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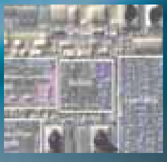
Versatile Power Conversion for Military And Aviation Applications

Technology
Breakthrough in the race to create bio-batteries

Special Report 1
Military electronics



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NEW MARKETS AND VARIABLE DEMANDS ON CAPACITY ARE PRIMARY DRIVERS OF OUTSOURCING

> *The tide is beginning to turn, and certain elements of design and prototyping in the defence, security and aerospace sectors are now being outsourced from the outset*

Research, development and production in the defence, security and aerospace sectors have traditionally been kept in-house due to the sensitivity of products and the highly competitive market. Protection of intellectual property has also been a key driver for organisations in keeping product design close to home.

This has resulted in opportunities for early life-cycle involvement by Electronics Manufacturing Services (EMS) companies being relatively rare. The tendency has been to only engage as products evolved from design and were ready to transition to volume production. However, the tide is beginning to turn, and certain elements of design and prototyping in these sectors are now being outsourced from the outset.

A recent survey by US consultancy Booz & Company found that this global move towards the outsourcing model is primarily being led by strategic drivers, such as market access and quality of supply, rather than just cost and time. Defence and aerospace companies are also finding that increasing productivity and growing/reducing capacity can prove more financially viable when working with outside partners.

In the aerospace market, Booz & Company considers that outsourcing spend will increase 5% per annum until 2020, outpacing most other markets in this period. This is being driven primarily by high growth sub sectors, such as power controls, sensors and engine controls.

However, outsourcing the development of sensitive technology should not be taken lightly and companies in the defence, security and aerospace sector need to ensure that they are partnering with an EMS company that has rigorous controls in place at all levels.

The high levels of complexity in these systems and the ongoing technology investments often make it difficult to maintain internal capability. It is essential that organisations identify the elements that are core competencies to their business versus those that can be outsourced. This will enable them to identify the main areas where an EMS partner can add the most value. It will also allow their internal teams to focus on the company's core competencies and ensure that they retain control over the elements that differentiate them in the market. The outsourcing partner will in turn support them with the design, manufacture and support of the product, reducing time-to-market and moving their operating cost from a fixed to a more variable model.

Understanding the EMS's level of capability and experience is key, as one company's breadth and depth of solutions will differ from another's. Since needs vary, it is important to closely match the company's requirements with the EMS company's capabilities, and also to future-proof the engagement to ensure that the selected partner has the wherewithal to meet future change in requirements. This may range from increased product complexity, global capability to meet cost or end market locations and financial stability to support increasing capacity requirements.

The EMS partner's experience in the defence, security and aerospace industry should be a given to ensure that it has the right regulatory standards in place and a clear understanding of the unique requirements of the sector.

Supply chain management is also a critical element to success. Many manufacturers have been affected by worldwide supply issues over the past few years as components go on allocation or end of life. The chosen partner must have the ability, tools and relationships to overcome these challenges. Being able to proactively manage component life-cycle issues is key, as well as having the processes in place to prevent counterfeit parts entering the supply chain.

Working with an EMS partner is a strategic decision and if the appropriate due diligence is done at the outset it will result in a long-term partnership that brings mutual benefits to both organisations.

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KEITHLEY LAUNCHES NEW MODEL 2450 SOURCE MEASURE UNIT FOR THE NEW GENERATION DESIGNER

Keithley Instruments, a Tektronix company, has updated its old SourceMeter source measure unit (SMU) instrument 2400 with a newer, jazzier, touchscreen version in Model 2450, offering extended voltage and current measurement ranges and lower source noise among other improvements, but at a price difference of around 20%-25%.

"The 2400 SMU model is nearly 20 years old so we will make it obsolete, but not just yet, " said Charles Cimino, Marketing Director at Keithley. "The new model – the 2450 – is in keeping with what engineers want, which is a quick set-up, fast measurements, lower source noise and a simplified interface."

"Younger engineers are getting into the field and using test instrumentation. They are differently trained from the dedicated test engineer [of yesteryear] and have been influenced by all the consumer electronics with multi-gestural touchscreens. Also, they don't have the time to learn about the complexities of an instrument, so we have simplified the interface and added an event log that will point out where errors have occurred during the instrument's use and how to fix them," said Keithley Senior Product Manager John Tucker.

However, despite its multi-gestural, icon-based, 5-inch capacitive touchscreen, Keithley 2450 SMU also has pushbuttons for easy switching between functions. Its front panel still has banana-jack connectors, whereas the back panel has the more secure, lockable triax connectors, for when equipment needs to be stacked. There are one-touch automatic setups for the instrument to act as a digital multimeter (DC voltage, DC current or ohms).

Keithley launches new touchscreen-based Model 2450 SMU instrument

Neverthless, despite its modern appearance and control functionalities, Keithley executives are keen to emphasise the improvements made to the analog side of the instrument, as Cimino said "we have really polished the analog side", including using proprietary technology to lower the noise of the SMPS in the instrument.

"This is our own-developed technology; we are good when it comes to power supplies, to DC currents and DC voltages, and in this instrument there's a very refined power supply that will not add noise to the measurements," he said. "Also, we have extended the current and voltage ranges – going to 10nA and 20mV respectively, whereas in the 2400 model they were 1µA and 200mV. That's quite a difference and it will help many design engineers improve their low-level measurements, without having to use another instrument."

The Model 2450 SMU is available now.

Breakthrough In The Race To Create Batteries from Bacteria

Shewanella oneidensis bacteria used to create the basis for bio-batteries

Scientists at the University of East Anglia have made an important breakthrough in the quest to generate clean electricity from bacteria. They found that proteins on the surface of bacteria can produce an electric current by simply touching a mineral or metal surface and, if the bacteria are placed on such a surface, electrical charge can be transferred through their cell membranes. By tethering bacteria directly to electrodes, it could mean a step closer to creating efficient microbial fuel cells or so-called bio-batteries.

The University of East Anglia team collaborated on the project with researchers at Pacific Northwest National Laboratory in Washington State, US, with funding provided by the Biotechnology and Biological Sciences Research Council (BBSRC) and the US Department of Energy.

The bacteria used in the project are Shewanella oneidensis, marine in nature. The research team created a synthetic version using just the proteins thought to shuttle electrons from inside the microbe to the mineral. These proteins were then inserted into the lipid layers of vesicles, which are small capsules of lipid membranes such as the ones that make up a bacterial membrane. Then the team tested how well electrons travelled between an electron donor on the inside and an iron-bearing mineral on the outside.

"We knew that bacteria can transfer electricity into metals and minerals, and that the interaction depends on special proteins on the surface of the bacteria. But it was not been clear whether these proteins do this directly or indirectly though an unknown mediator in the environment," said lead researcher Dr Tom Clarke from UEA's school of Biological Sciences. "Our research shows that these proteins can directly 'touch' the mineral surface and produce an electric current, meaning it is possible for the bacteria to lie on the surface of a metal or mineral and conduct electricity through their cell membranes.

"These bacteria show great potential as microbial fuel cells, where electricity can be generated from the breakdown of domestic or agricultural waste products," he said.

Case Study

photos: Saab

Saab cuts costs and boosts productivity with XJTAG boundary scan

“Defence and Security company Saab selected the XJTAG development system to speed up the process of debugging and testing multi-layer development boards destined for its IDAS and CIDAS projects used in electronic warfare systems.”

Saab serves the global market with world-leading solutions, products and services ranging from military defence to civil security. With operations and employees on every continent, Saab continuously develops, adapts and improves new technology to meet customers' changing needs. Saab operates in five business areas: Aeronautics, Dynamics, Electronic Defence Systems, Security and Defence Solutions, and Support and Services.

The versatility of the XJTAG system made it an attractive choice for world-leading defence and security specialist Saab, which needed a reliable test solution to test multi-layer development boards destined for airborne and naval electronic warfare systems used in its IDAS and CIDAS products.

“We have initially used XJTAG in the production environment to test our complex, high density, multi-layered board designs containing FPGAs and CPLDs, and have recently introduced the solution to the development and debug stage with great success,” says Eduard Stander, who works for the Controllers Group at Saab's Electronic Defence Systems, South Africa.

“Using XJAnalyser has allowed us to reduce initial debug issues, and to debug errors in a shorter time than our existing tools allowed us.”

“We have found that using the XJTAG solution, and the Layout Viewer in particular, has quantifiably reduced the cost of developing product test jigs in our production test department, because of the fast and accurate diagnosis the system provides.”

“We now can test products that have processors, SDRAM and FLASH memories, Ethernet PHYs, A/D Converters, real time clocks, serial ports, voltage regulators.”

The team at Saab opted for XJTAG because of its superior cost-to-performance ratio and, like many of XJTAG's customers, they were particularly impressed with the flexibility of the system.

XJTAG makes it easy to write test routines for devices and allows users to store them in a library so they can be reused again when the same, or a similar component, is used.

The XJTAG Professional System provides an extensive library of reusable scripts while XJEase, XJTAG's high-level test description language, allows engineers to write and customise tests for JTAG and non-JTAG components without needing to understand how boundary scan works. These tests can be re-used throughout the product lifecycle as well as in subsequent projects wherever the same component is used.

“The reuse of tests on the XJTAG system is a big time saver,” says Eduard. “The design for test (DFT) reports help us ensure that a very high percentage of our circuits are testable before we go into serial production and, with the aid of boundary scan tests, we get closer to our goal of 100% test coverage on production Shop Replaceable Units (SRU).”

He adds: “XJTAG's high-level test description language XJEase is central to this flexibility. The ability to design low level test with XJEase is a real advantage as the test scripts let you drive the non-JTAG components directly.”

Eduard says the company's next step is to integrate XJTAG's portable boundary scan oscilloscope product – XJTAG Expert – with its functional test equipment. “XJTAG is easy to use, highly effective and flexible enough to evolve with our test strategies as we focus on improving speed and productivity.”

opinion

Eduard Stander
Controllers Group
Saab

“The reuse of tests on the XJTAG system is a big time saver. The design for test (DFT) reports help us ensure that a very high percentage of our circuits are testable before we go into serial production and, with the aid of boundary scan tests, we get closer to our goal of 100% test coverage on production Shop Replaceable Units (SRU).”

“We have initially used XJTAG in the production environment to test our complex, high density, multi-layered board designs containing FPGAs and CPLDs, and have recently introduced the solution to the development and debug stage with great success.”

Data Bank

SAAB

Company	Saab HQ Sweden
Nature of business	Defense and security solutions
Customers	Global market with world-leading products, services and solutions from military defence to civil security
Locations	Operations on every continent
Employees	13,000
Revenue	SEK 23,5 billion 20% related to R&D
Web site	www.saabgroup.com

VERSATILE POWER CONVERSION FOR MILITARY & AVIATION APPLICATIONS

By Steve Munns, Mil–Aero Product Marketing Manager, Linear Technology Corporation

Sustainability initiatives, green energy and environmental regulation are part of everyday life both in a domestic setting and in the wider world. Commercial aviation has been at the forefront of efforts to use lightweight materials, improved aerodynamics and more efficient engine technology to respond to commercial pressures and tighter emission targets. Electrical efficiency has become increasingly important as aircraft shift from traditional air bleed systems and hydraulics to electrically-powered actuators, pumps and compressors to drive a multitude of systems. On the Boeing 787, ice protection relies on electro-thermal heater mats to replace hot air bleed from the engines, further reducing load and improving fuel economy and thrust. These developments have seen onboard electrical power demand escalate over three decades from around 300kW in the B767 to more than 1.4 megawatts in the B787, making the efficiency of power conversion more critical than ever before. The military are also following the same direction of travel, striving to make systems more energy efficient, reducing weight, size and heat generated, and thereby trimming down acquisition and operating costs.

Selecting components for use in military and aviation equipment includes all the usual design trade-offs and compromises, and in addition, is constrained by tough specifications for equipment survivability and rigorous qualification for use in harsh environmental conditions. Furthermore, corporate policies for component selection sometimes limit the types of products available to those pre-approved by component engineering and re-use of proven standard circuit blocks is encouraged.

It is therefore desirable to have products that lend themselves to multiple applications through innovative architectures and clever chip design such that fewer qualified or approved part types are in use. The problem is that even in a relative narrow area such as power conversion, applications and requirements vary widely. However, as we will see, some products such as the recently released LT8705 are versatile enough to make them candidates in these scenarios.

HIGH EFFICIENCY POWER CONVERSION

The LT8705 is a very high efficiency (up to 98%) synchronous buck-boost DC/DC controller that operates from input voltages above, below or equal to the regulated output voltage. Four feedback loops are integrated to regulate the input current, input voltage, output current and output voltage. The input current and voltage feedback loops prevent overloading of energy limited sources (i.e. solar cells) while the output current loop provides a regulated output current for a battery charger or current source.

The LT8705 operates over a wide 2.8V to 80V input voltage range and produces a 1.3V to 80V output, using a single inductor with 4-switch synchronous rectification. The high input voltage simplifies transient protection as it can withstand the surge voltage requirements specified in MIL-STD-704 and DO-160. With the addition of a surge suppressor such as LT4363, this can be further enhanced to meet the surge requirements of MIL-STD-1275.

Output power up to 250W can be delivered with a single device, making it suitable for a range of loads by sizing the power switching MOSFETs accordingly. Higher output power can be achieved by arranging multiple circuits in parallel.

The operating frequency is selectable between 100kHz and 400kHz and can be synchronized to an external clock. The LT8705 employs a proprietary current-mode control architecture for constant frequency operation in buck or boost mode and has powerful onboard quad N-channel MOSFET gate drivers. The user can select among forced continuous, discontinuous and Burst Mode operation to maximize light load efficiency.

Additional features include servo pins to indicate which feedback loops are active, a 3.3V/12mA LDO, adjustable soft-start, onboard

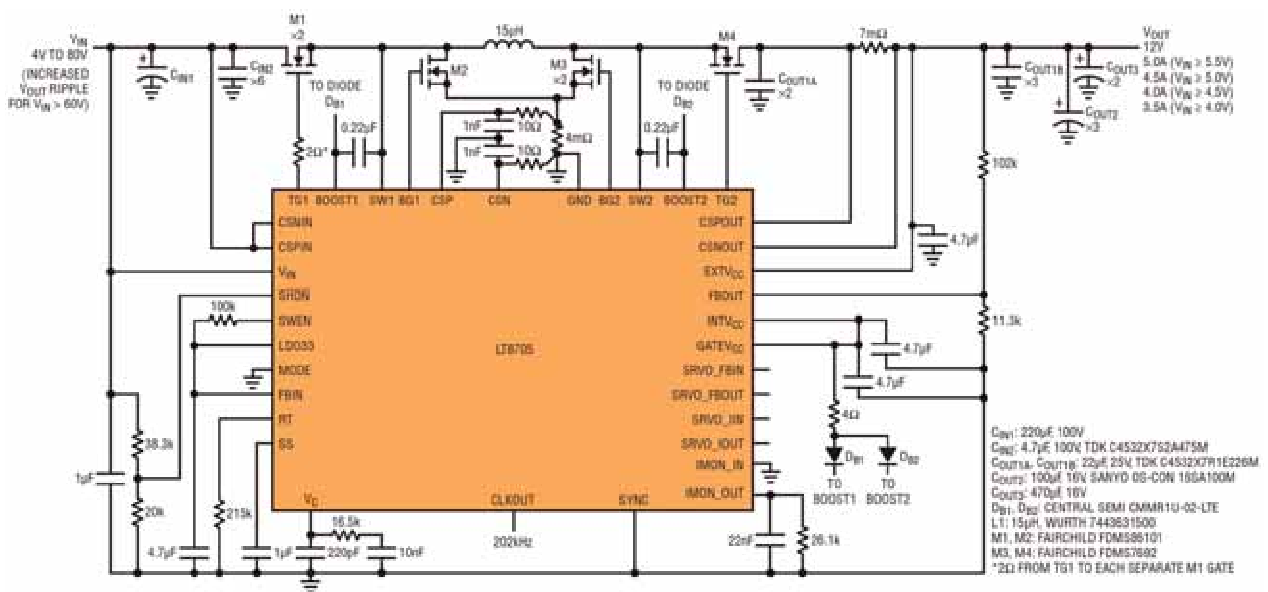

Figure 1: Typical Voltage Stabilizer

die temperature monitor and ±1% reference voltage accuracy over an operating junction temperature range of -40°C to 125°C. The LT8705 is available in a 38-pin 5mm x 7mm QFN and also a 38-lead TSSOP package with additional pin spacing for high voltage operation at altitude. Both lead-free and tin-lead terminal finish are available.

APPLICATIONS

The versatility of the LT8705 with its "anything in, anything out" flexibility lends itself to a variety of applications. In figure 1 the LT8705 is configured as a Voltage Stabiliser, with a nominal 28V input and 12V output to an intermediate bus it achieves >95% efficiency.

Super capacitors can be used to supply large peak currents required by powerful servo systems and actuators used in military hardware or to act as a temporary hold up circuit if power is interrupted. In this scenario the LT8705 can be used as a single component Bidirectional Supercap Charger to replace two traditional pulse width modulated supplies, in one direction to charge the supercaps and in the other to deliver energy to the load. No additional power routing/management are needed, reducing the parts count and power losses incurred by the additional circuitry.

Forward operating bases want to utilize solar energy to reduce the consumption of diesel fuel in electrical generators and the LT8705 can provide a Solar Panel Battery Charger solution. The solar cell produces current in proportion to the illumination level, while the open circuit voltage remains relatively constant (see Figure 2). By using the input voltage regulation loop and EA3 (see Figure 3), the LT8705 can extract maximum power, so called maximum power point tracking. On the output side, the LT8705 can run as a battery charger using the output current regulation loop and EA1 to provide a constant charging current until a predetermined voltage is reached, where the output voltage regulation loop can take over (not shown).

Finally, a Portable Power Supply for systems powered from battery packs, the LT8705 operating initially in buck mode to step down the battery voltage can then automatically transition through to boost mode to provide extended run time as the battery voltage reduces.

For more information on these applications please refer to the LT8705 datasheet.

PROTECTING AGAINST FAULTS

There is a need to protect high reliability systems from the propagation of faults both in the upstream direction to avoid damaging the main power bus and in the downstream direction to protect expensive electronics from faults in the power conversion chain.

The LT8705 activates a voltage lockout sequence if conditions for proper operation such as minimum VIN are violated or if overcurrent or overvoltage conditions are detected on input or output. After the fault condition has been removed and a predefined timeout period has ended, the converter will restart at a rate dependent upon the capacitor value assigned to the soft start pin.

Thermal management is also assisted by a secondary function of the CLKOUT pin, its duty cycle being linearly proportional to the die temperature. The maximum specified junction temperature is 125ºC but an internal thermal shutdown protects the reliability of the chip, at approximately 165ºC the power switch and the internal regulators are turned off. After the chip temperature drops by approximately 5°C, the part will re-initialize and perform a soft-start before resuming normal operation.

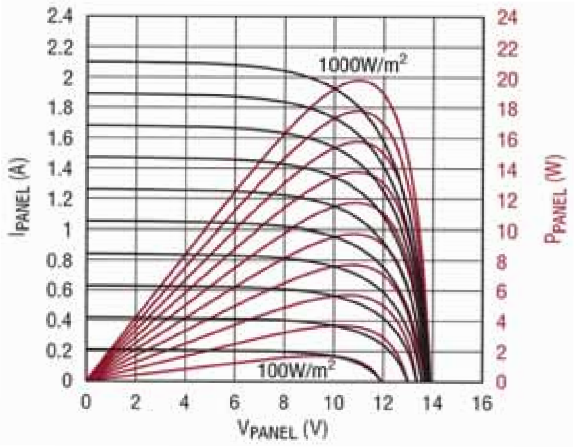

Figure 2: Solar Cell Output Characteristics

CONCLUSIONS

Increasing use of electrically-powered actuators, pumps and ancillaries provide more fuel-efficient solutions at the equipment level, but has increased the onboard electrical energy demand dramatically and highlights the importance of very efficient power conversion schemes.

