview of the module of the magnetic field distribution around the primary bar.

The current sensor accuracy is measured for different positions of the device, in a plane perpendicular to the transversal bar, for each 15 degrees position all around the bar.

**AC condition**

(Figure 3a and 3b).

In AC condition we can see concentrations of magnetic field in some specific area, due to the skin effect of the inrush current.

It is very important to take into account this phenomenon, and to select the gain and the position of the probes in order to avoid any saturation that could affect the accuracy level of the complete sensor.

**High constraints AC**

In all the cases that have been considered, the maximum deviation between simulation and experimental results reached the expected goals.

Considering a finite elements modelization tool, this good accuracy level can be explained because all the phenomena are studied inside the air, which presents linear magnetization characteristics, with no saturation properties to get in the way.

The simulation results analysing led us to define the right number of probes and geometry, taking into account the worst environment conditions.

Thanks to this tool, we saved a lot of time and avoided many prototypes and measurements realization. (Figures 5a and 5b).

**Current sensor**

**Mechanical characteristics**

The following picture gives the mechanical description of the complete current sensor, with the different options of fixation.

This kind of modular fixation is possible because of the low thickness and weight of this sensor that does not need any magnetic core inside.

The thickness of the product is only driven by the specifications on the galvanic insulation between primary and secondary, and the leakage currents. (Figure 6).

**Electrical characteristics**

The wide range of measurement is the main particularity of this new current sensor, with a continuously maximum current $I_{p_{max}}$ that can be five times the nominal current $I_{pn}$.

Furthermore, we provide as a standard, two different outputs: one dedicated to the nominal current, the other one dedicated to the maximum current.
The most significant electrical characteristics corresponding to the “NCS125” sensor are summarized in the table 1.

The current sensor is available with current and voltage outputs. On the connector configuration version, four outputs are available: 2 voltage outputs \( (I_{PN}, I_{P\text{max}}) \) and 2 current outputs \( (I_{PN}, I_{P\text{max}}) \). 2 voltage outputs or 2 current outputs are available on the cable configuration version. As an example, we show below the corresponding connection diagrams for the current output version (see Figure 7).

**Performances**

In order to achieve a good level of performance regarding the electromagnetic constraints and a good response to the dynamic primary inrush current \( (di/dt) \), we implemented a specific layout, disposition of components and floorplan.

Figure 8 gives the evolution of the secondary response to dynamic primary current with high magnetic disturbance on the primary bar (see Figure 8).

The accuracy level that is achieved with this new sensor is less than ±1% at the nominal primary current and ambient temperature, and less than ±2 %, in any case.

**Conclusion**

This technology based on the absence of magnetic core offers high savings in volume and weight of the new current sensor. Furthermore, this non-magnetic property offers the possibility to withstand continuously high level AC or DC current with no dissipation.
On the other hand, the designer needs to be very careful on the environment application, in order to avoid lower performances of the current sensor due to local saturation of Hall effect probes: shape of bars, working frequency, proximity of perturbation cables...

It is the reason why we developed, in the same time, a modelization tool, as a technical support to the design, avoiding the realization of lots of prototypes and measurements.

The first applications available on the market will be the ‘NCS165’ and ‘NCS125’, corresponding to an internal hole diameter of, respectively 165 and 125 mm; the primary nominal current range will span from 2 kA up to 30 kA. But this very compact new sensor will be very useful for many other applications needing high current and volume/weight savings. For example, it can replace the entire function provided by a shunt and conditioner, in the ratings targeted 2 to 30 kA, for the industry and the traction market.

This new technology has been patented, regarding the electronic design and the mechanical fixation mode.

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The field of Power Quality includes many different areas, from power levels, areas of applications, and technical concepts and of major importance for customers the delivery of reliable uninterruptible power supply. This falls into the specialized process industry, telecommunications companies and data centers.

Be aware that the 8:30am opening session on Thursday in room Paris requires early arrival in Nuremberg. Right after that at 8:45am the first Keynote will be held in room Paris. The Motor Control Technologies for the Hybrid Electric Vehicle—From the State of the Art to Future Trends by Shoichi Sasaki, Project General Manager, Toyota Motor Corporation, Japan.

Mr. Sasaki will give a brief introduction of hybrid systems, and their comparison, especially the system that is implemented in TOYOTA Prius, the first passenger vehicle introduced in the world is presented. And the motor control technologies used in the Prius are also presented. Challenges for further development of hybrid vehicles especially on the motor and inverter are discussed.

Wednesday we have two key notes starting at 8:30am with the first keynote in room Paris. “A 40-MW, 60-kV transformer-less electric drive system with the inverter and motor located in the North Sea, 70 km away from the rectifier. This paper describes this system and how it, along with other novel power electronic solutions, takes part in forming the future of high power electronics applications.”

Mr. Nestli will inform us about recent developments within power electronics and electric machines have enabled a 40-MW, 60-kV transformer-less electric drive system with the inverter and motor located in the North Sea, 70 km away from the rectifier. This paper describes this system and how it, along with other novel power electronic solutions, takes part in forming the future of high power electronics applications.

