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SPECIAL REPORT
RF AND MICROWAVE:

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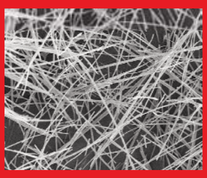
- EVOLUTION AND DEVELOPMENT OF MSA ANTENNAS
- GSM INDOOR POWER PROPAGATION

COMPONENTS FOR WIRELESS APPLICATIONS

DESIGN CONSIDERATIONS FOR PORTABLE DEVICES



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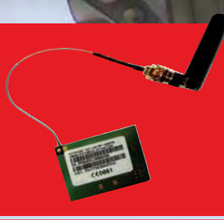
WORLD'S FIRST MELT-SPINNING CONDUCTIVE CARBON NANOFIBRE

FOCUS
CLOUD-BUSTING DANGER ZONE NEEDS NEW APPROACH



CONSTRUCTION
BUILD YOUR OWN SMS-BASED DATA LOGGER

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REGULARS

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We have 10 Si1120 Slider Board Demo Kits to give away
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ROHS2 SEEKS TO MOVE THE DIRECTIVE FORWARD AND GIVE GREATER CLARITY

What this piece states is that design engineers need to be aware of the significant developments in the ROHS Directive and its potential impact on their companies.

The potential impact of the amended RoHS proposals is one of the dominant aspects of the legislative scene at present.

The Restriction of Hazardous Substances (RoHS) Directive entered into force on 1st July 2006. It featured six restricted substances across eight broad categories of product pulled from the ten categories in the Waste Electrical and Electronic Equipment (WEEE) Directive. There were 29 exemptions to assist manufacturers and design engineers where no viable alternative was available and a whole raft of 'grey' definitions that required clarity. Subsequent proposals in December 2008 and more recently, driven by EC Presidents Sweden, in September 2009, look to move the directive forward and provide greater clarity. However, some of its provisions will potentially have cost and resource issues for industry.

The proposals recommend that the two remaining categories from the original WEEE categories, namely medical devices and monitoring and control instruments be added to the scope from 2014 (in-vitro diagnostics from 2016 and industrial test equipment in 2017). These were originally omitted from the directive due to reliability concerns over the use of lead-free solder.

While there are no substances actually restricted under either of the proposals, four were recommended for priority assessment. Three plasticisers used in a variety of applications and a flame retardant were highlighted for potential restriction. However, the Swedish proposals would withdraw these substances, which are also under the "authorisation of use process" within the REACH Regulations, from the text.

The Commission intends to adopt a methodology for the review of the restricted substances in Annex IV (the original six possible, but unlikely) and new substances deemed necessary in the future, based on the process set out in Articles 69 to 72 of the REACH Regulations. This would look to review a substance used in electrical or electronic equipment (EEE), or the waste derived from it, that poses a hazard to human health or the environment that is not adequately controlled. If, as per the Swedish proposals, RoHS is expanded to cover all EEE, then there will no longer be the "is it in or is it out of scope" issues as everything will be within scope unless specifically excluded.

Under a separate review by European Commission consultants, 29 exemptions will continue under the proposals, many with amended wording for clarity. Six will be withdrawn and one new one will be granted. These could come into force during 2010 and will be followed by a transposition period of, on average, 18 months allowing manufacturers the time to comply. In addition, a further six exemptions were added in June 2009 that had been proposed a year earlier.

RoHS proposals also clarify definitions such as equipment within out-of-scope equipment, spare parts and military where the latter clearly does not include dual-use equipment. Large Scale Industrial Tools are excluded from the text as part of the 2009 proposals.

A standard and rigid declaration of conformity appears in annex 7 and will replace the multitude of different certificates, statements and compliance documents under the original legislation. There now appears to be no scope for qualifying statements such as "so far as we are aware" and "to the best of our knowledge".

It is proposed that RoHS will become a CE mark directive placing responsibilities on manufacturers, importers and distributors. There are many requirements including building technical files and keeping them for 10 years, ensuring products comply and that they are supplied with the CE mark, as well as the manufacturer or importer is identified on the product. Sample testing should also be carried out where appropriate and corrective action is undertaken where product is found to be non-compliant.