Designers of military and aviation applications are often encouraged to reuse proven circuits and constrained to a narrow range of products that are approved. Therefore, it is desirable that such components are as flexible as possible so that they can be deployed in multiple applications.

One product that matches these requirements is the LT8705 synchronous 4-switch buck-boost controller. With up to 98% efficiency, wide input and output voltage range and four control loops, it provides a versatile solution for many military and aviation applications.

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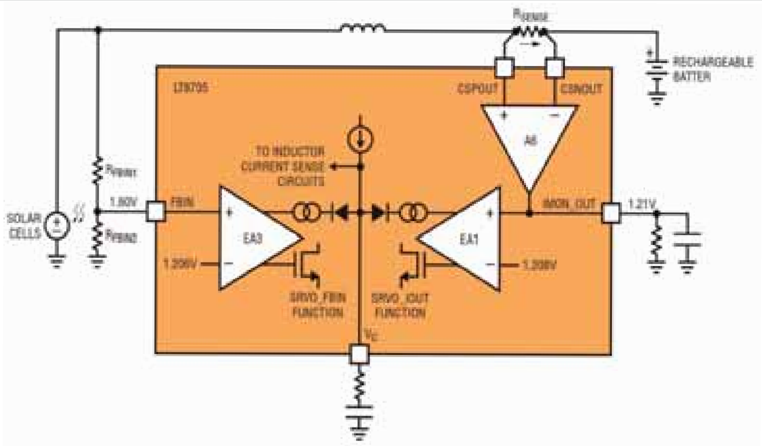

Figure 3: Simplified Solar Panel Battery Charger

Common Courtesy

MYK DORMER IS A SENIOR RF DESIGN ENGINEER AT RADIOMETRIX LTD
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"Efficiency" has become a watchword. We try to streamline our processes, optimise our designs and squeeze a whole sixty minutes of productive time into every working hour. We conduct "chairless" meetings, we eat working meals. We email, we text, we tweet. Every inefficient motion, unnecessary action and surplus word is ruthlessly deleted. Unfortunately, with the expurgation of inefficiency I note that we seem to be losing something else along the way: Courtesy.

Communication is becoming curt, brusque and imperative. Every word seems to get counted (literally, in a text message or on Twitter) and the literary garnish gets deleted. Conversations become monologues, requests become orders and replies degrade into truncated, barked commands. As we reduce the word-count of our communications, among the first things to be missed are the mechanisms of polite conversation ("please", "thank you"), shortly followed by a change to the imperative case and the replacement of requests ("may", "should") with diktats ("must", "will"). Along with this, answering a message with real textural composition is displaced in favour of cut-and-paste operations, underlines, highlighting and one-word replies.

This in itself isn't necessarily a serious problem – "it's only words" I can hear being said – but I am rather afraid that, as we change the way we communicate with our fellow workers, our attitudes to them are changed too – or rather, degraded –

"Conversations become monologues, requests become orders and replies degrade into truncated, barked commands

by the process. If you are speaking to a co-worker using the words and phrases that might be used to talk down to some lowly and ill-favoured servant in an earlier, feudal time, then it is only a small step to thinking of them as such, and a work relationship based on mutual respect can soon be replaced by contempt (and, from the one being treated like a "minion", resentment or rebellion).

At this point, I realise I probably need to make clear that I am not an ancient, swivel-eyed reactionary Luddite, calling for a return to quill pens, Dickensian prose and a blanket prohibition on the use of email (indeed, one can be just as condescending and offensive in a perfectly constructed poem as one can be in a five word memo, if not more so), but I am observing a change for the worse in the nature of workplace communication and interpersonal relationships. Perhaps it is related to increased economic pressures; to the introduction of new and different means of communication; or maybe the increasing disparity between shop floor and boardroom wages is a factor; but there definitely is a problem, and far from increasing efficiency, it is an environment where communications resemble the battlefield orders of Ghengis Khan, and people look at their colleagues with loathing or disdain. Unfortunately, this is a place where valuable, innovative work will not readily thrive.

Regrettably, this is not an issue with a clear resolution (we cannot re-wire our brains like some defective circuit board), and a general suggestion to "be better natured to each other", while laudable, does not address the communication problems. For my part, I am trying to do this:

- Treat my co-workers as people. They are not my "inferiors", "competitors" or "masters".
- Answer messages in whole sentences, with due thought to the content.
- Paraphrase and quote. Not cut-and-paste and highlight.
- Remember that polite requests and due thanks do not make me "weak", and that arrogant orders and dismissive attitudes do not make me "strong" or "efficient". In fact, quite the opposite is the case.
- Listen to what I say, and how I am speaking, and imagine how the listener hears it. ●

DIRECTIVITY PREDICTION OF PATCH ANTENNAS FOR MILITARY APPLICATIONS, USING ARTIFICIAL NEURAL NETWORKS

MUHAMMAD ZUBAIR AND **MUHAMMAD MOINUDDIN** FROM THE FACULTY OF ENGINEERING AT THE IQRA UNIVERSITY IN PAKISTAN USE A BACK-PROPAGATION ALGORITHM OF AN ARTIFICIAL NEURAL NETWORK TO PREDICT THE DIRECTIVITY OF A MICROSTRIP PATCH ANTENNA USED IN MILITARY APPLICATIONS

One of the important goals in the field of telecommunication engineering is to design an antenna which is lighter in weight, smaller in size, easy to install and efficient in its radiation properties.

Microstrip patch antennas have all those characteristics. They are employed in numerous commercial and military applications, such as medical appliances, mobile radios, cell phones, satellites, aircraft, spacecraft, rockets, radars, GPS receivers and missiles, and so on [1]-[5]. Because of their simple structure, patch antennas can also be designed to survive in harsh environments [6]; as such, they are most appropriate for use in military applications (high-data rate transmission, low power consumption), especially in the ultra wideband (UWB) range of 3.1GHz to 10.6GHz [7].

Among various radiation properties, directivity of the antenna is a measure of its radiation intensity in a particular direction, and one of the important parameters to be calculated when designing an antenna for an application. Here we focus on predicting the directivity of a microstrip patch antenna for military applications using the back-propagation algorithm of an artificial neural network. Directivity was then predicted at different values of dielectric constant and at various patch heights. The following sections describe the basic architecture of a microstrip patch antenna, radiation pattern of such an antenna and the application of artificial neural networks for predicting its directivity.

Microstrip Patch Antenna

A microstrip patch antenna is one of the most popular antennas used in today's communication networks. Its basic design consists of a metallic radiating patch mounted on a dielectric substrate of thickness h.

There are various types of patch antennas with respect to the structure of the metallic patch, which could be square, rectangular, circular, hexagonal, triangular, elliptical or otherwise. Figure 1 shows a rectangular patch antenna with length, width and thickness of L, W and t respectively. Its dielectric substrate has the dielectric constant ϵ_r. Typically, the patch is made up of copper or gold. The feed line and the metallic patch are mounted through a photo-etching technique [9], [10].

The antenna's dimensions depend on the free-space wavelength λ_0. The typical values of its parameters are as follows:

- Length of the patch L: $0.3333\lambda_0 < L < 0.5\lambda_0$
- Thickness of patch t: $t \ll \lambda_0$
- Thickness of substrate h: $0.003\lambda_0 \le h \le 0.05\lambda_0$
- Dielectric constant of substrate ε_r: $2.2 \le \varepsilon_r \le 12$

Some of the advantages and disadvantages of the microstrip patch antenna are given in Table 1 [11]:

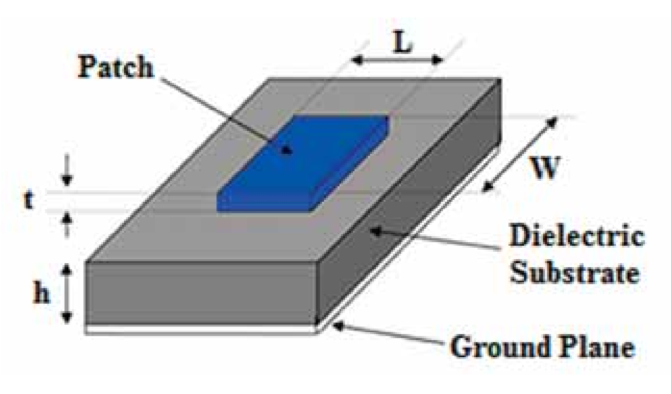

Figure 1: The structure of a microstrip patch antenna

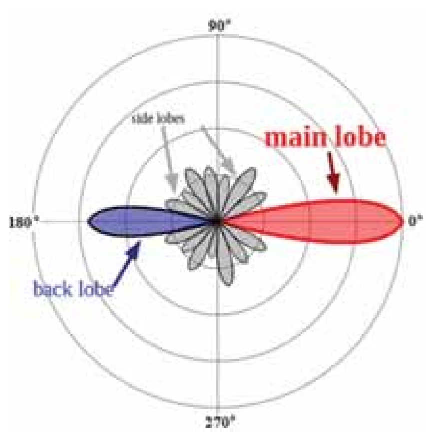

Figure 2: Typical radiation pattern of an antenna showing various lobes

Advantages	Disadvantages
Low weight	Less efficient
Small size	Low gain
Thin profile	Narrow bandwidth
Low fabrication cost	Higher ohmic loss in feed lines
Easily mass-produced	Low power handling capacity
No cavity backing required	Pure polarization is difficult
Linear and circular polarization	Excitation of surface waves
Easy to mount with integrated circuits	Poor end-fire radiation
Multiple-frequency operation possible	Poor isolation between antenna and feed line
Feed lines and matching circuit can be easily fabricated	Extraneous radiation from feed line and junctions

Table 1: Advantages and disadvantages of a patch antenna

The Radiation Pattern of an Antenna

The radiation properties of an antenna include field strength, radiation intensity, polarization, power flux density and directivity. The graphical representation of the antenna radiation is known as radiation pattern; it is the variation in antenna radiated power as a function of distance and direction from the antenna.

All antennas have directional qualities; they radiate different magnitude of power in different directions. The radiated power is contained in various lobes pointing in different directions.

A radiation lobe may be defined as an area of strong radiation intensity between regions of relatively weak radiation intensity [1]. The radiation lobe may be sub-classified as major lobe, minor lobe, side lobe or back lobe, as shown in Figure 2.

A major lobe is the lobe in the direction of maximum radiation. All others are known as minor lobes. Usually, a side lobe is a minor lobe adjacent to the main lobe and the back lobe is approximately 180° opposite to the beam of an antenna.

The radiation effectiveness of an antenna is determined through the major lobe(s). All other lobes usually have weak radiation pattern and have little effect on the overall radiation [12]. The radiation effectiveness can be measured by defining various parameters. One such parameter is the directivity of an antenna. This is an important parameter that must be maximized while designing any antenna.

Directivity

The directivity of an antenna can be defined as the ratio of radiation intensity from the antenna in a given direction to the average radiation intensity over all directions. If U is the radiation intensity of an antenna in any direction, U_o is the isotropic radiation intensity and P_{rad} is the total radiated power from the antenna, then its directivity D can be estimated as:

$$D = \frac{U}{U_0} = \frac{4\pi U}{P_{rad}} \tag{1}$$

The maximum directivity D_{max} in the direction of maximum radiation intensity U_{max} is therefore:

$$D_{max} = \frac{U_{max}}{U_0} = \frac{4\pi U_{max}}{P_{rad}} \tag{2}$$

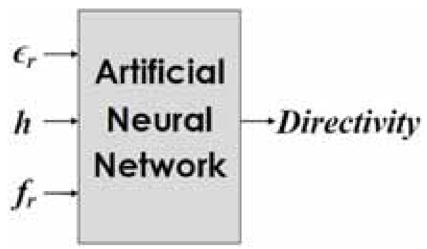

Figure 3: Back propagation ANN block for directivity estimation

However, the radiation intensity, radiated power and consequently the directivity of a patch antenna depends on substrate height h, substrate dielectric constant ϵ_r and the targeted resonance frequency 〖 f〗 _r.

Besides mathematical determination, there are many heuristic algorithms available to estimate such types of parameters. Although neural networks have successfully been used to estimate the resonant frequency of an antenna, they have not been employed for directivity estimation. However, we have made an attempt to estimate the directivity of a UWB patch antenna through the back-propagation algorithm of an artificial neural network. The inputs of the neural network are substrate dielectric constant, substrate height and resonance frequency, whereas the output is the directivity as shown in Figure 3.

The network has been trained for the continuous range of the UWB frequencies and substrate heights, and a few discrete values of dielectric constant have been selected for this purpose too. All the training parameters are shown in Table 2.

Parameters	Values or range of parameters
ϵ_r	1, 2.2, 3.3, 4.4, 5.7, 6.15
h	0.08 mm to 4.83 mm
f_r	3.1 GHz to 10.6 GHz

Table 2: Basic training parameters and their values/ranges for back-propagation neural network

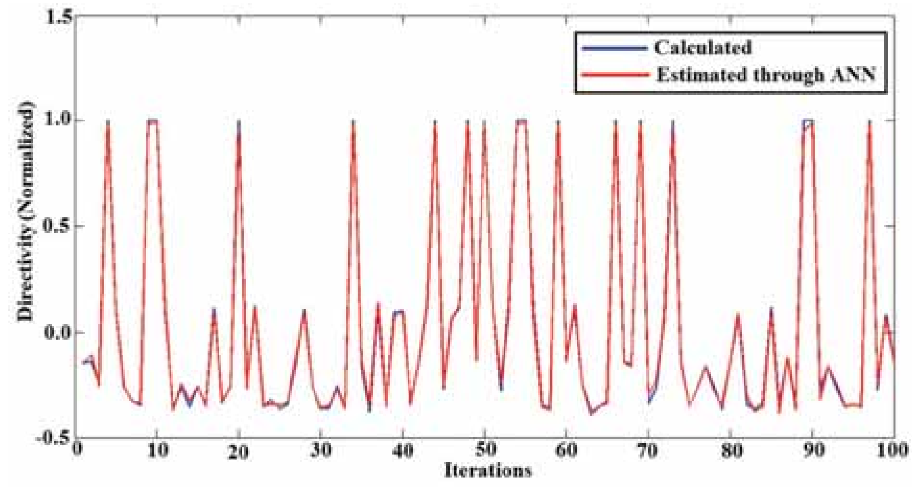

Figure 4: Training results of neural network for directivity estimation

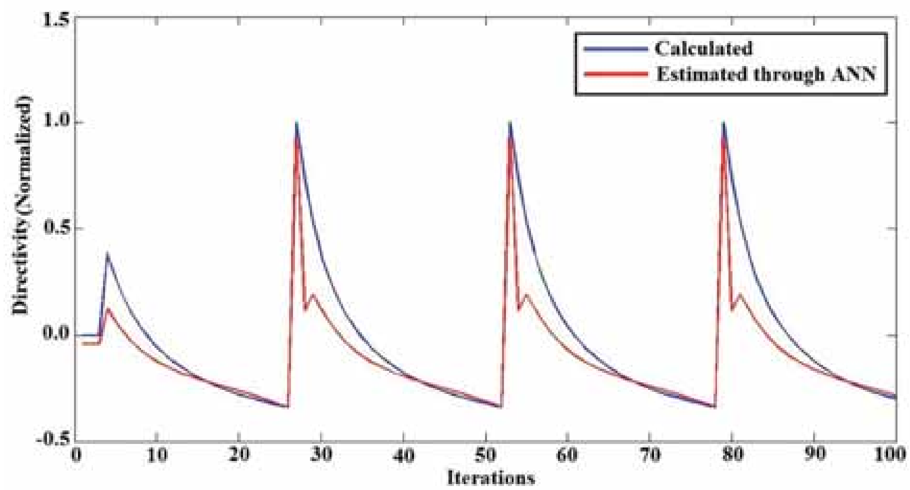

Figure 5: Testing results of neural network for directivity estimation

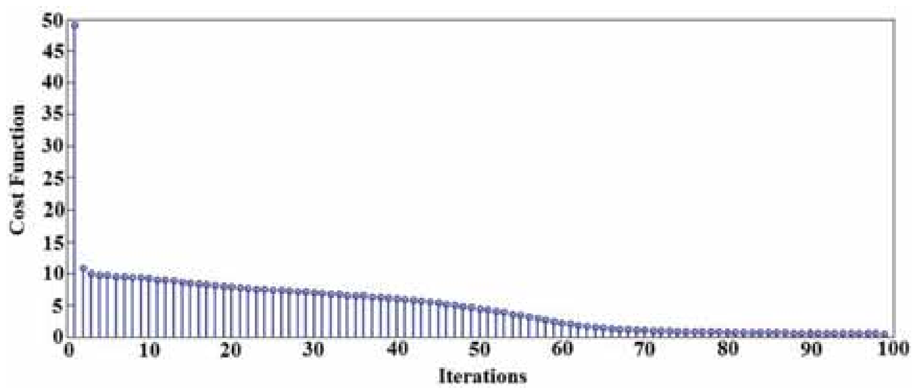

Figure 6: Decreasing trend in cost function

Figure 4 shows mathematically-calculated directivity and the estimated directivity (determined by the neural network) during the training phase, whereas Figure 5 shows the mathematically-calculated directivity and the estimated directivity (also from the neural network) during the testing phase. It is clear that the neural network has been trained up to an acceptable range. Its training can be further improved by inputting large training datasets for large number of iterations.

The training results are very effective and promising. Figure 6 indicates the decreasing trend in the cost function (error function), showing the effective training of the artificial neural network.

Test results show the declining cost function and prove the successful implementation of the algorithm. ●

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THERMAL PRODUCTS FOR MILITARY APPLICATIONS

Figure 1: Military applications need advanced materials

THE PERFORMANCE AND RELIABILITY DEMANDS ON TODAY'S MILITARY ELECTRONIC SYSTEMS REQUIRE DESIGNERS TO UNDERSTAND AND USE ADVANCED THERMAL MANAGEMENT MATERIALS TO THEIR MAXIMUM POTENTIAL. BY **TIM KEARVELL**, SENIOR PROCESS ENGINEER AT PARKER CHOMERICS

In the 21st century, financial and political constraints intensify demands for the military forces to deploy their firepower with ever greater precision. As a result, higher performing computing and communications technology is required to coordinate operations and guide weapons to their targets with the utmost reliability and accuracy.

With regard to electronics technology, increased system performance is usually achieved at the expense of higher operating temperature, which is the enemy of reliability. Reliability, however, is critical, since any equipment malfunction in the field can have serious human and strategic consequences. Moreover, today's equipment must meet its specified operational lifetime to avoid high ownership costs associated with early failures.

With increasing demands placed on embedded electronics in equipment such as radios, fly-by-wire systems, weapons guidance, surveillance and intelligence gathering devices, careful thermal management throughout every assembly is increasingly important to ensure fitness for purpose.

It is also worth noting that high-tech equipment is being packaged with increased densely in modern armaments. In

> Reliability is critical, since any equipment malfunction in the field can have serious human and strategic consequences

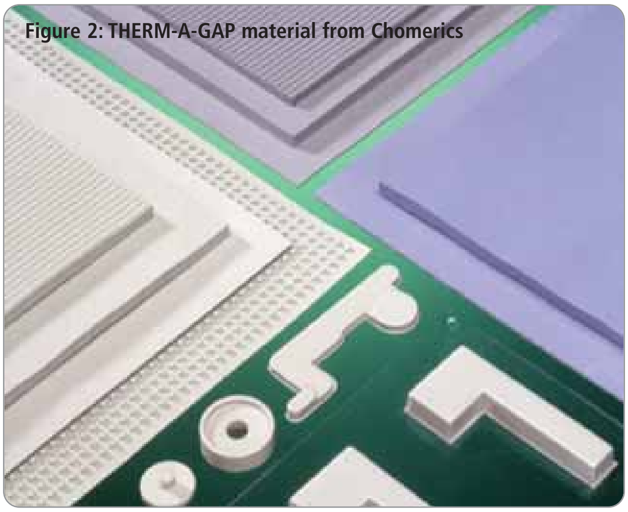


Figure 2: THERM-A-GAP material from Chomerics

the 1970s, embedded computer systems were responsible for running around 20% of typical aircraft system functionality. In the 1980s this increased to 45%, while modern aircraft can rely on embedded computing to manage up to 80% of system functionality. This trend places higher demands on thermal management, not only to dissipate heat generated by extra computing activity but also in the additional power supplies required throughout the airframe.