At 9:10am the second keynote in room Paris has the following topic. “Power Industry Restructuring: Challenges on new Technologies—From the State of the Art to Future Trends” by Noureddine Hadj sais, Director of IDEA-GIE and Professor at INP Grenoble, France.

Mr. Hadj sais informs us about what electric power industry is experiencing tremendous changes and restructuring in the way it’s operated and planned more rapidly than at any time in its history. Privatization, open market and open access, competition and customer-oriented strategies are the keywords of this upheaval in many areas of the world. As a result, electric power industry in its new environment is facing a rapid increase. The presentation will deal with three main parts: The event of deregulation, some feedback experiences and potential development in new power electronics based equipment in the context of restructuring of the power industry.

So mark your calendar for the last week of May to attend the most important European event in Power. My association of more than one and a half decades as a board member of the PCIM conference will provide additional fuel for our magazine and keep the focus strongly set for technology and their advanced application. Handling podium discussions at PCIM 2004 in Nuremberg in the exhibition hall will allow you to stop by and make your comments. Each day around lunchtime we will have short presentations from experts followed by an open discussion. This time I chose semiconductors as the focal elements for power electronics. MOSFETs on Tuesday, IGBTs on Wednesday and Rectifiers on Thursday will be the topic.

Come and select your personal schedule out of 187 presentations at the Conference and Exhibition, or at the technical tutorials.
Stepper Driver for Automotive Applications

Microstepping helps to overcome the resonance effects

DMOS FET drive, EasyStepper interface and tiny power package combine to simplify under-hood stepper motor control.

Bob Christie, Allegro MicroSystems

One of the major challenges for power integrated circuits is in under-hood automotive systems. These systems require semiconductors to drive the required power, provide diagnostic and safety features and operate under both temperature and voltage extremes. One example of this is the increased use of headlamp leveling where a small stepper motor is used to constantly maintain the level of the beam. In addition, new features such as headlamp steering are being introduced where a beam is made to follow the direction of the vehicle to give increased cornering visibility at night. To reduce EMC, the driving IC’s are increasingly being mounted close to the motors which means that they must be able to operate with not only the heat from the engine but also the heat from the headlamp pushing the ambient temperature as high as 135°C. Allegro MicroSystems have brought together their extensive experience in stepper motor driver design, advanced BCD technology and thermally efficient packaging to produce the A3980, which has been specifically developed for this type of application.

The A3980 provides a complete interface between a microcontroller or control logic and a stepper motor. The control circuit has only to provide a step and direction input to operate a two-phase bipolar stepper motor at up to 16 microstep resolution. There are no phase sequence tables, high-frequency control lines or complex interfaces to program. Microstepping gives the advantage of lower noise and vibration and helps to overcome the resonance effects that can stall a stepper motor at relatively low step rates. The A3980 integrates all the features to simply, accurately and safely control the current in the two phase coils of a small bipolar stepper motor. It includes power drivers, pwm current control, D-to-A converters and a translation table (see Figure 1). The integrated translator is an innovation from earlier products but new diagnostic circuits have been added to safely handle short circuits at the motor connections.

DMOS H-Bridge Drive

The power output to the motor is supplied by two, all n-channel, low resistance, DMOS H-bridges. An integrated charge pump, with an external capacitor, provides the gate drive voltage, higher than the supply voltage, for the high-side n-channel FETS. The H-bridge FETS are designed to maintain low on-resistance even down to 8V supply. The phase currents through these H-bridges is controlled by a fixed-off time current regulator which can operate in fast or slow decay mode and can use synchronous rectification to reduce power dissipation (see Figure 2).

Current Control

When using microstepping it is important to maintain a uniform torque at all microstep positions. While this is somewhat dependent on the motor characteristics, the phase currents must be stepped following a sinusoid, as shown in figure 2, so that the resultant torque from the two phase currents is at close to 100% at all microstep positions. If the relationship between the phases is incorrect the microstep angle will be affected and will cause motor vibration and noise. In the A3980, a D-to-A converter that is designed and calibrated to produce the required sinusoidal level at each microstep generates the reference for the current regulator. The result of this can be seen in Figures 3 and 4 which show the relationship between the two phase currents for half and sixteenth stepping. In sixteenth step the combination of the two currents produces a torque profile which is close to 100% at all microstep positions. The contribution of the driver to the microstep position error is less than 2% of the full step angle at any microstep position.

To further reduce noise and vibration, the decay mode is automatically selected based on the current at the next microstep (Figure 2). When the current has risen from the previous step, slow decay is used to minimise the current ripple in the motor winding. When the current has fallen from the previous step, fast decay can be used to counter the effects of the motor back-emf, which can distort the current waveform. However, while fast decay helps with the phase current control, it will cause an increase in the current ripple. This can be reduced, and the current control maintained using a mixture of fast and slow decay. Initially fast decay is used to ensure that the current is in control, then slow decay is used for the remainder of the off-time to reduce the current ripple. The proportion of the off-time for which fast decay is present can be adjusted for each motor.