Finally, under the Swedish proposals, the broad product categories and list of indicative products move from the RoHS directive and sit in annex 1 and 2 of the WEEE Directive, which reverses the proposals outlined in 2008.

Gary Nevison is Head of Legislation at Farnell

> **"UNDER A SEPARATE REVIEW BY EUROPEAN COMMISSION CONSULTANTS, 29 EXEMPTIONS WILL CONTINUE UNDER THE PROPOSALS, MANY WITH AMENDED WORDING FOR CLARITY"**

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Morgan Technical Ceramics In Pioneering Energy-Harvesting Research

The manufacturer of ceramic components, Morgan Technical Ceramics, is undertaking a Shorter Knowledge Transfer Partnership (sKTP) project with Glyndŵr University. The project will last 26 weeks, with the aim to design and build an energy-harvesting demonstration system that will provide a renewable source of energy.

The company is working with academics at Glyndŵr University to prove this alternative energy source by constructing a proof-of-concept prototype. Morgan Technical Ceramics turned to the University for its expertise in computer aided design (CAD), Finite Element Analysis, electrical power systems, power electronics and PCB design, which are essential for this new application area.

"Industry is under increased pressure to find alternative renewable energy sources and to improve energy efficiency," said Dr Ashley Darby, Business Manager for Piezo Shapes at Morgan Technical Ceramics. "By carrying out this sKTP in collaboration with Glyndŵr University we can share our knowledge and expertise to innovate and identify opportunities for energy harvesting utilising piezo electric ceramics."

sKTPs are part-funded by the UK government. They aim to enable companies to gain access to qualified people and experts within the UK's universities to help take an organisation forward and work in new areas.

Morgan Technical Ceramics develops piezo electric ceramics for many markets and applications, including ultrasonic cleaning and welding, sonar and medical imaging. It is now carrying out this pioneering research to create a system based on piezo electric devices connected to a mat that will collect and store energy from footfall for reuse. The project will specifically look at how to best match the electronics to the piezo ceramic to develop more efficient energy harvesters.

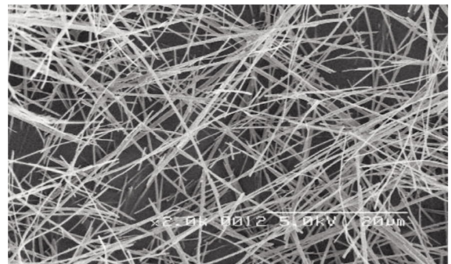
World's First Melt-Spinning Process Creates Highly Conductive Carbon Nanofibre

Japanese technology group, Teijin Limited, and the Tokyo Institute of Technology have developed a highly Crystalline Carbon Nanofibre (CNF), offering 30% greater electrical conductivity than conventional products. The extra-conductive CNF, which is 100-300nm in diameter and 20-micrometers long, has been developed with a melt-spinning process, a world's first for such fibre.

Since melt-spinning is widely used for the production of ordinary chemical fibres, the newly developed CNF can be manufactured by utilizing current facilities, which will help to minimize manufacturing costs. In addition, it is possible to manufacture CNF of high purity because no catalyst is used during the production process.

The primary application presently envisioned for the new CNF is battery components, particularly lithium-ion batteries for electric vehicles, including electrodes and additives for secondary batteries and capacitors. Other likely uses include plastic additives and fuel-cell gas-diffusion layers.

Teijin aims to commercialize the new CNF in 2011.



100nm crystalline carbon nanofibre (CNF)

STRATEGY UNVEILED TO DOUBLE SCOTLAND'S DIGITAL MEDIA SECTOR REVENUES

Doubling the value of Scotland's digital media sector revenue to £6.3bn by 2012 is one of the aims of a new strategy published recently by The Scottish Digital Media Industry Advisory Group. The strategy document, called 'Digital Inspiration', is the first of its kind to be unveiled for Scotland's digital media sector.

The key recommendations within the strategy include increasing both the number and scale of digital media companies, to create a national drive to increase the volume and value of innovative digital media platforms owned or managed from Scotland, to prepare a greater and more profitable role for Scottish companies in the chain of distribution and interactivity, and have a much more profitable leverage of intellectual property rights.