In addition, military electronic suppliers are under pressure to deliver lower-cost solutions, which can be met by creating electrical subsystems that are generic and modular and, as such, can be used within multiple equipment platforms. Increased hardware commonality can yield economies of scale, as well as potentially reduce R&D and testing costs. This approach is similar to that seen in the automotive industry, where a common electronic control unit (ECU) may be used in several different vehicle models with simple changes in software or firmware. In turn, however, subsystems such as radio or navigation modules must become more compact in size to simplify integration, particularly as limits on dimensions imposed by any future platforms may be unknown.

Thermal Materials and Heat Transfer

Today's equipment designers can choose from a wide variety of thermal management solutions to help maintain electronic components within acceptable temperature limits throughout their entire operating envelope to maximum performance under maximum ambient temperature conditions.

In high-performance consumer equipment such as personal computers and game consoles, cooling fans are typically used, in addition to heatsinks, to remove heat from hard-working processors, memories and power components. Cooling fans are often not acceptable in military applications, from reliability and EMI standpoints, if the equipment is battery powered, or if the enclosure is to be sealed.

Current best practice is to use thermal materials to eliminate air (which has poor thermal conductivity) at the interfaces between components and attached heatsinks, or in any small gaps between the component and the module enclosure acting as a heatsink or part of a heatsink system. Such gaps can be in the range of 1mm to 5mm. Since the thickness of air gaps may be inconsistent from one unit to another, gap fillers must be able to accommodate variations to remain in full contact with each surface without exerting high forces on component casings.

Such materials are typically based on elastomeric polymer compounds containing thermally-conductive filler particles. A wide range of formulas is available offering various combinations of properties such as hardness, compression force and thermal conductivity, and new materials continue to emerge to address changes in application demands or designers' requirements.

Latest Properties and Performance

Gap fillers in the form of pads have become a staple of the equipment designer's thermal-management toolbox. Alternatively, gap fillers in the form of a gel can be dispensed and formed in place during equipment assembly to meet the exact needs of each individual application. Fully cured gels

Figure 3: Chomerics is also offering THERM-A-FORM

THERMAL SOLUTIONS FROM CHOMERICS

CHOMERICS'S THERMAL-MANAGEMENT SPECIALISTS HAVE WORKED CLOSELY WITH MILITARY CUSTOMERS IN DESIGNING ADVANCED THERMAL MATERIALS TO COMBAT EXCESSIVE TEMPERATURES IN HIGHLY MINIATURISED HIGH-PERFORMANCE MODULES.

Latest advances include its THERM-A-GAP569, 570, 579 and 580 materials, which deliver significantly improved thermal performance and conformability over previous gap fillers. All are available on aluminium foil or on a clean-break glass-fibre carrier for enhanced resistance to cut-through, and may be specified with a high-strength acrylic pressure-sensitive adhesive for permanent attachment to the cold surface. The Cho-Therm 1671 material also offers a high temperature option.

Gel type gap fillers include THERM-A-GAP Gel 30 and Gel 30G – the latter having glass beads that act as a compression stop to provide electrical isolation. These are fully cured gels that require no post-assembly heating or cure time.

Materials such as Chomerics's THERMFLOW T557 or T558 are typically supplied as pads or adhesive film that softens at device operating temperatures to display grease-like performance.

THERMFLOW T558 and the high-performance THERMFLOW T766 variant are recommended for applications where rework and ease of disassembly are required. This can be important for military equipment, which is expected to be repairable, unlike general commercial products that typically are simply replaced in the event of failure.

require no post-assembly heating or cure time. This type of material is ideal for applications where typical gap filling pads cause excessive stress on component solder joints and leads, risking damage to components and the PCB. They can also help with tolerance build-up issues.

Phase-change materials are another category of thermal materials, typically used to fill air gaps at the interfaces between a component and a directly attached heatsink.


Figure 4: Materials used in military applications must be suitable for excessive temperatures

Alternatively, thermally-conductive adhesive tapes may be used to attach heatsinks and components. These typically comprise a pressure-sensitive acrylic adhesive featuring high bond strength and loaded with thermally-conductive aluminium oxide, which is coated onto a 0.05mm aluminium foil carrier. The other side of the foil carrier has a pressure-sensitive adhesive capable of adhering to surfaces such as plastics for example.

Calls for High Performance

The increasing demands placed on modern military electronics call for high-performance thermal materials to help manage component temperatures to ensure reliability and longevity. Proper thermal management requires a good understanding of heat transfer fundamentals, as well as knowledge of the latest available interface materials and their key physical properties.

AVIONICS VHF COMMUNICATION TRANSCEIVERS

STOJCE DIMOV ILCEV FROM DURBAN UNIVERSITY OF TECHNOLOGY (DUT) DESCRIBES THE RANGE OF VHF RECEIVERS USED IN AVIONICS APPLICATIONS

The end of the last and the beginning of the new millennium mark two special centenaries: it's been over a century since Russian Professor Alexander Stepanovich Popov built the first radio receiver in May 1895 and the Wright brothers flew the first time ever, a distance of a few hundred feet, in December 1903. Both of these inventions have revolutionized the world.

The first airborne radio was pioneered in the 1920s with onboard transceivers and a low-frequency aeronautical radio system; modern-day transmitters (Tx) and receivers (Rx) emerged in the late 1940s. Arguably, they have not changed significantly since then. Today, there is a requirement to enhance the legacy of aeronautical radio, providing users with more flexibility, reliability, functionality, simplicity and immunity to interference. Finally, the additional developments introduced datalink services such as Aircraft Communications Addressing and Reporting System (ACARS) and VHF Data-Link (VDL) and aeronautical satellite services as a second-generation stop-gap, which should be emphasized.

Channelization and Band Splitting

Taking channel frequency accuracy and the actual bandwidth occupied by the Double Side Band-Amplitude Modulated (DSB-AM) spectrum into account, it is possible to reduce the channel spacing and hence increase the amount of channels available in a given spectrum. In the 1950s, the 100kHz channel spacing was first introduced, which doubled the capacity to 140 available channels. In 1959, the World Radio Conference (WRC) further extended the band to 118-136MHz, which meant 180 channels at 100kHz were achievable.

In the 1960s, however, this methodology was extended further, so with 50kHz channel spacing now easily achievable, and this doubled the capacity again to 360 channels at spacing of 50kHz. In 1972, 25kHz channel spacing was introduced and this doubled the capacity again to a theoretical 720 channels. This alone was not enough to curb demand, so in 1979 WRC extended the aeronautical allocation in the VHF band further to 117.975-137.000MHz, which is where it is today with a theoretical 760 channels and spacing of 25kHz. A further reason for the channel splitting at the width of 8kHz approach was to achieve backward compatibility between old and new radio systems.

VHF frequencies in the range 117.975 to 137MHz should be in accordance with the MID Region (Middle East) Facilities and Services Implementation Document (FASID) Appendix B to CNS systems (see Table 2). Technical characteristics of ground facilities should be in accordance with the Annex 10 to the Convention on International Civil Aeronautical Organization (ICAO), and all aircraft will be required to carry VHF equipment compliant with 8.33kHz channeling.

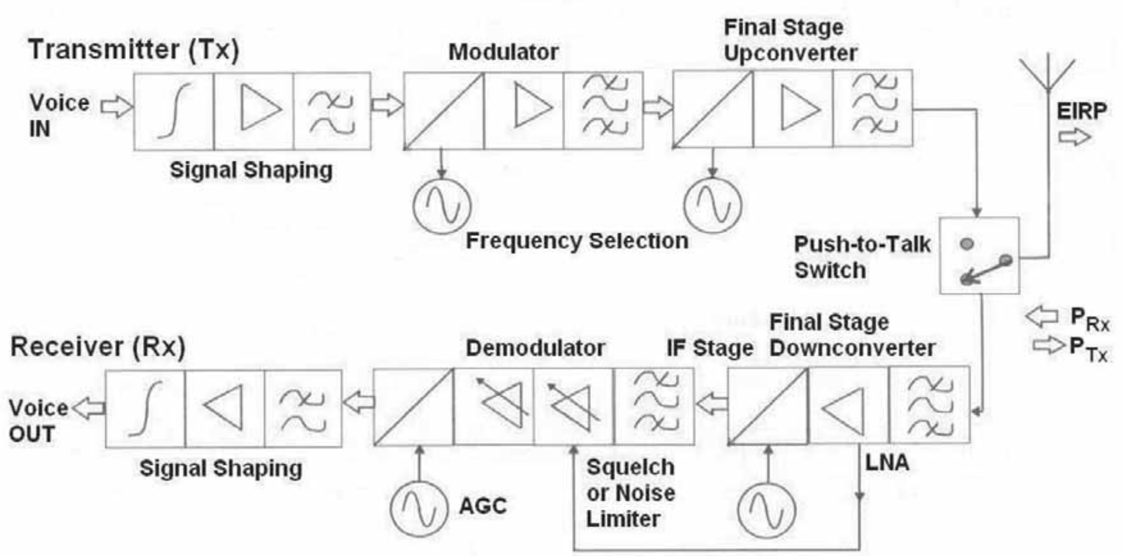


Figure 1: Aeronautical VHF 25kHz radio transceiver block diagram

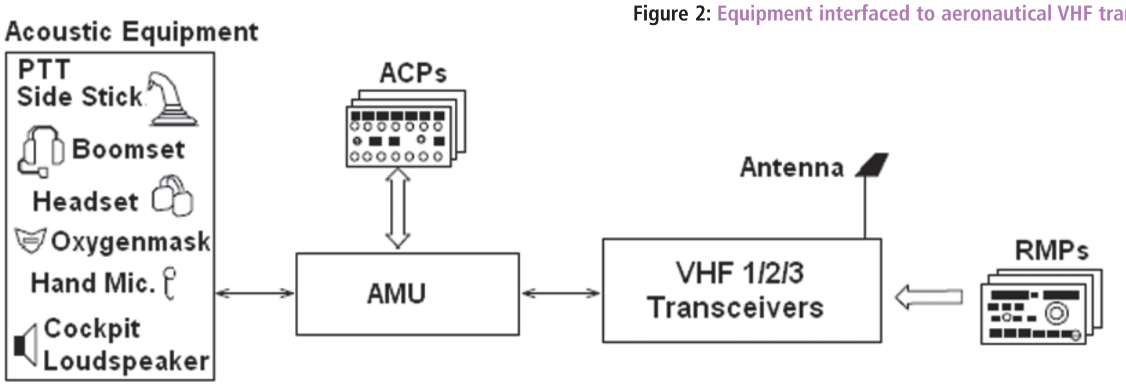


Figure 2: Equipment interfaced to aeronautical VHF transceivers

Aeronautical VHF 25kHz Transceivers

In Figure 1 is the system block layout of a typical DSB-AM transceiver, which consists of 25kHz Tx and Rx components for modulation and demodulation, upconversion and downconversion, IF stages, RF selection, Automatic Gain Control (AGC), Low Noise Amplifier (LNA), Signal Shaping Voice Switch and Squelch.

> Today, there is a requirement to enhance the legacy of aeronautical radio, providing users with more flexibility, reliability, functionality, simplicity and immunity to interference

Important components in the transmitter are:

1. **Signal Shaping** – This block is at the mouthpiece, where the voice as spoken by the pilot/controller/other is converted into electrical speech signals. These are compressed, whereas "companding" (compressor/expanding) is a standard technique for most voice communications. This technique provides overall noise reduction and Signal-to-Noise Ratio (SNR) improvement. The next stage is a voice amplifier and then signals are passed into a low-pass filter, which usually limits the voice signal from around 80Hz up to 4800Hz. The filter is usually a raised cosine filter, which has a relatively slow cut-off frequency above 4800kHz.
2. **Modulator** – The refined voice signal (baseband signal) is mixed with the carrier (intermediate) frequency, which is synthesized with a crystal oscillator that provides a highly stable frequency. The synthesis circuitry is controlled by the RF selector interface on the radio. Combining the carrier and baseband is usually done in a non-linear device, such as a diode or a transistor circuit. The resultant signal is then amplified and the unwanted modulation products (distortion) removed by a bandpass filter. The result is an Intermedate Frequency (IF) modulated signal. The IF stages are sometimes, but not always, used as the first part of a two-part modulation process to facilitate easy filtering out of unwanted products and a good quality of modulation.
3. **Final-Stage Upconverter** – The IF signal is now mixed with the carrier frequency, amplified by an RF power amplifier around 25W (RMS) and cleaned up by a bandpass filter, which limits the signal to a 25kHz RF channel. Again a raised cosine filter is used to clean up the signal, which in the case of an aircraft dual-simplex system is sent on to the push-to-talk switch and antenna system. In the more advanced signal processing transceivers, this stage is sometimes bypassed and the baseband modulated direct to RF carrier.
4. **Push-to-Talk Switch** – The aeronautical broadband VHF system operates in simplex or half-duplex mode. When an operator/pilot wants to talk, they press the push-to-talk button to activate the transmitter and disconnect the receiver. Conversely, when the push-to-talk switch is not pressed (idle mode), the transceiver connects the antenna system to the receive branch.

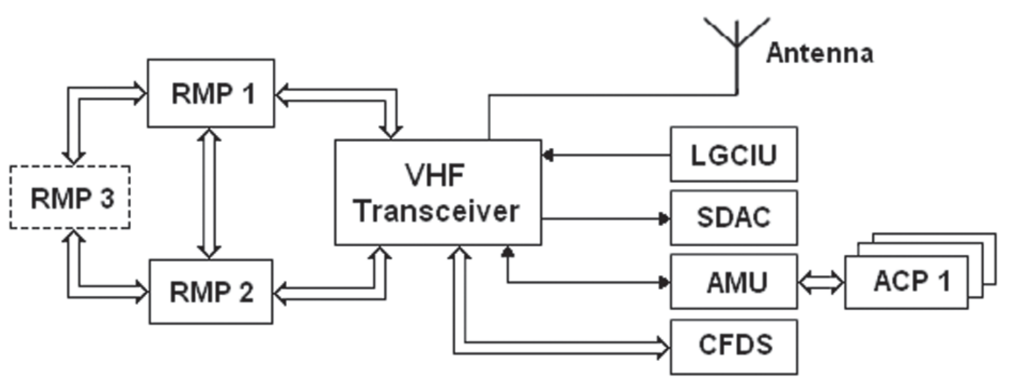


Figure 3: VHF system description and operation

Receiver Path

In simple terms, the receiver path is reverse of the transmitting operation with the following modes:

1. **Final-Stage Downconverter** – When the push-to-talk switch is in idle mode, an incoming RF signal travels to the bandpass filter. It excludes all the other RF signals coming from the antenna, except for those in the nominal VHF range (approximately 118 to 137.975MHz). This filtered signal is then amplified and passed to the first demodulator stage, where it is mixed with the carrier frequency to downconvert to a resultant IF signal. This provides the selectivity to capture the specific RF channel wanted.
2. **Demodulator Stage** – The signal is then cleaned again by a bandpass filter to remove any unwanted artifacts from non-linearities in the mixing, and passed on to a noise-limiting squelch circuit. The function of the squelch circuit is simply to act as a receiver on and off switch; i.e. if there is sufficient signal coming through the downconverter circuit, it will switch on the receiving amplifier so that sound can be heard. This is to make listening more comfortable without background noise and static. In the next stage the signal is demodulated, or 'reverse modulated', which can be performed coherently or non-coherently (the simplest form) with a simple RC circuit.
3. **Signal Shaping** – The signal is passed through a low-pass filter to reduce some of the higher frequency crackles and noises. It is then amplified and expanded in the reverse process of compression and passed on to a loudspeaker or headset, as applicable.

Figure 4: VHF rackmounted large transceiver systems

Configuration of A VHF Transceiver (Rx/Tx) System

The aeronautical VHF transceiver is used onboard all types of aircraft for commercial traffic control, safety, security and distress communications. Airborne VHF communications transceivers are intended for installation on the trunk civil airplanes to establish speech communication between airplanes' crew and air traffic control, and automatic "Air-Ground" and "Ground-Air" data exchange systems. Thus, radio communications are an important requirement for the safe and proper operation of aircraft in flight and at airports. Airport operators, station operating personnel, technicians and contractors need to be familiar with these requirements before installing VHF radio.

The VHF radio system allows short distance voice communications between different aircraft in flight or on the ground, or between the aircraft and a ground station at airports. VHF is used for short-range voice communications and the range of VHF connections is limited to a little more than Line-Of-Sight (LOS). It is therefore important to position the ground equipment as high up as possible to increase range. It is common for VHF connections to have a range of approximately 250 nautical miles.

Figure 2 shows how VHF transceivers interface with Acoustic Equipment (AE), Audio Control Panels (ACP), Audio Management Units (AMUs) and Radio Management Panels (RMP). For voice communications, pilots and crew use AE, which contains PTT side-stick radio selectors, boomsets, headsets, oxygen masks, hand-microphones and cockpit loudspeakers. The AMU connects the crew and the VHF system; ACPs allow selection of the VHF1, VHF2 or VHF3 transceiver in transmission or reception mode and for the control of received audio signal; while RMPs select the VHF frequencies. The VHF transceiver (tuned to the frequency selected by one of three RMPs) transforms the audio into VHF signals (in transmission mode) or VHF into audio signals (in reception mode).

The usual VHF system onboard aircraft is shown in Figure 3 and comprises three VHF transceivers, three blade antennas associated

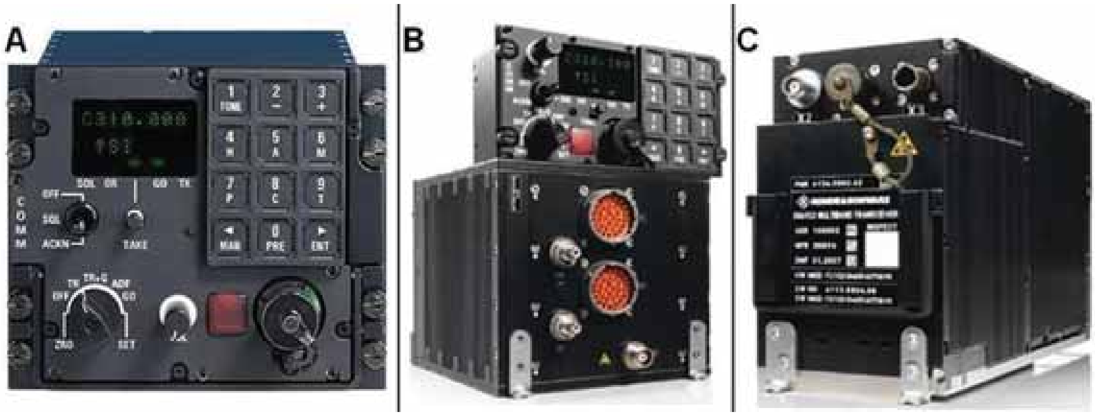


Figure 5: Software defined VHF/UHF transceivers

with control systems, three RMPs (the third one is optional, however), three ACPs, one landing gear and Control Interface Unit (LGCIU) and one Centralized Fault Display System (CFDS). The RMPs are used for VHF frequency control and display.