Protection and Diagnostics

To improve system reliability, the A3980 monitors all supply voltages and operating temperature to provide under-and over-voltage lockout and thermal shutdown, and indicates any faults on two flag outputs. It also monitors the voltage across H-bridge FETS in order to detect short circuits on the outputs and take action to avoid excessive heating or damage to the internal power drivers. As soon as a FET is turned on the voltage across it should rapidly drop to a low value. The monitor circuit is disabled for a few microseconds after turn-on to ensure that capacitor charging currents do not cause a false error. After this short delay any power FET that is supplying excessive current, due to a short circuit, will be turned off to avoid damage. Even during the few microseconds when the FET is on it is possible to experience currents in excess of eight times the normal operating current, see Figure 5, which the power FETs must be capable of handling without damage.

Figure 1. The A3980 integrates all the features.

Figure 2. Resultant torque from the two phase currents.
Since the A3980 is a power IC, packaging is another key element in a successful design. Although the thin small-outline package (TSSOP) is only 1.2mm high with a footprint of 10mm x 6mm it is capable of dissipating over one Watt at 125°C when suitably mounted and will allow the A3980 to operate at up to 500mA at an ambient temperature of 135°C. Thermal resistance from the heat generating area on the IC to the exposed thermal pad is only 0.5°C/W.

When mounted on a 4 layer board with a ground plane heatsink area the thermal resistance to ambient can be as low as 25°C/W. Many of the design and packaging innovations used in the A3980 have been applied to other recently released products including single H-bridge drives for brush DC motors and relays, and a number of FET drive circuits for larger brush-, and brushless DC motors.

Figure 3. Sixteenth Step
Figure 4. Half Step
Figure 5. Short to ground behaviour

The speed enhancement over traditional SDRAM is the result of transmitting data on both the positive and negative edges of the clock. Additionally, DDR SDRAM reduces device input capacitance, reduces access time uncertainty by using on-chip delay locked loops, improves data capture reliability by adding data strobes and features an active termination scheme called SSTL_2 (Stub Series Termination Logic).

DDR use has provided increased memory speeds. DDR200 yields a 200-Mb/s rate with a 100-MHz clock. DDR333 is the next speed step in the DDR SDRAM products family that provides a 333-Mb/s rate with a 167-MHz clock. DDR memory not only increases the memory bandwidth, but also reduces memory power consumption. This is the result of lower operating supply voltages (2.5 V vs. 3.3 V for SDRAM), lower voltage swing associated with SSTL_2 logic and reduced time in active mode.

There are three voltages that need to be generated and regulated in a DDR memory system. In order to get the high speed and keep the signal integrity, the bus impedance is controlled and terminated through a resistor to a midlevel voltage called VTT. The signals are single-ended, but generated and compared differentially with respect to the mid-level reference voltage VREF. VTT tracks VREF. VREF is bypassed to both the VDDQ and VSS ground plane using balanced decoupling capacitors. The other supply associated with DDR SDRAM is VDDQ. This supply powers the DDR SDRAM I/O power, the clock synthesizer and the output drivers of the North Bridge. In addition, VDDQ most likely supplies the NB core, which still routinely operates at 2.5 V. DDR SDRAM officially requires another supply for its core, and this one is called VDD. For most memories (i.e. Micron) the VDD has the same specifications as VDDQ and the two are externally connected as one.

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As mentioned, the power level of the reference voltage VREF is very low, in the range of several mA, and is usually provided by a buffered resistor divider. The other two required voltages, VDDQ and VTT, can be provided by two independent synchronous buck converters or a dual synchronous buck converter. Linear regulators can also be used at the expense of system efficiency and reliability.

Power Architectures for DDR Memory

There are two main architectures for powering VDDQ and VTT. One is to derive VDDQ and VTT independently from the input voltage source VDC, as shown in Figure 2a. The input voltage can be a 3.3-V system bus, a 5-V system bus, or a 12-V system bus. In Figure 2b, the VDDQ and VTT buck converters are cascaded which means only the VDDQ voltage is derived from the input voltage source VDC. The VTT voltage is obtained from the VDDQ.

The advantages of the cascaded architecture are many. First, the VDDQ converter used in the independent architecture has to be rated for current two times (2X) higher than that of the VDDQ converter in the cascaded architecture. In terms of component selection this means that MOSFETs with lower RDS(on) are required. Also, the output inductor must have bigger-gauge wire to be able to support the higher current. In addition, more filter capacitors are required. This results in higher BOM costs.

The efficiency of the VTT converter that boosts energy back to the primary source while in sink mode is inversely proportional to VDC. This may not affect the overall power system efficiency if VDC is 3.3 V to 5 V. However, at a VDC of 12 V, the efficiency decreases significantly. Also, the VDDQ minimum current for the independent architecture may go down to zero. The efficiency will suffer in this mode (light load), because of the nature of the synchronous buck converter.