Digital media markets offer huge potential for Scotland, says new strategy

The vision of the Digital Media Industry Advisory Group is to create a high growth, world class cluster of content, platform and technology providers, developing and distributing innovative digital content and technologies to global markets.

"This debate is extremely important for Scottish Enterprise, other public sector organizations and industry, to inform how we can support the sector to achieve its growth potential, and ultimately result in Scotland's economic growth," said Terry Hurley, senior director of Digital Media and Enabling Technologies at Scottish Enterprise.

Achieving this vision will require commitment and investment from businesses, academia, government and the public sector in five critical areas for development: innovation, interactive distribution platforms, internationalization, investment and infrastructure.

www.digitalinspiration.org.uk

The Test-Jig TRAP

Myk Dormer

THE PROCESS OF introducing a new product or design to the marketplace has many important stages: initial specification, feasibility, design, pre-production introduction, approvals testing and full production – not to mention the parallel areas of purchasing, marketing, advertising and sales.

As engineers, our tendency is to focus on the interesting parts (research, feasibility studies, prototyping) and the difficult areas (realizing the complete, final design and specification compliance testing). But, we tend to pay less attention to less glamourous tasks, such as, for instance, the test process and, in particular, the early stages of it.

In the perfect world, engineering departments would be large, well staffed and lightly loaded. Designs would be well specified, efficiently managed and executed by teams of carefully selected specialists and, near the end of the design and prototyping phase, there would be a hand-over process to an equally competent team of production and test engineers who would seamlessly take over the design and carry it through the subsequent production release steps, to become a lucrative, volume-selling product.

The low power wireless industry isn't like that. For the most part, the companies, both module suppliers and end-users, are small to middle-sized concerns with very little in the way of spare resources. Both production and engineering departments operate with the minimum possible staff levels, frequently requiring individuals to fill two or more roles. This combines with short design cycles (admittedly for relatively simple basic hardware), numerous customer support tasks and typically a wide range of products in the company catalogues.

"IN THE PERFECT WORLD ENGINEERING DEPARTMENTS WOULD BE LARGE, WELL STAFFED AND LIGHTLY LOADED, AND DESIGNS WOULD BE WELL SPECIFIED, EFFICIENTLY MANAGED AND EXECUTED BY TEAMS OF CAREFULLY SELECTED SPECIALISTS"

From the engineer's perspective this working environment has some obvious benefits: the work is varied and can be technically demanding – in a good way. Projects come to fruition satisfyingly quickly and design teams are small – often just one or two engineers, and, so, are efficient. There is relatively little red tape or (apparently) pointless company 'procedures'. No-one could call it boring.

The workload is, however, high. This, in turn, puts engineering effort at a premium, with overwhelming pressure to 'finish that and start this', in fact the 'single project at a time' job is, for the most part, an unattainable dream. And this is where the trouble starts. The initial phases of a design cannot effectively be hurried. Specifications must be written, basic tests done and the circuit, PCB and mechanical designs completed. Firmware needs to be written and proven, and the final, integrated, product design tested.

At this point there seems to be a finished unit on the lab bench. Management, marketing and sales will begin clamouring for it. Customers will be told and orders will begin to arrive. Before you know it, production hand-over starts. All the information to build the thing already exists (more or less), and so gets hurriedly written up and released to the (often sub-contracted) manufacturing department. And that's that. You rush to start the next design or customer support task.

Then the first production units start coming off the line. It's at this point that the missing part of the project becomes apparent. Production level test jigs, assemblies and procedures simply do not exist. Weeks' worth of lab-bench tests have already been done (so the actual information exists) and there is probably some lash-up to connect test gear to the unit (by now consigned to the junk box), but that's a whole world away from anything that can be handed to an average production test technician. Most likely, even the final assembly details aren't properly tied down. Mechanically, there are probably still 'prototype' processes done by skilled hands without assembly jigs. In all, the production teams find themselves making things they cannot test and, therefore, sales cannot sell.