The VHF transceiver has two serial input ports: port A for normal use and port B in case of an RMP failure. Port selection is done through the port selection information signal. Selected frequency information is sent to the VHF system as a serial 32-bit word; the system requires one serial 32-bit word for complete tuning data. The System Data Acquisition Concentrator (SDAC) acquires the VHF Push-To-Talk signal and provides this information to the Electronic Centralized Aircraft Monitoring (ECAM) and the Digital Flight Data Recorder DFDRs. In case of continuous emitting, the ECAM displays: "COM: VHF 1 CONT EMITTING".

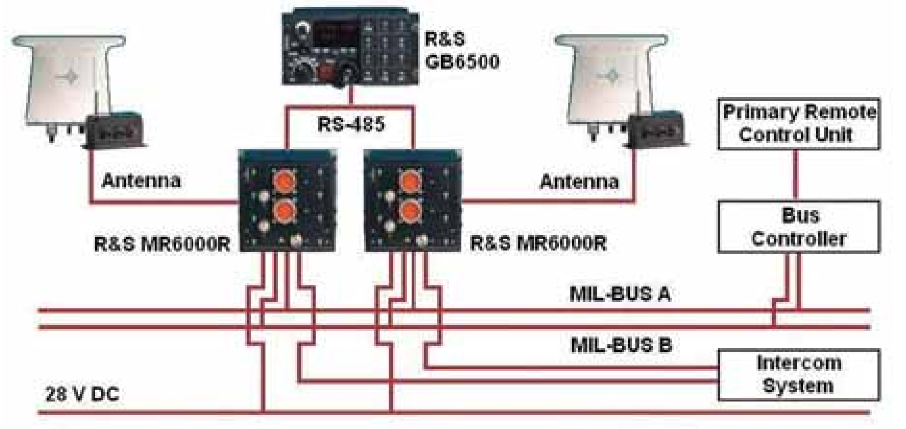


Figure 6: Transceivers integration through different interfaces

The VHF unit is linked to the AMU for connection to the audio integrating and Selective Calling (SELCAL) systems. The ACPs are used for VHF transmission or reception selection mode and control of the received audio signal levels through the AMU. The LGCIU indicates the flight or ground aircraft status. This information is used by the VHF Built-In-Test-Equipment (BITE), in order to count the flight legs in case of the Centralized Fault Display Interface Unit (CFDIU) failure. The BITE functions of the VHF transceiver are monitored by the CFDS.

The VHF cockpit system is configured by ARINC 716/600 transceiver architecture, with parameters defined in ICAO Annex 10, connected with a standard NAV/COMM control panel, to comply with RTCA DO (Radio Technical Commission for Aeronautics Document) 160E environmental conditions and test procedures for all airborne electronics and electrical equipment and instruments, and to be specified according to the frequency selection standard (described in ARINC 720-1).

Large VHF Rack-Mounted Transceiver Systems

These VHF transceivers are large rack systems with adequate control panes that are installed in the aircraft cockpit:

1. **Chelton VCS 40 VHF Transceiver** – This system includes a digital VHF transceiver designed to ARINC 700 series air transport specifications, shown with control panel on top in Figure 4a. It features a 20W solid-state transmitter and can work with 25kHz or 8.33kHz channel spacing. The transceiver is tuned via individual Series III control heads or the ARINC 429 data bus, allowing it to interface with flight management systems and other standard 429 protocols to include the Chelton RMS-555 radio management system.
2. **Rockwell Collins VHF-2100 Transceiver** – This unit is high-speed multi-mode data radio, with full digital voice/data and analog capabilities, shown in Figure 4b. Key features of this unit are: ARINC 750 and 716 compatible and VDL Mode 2/3 capabilities; it meets the ICAO Annex 10 requirements for FM immunity; dual-bandwidth IF filters for 25/8.33kHz operation; ultra low phase noise frequency synthesizer with 5PPM stability; etc. This aeronautical transceiver is equipped for a changing environment, as airspace frequency congestion, VDL Mode 3/4 amd others all contribute to the uncertainty of tomorrow's airspace needs.
3. **Rohde & Schwarz M3AR Software Defined VHF/UHF Transceiver** – This unit is a multiband-capable airborne transceiver of modular design and state-of-the-art technology. Frequency hopping is an ECCM method that is available as an option in all types, which provides reliable protection against active jamming, even at high speed flights. It can also encrypt voice and data transmissions up to 16kb/s.

Civil aviation requires VHF/UHF frequency ranges at: 108MHz to 117.975MHz AM (receive only) and 118 to 136.975MHz AM, with additional 8.33kHz channel spacing. Military aviation uses frequency ranges of 30 to 87.975MHz FM and 225 to 399.973MHz AM/FM. This VHF/UHF unit consists of MR6000A in an ARINC 600 housing, including the MR6000L and MR6000R models, both of which are ARC-164 form- and fit-compatible. The R&S MR6000L, illustrated in Figure 5a, contains a local control panel, while MR6000R is remote-controlled, shown in Figure 5b. However, all M3AR radios can be remote-controlled via the MIL-STD-1553B data bus, as well as by the R&S GB6500 control unit, shown in Figure 5b. The MR6000A transceiver, shown in Figure 5c has a frequency-agile pre-/postselector for best co-channel behaviour. The fast frequency-hopping filter effectively reduces wideband noise during transmission. In receive mode, any unwanted signals are suppressed by the filter, thus preventing negative effects such as cross-modulation, blocking or de-sensitization. Software that can be adapted to changing standards without hardware modifications and state-of-the-art technology ensures a long product-life. The receiver features excellent sensitivity, high cross-modulation immunity, selectivity and suppression of strong interference signals. The transmitter is optimized for low spurious emissions and the suppression of wideband noise.

The R&S M3AR transceivers have the following features:

1. A flexible range of applications, including high power for secure communications, even during very-low-level flights and higher altitude instrument flying; a pre-set concept permits flexible participation in various networks through simple presets; suitable for military fixed-or rotary-wing aircraft; and flexible

integration through different units interfaces (MIL-STD-1553B data bus, RS-485, ARC-164) or front panel control.

2. The M3AR family can be flexibly integrated into an aircraft, via the MIL-STD-1553B data bus, RS-485, ARC-164 or front panel control, as shown in Figure 6. The MR6000L/MR6000R with a local control panel is easily installed directly in the cockpit. Alternatively, the MR6000L/MR6000R offers remote control capability via the MIL-STD-1553B data bus, through the R&SGB6500 control unit or by means of RS-485 serial interface in conjunction with the applicable R&S protocol. A maximum of three GB6500 units can control up to five M3AR transceivers over a system bus.

> The aeronautical VHF transceiver is used onboard all types of aircraft for commercial traffic control, safety, security and distress communications

VHF Panel-Mounted Transceiver Systems

The VHF panel-mounted transceiver systems are medium and small panel systems integrated with a control panel display and installed onboard medium or small aircraft and helicopters. These include:

1. Icom VHF iA200 Air-band Transceiver – This transceiver displays all information on-panel for easy day/night viewing, shown in Figure 7a. The USE and STBY (standby) frequencies simultaneously appear on the display. Switches and the function display are dimmed for night flying. The automatic squelch function eliminates inconvenient manual squelch adjustments.

The front panel is shown in Figure 7a consists of the following:

1. The large tuning knob changes the STBY/USE window frequency in 1MHz steps, selects a memory channel and programs a selected memory channel as a blank channel.
2. The small tuning knob changes the STBY/USE window frequency in 25 or 50kHz steps.
3. The volume control turns power ON and adjusts the audio level, while when pulled OUT opens the squelch manually for testing.
4. The channel switch recalls a memory channel in the STBY/ window, so when pushed and held, it allows programming of the memory channel.
5. The frequency exchange switch exchanges the USE/window frequency for the STBY and vice versa, but when pushed and held it hides the STBY/window frequency and allows the selection of the USE window frequency directly.

2. Filser ATR 57 VHF Transceiver – This is the smallest transceiver covering the aeronautical RF range from 118MHz to 136.975MHz in 25kHz increments with 760 channels, shown in Figure 7b. This unit was developed to meet all the operational requirements encountered in VFR flying; it is designed as a single block unit with 57mm diameter for instrument panel mounting. All controls and indicating displays are located on the front panel. On the rear panel is a sub D9 connector interfacing with the aircraft wiring. The VHF antenna connects to a BNC socket. The volume and squelch level can be selected easily. The controls, as illustrated in Figure 7b, are:

1. Volume/Squelch/VOX button;
2. ON/OFF/switch;
3. MHz/kHz push-button;
4. Tuning knob for volume/squelch/VOX and standby frequency;
5. Change standby frequency to active frequency;
6. Store button;
7. MEM select stored frequency;
8. "B", low-battery display, shown when voltage is < 10.5V;
9. "><", changing the frequency range;
10. MHz-range of standby frequency;
11. KHz-range of standby frequency;
12. "-", shown at loss of transmitting or receiving frequency setting; and
13. "T", shown during transmitting mode, and "R", shown during receiving mode.

This unit can memorize nine VHF frequencies for faster access in operation and contains a special intercom facility controlled by the VOX (Voice Operated X-mission). This is a voice-level-controlled switch for the headset to display all information on-panel while not speaking. For good VOX performance, identical microphones should be used in order to guarantee the same input level. Two microphones, two headphones and an additional speaker can be connected to the unit. For intercom operation with very different microphones an optional intercom switch can be installed to turn off the background manually.

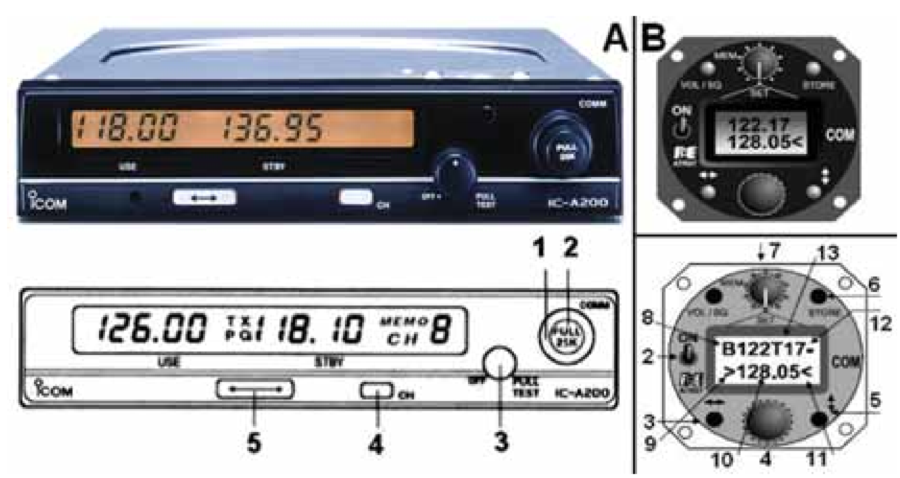


Figure 7: Aircraft medium and small panel-mount VHF transceivers

UNDERSTANDING THE 3-D GEOMETRY OF A TRI-GATE TRANSISTOR AND HOW IT CAN IMPROVE FPGA PERFORMANCE

By Craig Davis, Product Marketing Manager, Altera

Altera® has recently announced their Generation 10 family of FPGA devices. This new breed of FPGAs uses the 3-D geometry and structure of the Intel Tri-Gate transistor. The Tri-Gate (also known as FinFET) technology provides a host of important improvements over the historic planar transistor structure, all related to the three sided 'wrap-around' effect of the MOSFET 'gate' around the source-to-drain 'channel', hence Tri-Gate. These advantages manifest in improved performance, reduced active and leakage power, transistor design density, and a reduction in transistor susceptibility to charged particle single event upsets (SEU). See Figure 1

The key performance advantage of Tri-Gate transistor architecture over traditional planar transistors can be found in the effective width of the conducting channel. The current drive capability and performance of a transistor is directly proportional to its effective channel width. The effective channel width can be significantly enhanced in a 3-D transistor structure relative to a planar transistor because of the ability to extend the width in the third dimension without any impact on the layout area as shown in

Figure 1. This provides the potential for both enhanced design flexibility for the designer of the transistor, as well as increased performance without the same penalties in 2-D area that exist when enhancing channel width in a planar transistor.

The power advantage results from the improved control of the channel by the gate's electric field on three sides of the fin. This reduces the sub-threshold leakage current from source to drain in the 'off' state as compared to a planar transistor. In addition, the power supply voltage can be significantly reduced with Tri-Gate transistors while maintaining superior speed due to the increased effective width compared to a planar transistor. The combination of lower supply voltage and reduced leakage current results in substantial power savings. See Figure 2.

Each new generation of silicon manufacturing technology generally involves a geometry shrink, or reduction in overall gate and transistor structure, that results in higher density and more capable silicon. The 3-D Tri-Gate structure itself also accommodates higher density transistor designs by extending the transistor width characteristic into the third dimension. This allows designers the ability to trade off the size and width of the transistor 'fin' based on performance, power, and transistor density packing objectives. In the case of Altera's move to 14 nm Tri-Gate design, Altera will benefit from both the transistor geometry shrink to 14 nm, and from further density improvements allowed by Tri-Gate transistor design.

The SEU advantage results from the small cross-sectional area connecting the fin to the substrate in the Tri-Gate structure. This creates a smaller cross-sectional area over which charge generated by ionizing particles can be collected than in a planar transistor. The reduced susceptibility to charged particles causing bit-flips in 3-D transistor-based circuits is supported by early testing on Intel's 22 nm implementation of Tri-Gate transistors in their products.

The substantial advantages of Tri-Gate silicon technologies will allow Altera to deliver previously unimaginable performance in FPGA and SoC products. This will include a historic doubling of core performance as compared to other high-end FPGAs, bringing FPGAs to the gigahertz performance level. Overall active and static power numbers will reduce by 70 percent through a combination of process, architecture, and software advances.

Altera users can begin designs today that take advantage of the significant performance and power efficiency benefits of Tri-Gate technology in FPGAs. This is possible by beginning designs with the Arria®10 portfolio of 20 nm FPGA devices. Users can then take advantage of pin-for-pin design migration pathways from Arria 10 FPGA and SoC products to Stratix® 10 FPGA and SoC products as they become available.

For more information: www.altera.com

Figure 1

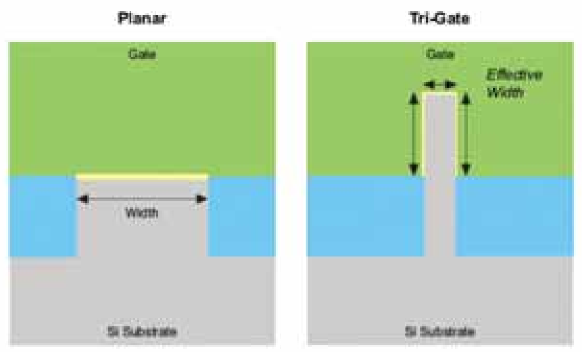
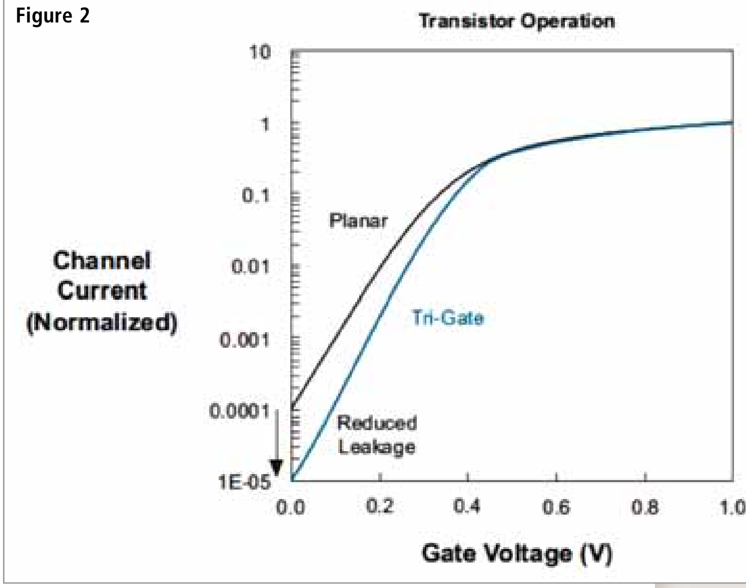


Figure 2



FREQUENCY ADJUSTMENT OF FLYBACK CONVERTERS, BASED ON INDUCTANCE CORRECTION

LING-FENG SHI, ZHI CAI AND QIN-QIN LI OF XIDIAN UNIVERSITY IN SHAANXI, CHINA, PROPOSE A CIRCUIT THAT COMPENSATES FOR INDUCTOR VARIATIONS IN TRANSFORMERS AND POWER SUPPLIES

The flyback transformer is the key part of flyback converters. However, complex design parameters and different manufacturing processes often lead to inductor variations in the primary inductance. In order to avoid these effects on the output power and the switching power-supply's performance, an inductance correction circuit is suggested here. By adjusting the switching frequency, this circuit completely compensates for the output power variations caused by such transformer inductance variances.

The design of the circuit is verified using an HSpice simulator based on the 0.5µm 700V BCD process. For flyback AC/DC converters with 220V/50Hz input and 5V/1A DC output, inductance variances are completely compensated with this circuit. As the primary inductance of the transformer varies as much as 10%, the output voltage variance is limited to ±10% and the output current variance is limited to ±3.4%.

Using Power Supplies

Switching power supplies are widely used in communications, computers and other fields. The flyback converter has been an important part of such applications because of its excellent performance for multiple outputs.

In a flyback converter, the transformer operates like an inductor made of two elements. The primary side is used to magnetize the core and store the energy on a cycle-by-cycle basis, whilst the secondary side demagnetizes the core and transfers stored energy to the load. So, if there is a large variation in the primary inductance compared to the ideal, the performance of the flyback converter will drop dramatically and the accuracy of the output signal will be badly affected too. However, conventional design methods always tend to ignore the deviation caused by these variances.

Here we present a specific implementation of an inductance correction circuit to be applied on flyback converters. It calculates the variance of the primary inductance and compensates the output power according to the current detected from both the feedback and control pins in each cycle.

Basic Concepts

A commonly used flyback power supply circuit is shown in Figure 1. The input AC signal suppresses differential-mode and common-mode interference and acts as a rectified input voltage V_{in}. The on and off state of the MOSFET is determined by the switch control chip. During the on time of one switching cycle, the current flows through the primary side of the transformer and energy is stored in magnetized inductance. At this time the secondary rectifier diode is off and the transformer has no load.