The overall power consumed by a termination circuit remains constant and is strictly a function of the VTT voltage, the value of the resistors, and the number of the outputs being terminated as seen by the following equation:

\[ P_{\text{T}} = \frac{V_{\text{TT}}^2}{R_{\text{TT}}^N} \]

However, in the cascaded architecture, because of the lower input voltage for the VTT converter (uses the VDDQ as input), switching losses are several orders of magnitude lower. This conversion losses can be reduced by using MOSFETs with lower RDS(on) without a significant increase of the switching losses. Another benefit is that when the VTT voltage is derived from the VDDQ voltage, some protection features can be simplified or completely omitted. For example, the Over-Voltage Protection (OVP) for the VTT output can be avoided, because the drivers’ outputs are rated to the maximum VDDQ voltage. Similarly, the Over-Current Protection (OCP) for VTT can also be omitted, because the OCP on the VDDQ suffices as the termination resistors consume the majority of the memory power.

Intersil’s DDR Memory Power Solutions

Intersil was the first supplier of a highly integrated, fully compliant, dual DDR synchronous PWM buck controller for desktop applications. The Intersil Endura ISL6530 and ISL6531 provide the VDDQ, VTT, and VREF outputs from a single 24-pin SOIC or 32-pin 5 mm X 5 mm Quad Flatpack No leads (QFN) package. These devices operate from a single 5-V supply and 5 V is the bus voltage used for power conversion. The VTT converter sources and sinks the VTT load current. Figure 3 demonstrates the VTT current sinking loop. An application circuit using the ISL6530 is shown in Figure 4.

Close relative to the ISL6530 is the ISL6531. The ISL6531 differs from the ISL6530 in that it has internal fixed gain compensation for the VTT regulator.

Figure 2. Independent (a) and Cascaded Architectures (b).

![Independent Architecture](image1)

![Cascaded Architecture](image2)

Figure 3. ISL6530 VTT current sinking loop.

Figure 4. ISL6530 Dual DDR Converter Application.

Proper selection of the output inductor insures stability and proper bandwidth. Figure 5 shows a typical DDR application using the ISL6531.

![Proper selection of the output inductor](image3)

Both the ISL6530 and ISL6531 have many features that make these power management devices very suitable for desktop, workstation, and low-end server DDR memory platforms. Both controllers are 5-V input, single-supply devices that provide all the required DDR voltages from a single package for reduced printed circuit board area. Each has a fixed 300kHz switching frequency, for simple design, and uses the upper VDDQ converter MOSFET RDS(on) as a free current sensing element. This technique eliminates a precision discrete current sense resistor with its associated component and surface mount placement costs.

The two PWM controllers switch out-of-phase, minimizing the input ripple current and the number of output capacitors. The devices also have a separate VREF_IN pin, that allows the user to override the internal resistor divider, and achieve output voltages other than the pre-selected VTT at 50% VDDQ.

The ISL6530 and ISL6531 also support DDR system “S3” sleep mode power. The VTT is held at 50% VDDQ via a low-power window regulator to reduce power consumption and minimize wake-up time. Figure 6a shows the transition of VTT from active to sleep mode. This is accomplished by applying a logic high signal to the V2_SD pin. Figure 6b shows VTT return from sleep mode.

Other features include: Power Good for system status monitoring, Shutdown for protection, 0 to 100% duty cycle for fast DDR load transient response and an internal +0.8V Vref that makes these dual DDR regulators ideal for future DDRII memory systems. Figure 7a shows the VTT regulator current sourcing function during a VTT transient. Figure 7b shows the VTT regulator current sinking function during a VTT transient.

The 32-pin 5x5 QFN package provides the additional benefits of reduced DC/DC converter area and improved thermal performance in comparison to the 24-pin SOIC. The heat generated from the switching of the on-board MOSFET drivers is easily transferred to the PCB ground pad, onto which the copper pad on the bottom of the QFN is soldered. The QFN picture and...
Layout is very important in high frequency switching converter design. With power devices switching efficiently at 300 kHz, the resulting current transitions from one device to another cause voltage spikes across the interconnecting impedances and parasitic circuit elements. These voltage spikes can degrade efficiency, radiate noise into the circuit and lead to device over-voltage stress. Careful component layout and printed circuit board design minimize the voltage spikes in the converter. As an example, consider the turn-off transition of the PWM MOSFET. Prior to turn-off, the MOSFET is carrying the full load current. During turn-off, current stops flowing in the MOSFET and is picked up by the lower MOSFET. Any parasitic inductance in the switched current path generates a large voltage spike during the switching interval. Careful component selection, tight layout of the critical components and short but wide traces, minimize the magnitude of voltage spikes.

There are two sets of critical components in a DC-DC converter using the ISL6530. The switching components are the most critical because they switch large amounts of energy, and therefore tend to generate large amounts of noise. Next are the small signal components that connect to sensitive nodes or supply critical bypass current and signal coupling.