The only solution is to throw the problem back at the engineer. As a 'stopgap measure' the first production batches end up being assembled, tested and frequently re-worked through the R&D lab, which uses up more of the already scarce engineering resources.

This leads us to the title of the article. At this point, the day-to-day priority attached to getting the new products tested and shipped is considerably higher than that attached to the job of building production-usable jigs and sorting out the, frequently automated, test equipment needed. Most likely, this mundane task is even lower priority than the pre-existing workload, too.

So the jigs never get built. Products end up being produced and sold with the unspoken knowledge that they can only be finished by the R&D engineer. The first time this happens, it probably won't make too big an impact. After two or three products end up going this way, and especially if they get popular, then the product test/assembly load pushes out almost all of the actual design and even support tasks to the point that there is no longer sufficient non-production effort left to build the jigs that would solve the problem in the first place. You're now in the 'test jig trap'.

It gets worse. The usual response to this state of affairs at the management level is to conclude that the engineering department is overloaded (correct!) with too many design jobs (wrong!). The future (of the company) design work is shelved while the (visible to the accountants) production and support tasks remain. Finally, when the obsolescence of the product range becomes too obvious to ignore, new staff – or worse, contractors – are hired to design the 'next' generation of units. And production units are still being tested by the original engineer, who by now is demoralized and, effectively, demotivated.

There is a simple solution to this issue: plan the production and test components of the project in from the start and do not release to production until the whole of the project and not just the little item that gets sold at the end is ready. It is easy to say, but very awkward to implement.

While obvious common-sense in any relaxed discussion, too many factors are in the way in the real day-to-day work situation (demands for shorter time-to-market, insufficient manpower, even the intrinsic desire of the engineer to work on something more 'fun' than 'another jig').

It's difficult, but the alternatives are worse.

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

CLOUD BUSTING: WHY CLOUD COMPUTING REQUIRES A NEW APPROACH

By **Wim Nauwelaerts** and **Pauline Le Bousse**, attorneys in the Privacy Practice Group of Hogan & Hartson LLP

The data breach involving Twitter is only one example of individual's privacy being compromised as result of unprotected cloud computing services

LAST JULY it was reported that a hacker had broken into the email account of an employee of social networking site Twitter, giving the hacker indirect access to Twitter's documents through Google Apps. Twitter uses Google Apps for a range of web-based services such as email, word processing and spreadsheets, and to store its company data "in the cloud".

As a result of the breach, the hacker was able to expose Twitter's business information as well as personal data relating to the company's employees and even their family members. Luckily for Twitter and its employees, apparently the hacker just wanted to make the point that no one's data is safe on the Internet, which is why he sent some of the hacked data to a couple of technology news blogs.

The Twitter case is yet another illustration of the growing concern about data privacy and security in the context of what is now often referred to as "cloud computing".

So, What Is Cloud Computing?

Many attempts have been made to define "cloud computing", but the definition of Ontario's Information and Privacy Commissioner Ann Cavoukian probably captures the essence of the phenomenon. Cavoukian describes cloud computing as "a fundamental shift in how data are managed and processed. Rather than running software on a desktop computer or server, Internet users are now able to use the 'cloud' – a networked collection of servers, storage systems and devices – to combine software, data and computing power scattered in multiple locations across the network".

IT LOOKS UNLIKELY THAT IN THE SHORT TERM EUROPEAN REGULATORS WILL AMEND EXISTING DATA PROTECTION RULES TO ADDRESS THE PRIVACY AND SECURITY ISSUES POSED BY CLOUD COMPUTING

Put simply, cloud computing refers to a remote computing model which obviates the need to install software and hardware or store data on one's own computer or devices. Or, as Oracle founder CEO Larry Ellison recently noted, cloud computing is "nothing more than a faddish term for the established concept of computers linked by networks".

There are different cloud computing models in use today. Through cloud computing, software can be offered as an online service ('Software as a Service' or 'SaaS'). Here, a software provider licenses an application to users for use as a service-on-demand. The application typically runs on the provider's cloud infrastructure (e.g.

networks and servers), providing for a complete cloud computing experience.