During the off time, the energy stored in magnetized inductance is released and transferred on to the secondary side. After rectification and filtering, the output is a DC voltage. We have

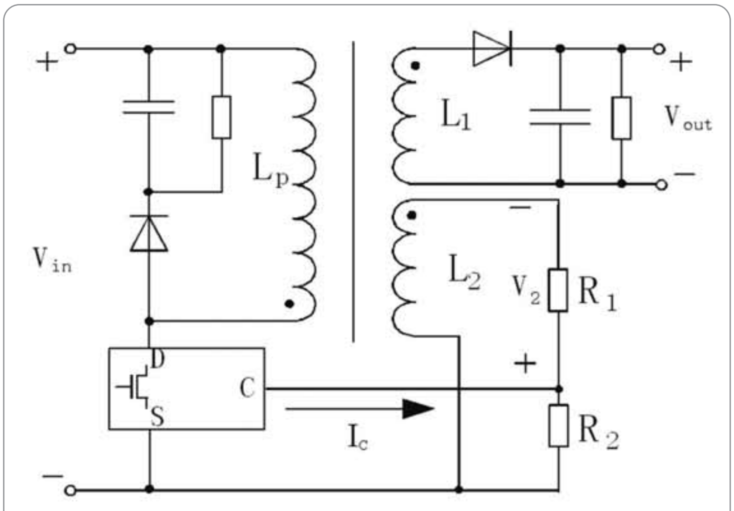


Figure 1: Typical flyback converter circuit

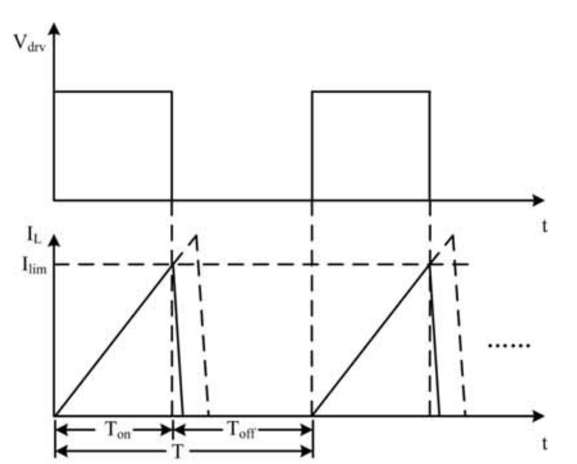


Figure 2: Relationship of inductance current I_L and driving signal V_{drv}

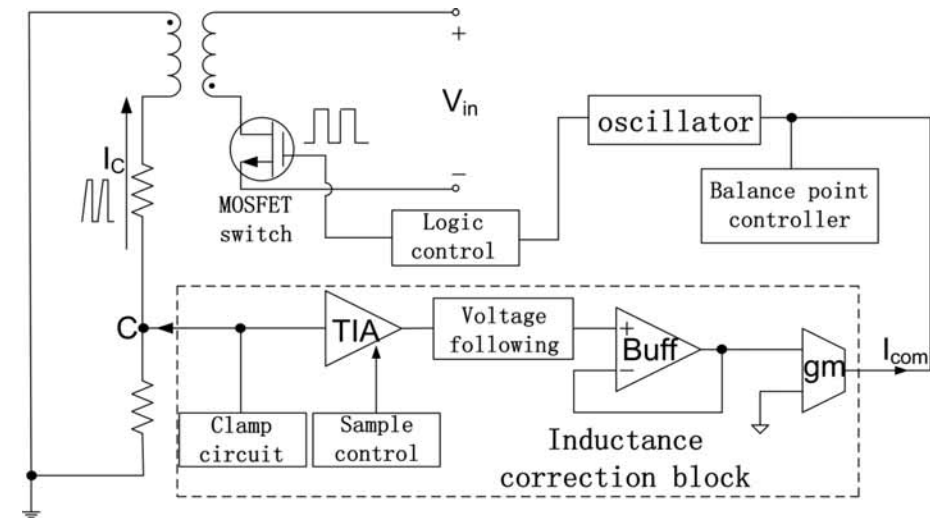


Figure 3: Function block of the inductance correction circuit

selected DCM (Discontinuous Conduction Mode) for inductance correction, in which the inductor current falls to zero after the MOSFET switch is closed and held until the next switching cycle begins. The energy stored in the transformer during the on time is then completely transferred to the output terminal.

Assuming the efficiency of the transformer is η, the energy stored and released in the primary side of the transformer during one cycle is:

$$E_P = \frac{P_O}{f_{sw}\eta} \tag{1}$$

where P_O is the output power and f_{sw} is the switching frequency of the MOSFET.

At the same time, the energy stored on the primary side during the on time of one cycle is:

$$E_P = \frac{I_{\lim}}{2} V_{in} T_{on} \tag{2}$$

where $I_{\lim}$ is the peak inductance current and T_{on} is the on-time of the MOSFET.

Assuming the primary inductance is:

$$L_p,\ V_{in} = L_p \frac{di}{dt} \text{ and } \int_0^{T_{on}} V_{in} dt = \int_0^{I_{pk}} L_p di$$

respectively, according to the relationship in Figure 2, so I_{lim} can be expressed as:

$$I_{\lim} = \frac{V_{in} T_{on}}{L_P} \tag{3}$$

It follows from Equations 1 to 3 that:

$$P_O = \frac{f_{sw}\eta L_P I_{\lim}^2}{2} \tag{4}$$

Thus, by adjusting the switching frequency f_{sw}, the output power variations caused by transformer inductance variances can be completely compensated for.

The Measuring Principle of Inductance Variance

As shown in Figure 1, a three-winding transformer was selected, where L_p is the primary winding, $L1$ the secondary winding and L_2

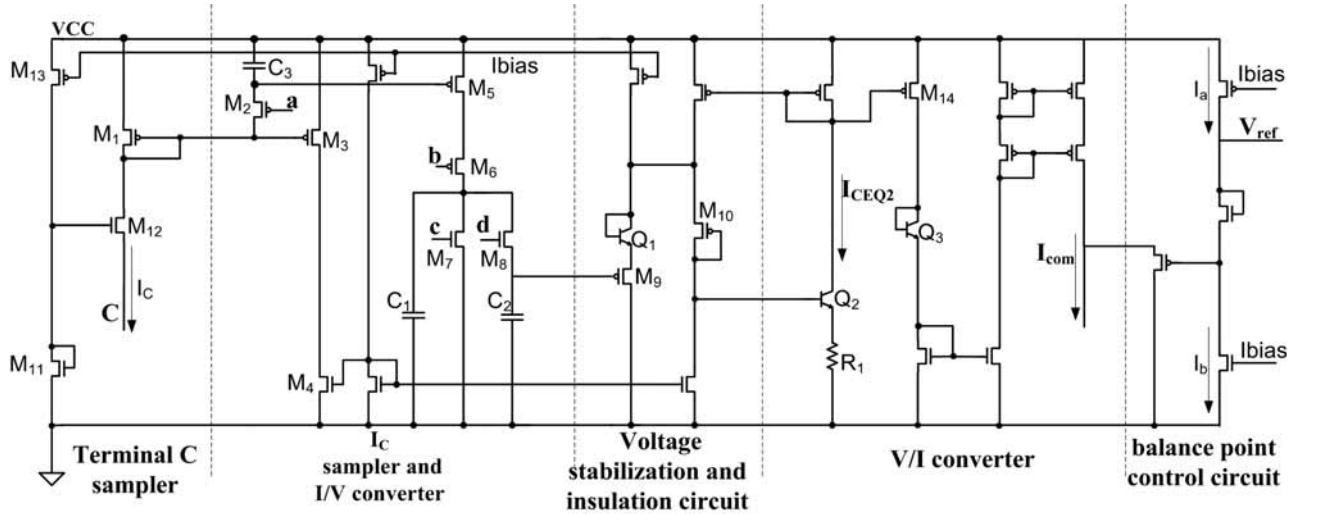


Figure 4: The proposed correction circuit

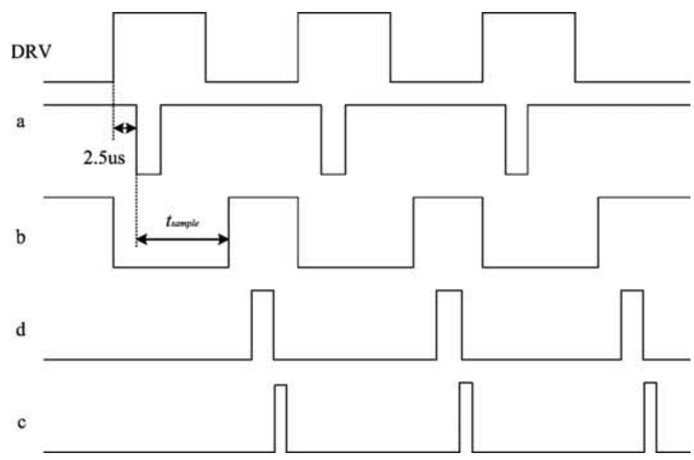


Figure 5: Current sample and I/V converting timing design

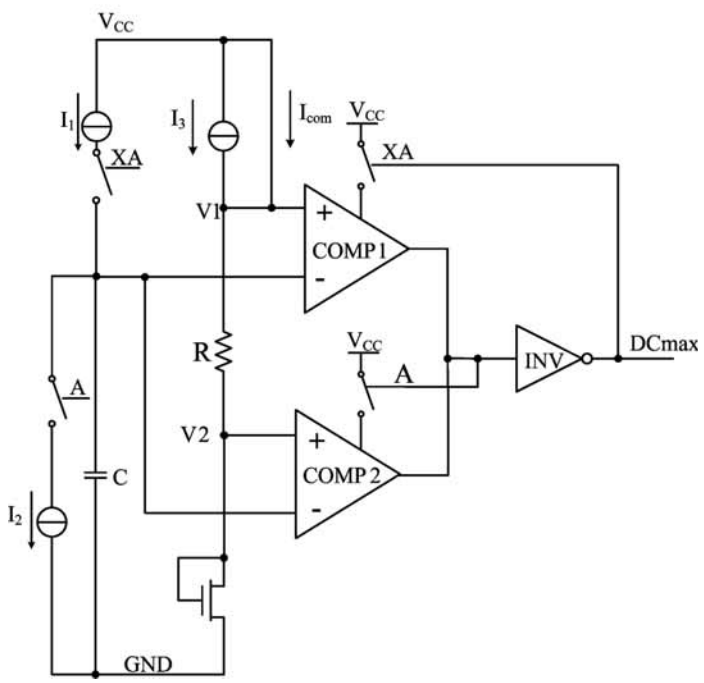


Figure 6: Oscillator

the feedback control winding. The winding inductance of the transformer is:

$$L = \frac{k\mu_0\mu_S N^2 S}{l} \qquad (5)$$

where l is the length of transformer windings (m); k is the proportion of the winding radius R to the length l; μ_o is the vacuum magnetic permeability and is equal to $4\pi\times10^{-7}$; μ_s is the relative permeability of a magnetic core inside a winding; S is the sectional area of the windings (m²); and N is the winding turn ratio.

Assuming that the magnetic conductivity of the magnetic cores is constant, changing the different number of primary windings will lead to a different primary inductance L_P, producing inductance variance.

If we assume the number of primary winding turns of the transformer is N_P, the feedback winding turns is N_2, then the winding turns ratio is $n = N_2/N_P$. During the on time of the MOSFET, the voltage across the feedback winding L_2 can be expressed as:

$$V_2 = \frac{N_2}{N_P} V_{in} = nV_{in} \qquad (6)$$

If the potential of terminal C is clamped to 0, the voltage across the voltage divider will be 0:

$$V_2 = I_C R_1 \qquad (7)$$

It can be derived from Equations 5 to 7 that:

$$I_C = \frac{1}{\sqrt{L_P}} \times \frac{V_{in}N_2}{R_1} \sqrt{\frac{k\mu_0\mu_S S}{l}} \Rightarrow I_C \propto \frac{1}{\sqrt{L_P}} \qquad (8)$$

So I_C^2 is inversely proportional to L_P. That means the variations of L_P can be expressed by the current I_C coming out of pin C. In an application, the actual value of L_P is relatively small (in this article the standard value of the primary inductance is 1.0mH). Consequently, this inverse relationship between I_C and L_P reduces the absolute error of L_P, and the range of inductance variances can be adjusted by an inductance correction circuit. According to the inductance correction compensation principle mentioned earlier, by adjusting the switching frequency f_{sw} and setting up an inverse appropriate relationship between I_C and f_{sw}, the inductance variance can be completely compensated for, and the output power will remain unchanged.

Design and Implementation of the Circuit

According to the earlier analysis, the inductance correction circuit functions during the switch's on time in each cycle. The frequency of the oscillator is adjusted by the feedback current at pin C.

As shown in Figure 3, the proposed implementation in this article realizes the inductance-adjusting function in three parts. The first part is the integrated correction circuit block, which samples the current flowing through pin C. The output current I_{com} changes with I_C.

The second part is the oscillator, with frequency directly related to the current I_{com} and which controls the switch; that way the output power's variation caused by the inductance variance is corrected.

The third part is the balance point control circuit, used to keep a stable current flowing into the oscillator.

Operating Principle of the Internal Correction Circuit

The internal correction circuit is shown in Figure 4, in which M_1, M_{11}, M_{12} and M_{13} are made of a voltage-clamped circuit at C. When the diode-connected transistor M_{11} has a large W/L $[(W/L)_{11} = 45]$, then $V_{GS11} \approx V_{TH}$ and M_{12} has a much larger W/L $[(W/L)_{12} = 150]$, so the voltage at terminal C is clamped to 0 during the on time of the switch:

$$V_C = V_{GS11} - V_{GS12} = 0 \qquad (9)$$

M_1, M_2 and M_5 constitute a current-sample circuit; M_6, M_7, M_8, C_1 and C_2 are used as I/V converting circuit. In Figure 4, a, b, c and d are the digital signals controlling the relevant MOS transistors, and their design is shown in Figure 5.

The current sampler and I/V converter operate as follows: When the driving signal changes from low to high, corresponding to 2.5μs, after which a stable and precise current can be obtained and the MOSFET turns on, terminal a will turn M_2 on with a low narrow pulse, which makes M_2 and M_5 create a current mirror, where the current I_C flowing through M_1 is 'copied' on to M_5 in proportion. The capacitor will keep the gate voltage of M_5 constant after M_2 is on, to maintain the sample current. Terminal b will turn on M_6 when the MOSFET is on, and the sample current will flow into C_1. The voltage of C_1's upper plate can be expressed as Equation 10:

$$V_{C1} = \frac{1}{C_1}\int_0^{t_{sample}} I_C dt = \frac{I_C}{C_1} t_{sample} \tag{10}$$

where t_{sample} is the charging time of C_1.

At the end of on-time T_{on}, DRV changes from high to low; terminal d sends the voltage of V_{C1} to the gate of M_9 with a high pulse and, at this point, capacitors C_1 and C_2 are in parallel. After the high pulse of terminal d, terminal c outputs a high pulse to discharge capacitor C_1 before the arrival of the next clock cycle. Up until then, the charge in C_2 will keep the voltage of M_9 steady.

The process of the I/V conversion is described by the equations as follows: Assume that the initial gate voltage of M_9 is zero. According to the conservation of charge stored in a capacitor, after one period, the gate voltage of M_9 can be expressed as Equation 11:

$$V_{G9}(1) = \frac{C_1}{C_1 + C_2} V_{C1} = \frac{I_C}{C_1 + C_2} t_{sample} \tag{11}$$

After two periods:

$$V_{G9}(2) = \frac{C_1 V_{C1} + C_2 V_{G9}(1)}{C_1 + C_2} = \left[\frac{1}{C_1 + C_2} + \frac{C_2}{(C_1 + C_2)^2}\right] I_C t_{sample} \tag{12}$$

After n periods:

$$V_{G9}(n) = \frac{C_1 V_{C1} + C_2 V_{G9}(n-1)}{C_1 + C_2} = \left[\frac{1}{C_1 + C_2} + \frac{C_2}{(C_1 + C_2)^2} + \cdots + \frac{C_2^{\,n-1}}{(C_1 + C_2)^n}\right] I_C t_{sample} \tag{13}$$

$n \to \infty$, V_{G9} tends towards stability.

$$V_{G9} = V_{C1} = \frac{I_C}{C_1} t_{sample} \tag{14}$$

when the I_C has a change ΔI_C induced by the inductance variance of L_P, V_{G9} will be stable, as described by Equation 15:

$$V_{G9} = \frac{I_C + \Delta I_C}{C_1} t_{sample} \tag{15}$$

Also, I_C has a negative relation to $\sqrt{L_P}$ according to Equation 8. M_9, M_{10} and Q_1 make up a voltage-follower, which is used for voltage stabilization and isolation.

The base voltage of Q_2 can be expressed as Equation 16:

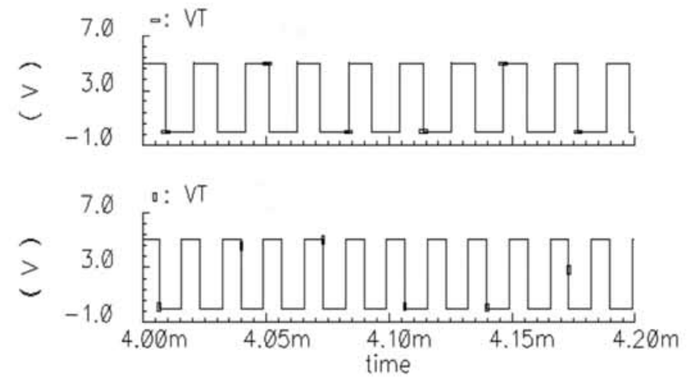


Figure 7: Oscillator output waves when L_P = 0.9mH

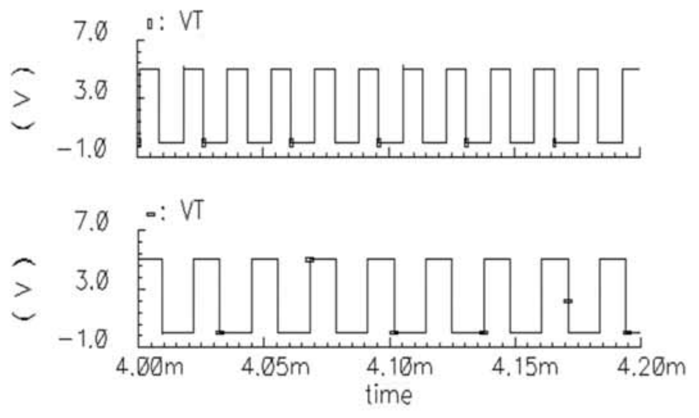


Figure 8: Oscillator output waves when L_P = 1.2mH

$$V_{BQ2} = V_{G9} - V_{GS9} + V_{BEQ1} + V_{GS10} \tag{16}$$

Q_2 and R_1 form an operational transconductance amplifier, which converts the base voltage V_{BQ2} to current I_{CEQ2}:

$$I_{CEQ2} = \frac{V_{BQ2} - V_{BEQ2}}{R_1} \tag{17}$$

where M_9 and M_{10} have the same W/L of 10/1, and bias current of 1μA and $V_{BEQ1} = V_{BEQ1}$. Consequently, combined with Equation 16 and Equation 17, Equation 18 can be obtained as:

$$I_{CEQ2} = \frac{I_C + \Delta I_C}{C_1 R_1} t_{sample} \tag{18}$$

This current is mirrored by M_{18}.

The Oscillator

The structure of an oscillator is shown in Figure 6. The two comparators' threshold voltages V_1 and V_2 are created when the current source I_3 flows through the resistance R; they are then compared with the voltages formed by the charging and discharging of the capacitor. The high or low output voltages form the square wave signal DC_{max}. The current produced by the inductance correction circuit flows through the upper plate of C, and generates the oscillator frequency f_{sw}. The value of V_{ref} has to be adjusted to ensure $I_a = I_b$ and $I_{COM} = 0$ when the oscillator works at the normal frequency (Figure 4), i.e. the inductance correction circuit does not feed any current to the oscillator.