A multi-layer printed circuit board is recommended. Figure 9 shows the connections of the critical components in the converter. Note that capacitors CIN and COUT could each represent numerous physical capacitors. Dedicate one solid layer, usually a middle layer of the PC board, for a ground plane and make all critical component ground connections of the critical components in the converter. Note that capacitors CIN and COUT could each represent numerous physical capacitors. Dedicate one solid layer, usually a middle layer of the PC board, for a ground plane and make all critical component ground connections to the ground plane through vias to this layer. Dedicate another solid layer as a power plane and is picked up by the lower MOSFET. Any parasitic inductance in the switched current path generates a large voltage spike during the switching interval. Careful component selection, tight layout of the critical components and short but wide traces, minimize the magnitude of voltage spikes.

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Power Supply Sequencing, a New Approach

New generation of modular POL converters

Most cards designed for today’s communications and data processing applications demand a diversity of IC supply voltages. Correctly sequencing these supplies during power-up and power-down has long been a design issue, which is now being compounded by the stringent demands of the latest ICs.

By Mark O’Sullivan, Artesyn Technologies

This article looks at various sequencing methods, highlighting how a new generation of modular point-of-load (POL) converters with built-in sequencing capabilities offers a particularly cost-effective solution.

Silicon manufacturers are steadily increasing the performance and functionality of high-performance ICs by moving to sub-micron fabrication. This trend is accompanied by ever-lower operating voltages, to maximise switching speeds and prevent secondary breakdown of very small geometry transistors. Consequently, virtually all high-performance ICs, including DSPs, ASICs, FPGAs and CPLDs, now demand several supply rails—one for their high-speed processing core, and one or more for their I/O functions. Typical core values are 1.2 V, 1.5 V or 1.8 V, while I/O functions are usually higher at 2.5 V, 3.3 V or 5 V.

Power sequencing is essential

To avoid potential damage and latch-up of the processing core, silicon manufacturers strictly define the power-up and power-down sequence between the I/O and core voltage. However, satisfying the sequencing requirements of all devices on a card poses a considerable design challenge, because different IC manufacturers recommend different methods. It can even get so complicated that the end application can have a bearing on the sequence.

Designers mainly have a choice of three supply sequencing methods, known as sequential, ratiometric and simultaneous. With sequential sequencing, the rise of a primary supply controls the rise of secondary supplies, once a suitable delay period has elapsed. Ratiometric sequencing is a variant on this, deriving a secondary supply control signal from a resistor divider on the primary supply; it is principally only used with a few voltage regulator ICs and is consequently not discussed in this article.

Sequential sequencing is a variant on this, deriving a secondary supply control signal from a resistor divider on the primary supply; it is principally only used with a few voltage regulator ICs and is consequently not discussed in this article.

Simultaneous sequencing allows all supplies to begin rising together at the same rate, until each supply reaches its set point. This method offers the greatest opportunity for satisfying the different sequencing requirements stipulated by different IC manufacturers, as detailed later.

Sequential sequencing—various approaches

The simplest form of power sequencing places an RC network between the primary supply and the remote on/off control input of the secondary power source—typically an isolated or non-isolated DC/DC converter or power regulator module. A major weakness of this method is that there is no way of guaranteeing that later voltages will not come up if an earlier voltage fails to come up, so designers often include a voltage comparator and a voltage reference to ensure that the first supply is within a proper voltage range before the second supply starts powering up, as shown in Figure 1. This process can be repeated on successive supplies.

The drawback to this method is the complexity of the additional circuitry that is required, especially if it needs to shut down in the reverse order to start-up.

Board designers can implement this type of sequencing relatively easily—several specialist IC manufacturers produce supervisory ICs incorporating such circuitry—but it occupies valuable board space, carries an additional cost overhead, and becomes unwieldy as the number of voltage supplies rises. Figure 2 shows a typical circuit based on discrete components, using a supervisory IC to monitor the outputs of three DC/DC converter modules.

During power-up, once the supervisory IC determines that all three convert- ers have reached their nominal regulation value, the voltage rails are applied to the loads simultaneously. This approach suffers from a high component count, and the designer has been forced to include MOSFET power switches in each supply path; these introduce losses, and can only handle relatively low load currents.

Several semiconductor manufacturers also produce fully-integrated sequencers, which are essentially microprocessors that control the sequencing of on-board power sources and provide other power management functions, such as monitoring. Fully-integrated sequencers provide a less cumbersome and more accurate sequencing approach than discrete IC-based implementations, and offer considerable configuration flexibility. However, they are invariably complex devices that require programming, and for many board designers represent an overly sophisticated solution. Again, designers usually need to incorporate power switches in the supply paths.

Board layout is complicated because several signal lines must be routed between the sequencer and each converter, limiting functionality, and the sequencers can be more expensive than the converters they control.

This situation is set to change dramatically, following the introduction by a number of manufacturers of a new generation of POL converters that provide built-in power sequencing facilities and offer current outputs from 6 to 30 A.

Auto-Track sequencing

This new form of power sequencing is unique to the PTH series of POL converters developed by Artesyn Technologies, Texas Instruments and Astec Power under the terms of the Point-of-Load Alliance (POLA) initiative. Auto-Track simplifies the circuitry required to make each module power up and down in sequence. The basic implementation facilitates simultaneous sequencing; instead of successively delaying voltages, they are allowed to begin rising together at the same rate. Taking two voltages—for core and I/O functions—as an example, both rise until the core supply reaches its normal regulation (set-point) value; the higher I/O supply then continues to rise until it too reaches its set-point value. During shutdown, the exact opposite occurs.

Many board designers already use simultaneous sequencing for dual-supply applications. However, implementation often proves difficult because one or more of the on-board power modules must be precisely controlled during power transitions. To achieve this with standard commercial power supply modules, the board designer needs to incorporate additional components and requires detailed information about the module’s output regulation circuitry—which is often not made available by the manufacturer.

The built-in Auto-Track sequencing capabilities of all PTH series POLA-compatible power modules overcome these issues by allowing their output voltage to be precisely controlled during power up and power down using only
DC/DC CONVERSION

three external components. The control signal can be derived from a master ramp generator, the output voltage of another power module, or the module’s own internal ramp. Figure 3 shows a typical arrangement, using the modules’ internal ramp facilities.

The operation of Auto-Track sequencing is very simple. Every PTH series power module has an extra control pin, called Track. The output voltage of each module precisely follows the voltage applied to its Track pin, from 0 V to its set-point. Once the voltage on the Track pin is raised above the module’s set-point, the output voltage remains at this set-point.

A power-up sequence is initiated by applying a logic high signal to the transistor shown in Figure 3, pulling all the Track pins to ground for about 10 ms to let the modules complete soft-start initialisation. During this time, the output of all associated modules will be 0 V. After this period, the transistor can be turned off, allowing the track control voltage to automatically rise towards the modules’ input voltage. Each module’s output voltage will rise simultaneously, until it reaches its respective set-point, as shown in Figure 4.

Power-down is accomplished by reducing the track control voltage to 0 V. The only constraints are that the power modules must have a valid input voltage until the power-down sequence is completed, and the track control voltage must not fall faster than the Auto-Track slew rate of 1 V/ms.

Artesyn has now launched 15 PTH series non-isolated point-of-load DC/DC converter modules, all featuring Auto-Track power sequencing and fully compatible with POLA products from other members of the alliance. The modules cover a wide range of input/output voltages, and offer a choice of nine current ratings, from 6 A to 30 A. Electronics designers can obtain these flexible low-voltage power modules from a variety of manufacturers, enabling them to implement advanced power sequencing schemes for multi-rail boards very easily and cost-effectively. Simply compare the component count of the discrete circuit shown in Figure 2 with the Auto-Track configuration shown in Figure 3 to gain an impression of the potential savings offered by this new approach to power sequencing.

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Figure 3: Typical circuit using Auto-Track sequencing.

Figure 4: Graph showing Vo1 and Vo2 vs. time when using the circuit in Figure 3.
Small Schottky with Big Potential

A true chip scale device

Making the anode and cathode connections directly through solder pads instead of protruding leads not only reduces the PCB footprint by 78% compared to the next smallest package, but also reduces the profile by 30%

John Lambert and Shawn O’Grady, International Rectifier

As consumer desire for smaller portable equipment with more integrated features such as built-in cameras and internet capability on cell phones and personal data assistants (PDAs) grows, so is the demand for smaller electronic components. According to a recent report from the Communications Industry Researchers, the total market for Power ICs and associated discrete components used for power management in mobile applications will reach 4.3B USD in 2004 and climb to 7.2B USD in 2008. In some instances low power components can be miniaturised by integration, but there are still many power components such as transistors and rectifiers that are not easily integrated because of size limitations or the ability to sufficiently dissipate heat. Realising this, component manufacturers have been racing to reduce package size and improve the performance of devices that are not easily integrated into a single piece of silicon.

The race for component size reduction began in the mid 80’s when Motorola introduced the first surface mount power package called the D-Pak. Until then, most three-pin power components were housed in larger lead frame packages, like the DO-214. Once surface-mount technology began gaining share in the transistor market, diode manufacturers began applying similar technologies to the two-pin devices. One of the first surface mount rectifier packages to appear on the market in the late 80’s was the D-64, which housed a 1A Schottky and had a 15.4mm2 footprint. The next major size reduction for a 1A Schottky came by way of the PowerMite (DO-216AA) in the mid 90’s with about a 7.1mm2 footprint. This was as considerable footprint reduction since there was hardly any incremental improvement between the time when the D-64 was released and the DO-216AA was introduced to the market. Since then there has been very little improvement in diode size reduction while the value of board space continues to increase with the demand for more functionality in portable products.

The problem with further size reduction in power components such as diodes is that in order to conduct a given amount of current, a certain amount of silicon for a given technology is required to deliver desirable parametric characteristics and also efficiently dissipate heat. With traditional technologies, even if the silicon area could be reduced substantially and continue to meet parametric requirements, the die would still need to be placed on a leadframe and then over-molded to isolate the silicon from environmental elements. Unfortunately, with existing processes the leadframe and over-mold volume typically exceeds the silicon volume by a factor of well over five. The additional volume required for the surrounding package material dramatically impacts the ability to fully minimize board space and also introduces undesirable characteristics such as increased thermal resistance from junction to ambient and lead inductance; not to mention assembly process steps and cost.