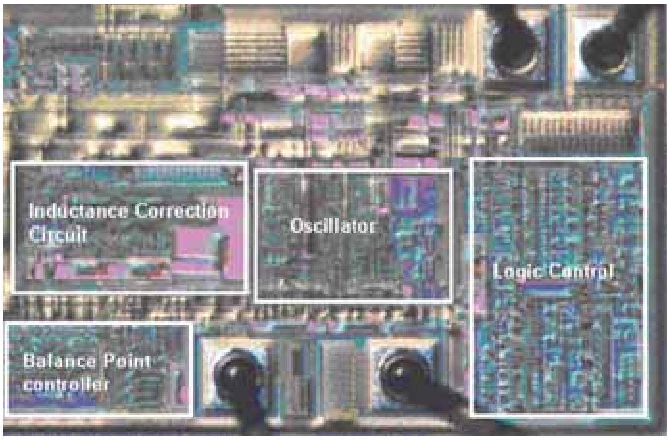


Figure 9: Micrograph of the proposed inductance correction circuit

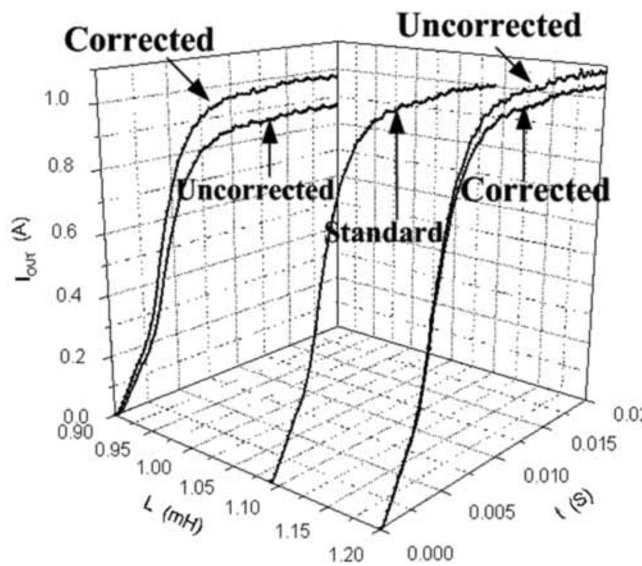


Figure 10: Effect on output current by inductance correction circuit

Circuit Verification

The proposed circuit is verified in an AC/DC flyback converter with 220V/50Hz input, 5V/1A DC output and a 5Ω load resistor conditions. It is calculated that the standard value of the primary inductance should be 1.0mH. Figure 7 and 8 show the situation when the value is lower (0.9mH) or higher (1.2mH) that this value. Both of them show the differences in frequency with and without an inductance correction circuit (also see Figure 9). It can be concluded that the frequency of the oscillator changes significantly with a deviation in the primary inductance.

The correction effect is shown in the current waves as seen in Figure 10, which illustrates the output current wave when L_P is normal and with an error. It can be seen that this inductance correction circuit reduces the output current variances from ±8.2% to ±3.4% by the simulation results in DCM when the primary side inductance variance is within ±10%; the error is halved.

The proposed circuit can, therefore, be used in reference circuits and to improve pulse modulation techniques, as well as the performance of switching power supplies. ●

FACE IDENTIFICATION AND VERIFICATION USING FINGERPRINT RECOGNITION

BIOMETRIC FEATURES HAVE BEEN USED FOR RECOGNITION AND IDENTIFICATION FOR SOME TIME, HOWEVER, RELIABLE AUTOMATIC RECOGNITION OF PEOPLE IS NOW OF INTEREST TO MANY RESEARCHERS, SAYS **DR GHOLAMREZA ANBARJAFARI**, SENIOR LECTURER AT CYPRUS INTERNATIONAL UNIVERSITY, LEFKOŞA, TURKEY

Biometric features of people, such as the face, irises and fingerprints have been used for individual's recognition and identification for some time. Face and fingerprint recognitions are two of the most well-known biometric recognition methods, with fingerprint recognition being used for centuries. Fingerprints are a unique human identifier and this method dates back to the second century BC in China, where the identity of the sender of an important document was verified by his fingerprint impression in a wax seal.

The modern use of fingerprints dates to 1850s; however in the late 1960s, the FBI and the Home Office in London worked on a system simultaneously, to eventually develop a minutia-based fingerprint identification system. Such system was first installed in Tokyo in 1981 and then San Francisco in 1983.

The first country to adopt a national computerized form of fingerprint imaging was Australia in 1986, which implemented the technology into its law enforcement system. In 1996, after nearly a year of analysis, the US National Institute of Standards and Technology adopted minutia-based recognition too, with biometric data stored on smartcards.

The earliest work in computer recognition of faces was reported by Woodrow W. Bledsoe in the mid 1960s. Another researcher, Kanade, used a method of characterizing the face by geometrical parameterisation, whereby distances and angles between points are used. Statistical face recognition systems, such as the Principal Component Analysis (PCA) based eigenfaces method, introduced by Turk and Pentland, attracted a lot of attention. Relhumeur et al introduced the fisherfaces method, based on Linear Discriminate Analysis (LDA), which minimizes the discrimination within a class and maximizes the discrimination between classes.

The histogram of a gray-level image is considered another suitable statistical descriptor, and it shows the distribution in terms of occurrence frequencies of gray-level pixel intensities.

The histogram of a face can be considered to be its signature, so a two-dimensional face image can be represented as a one-dimensional vector. Yoo et al used chromatic histograms as a model of faces to perform face detection. Timo Ojala, Matti Pietikhenl and David Harwood divided a face into several blocks and then extracted the Local Binary Pattern (LBP) feature histograms from each block and concatenated them into a single global-feature histogram, efficiently representing the facial image. The recognition is performed by simple distance-based histogram matching. Hasan Demirel and myself introduced a probability distribution function based face-recognition system using the Kullback-Leibler divergence as a metric, in order to find the distance between two PDFs.

In this article we introduce an identification of a person by using the PCA-based face-recognition method, followed with fingerprint verification.

Figure 1: Fingerprint image

Fingerprint Recognition

A typical fingerprint feature pattern is shown in Figure 1. It is typically composed of many ridges and furrows, and there are good similarities in small sections between them, such as the parallelism between some of them and their average widths. However, fingerprints are not distinguished by the ridges and furrows themselves, but by minutia – abnormal points on the ridges. Among the variety of minutia types, two are most significant: termination, which is the ending of a ridge, and bifurcation, which is the point on the ridge from which two branches derive.

Fingerprint-matching techniques can be placed into two categories: minutiae-based and correlation-based. Minutiae-based techniques first find the minutiae points and then map their relative placement on the finger. However, there are some difficulties with this approach, including extracting the minutia points accurately when the fingerprint is of low quality. Also, this method does not take into account the global pattern of ridges and furrows. The correlation-based method is able to overcome some of these difficulties, but it has shortcomings, too.

Correlation-based techniques require the precise location of a registration point and are affected by image translation and rotation. In order to classify fingerprints, there are a few steps to follow:

- Image noise elimination;
- Edge detection;
- Feature extraction.

Fingerprint recognition can be grouped into two sub-domains: verification and identification. In this article we have used fingerprint identification for verification of faces. Figure 2 shows the general steps of a fingerprint recognition system.

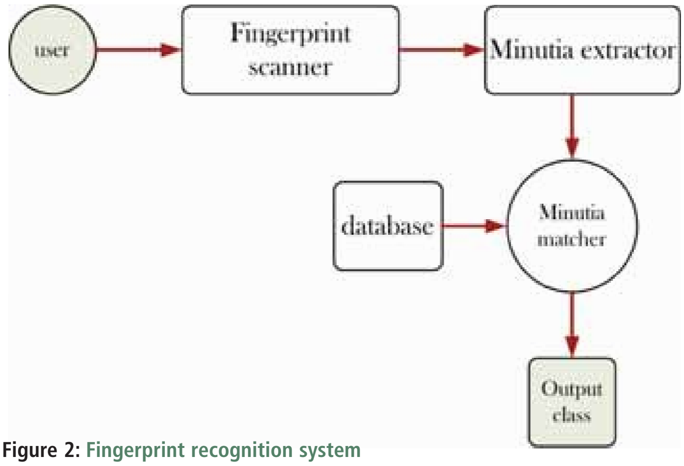


Figure 2: Fingerprint recognition system

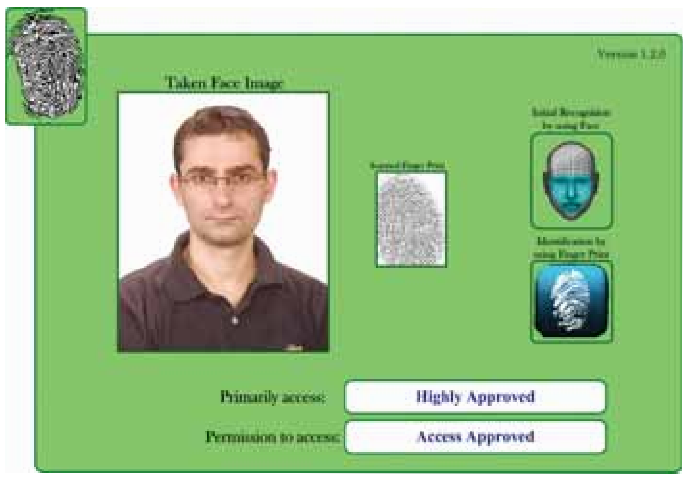


Figure 3: The GUI's main window, consisting of several interactive push-buttons

PCA-Based Face Recognition

The eigenfaces method is based on linear PCA where a face image is encoded into a one-dimensional vector. All face images are broken down into a small set of characteristic feature images called eigenfaces. Each face image is projected onto a subspace of meaningful eigenfaces, i.e. those with non-zero eigenvalues, so the collection of weights will describe a face. Recognition of a new face is performed by projecting it onto the subspace of eigenfaces and then comparing its weights with the corresponding weights of each face from a known database.

Assuming all face images in a database are of the same size w×h, eigenfaces are obtained as the eigenvectors of the covariance matrix of the data points.

Let Γi be an image from the collection of M images in the database. A face image is a two-dimensional array of size w×h, where w and h are width and height of the image, respectively. Each image can be represented as a vector of dimension w×h, and the average image Ψ is then defined as:

$$\Psi = \frac{1}{M}\sum_{i=1}^{M}\Gamma_i \qquad (1)$$

Each image Γi differs from the average image Ψ by the vector:

$$\Phi_i = \Gamma_i - \Psi \qquad (2)$$

The covariance matrix of the dataset is defined as:

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi_n\Phi_n^T = \Lambda\ \Lambda^T$$
$$\Lambda = [\ \Phi 1\ \Phi 2\ \dots\ \Phi M\ ] \qquad (3)$$

Since there are M images in the database, the covariance matrix C has only M-1 meaningful eigenvectors. Those eigenvectors u_l can be obtained by multiplying eigenvectors v_l of matrix L = $\Lambda^T\Lambda$ (of size M×M) with difference vectors in the matrix Λ.

The eigenvectors u_l are called the eigenfaces. Eigenfaces with higher eigenvalues contribute more in representing the face image. The face subspace projection vector for every image is defined by:

$$\Omega^T = [\omega_1 \quad \omega_2 \ \dots\ \omega_{M'}]$$
$$\omega_k = u_k^T(\Gamma - \Psi) \qquad k = 1,2,\dots,M' \qquad (4)$$

The projection vectors are indispensable in the face recognition tasks, due to their uniqueness. The projection vector, which represents a given face image in the eigenspace, can be used for face recognition. Euclidian distance, ε, between the projection vectors of two different images (Ω_1 and Ω_2) is used to determine whether a face is recognized correctly or not:

$$\varepsilon = \|\Omega_1 - \Omega_2\| = \sqrt{\sum_{i=1}^{M}(\omega_{1i} - \omega_{2i})^2} \qquad (5)$$

While for a perfect reconstruction of the face image all the coefficients may be needed, for recognition only the most significant coefficients play an important role.

Graphical User Interface Of The System

The proposed system takes a picture of the face of the user, and then uses PCA to classify the person. The classified face image will be verified by recognizing the fingerprint of the user which has been entered into the system via a fingerprint scanner. If the fingerprint also verifies that the face belongs to the correct class, an access verification message will be displayed, otherwise access is denied.

The software was written in MATLAB 2009. In order to make the programme more user-friendly, we also used the software's toolbox's GUI. The system has been trained and the GUI used for test only. If a new person is introduced into the system, their various facial expressions, as well as two fingerprint images, will be saved into the database.

The codes are changed into an executable file, FPFR.exe, which will start the programme. Creating an .exe, .obj and .dll file of the codes will make programming the hardware interface in C/C++ much easier. These files can be called in any high-level computer language.

The main window is shown in Figure 3. It consists of two push-buttons, two figure-locations to show the input face image and the input fingerprint image, and two text-boxes to announce the primary recognition, obtained from face recognition, and the final access condition after verification by using fingerprint. The two push buttons are:

- Initial recognition by face – this captures a face image and then classify the face using PCA.
- Identification by fingerprint – this starts the verification process. The complete procedure will be performed while this window is open. 'Access Denied' or 'Access Approved' notices will be displayed in the provided box after verifying the face.

The proposed system was successfully tested on a database of 100 face and fingerprint images of students at the Cyprus International University. The system achieved a 100% verification rate. ●

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KEYNOTE 2: Jeffrey Cassis, Senior Vice President, GM Global Lighting Systems, **Philips Lighting**, The Netherlands

KEYNOTE 3: Katya Evstratyeva, Analyst, **Strategies Unlimited**, USA

Klaus Vamberszky, Executive Vice President Technology, **Zumtobel Group**, Austria

Zoltan Koltai, EMEA Technology Director, **GE Lighting**, Hungary

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WEI CHEN, JIN LIU, QIANPING WANG, ZHENGMING XIE
MINING AND TECHNOLOGY IN JIANGSU PRESENT THEIR

Small Platform Control System Based on A Stable Free Pendulum

A stable control system is of great importance in navigation and autopilot applications and, especially, in the navigation of rescue robots. A coal-mine or disaster relief rescue robot for example, must always locate its targets while navigating in complex environments. For such applications, robots benefit from small size, light weight and flexible control systems. With fewer components such a control system can be more easily integrated into the robot.

We created such a system, which we describe here. It is composed of a swinging frame, a control unit, and a proportional integral derivative (PID) algorithm. The swinging frame includes angular sensors, ball bearings, steering gear and so on. The small control system includes a Freescale microcontroller unit (MCU) – the MC9S12XS128MAA, a potentiometer with 5K resistance, and other components.

The MC9S12XS128MAA is a 16-bit microcontroller from Freescale's S12 series. It has 80 pins, 8kB of RAM and 64kB of flash memory. The chip offers two asynchronous serial communication ports (SCI), three synchronous serial communication ports (SPI), 8-channel input capture/output compare timers, a 12 8-channel A/D converter (ADC) module and 8-channel pulse-width modulation (PWM) module. As such it can act as the core control processor and thus meet the requirements of our control system.

In addition, there's the single controller, peripheral modules including the core controller, electric power source, a motor drive and steering engine angular transducer, as illustrated in Figure 1.

The Setup

A laser source is fixed on a platform to make it focus on the vertically positioned target, which is 150cm away from the swing platform. Looking at Figure 3, when the vertical pendulum is in stationary and horizontal state, the height of the target is adjusted, so the laser can focus on it. This focus is then marked as a point. After the pendulum is pushed to an angle θ (between π/6 and π/3), the system is started. The laser is made to focus on the marked point within 15 seconds, and then continue to keep focusing on this point during the swing of the pendulum.

In order to keep the laser focusing on the marked point, the angle of the pendulum must be adjusted according to its movement. There is a simple trigonometric relationship between the adjustment of the horizontal position and the swing angle, so the steering angle can be calculated. The system uses built-in feedback steering to precisely control and adjust this angle.

We set the feedback value of the potentiometer angle sensor as a controlling parameter of the PID, and analyze the movement characteristic of the free pendulum plate. The relationship between the horizontal angle of the pendulumn plate (Figures 2 and 3) and the vertical angle of pendulum was then modelled. The exponential smoothing prediction algorithm is then applied to process. By tracking and controlling the dynamic mode of its plate, the stable pendulum can then move in synch with the system.

The 12-bit ADC inside the microcontroller can achieve accuracy of 0.1 degree. The modified steering gear acts as the power system to control the plate movement, which can then achieve a continuous 360-degree rotation and precise positioning. The internal potentiometer voltage output is used to calculate the angle of the pendulum plate. It was implanted on the pendulum shaft rotated by the pendulum arm (see Figures 2 and 3). The ADC measures the potential voltage and angle of the plate.

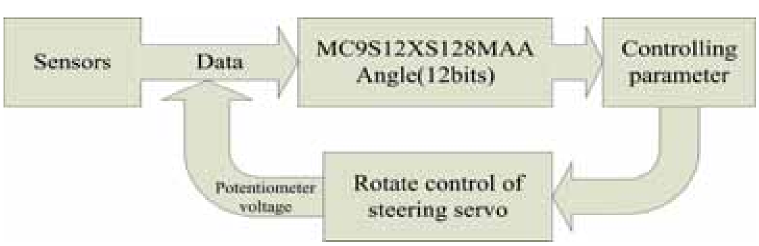
This is a closed-loop control system. The motor is equipped with a high precision potentiometer. As the ordinary steering gear can only rotate 180 degrees, we removed any physical restrictions and used the internal potentiometer voltage as control feedback.

The motor drive circuit with the L298 core acts as the driver module of the steering gear, which is attached to an opto-coupler. This model can be isolated from the control system; it can supply a large current; and is easy to control. As such, the steering control signal can also be easily converted to a DC motor control.

The Swinging Frame Structure

As illustrated in Figure 2, the height of the swinging frame is 150cm and its width 50cm. The upper end of the swinging frame is fixed by two ball bearings on a crossbar. With a fixed swing arm, they can swing freely in the vertical plane.

Figure 1: Block diagram of the system



AND **XIAOLONG SU** FROM THE CHINA UNIVERSITY OF PROJECT REVOLVING AROUND A FREESCALE MCU

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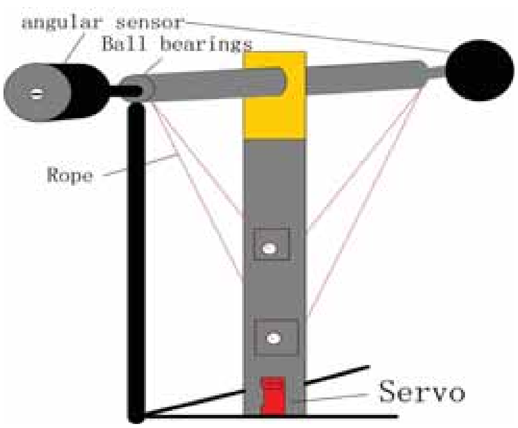

Figure 2: Swinging frame structure

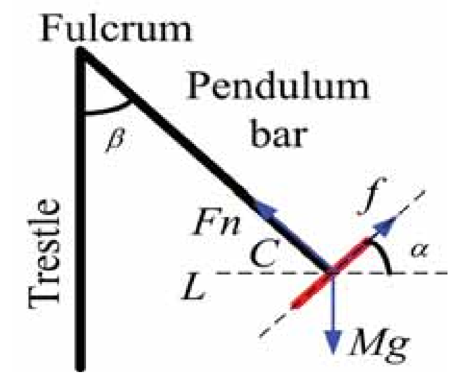

Figure 3: A stable placed structure

We placed the angle sensor on the end of the beams, with the modified steering gear at the end of the swing arm. This structure is similar to a pendulum system, whose cycle is:

$$T = 2\pi\sqrt{l/g}$$

When the pendulum swings, the stable objects will not fall of the plate, and the stable state is maintained by controlling the state of the pendulum. As shown in Figure 3, stable objects during their swing can be described by gravity *Mg*, supporting force *Fn* and frictional force *f*.

If the stable objects maintain a stable status, the plate motion state must match that of the stable objects; therefore, the acceleration of the plate must be the same as that of the stable objects. *Fn* is perpendicular to the plate, and the stable objects can keep their stable state when the plate traction is orthogonal to the plate.

Not much control is required on the plate during the swing. The key period of plate control is at the beginning, when the plate is parallel to the ground. Since angle $a = \beta$, we can see the steering gear rotation angle is proportional to the value of the angle sensor.

Circuit Design of a Small Control System

Figure 4 shows the small control system. AD0 is connected to the left angle sensor, AD1 is connected to the right angle sensor and AD2 steering gear's internal potentiometer pin. P1 is connected to steering gear's PWM interface. The function of the ENA pin is to switch the steering gear to the DC motor.

There are two kinds of sensors: one is a precision

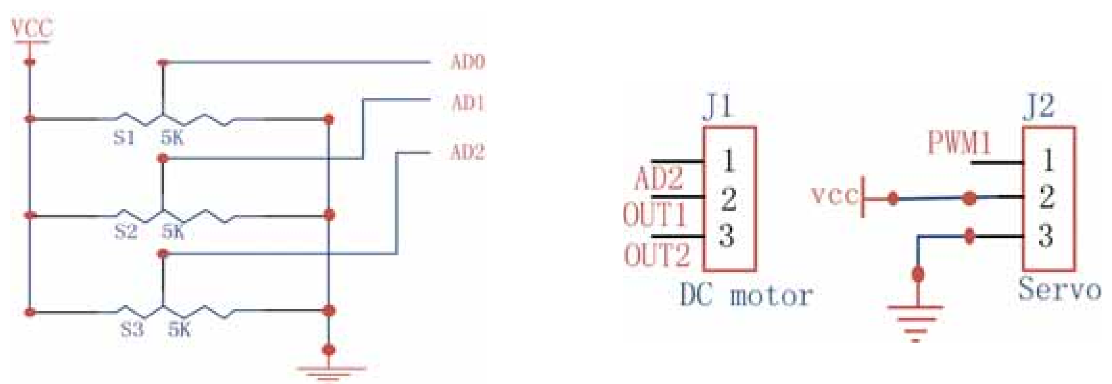

Figure 4: (a) Sensor module circuit; and (b) The interface of the modified steering gear circuit

THE PROJECT

This project is supported by "the Fundamental Research Funds for the Central Universities" (Grant No. 2013XK10) at the School of Computer Science and Technology, China University of Mining and Technology, Xuzhou city, Jiangsu province, PRC, 221116.

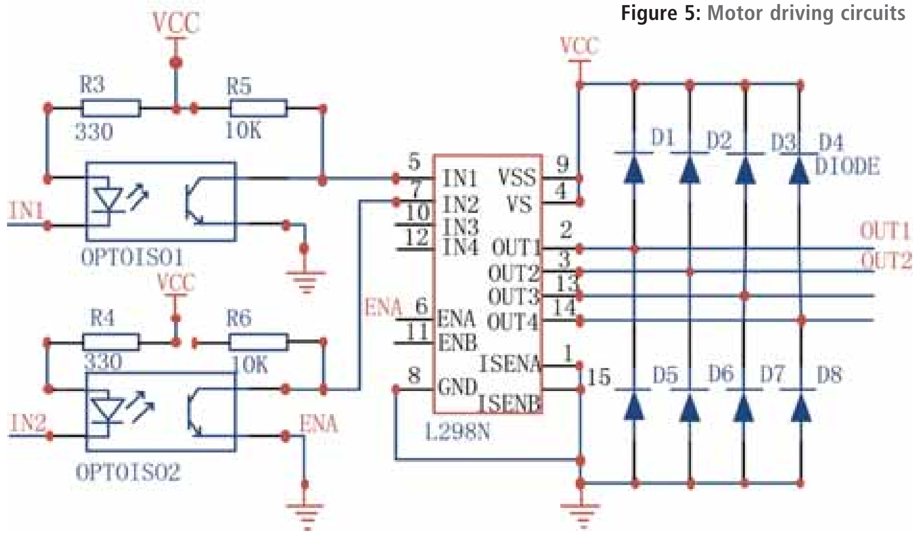

Figure 5: Motor driving circuits

potentiometer and the other is located inside the steering gear, as shown in Figure 4a. By removing the physical restrictions of the steering gear's motor, which can limit the arm within the angle of π/2, the output of feedback of the steering gear and the source of DC power can be collected, as shown in Figure 4b. The speed of the DC motor can easily be controlled with a PWM wave, as illustrated in Figure 5.

The Control Algorithm

The PID position-control algorithm is used to control the plate angle, rendering a smooth rotation. We used an exponential smoothing prediction algorithm to improve system responsiveness during plate rotation.

In the PID position-control algorithm, unit P is $K_p e(t)$; the integral unit I is:

$$K_i \int_0^t e(\tau) d\tau$$

and the differential unit D is:

$$K_d \frac{de(t)}{dt}$$

so the discrete position of the PID control algorithm can be expressed as:

$$u(k) = K_p e(k) + K_i \sum_{i=0}^{k} e(i) + K_d [e(k) - e(k-1)]$$

Robert G. Brown's exponential smoothing method is a time event analysis and forecasting method based on average movement. The follow-up status of the control system can be forecast by calculating the exponential smoothing values. The exponential smoothing value S_t is a weighted mean of the current values y_t and the previous time exponential smoothing values S_{t-1}, i.e.

$$S_t = ay_t + (1-a)S_{t-1}$$

where the smoothing constant is:

$$a \in [0,1]$$

Experiments

We carried out tests on the pendulum shaft angle sensor 1 and steering gear's sensor 2. According to a fixed angle of the ADC, as shown in Table 1, the values of the precision potentiometer and steering gear's potentiometer are linear with relation to this angle.

The test results show that the steering gear can work and keep a certain position well, when the pulse width is between 0.5ms and 2.5ms. However, when the pulse width is greater than 2.5ms and the rotation angle is 2π, the wider the pulse width, the faster the steering gear will rotate.

We also tested the system's stability. The object on the plate didn't fall when the plate rotates at the 2π angle. However, when we increased the number of stable objects to eight or more, all stacked, the fall rate increased. Since the steering gear still has a small angle of the swing in equilibrium, the possibility of failure exists when the system is aiming to become static. As the response of the steering gear is slow when it works in the opposite direction, the failure rate will increase when the system's swing changes direction.

angle	-60	-50	-40	-30	-10	0	10	30	40	50
sensor 1	1361	1412	1472	1573	1653	1712	1777	1897	1958	2020
sensor 2	1138	1212	1285	1358	1430	1502	1572	1712	1780	1842

Table 1: Angle test of angle sensors

Pulse	0	0.5	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45
turn angle	No turn	Left limit	Left	Center	Right	Right limit	Turn 2π	Turn 2π	Turn 2π	Turn 2π

Table 2: Steering gear pulse width in response to the test

WHAT THE READERS SAY

AN ALTERNATIVE ROUTE

In the '*The End of the Road?*' article in EW, April 2013, Messrs Catt, Bishop and Wakefield have devised an interesting experiment which demonstrates clearly how a transient step propagates along a transmission line, by monitoring the voltage at selected points along an 18m co-axial cable. However, it is rather presumptuous to claim that no-one else has pondered the significance of the phenomenon.

If the 75-ohm cable is visualized as a string of capacitive elements which have all been charged up to 8V and a reed switch operates to connect the near-end capacitive element to a 75-ohm resistance, then this capacitor will deliver a current to the load via a source impedance of 75 ohms. The voltage at the reed switch will drop from 8V to 4V.

Since action and reaction are not instantaneous, the 75-ohm load does not appear at the second capacitive element until a period of time (say 1ns) has elapsed. The second capacitor now 'sees' a load of 75 ohms, and its voltage drops to 4V. The same thing happens with every capacitive element in the string. A voltage step propagates up the line towards the open-circuit at the far end.

Since each element of the line is inductive, a transient voltage appears along that element during the time its capacitance is discharging. The amplitude of the voltage is equal to the inductance of the element multiplied by the rate of change of current in that element. As the voltage step propagates towards the far end, the static energy of the electric charge is converted into the dynamic energy of transient current.

> *The multitude of interference problems which now exist calls for each and every designer to understand and control the coupling mechanisms*

When the voltage step reaches the open circuit at the far end of the line, the dynamic energy of the current transient is reflected back down the line. This effect is analysed by treating the current as the sum of two partial currents; incident and reflected. The reflected current propagates back down the line to the near end.

Such reasoning leads to the setting out of the fundamental equations of transmission line theory and to the derivation of reflection coefficients. The underlying concepts have been in existence for more than fifty years.

That being so, why do textbooks on Circuit Theory not explain the transient behaviour of transmission lines in the simple terms of the above few paragraphs? It should not be beyond the capability of the academic establishment to analyse the relationship between Electromagnetic Theory and Circuit Theory without resorting to the use of arcane mathematics. But that is not going to happen any time soon.

The multitude of interference problems which now exist calls for each and every designer to understand and control the coupling mechanisms. This objective can be achieved by creating circuit models of these mechanisms. It cannot be achieved by following design rules or by consulting gurus. It is up to us, as circuit designers, to work toward that objective.

Ivor Catt may be wrong about many things. But he is on the right track.

Ian Darney
UK

ARE CERTAIN ELEMENTS MISSING?

In the April, Centenary edition, Electronics World published an article by Ivor Catt. He describes a transmission line capacitor discharging and how the charge was stored in it.

The potential difference is shown reducing in half steps sequentially towards the open end and then towards the load. The article concludes the discussion with two superimposed circulating fields. There is not a description of how separate fields came about, or how the leading edges come to coincide with the line ends at just the time that the switch is closed. The traces do however suggest it is one re-circulating field, twice the line length.

A small rearrangement of the apparatus that would shed more light on how the source of the potential difference is stored is needed here, for example, to see the scope traces of the line charging. It is not clear how the battery contributes in the process that involves half its own potential difference.

Also, it would be illustrative to see how the source of the potential difference circulates in real time. If the load was replaced with a line of the same length as the transmission line capacitor, creating a charged area of 2l circulating a transmission line capacitor of round trip 4l.

Intriguing!

Owen Partridge
UK

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DSEI, internationally established as the leading exhibition for land, sea and air applications of defence and security equipment and services, will take place at ExCeL London, 10-13 September 2013. The biennial event is the world's principal fully-integrated defence and security showcase, featuring specialist zones dedicated to land, sea, air and security, alongside exclusive waterborne demonstrations in the dockyard adjoining the venue. The event brings together the entire industry to source the latest equipment and systems, develop international relationships, and generate new business opportunities. It provides unrivalled access to key markets across the globe.

Combining a high quality exhibitors across the supply chain, networking opportunities and the ability to see new technologies first hand on the show floor, DSEI provides an inspirational experience to nearly 30,000 visitors.

As the must-attend event of 2013 with more exhibitors and educational content than ever before, DSEI gives access to:

- Around 1,400 international exhibitors – an unrivalled range of suppliers from more than 50 countries.
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Exhibition Evolution

DSEI is organised by Clarion Events. The last such event was held in 2011 and showcased 1,391 exhibiting companies from 46 countries in 30 national pavilions to 28,440 international visitors and 1,070 global VIPs.

In a new development for DSEI 2013, the show's structure has evolved to further facilitate networking opportunities. This has been achieved by co-locating associated products and technologies in six themed zones: the Land Capability Zone; Naval Zone; Air Zone; Security & Special Forces Zone; Unmanned Systems Showcase; and the Medical & Disaster Relief Zone. This, in conjunction with an enhanced seminar programme, has motivated a record influx of first-time exhibitor registrations.

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Euroquartz To Show High Reliability Frequency Control Products At DSEI 2013

Frequency control specialist, Euroquartz, will show its wide range of high reliability crystal and oscillator products at the Defence & Security Equipment International (DSEI) 2013 exhibition, ExCeL, London, 10 to 13 September 2013.

In addition to making and supplying commercial and industrial frequency control products, Euroquartz also supplies markets where high reliability components are essential. These include crystals and oscillators for electronic systems used in satellites, civil and military aircraft and a broad range of defence-related equipment, as well as applications as diverse as train control systems and medical electronics.

The company's well established EQXO-2000BM range of oscillators offers customers the security of full MIL screening when required where their ability to operate at high temperatures indefinitely has ensured the parts have been a popular choice for aerospace, upper atmosphere and space applications.

www.euroquartz.co.uk

Apacer Exhibits Its Product Portfolio At DSEI

Apacer Technology will be presenting its product portfolio and technologies at DSEI. The company designs, manufactures and markets high quality, high performance flash and DRAM memory used in a variety of demanding storage applications.

Defense and military applications are mission-critical operations, requiring the most demanding, reliable and robust systems. Without unplanned downtime, defence and military applications can't survive the hostile environment where temperature, altitude, humidity conditions are severe and extreme. Moreover, anti-vibration and shock resistance are vital system requirements too.

As one of the innovators in the field of SSD and DRAM solutions, Apacer is committed to offering a wide range of products featuring industrial reliability, rugged design and cutting-edge technology for, amongst others, defense and military applications. Its product range can be applied in a variety of defence and military.

www.apacer.com

Smiths Connectors at DSEI 2013

Smiths Connectors will be exhibiting at DSEI 2013 at Stand S5-285. Amongst its broad range of interconnect products, it will feature its new generation of high-density, low-profile connectors – the Hypertac Micro SnapTac Series. This latest innovation incorporates all tried-and-tested features and benefits that have been built into the SnapTac connector family, and delivers a light-weight, robust and reliable solution for combat systems.

Smiths Connectors will also feature its innovative, high-speed, high-density Hypertac KVPX connector series. This series enhances the company's ruggedized standards-compliant interconnect portfolio of connectors designed for the demanding requirements of defence, space and commercial aviation applications. KVPX is fully footprint compatible with VITA 46 and VITA 48 Standards and delivers outstanding performance under a variety of extreme environmental conditions.

www.smithsconnectors.com

Full MIL-DTL-38999 Series III Class Z Approval For Amphenol's RoHS Plating Finish

Amphenol launched a new RoHS-compliant plating finish last year and has now announced MIL-DTL-38999, Series III, Class Z Approval, the first UK connector manufacturer to achieve this success. QPL (qualified product listing) provides additional validation and certification over and above existing customer and programme approvals. In addition, Amphenol is the first corporation to provide multiple site qualifications with manufacturing in the UK and in the US.

To be displayed at the forthcoming DSEI exhibition in London will be new, approved and RoHS-compliant plating alternatives to Cadmium. Black Zinc Nickel plating is now offered on a wide variety of connectors and accessories including MIL-DTL-38999 and proprietary MIL-C-26482. This conductive and non-reflective finish is approved for 500hrs salt spray endurance and is fast becoming the new defence industry standard.

Until recently, Cadmium plating has been the industry preference for aeronautical and defence applications due to its exceptional environmental and electrical performance.

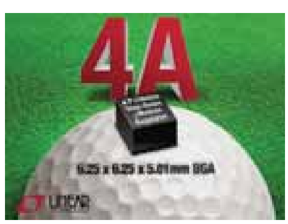
www.amphenol.co.uk

Tiny 4A Step-Down µModule Regulator's Entire Solution Occupies Less Than 1cm²

Linear Technology has launched its LTM4624, a 14V, 4A step-down µModule (micromodule) regulator in a 6.25 x 6.25 x 5.01mm BGA package which, including a few passive components, fits within 1cm² on a single-sided PCB or 0.5cm² double-sided. Like other µModule regulators, the LTM4624 includes the DC/DC controller, power switches, inductor and compensation in a single package. Only two external ceramic capacitors (1206 case size) and a resistor (0603 or smaller case size) are required for operation. The LTM4624 operates from a 4V to 14V input supply, delivering a regulated output adjustable between 0.6V to 5.5V, ideal for applications in communications, storage, industrial and medical systems.

The LTM4624 operates at a 1MHz typical switching frequency with a very low 5mV output ripple at full load during a 12VIN to 1.5VOUT conversion. With the addition of an external bias supply above 4V, the LTM4624 can operate from an input voltage as low as 2.375V.

www.linear.com



TMD Technologies Chooses DSEI Exhibition To Highlight Advanced Microwave Power Modules

First time exhibitor at the DSEI defence and security exhibition in September, TMD Technologies will be highlighting its latest microwave power modules. Particularly applicable for avionics applications, these MPMs are ultra compact and lightweight, as well as providing high efficiency and reliability.

Suitable for radar, EW and communications applications, the pulsed and continuous wave "drop-in" amplifier blocks are fully integrated, making installation simple and safe.

TMD's high power, fast-warm, Ku band travelling wave tubes (TWTs) designed for missile seekers, will also be on display. One model is the PT6789, which operates at the top of the Ku radar band and provides a peak power as high as 1000W. It also offers a high duty ratio of up to 33%, at very high pulse repetition frequencies.

Other applications for the UK company's microwave products include ECM and towed decoys for EW, satellite communications links, simulation and training, as well as EMC testing, high power component testing and scientific research.

www.tmd.co.uk

A MONTHLY COLUMN ON TEST AND MEASUREMENT (T&M) ISSUES

T&M Needs A New Perspective, Maybe Even Two

BY **REG WALLER**, EUROPEAN DIRECTOR, ASSET INTERTECH INC

Not long ago, from a test and measurement perspective, we could say with confidence that hardware was hardware and software was software, and never the twain shall meet. Now, the boundaries that set them apart are suddenly becoming blurred.

Of course, hardware and software have always depended on each other, but over the last several years they have become inextricably intertwined. If one isn't working properly, chances are that the other isn't either. The trick is to figure out which one is misbehaving and fix it so the entire system functions better.

In order to get the system working properly, we've got to debug, validate and test both hardware and software simultaneously.

What's really startling when you take a long hard look at the composition of today's complex computing and communications systems is the sheer volume of software in them. It's not just an operating system and a few applications any more. Now we've got many more processing cores, some in hardware and others implemented in code. We also have multiple high-speed buses, some very specialized and others general purpose, but they're all getting very fast. We're are also seeing multiple silicon chips stacked on top of each other in the same package. So what's holding all of this together? What's binding all of the hardware and the many software elements into a coherent entity?

It's software, or more specifically, the firmware that interconnects all the hardware and the various software threads. We're seeing an explosion in firmware and it demands to be debugged in parallel with hardware validation and test. But enabling parallel hardware/software debug, validation and test will require a new perspective on T&M. Given the current state of technology, our old probe-based outside-in perspective has problems because it limits an engineer's visibility into the system instead of enlarging it.

Physical access for probing chips or circuit boards has been disappearing for some time now. The pins on chips that might be probed in the past are now under the die, and test pads that formerly dotted circuit boards have become an endangered species. Designers know that test pads on high-speed serial buses cause too many signal integrity problems; it's better to eliminate them entirely. The alternative to an outside-in point of view is an inside-out perspective based on embedded instrumentation. Through soft access, developers can debug, validate and test hardware from the inside out by utilizing the on-chip and on-board T&M resources that are commonly found in today's designs. Why worry about where you can or cannot place a probe when you don't need to probe at all?

New Perspectives Lead To New Methodologies

New methodologies that integrate the inside-out perspective into hardware with the bottom-up perspective into firmware offer a fuller picture of the system as a whole, by giving a close up and personal perspective on problems that stem from the inter-relationship between hardware and software, as well as those traditional problems that can still be isolated in hardware or software.

An example use-case might illustrate this point better. To get projects out on time, software and hardware engineering know they need to stop the finger-pointing and start working together. New debug, validation and test methodologies would help because both disciplines can leverage the expertise of the other without individual engineers climbing a steep learning curve to become an expert in the other's discipline.

So, for example, a software engineer wants to collaborate with his hardware colleague, but he doesn't have the time or inclination to become a hardware expert. With a prototype bring-up methodology that integrates perspectives into both hardware and software, the software engineer can leverage his colleague's hardware knowledge by deploying simple push-button tests that rule out hardware-based discontinuities between the firmware and hardware or faults in the underlying hardware. The task of system debug – which is the ultimate goal – is optimized by limiting and focusing the investigation immediately. The real cause of the bug is found quickly, with less effort and the system moves into manufacturing sooner.

We're seeing today software debug and hardware validation/test are being drawn closer together by the needs of software and hardware engineers, who need to quickly transition designs out of the design department and into manufacturing. Doing both hardware validation/test and software debug in parallel is the best way to accomplish this. Doing one and then the other takes too long and really doesn't work very well.

Systems are comprised of both hardware and software; not one first and then the other. We've got to get to a place where software debug and hardware validation/test inform each other. To get there, we need a new perspective on our methods. ●

Dual Channel MOSFETs Simplify Synchronous Buck Design

Advanced Power Electronics Corp (USA) launched an asymmetric dual N-channel enhancement mode power MOSFET targeting synchronous buck DC/DC converter power designs.