Fortunately, there is a new approach that combines existing silicon and chip scale packaging (CSP) technology to deliver Schottky diodes with the smallest footprint and competitive parametric characteristics while minimizing the undesirable characteristics of packaged components. International Rectifier developed this approach to deliver the smallest 1A Schottky diode in industry. As shown in Figure 1, the IR140CSP FlipKY uses solder balls placed at a 0.80mm pitch to allow conventional surface mount processes to be used. The manufacturing process used to create the solder balls, also known as bumps, is well known and widely documented.

Figure 1: FlipKY technology compared to existing package technology.

Like previous silicon designs that place the anode and cathode on opposite sides of the die, the 4 ball 1.5mm x 1.5mm device provides anode and cathode connections on one side of the silicon. With a total area of 2.25mm2 the FlipKY is 32% the size of the DO-216AA package and is less than 14% of the size of the ubiquitous SMD package (see Figure 2).

Figure 2: Package Size Comparisons.

Making the anode and cathode connections directly through solder pads instead of protruding leads not only reduces the PCB footprint by 78% compared to the next smallest package, but also reduces the profile by 30% as shown in Figure 2. This enables the FlipKY to be designed into very tight spaces with very low height restrictions. The leadless connections allows designers to easily place the diode on a PCB exactly where it’s needed, further reducing board level inductances and increasing the overall efficiency of the circuit.

This is particularly important if the device is being used as a freewheeling diode in a synchronous buck converter. Any inductance between the switch node and Schottky diode will delay the time it takes for the Schottky to begin conducting. Delaying the conduction through the Schottky increases power loss and thus reduces efficiency. Further more, if the inductance between the switch node and the Schottky diode is high enough, the Schottky diode will not conduct at all.

As a true chip scale device, the FlipKY uses solder balls placed at a 0.80mm pitch to allow conventional surface mount processes to be used. The manufacturing process used to create the solder balls, also known as bumps, is well known and widely documented.
have over-mold encapsulation, it has the ability to dissipate heat directly into the air making it thermally efficient. The thermal resistance from junction to ambient (Rth-JA) is rated at 62°C/W max. Additionally, because the four 0.25mm balls make a direct solder connection from the die to PCB the thermal resistance from junction to board (Rth-J-PCB) is also very efficient for the footprint area and has a typical value of 40°C/W when mounted on a 1" square PCB.

Figure 4: Cross Sectional View of Solder Bump Interconnect.

Typical applications for the IR140CSP include portable equipment, such as cell phones, PDAs, laptop computers, hand held computers, MP3 players and hard disk drives where space savings and performance are crucial to equipment performance.

Figure 3: Board Footprint Comparisons.

The IR140CSP not only offers significant space saving compared to standard leadframe devices, but also delivers very attractive parametric characteristics. The device has an ultra-low 1A quiescent current, very attractive parametric characteristics. Typical applications for the IR140CSP include portable equipment, such as cell phones, PDAs, laptop computers, hand held computers, MP3 players and hard disk drives where space savings and performance are crucial to equipment performance.

VersaCREST technology reduces peak-to-average power by 6 dB

The AD6633 is Analog Devices’ first digital up-converter with crest factor reduction technology for CDMA2000, W-CDMA, and TD-SCDMA, 3G wireless transmitter applications. Operating at 125 MSPS and processing four or six channels, the AD6633 is capable of trading crest factor reduction against signal distortion. The signal distortions can be allocated dynamically to any individual channel; thus, allowing operators to configure performance preferences for high quality data or lower quality voice communications. The converter also features programmable bandwidth channel filters that can be implemented for CDMA2000, W-CDMA, or TD-SCDMA standards, enabling manufacturers to use a single device across multiple platforms.

Analog Devices extended its VersaCOMM family of digital up-and-down converters. Among the new products is the AD6633, a digital up-converter featuring breakthrough technology that significantly reduces output power requirements for CDMA base station power amplifiers (PA). The AD6633’s innovative VersaCREST crest reduction engine enables optimal baseband-to-IF (intermediate frequency) signal conversion by anticipating and reducing power peaks earlier in the signal chain. Traditionally, base station manufacturers have relied on expensive, highly linear power amplifiers to avoid output signal distortion caused by large peaking signals. Analog Devices’ new solution reduces peak-to-average power by up to 6 dB, the equivalent of replacing a 40 W amplifier with a 10 W amplifier. This means manufacturers can either reduce their power amplifier expense while achieving dramatic power savings of up to 75 percent, or, using the existing 40 W PA, an operator can support up to four times the coverage area.

www.analog.com

www.irf.com

www.zetex.com

Figure 2: Under-bump metallurgy

www.powersystemsdesign.com
Brushless DC Motor Control IC for Automotive

Toshiba’s TB9060 controller IC for automotive brushless DC motors combines sensorless operation with hardware-based PWM motor control. The result is a highly integrated solution that simplifies the design, reduces the size, minimises the electrical noise, lowers the power consumption, and improves the reliability of three-phase DC brushless motors used in pumps and other automotive applications. By completely eliminating the need for Hall sensor feedback, the TB9060 facilitates the use of smaller motors and simplifies overall wiring requirements. In addition, removal of the need for Hall sensors ensures that information on motor position is not adversely affected by the electrical noise encountered in automotive environments.