Packaged in a small square PMPAK 3x3mm pack, the AP6950GYT comprises a high-side control MOSFET (CH-1) and a low-side synchronous MOSFET (CH-2), providing a compact solution optimised for synchronous buck applications. Drain-source breakdown voltage for both channels is 30V, while on-resistance is low at 18mΩ (CH-1) and 10.5mΩ (CH-2)

"Our MOSFETs provide the designer with cost-effective performance whilst retaining the best combination of fast switching, ruggedized device design and low on-resistance," said Ralph Waggitt, President/CEO of Advanced Power Electronics Corp (USA).

Devices are RoHS-compliant and halogen-free; more information is available at:

www.a-powerusa.com

OMC'S ACTIVE ALIGNMENT BASED FIBRE OPTIC LINKS SOLVE CONSISTENCY PROBLEMS

OMC now offers a fibre optic link service specifically tailored to meet the demanding requirements of the high voltage market. HV applications, such as power distribution networks and power supplies, often require optical isolation because of the voltages, however, achieving consistency of performance has proven a challenge for many providers.

During manufacture of its housed optical transmitters (Tx) and receivers (Rx), OMC powers each active element and tunes the performance of the device to ensure that the electro-optical characteristics of each and every device fall within a customer-specific performance window, exactly matching the required performance specification. Equally, when manufacturing the corresponding optical fibre cable assembly to be used between the Tx/Rx, OMC's unique production techniques can ensure a very high level of consistency of link attenuation, which is matched to the Tx/Rx performance window, meaning that each and every link will function regardless of how the transmitters, receivers and cables are paired during assembly/installation.

www.omc-uk.com

TTI INC WINS TE CONNECTIVITY'S GLOBAL DISTRIBUTOR OF THE YEAR FOR THE FOURTH TIME

TTI Inc has been named TE Connectivity's Global 2012 Distributor of the Year for the fourth consecutive year – deemed unprecedented.

TE Connectivity's Distributor Award is based on a number of key performance metrics including sales growth, demand identification and business creation, new customers and logistics improvements leading to reduced costs and improvements in efficiency. Due to rigorous measures, this TE award is seen as one of the most difficult and prestigious awards to achieve.

"To win this award at any time would be an honour, but to win it for an unprecedented four years running is a huge validation of our people, processes and business strategy," said Glyn Dennehy, TTI's Senior Vice President and General Manager in Europe.

At the awards ceremony, Mike Morton, President, TTI Americas, added: "I am delighted to accept this award on behalf of the TTI team across Europe, Asia and America, and thank them for their contribution in making this remarkable achievement possible."

www.ttieurope.com

AVX AND AVNET CELEBRATE 50 YEARS OF SUCCESS

AVX Corporation has become the first passive supplier to celebrate a 50-year channel milestone with Avnet Electronics Marketing Americas, a business region of Avnet Inc, one of the largest distributors of electronic components, computer products and embedded technology serving customers globally.

The two companies celebrated this singular milestone with a commemorative dinner at a recent EDS in Las Vegas, during which Avnet Electronics Marketing Americas President Ed Smith, presented AVX Vice President of Sales Pete Venuto with a commemorative award.

"AVX is honoured to be recognized as the first passive supplier to celebrate such a significant milestone with Avnet. Throughout the past half century, our shared commitment to customer satisfaction and passion for bringing next-generation technologies to market has bolstered the relationship between AVX and Avnet and has helped both companies succeed in efforts to provide a comprehensive catalogue of products and solutions, coupled with outstanding customer service, to our joint customers across the globe," said Venuto.

www.avx.com

MOUSER AND INTEL ANNOUNCE GLOBAL DISTRIBUTION AGREEMENT

Mouser Electronics has signed a global distribution agreement with Intel to represent its entire portfolio of mobile, desktop and server products. Included in the Mouser's Intel portfolio are the latest 22nm Core i7, i5, i3, Pentium, Celeron and Xeon processors – ranging from the most advanced fourth generation core through previous generation core and Atom processors. Also available are Express chipsets, Ethernet controllers, system controllers and Intel's Next Unit of Computing (NUC) to round out the Intel lineup.

"We are extremely excited to announce our agreement with Intel," said Jeff Newell, Mouser Electronics's Senior Vice President. "Offering the newest Intel products at Mouser will allow design engineers to build tomorrow's electronic products using today's most advanced semiconductor technologies."

"With Intel's robust product portfolio and Mouser's global network of design engineers, the new partnership enables innovative new designs for the future," added CJ Bruno, Intel VP, GM of Americas.

www.mouser.com/intel

Wider Range Of Hi-Rel Connectors From Harwin Available From Stock

Harwin has broadened its range of Datamate Mix-Tek mixed-technology connector series that is available as standard off-the-shelf products. Now horizontal and coax versions of the popular 2mm pitch hi-rel family are immediately available for designers, reducing design time.

Harwin's Datamate Mix-Tek connector range can be customer-specified in a huge number of configurations of signal, power and coax contacts. But in order to respond to industry demands for fast turnaround, the company has made the most commonly-chosen variations available as standard items.

The new horizontal format and coax contact variants add to 41 other configurations that are also stocked as standard items, these include power-only configurations from 2-10 power contacts and mixed contact configurations from 2-signal/2-power through to 12-signal/4-power. The standard range focuses on the most popular male PCB contact styles mated with female crimp options. Hexagonal slotted Jackscrews are offered across the range.

www.harwin.co.uk

Sabtech to Showcase New Communications Solutions for C5ISR At DSEI 2013 in London

Sabtech, an established leader in the design, manufacture and support of tactical data communications solutions for military and government agencies, announces it will unveil several new products for command, control, communications, computers, combat, intelligence, surveillance and reconnaissance (C5ISR) during DSEI, September 10-13 at the ExCel London international exhibition and conference centre at Stand N4-344 in the US Pavilion.

During the four-day exhibition, Sabtech executives will discuss their latest advancements for providing state-of-the-art tactical communications technology designed to advance the reliability of data input and output (I/O) supporting Naval and Airborne Tactical Data Systems (NTDS/ATDS). With the continuing goal of connecting open architecture communications technology to legacy equipment, Sabtech introduces several new products at DSEI. Among them is PowerNet – the second generation PowerNet family of NTDS to Ethernet converters.

www.sabtech.com

ITT'S HIGHLY ENGINEERED TECHNOLOGIES PROVIDE INCREASED SOLDIER PROTECTION

ITT ICS offers a diverse range of connector products serving multiple applications within land, air, naval and unmanned system environments. New products offer more integrated, architected solutions that are intelligently designed and engineered to enhance soldier protection. Among its products on display at this year's DSEI event will be Nemesis – a new series of connectors with smaller form-factor versions and enhanced seals for maximum connectivity, durability and reliability within the soldier-wearable market; and 38999 Aluminum Hermetic – latest sealing technology and corrosion resistant materials make this connector ideal for circuit board applications that can withstand the most rugged environments.

The company will also show its newly engineered IED damper, which meets the growing need to protect soldiers with maximum in-vehicle shock absorption, and HERM, fund to be ideal for naval and land applications. HERM provides shock and vibration protection for a variety of electronic communications systems.

www.ittcannon.com

TE CONNECTIVITY EXTENDS INDUSTRIAL COMMUNICATIONS PORTFOLIO

TE Connectivity (TE) announced the release of the Industrial Mini I/O connectivity system – a small, compact, latching, wire-to-board I/O interface that allows for safe high-speed connections at all angles.

Designed with two points of contact to enable reliable connections, this connector is built for industrial and high vibration environments, allowing for increased reliability compared to other I/O alternatives. The compact latching feature provides a high retention rate force of up to 98N which protects the plug from accidental pull and un-mating – reducing downtime, unstable connections and unnecessary consequential losses. Saving up to 75 percent of space compared to conventional RJ45 plugs, the Industrial Mini I/O connectivity system provides engineers with greater design flexibility on the PCB and ultimately gives engineers the freedom to decrease the size of their overall applications. With these benefits, the Industrial Mini I/O is well equipped to lead Industry 4.0 trends towards miniaturization and intelligent production.

www.te.com/products/mini-io

STADIUM IGT SECURE ACCESS CONTROL PANELS FEATURE INNOVATIVE "THIN-FILM" BACKLIGHTING TECHNOLOGY

Stadium IGT, one of the UK's longest established HMI solutions providers, can now provide access and security system manufacturers with bespoke control panel solutions offering a number of innovative features. In its basic form, the panel can be simply a cover-plate for an RF sensor with stop/go indication. Enhanced panels can include integration for ID card reading, the addition of a display for user information and high impact product or corporate branding.

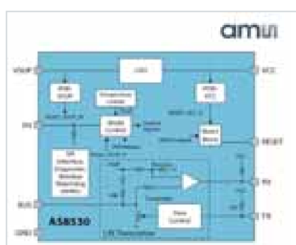
A unique feature of access panels from Stadium IGT is the use of its market leading "Thin-Film" LED backlighting technology. This offers uniform light intensity of the display, low profile (2.00mm or less), rugged construction utilising hard coat acrylics (up to 5.0mm) and the option of construction with glass for high-end architectural applications. The advanced backlighting technology offers illuminated logos and icons, colour changing signs and 'secret till lit' legends for user information.

www.stadium-igt.com

ams Introduces First LIN Slave Companion IC For Automotive ISO26262 Requirements

ams AG announced that the AS8530 is the world's first miniature power/transceiver IC to support LIN slave applications, which complies with the ISO26262 functional safety standard.

The AS8530 is a power management and communication device that includes a LIN 2.1 transceiver, a 50mA LDO to supply a local micro and a reset generator in an 8-pin SOIC 8 package. As a differentiator, the AS8530 offers a series of system management functions through a shared pin serial interface, all within the same small, 8-pin SOIC8 package.



The addition of enhanced diagnosis functions provides built-in support for the requirements of ISO26262. A two-wire serial port routed through shared Enable and TX pins allows the device to read out status registers and provide diagnosis information to the system's microcontroller. It also supports additional features such as a window watchdog function and access to back-up registers to store data when the microcontroller shuts down.

www.ams.com

MOLEX TO DEMONSTRATE AEROSPACE AND DEFENCE INDUSTRY EXPERTISE AT DSEI 2013

Molex Incorporated will demonstrate its in-depth knowledge and expertise of the aerospace and defence industry at this year's DSEI Exhibition.

A particular highlight at the stand during DSEI will be the launch of the Temp-Flex air-dielectric ultra-low-loss flexible microwave coaxial cables. Delivering up to 88% velocity of propagation for increased signal speed, this cabling is suitable for device manufacturers specifying microwave coaxial cables in high frequency aerospace and defence applications, such as those found in radar, vehicle, satellite, space, RF and test and measurement equipment.

Among the many RF products at that stand will be sealed connectors; backplane and multi-port connectors; micro-coax connectors and board-to-board connectors.

Within Molex's extensive fibre optic product offering is the VITA 66.1 Ruggedized Optical MT Backplane Interconnect System designed to meet the ANSI- ratified VITA 66.1 specification for VPX architecture. For maximum design flexibility, MT termini are available in 8, 12 or 24 fibres in standard multimode and single-mode or VersaBeam (expanded beam).

www.molex.com

CONNECTOR SERIES DEVELOPED ESPECIALLY FOR LED APPLICATIONS

The L1 series from Panasonic Electric Works has been designed especially for the contacting of individual LED strips in LED tubes, and other lighting applications. The L2 series, which is a single-part connector type, can be used in LED tubes as well as in other LED applications such as LED bulbs, LED spots or LED drivers when place is limited.

A L1 series connector consists of two joint plugs which are reflow soldered to the LED chips and a common receptacle connecting the two jacks. The tactile feedback when inserting the plug indicates to the user that the connection has been successfully made. The special floating design of the connector helps to compensate for greater tolerance-related deviations in the application.

The floating design tolerates the following deviations: ±0.3mm in X direction, ±0.5mm in Y direction and ±0.3mm in Z direction. The contact gap for the 2-pin connector is 2.4mm.

www.panasonic-electric-works.co.uk

New IQD Military Oscillator Withstands 100,000G Shock

IQD's new HGXO series of surface mount oscillators is designed primarily for military applications such as smart munitions and projectile electronics, although the devices can also be used in demanding industrial applications. Designed around a hermetically sealed high-shock crystal and a CMOS compatible integrated circuit, the new device is able to survive shock levels of up to 100,000G and vibration levels of 20G at 10-2000Hz swept sine in accordance with MIL-STD-202G.

Housed in an industry standard 7 x 5mm 4-pad ceramic package with metal lid, five supply voltage versions are available at 5.0V, 3.3V, 3.0V, 2.5V and 1.8V, thus providing compatibility with the latest generation of low power chipsets. Output frequencies can be specified between 460kHz and 50MHz with a 15pF HCMOS drive capability. Frequency tolerance is available down to ±10ppm, whilst frequency stability can be specified at ±40ppm over the full military temperature range of -55 to 125°C, down to ±10ppm over commercial temperature ranges coupled with low frequency ageing characteristics.

www.iqdfrequencyproducts.com

AMD LOWERS G-SERIES ENERGY CONSUMPTION

AMD has announced a new, low-power Accelerated Processing Unit (APU) in the award-winning AMD G-Series SOC family with the GX-210JA, further reducing x86 power requirements for embedded designs. The new GX-210JA APU, a full System-on-Chip (SoC) design, uses one-third less energy than the previous low-power Embedded G-Series SOC product, while providing industry-leading graphics capabilities. At only 6 watts maximum thermal design power (TDP) and approximately 3 watts expected average power, this new member of the G-Series SOC family will enable additional fanless designs for a variety of applications ranging from industrial controls and automation, digital gaming, communications infrastructure and visual embedded products, including thin client, digital signage and medical imaging.

The GX-210JA is part of the AMD Embedded G-Series SOC processor family that offers superior performance per watt in the low-power x86-compatible product category with 6W-25W TDP options.

www.amd.com

BINDER M8 SHIELDED CONNECTOR RANGE EXTENDED TO CATER FOR ETHERNET APPLICATIONS

The Binder range of M8 shielded cable connectors has been extended to accommodate cables up to 6 to 8mm so that they can be used with Ethernet cables. Until now, this popular range of connectors could only accommodate cables up to 5.5mm diameter but a new, wider cable gland extends the application area to include industrial Ethernet and other applications requiring larger diameter cables.

Protected to IP67 when mated, Binder M8 connectors are available in three and four pole male and female format and have a shielded, nickel-plated brass connector body and gold-plated brass male and bronze female contacts. Termination is via a secure screw clamp and the rated current is 4A. The connectors have a life in excess of 100 mating cycles.

Based in Hemel Hempstead, Binder UK is the subsidiary of Franz Binder GmbH, the highly successful manufacturer of circular and other connector products that serves the instrumentation, sensor, automation, medical and industrial equipment markets.

www.binder-connector.co.uk

Comprehensive Catalogue from Kemtron

Kemtron, UK-based manufacturer of RFI/EMI shielding solutions, has published a comprehensive new catalogue in response to customer demand.

The 144 page printed catalogue has proved popular with customers who have limited Internet access, or who prefer the convenience of a paper version that they can bookmark, add notes or use as a working reference tool.

Managing director David Wall said: "We have had a fantastic response from customers in countries like Germany, India and Turkey, as well as the UK. They welcome the fact that they can have a printed catalogue when so many suppliers only offer information on the web."

The catalogue provides detailed product overviews, technical specifications, application information and design considerations for Kemtron's range of RFI/EMI shielding solutions, as well as background information on EMC and useful design tools.

www.kemtron.co.uk

SYNOPSYS AND UMC COLLABORATE TO ACCELERATE DEVELOPMENT OF A 14nm FINFET PROCESS

Synopsys and Taiwanese firm United Microelectronics Corporation (UMC) are collaborating to develop a 14nm FinFET process. The collaboration has already resulted in the successful tapeout of UMC's first process qualification vehicle in its 14nm FinFET process using Synopsys's DesignWare Logic Library IP portfolio and StarRC parasitic extraction solution, which are parts of the Galaxy Implementation Platform.

Due to its performance, power, intra-die variability and lower retention voltage over the planar CMOS process, the FinFET process is gaining significant interest from designers. This process qualification vehicle will provide early silicon data, enabling UMC to tune its 14nm FinFET process and Synopsys to refine its DesignWare IP portfolio for optimal power, performance and area. It also provides data to enable better correlation of the FinFET simulation models to the silicon results. This is the first milestone of an ongoing collaboration to validate UMC's 14nm FinFET processes using DesignWare IP solutions.

"The successful tapeout of this qualification vehicle is a significant milestone for UMC," said Arthur Kuo, UMC vice president in charge of the company's corporate marketing division. "Our goal is to provide customers with a highly competitive FinFET technology solution that will help them maintain their products at the leading edge. We selected Synopsys for this important collaboration based on their FinFET experience and expertise, as well as their track record of developing high quality DesignWare IP in the most advanced nodes. The results of this collaboration will yield significant benefits to the design community in the areas of power, performance and cost."

Synopsys's FinFET-ready DesignWare Logic Library IP portfolio consists of high speed, high density and low-power standard cell libraries that include multiple voltage threshold implementations and support multi-channel gate lengths to minimise leakage power. In addition, the available Power Optimisation Kits (POKs) and Engineering Change Order (ECO) Kits deliver outstanding performance with low power and small area, meeting the speed and density requirements of advanced SoCs.

The StarRC parasitic extraction tool offers advanced extraction capabilities at 14nm, based on precise 3D modeling of the new parasitics found in FinFET devices. Due to its unique ability to describe the exact silicon profile of FinFET transistors, StarRC's embedded field solver generates highly accurate device model parasitics which enable 14nm IP developers to optimise their designs for maximum performance and lowest power.

MAURIZIO DI PAOLO EMILIO, Telecommunications Engineer, INFN – Laboratori Nazionali del Gran Sasso, Italy: FinFET seems to be the most promising and disruptive technology at the moment, able to maintain Moore's Law and designers' expectations.

FinFET technology impacts all the electrical parameters of a transistor and this collaboration is expected to bring reductions in power consumption (static and dynamic), and increases in speed and voltage supply range.

Originally, the FinFET architecture was conceived as being built on SOI (silicon-on-insulator) wafers: the oxide layer provides a 'stop' for the etch processes used to define the raised channel fins. On a bulk-silicon process, control over fin depth is more difficult, although the manufacturing issues appear to be manageable.

The FinFET era started in 2011, when Intel unveiled the new-fangled transistor technology at the 22nm node. FinFETs can potentially help make a big step forward in the never-ending effort to reduce power consumption and increase switching speed and number of transistors on a single die.

PROFESSOR DR DOGAN IBRAHIM, Near East University in Nicosia, Cyprus: FinFET seems to be the next frontier in the electronics technology. By providing close control over current and reducing gate leakage, this multi-gate FET transistor offers significant power and performance advantages over traditional transistors, and it is gaining huge interest from chip designers and manufacturers. We expect the collaboration between Synopsys and UMC in the design of 14nm FinFET process will certainly result in a major breakthrough in the electronics technology.

> Originally, the FinFET architecture was conceived as being built on SOI (silicon-on-insulator) wafers: the oxide layer provides a 'stop' for the etch processes used to define the raised channel fins

HAFIDH MECHERGUI, Associate Professor in Electrical Engineering and Instrumentation, University of Tunisia: It is interesting to note that recently industrial collaborations between companies have intensified. I guess the difficulties imposed by the current economic climate and the cost and complexities associated with developing new technologies is encouraging such pairings.

The collaboration of UMC and Synopsis is one such example. This is a targeted cooperation to allow in a short time the fast implementation of a 14nm FinFET and its validatation. The competition between big industrial companies needs an industrial policy based on such innovation, a privileged partnership of co-operation where the aim is to increase the share of added-value by proposing broader products and services to their customers.

Both companies, UMC and Synopsys, are well-known firms, dynamic and inventive, with a policy of innovation. Cooperation and competition will help place these companies at the top of world's rankings.

If you are interested in becoming a member of our panel and comment on new developments and technologies within the electronics sector register your interest with the Editor by writing to svetlanaj@sjpbusinessmedia.com