The TB9060 is a three-phase, full wave sensorless brushless DC motor controller IC offering forward and reverse modes and capable of controlling output voltage from an external PWM input signal. Two types of PWM output (upper PWM control and lower alternating PWM control) and a lap turn-on function for smooth phase current switching contribute to reduced power consumption and electrical noise. The device offers configurable lead angle settings of 0°, 7.5°, 15°, and 30°, allowing automotive designers to ensure optimum efficiency depending on speed and load conditions.

The IC operates across the full automotive temperature. Built in protection includes an overcurrent function that can be used to switch the drive circuit off when an abnormal motor current signal is detected.

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Electrolytic capacitors support high voltage applications

Reduced case size NRE-WB aluminium electrolytic capacitors from NIC Components Europe are ideal for use in electronic ballasts for fluorescent lighting and other high voltage applications that require elevated temperature, extended load life performance.

The greater efficiency of fluorescent lighting—which is able to convert approximately 25% of its energy to light versus just 5% achieved by filament lighting—couples with an ongoing drive towards greater efficiency, has created a large and growing market for electronic lighting ballasts. NRE-WB miniature radial leded devices have a high ripple current rating of up to 2.0A (100kHz, +105°C), and are available with capacitance values from 10mF to 220mF and voltage ratings of between 200VDC and 450VDC. Extended load-life of up to 10,000 hours at high temperature makes NRE-WB capacitors suitable for applications where the replacement of worn components is difficult and cost prohibitive.

A wide operating temperature range of −25°C to +105°C enables the new capacitor series to give stable, reliable performance in applications where high temperatures are present such as fluorescent lighting or in densely packed high voltage power supplies. Case sizes range from 10mm x 20mm up to 18mm x 31.5mm depending upon rated voltage and capacitance value.

NIC response management is:
NIC Components Europe Ltd.
14 Top Angel, Buckingham Industrial Park, Buckingham, MK18 1TH, UK.

www.niccomp.com

Brushless DC Motor Control IC for Automotive

Hall sensor feedback, the TB9060 facilitates the use of smaller motors and simplifies overall wiring requirements. In addition, removal of the need for Hall sensors ensures that information on motor position is not adversely affected by the electrical noise encountered in automotive environments.

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Reduced case size NRE-WB aluminium electrolytic capacitors from NIC Components Europe are ideal for use in electronic ballasts for fluorescent lighting and other high voltage applications that require elevated temperature, extended load life performance.

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A wide operating temperature range of −25°C to +105°C enables the new capacitor series to give stable, reliable performance in applications where high temperatures are present such as fluorescent lighting or in densely packed high voltage power supplies. Case sizes range from 10mm x 20mm up to 18mm x 31.5mm depending upon rated voltage and capacitance value.

NIC response management is:
NIC Components Europe Ltd.
14 Top Angel, Buckingham Industrial Park, Buckingham, MK18 1TH, UK.

www.niccomp.com

Brushless DC Motor Control IC for Automotive

Hall sensor feedback, the TB9060 facilitates the use of smaller motors and simplifies overall wiring requirements. In addition, removal of the need for Hall sensors ensures that information on motor position is not adversely affected by the electrical noise encountered in automotive environments.

The TB9060 is a three-phase, full wave sensorless brushless DC motor controller IC offering forward and reverse modes and capable of controlling output voltage from an external PWM input signal. Two types of PWM output (upper PWM control and lower alternating PWM control) and a lap turn-on function for smooth phase current switching contribute to reduced power consumption and electrical noise. The device offers configurable lead angle settings of 0°, 7.5°, 15°, and 30°, allowing automotive designers to ensure optimum efficiency depending on speed and load conditions.

The IC operates across the full automotive temperature. Built in protection includes an overcurrent function that can be used to switch the drive circuit off when an abnormal motor current signal is detected.

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Electrolytic capacitors support high voltage applications

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IR's IR2304 and IR2308 600V half-bridge control ICs give circuit designers the ability to select the best control IC for their lighting ballast, appliance and SMPS applications.

The IR2304, with a high pulse current for minimum driver cross conduction, is an optimized solution for low drive current MOSFETs or IGBTs. The IR2308 is a rugged IC with two non-inverting inputs for larger MOSFETs or IGBTs in high frequency applications.

Features
- Core conduction prevention logic
- Rugged negative transient voltage tolerance
- Under-voltage lockout for both channels
- IR2304
  - Cost-effective, 500V half-bridge control IC
- Optimized gate drive for smaller MOSFETs
- Logic compatible

Benefits
- Improved time to market
- Reduced board space
- Reduced design risk
- High noise immunity
- Maximum design flexibility
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So leave those discrete, pulse transformer and opto-coupler solutions behind and take advantage of reduced component count, space savings and increased reliability with optimized control ICs from International Rectifier.

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