In the case of 'Platform as a Service' (PaaS), the user relies on the provider's cloud infrastructure as the main or sole solution to run its own applications.

Another form of cloud computing is 'Infrastructure as a Service' (IaaS), where the user combines the cloud provider's infrastructure with its own or other computing infrastructure to deploy its applications.

The Pros

Cloud computing arguably offers several advantages from the viewpoint of users, as well as service providers. For users, cloud computing can offer an affordable alternative to conventional computing models that require significant investments in IT resources and infrastructure.

In addition to cost savings in terms of IT infrastructure, the software applications available through the cloud are often free or cheaper than comparable desktop products. Moreover, users can access cloud computing services from almost any location or device and, in the event of hardware failure, users' data remains available in the cloud.

By providing their services through the cloud, providers can easily monitor their services and keep them up-to-date. Since users do not receive any hard copies, it is also easier for cloud providers to protect their technology against piracy and reverse engineering. If a user violates the provider's terms of use, access to the service can be denied and the user's account can be terminated in a heartbeat. Last but not least, many providers of "free" cloud-computing services (e.g. webmail) seize the opportunity to monetize users' information by including (targeted) advertisements in their offerings.

The Cons – From an EU Privacy Perspective

The ubiquitous and dynamic nature of cloud computing services – with data being stored and processed remotely in the cloud – makes those services particularly vulnerable from a data protection and privacy perspective. Data security and privacy threats exist due to the fact that information, including personal data, is stored and processed remotely, usually without users knowing where the data actually resides.

The data breach involving Twitter is only one example of individual's privacy being compromised as result of cloud computing services, and it can be expected that more of these breaches will occur as cloud computing services become more popular.

The real problem is that existing laws and regulations are not always suitable for dealing with the specific data protection and privacy issues raised by cloud computing. In Europe, for instance, users' data privacy will be protected by the EU Data Protection Directive (95/46/EC), which has been transposed into the national laws of all EU member states. However, the EU Data Protection Directive was written at a time when the Internet was still in its infancy. Therefore, applying the traditional data protection and privacy principles to cloud computing services is a challenge, to say the least. What follows are some of the difficulties that users, cloud providers and authorities may encounter when applying existing data protection and privacy rules to data in the cloud.

- EU data protection rules only apply to the "processing of personal data". Although this concept is typically given a broad scope of application, in the context of cloud computing it may not always be straightforward to determine whether or not a particular cloud provider is actually processing personal data (for example, in the case of Infrastructure as a Service). There has also been considerable debate about whether or not collecting IP addresses (e.g. by a cloud provider) constitutes processing of personal data.
- Another issue relates to the fact that in many cases it has become more difficult to locate personal data in the cloud, especially if replicas of users' data are kept in several places. EU data protection rules apply to personal data that are being processed in the EU, so for the application of these rules it is crucial to establish where the data processing takes place. Sometimes the cloud provider's terms of use or privacy policy will shed light on this question, for example, by stipulating that users' data will not leave the EU. However, if a cloud computing service involves a multitude of providers, determining which cloud provider is subject to EU data protection rules for what data

Applying the traditional data protection and privacy principles to cloud computing services is a challenge processing can prove to be a Herculean task.

- Even if it possible to identify which cloud provider is subject to EU data protection rules, this does not necessarily mean that the cloud provider is responsible for the processing of personal data under EU data protection rules. In the EU, the data "controller", i.e. the person who determines both the purposes and the means of the data processing, will be responsible for complying with EU data protection rules. In many cases, a cloud provider will only process personal data at the instructions of the user, who will be considered the data controller. However, in the case of Platform as a Service, a user typically does not have any control over the means used to process the data. Consequently, data protection authorities could take the position that both the user and cloud provider are data controllers liable under data protection law. In addition, a cloud provider may fall within the ambit of EU data protection rules if the provider analyses users' personal data for purposes of behavioural advertising.
- EU data protection law restricts transfers of personal data to non-EU countries: if the country of destination is not recognized as offering an adequate level of data protection, the parties involved in the transfer will usually be required to put in place a contractual framework to ensure that the data remains protected. In practice, cloud providers will often move users' personal data from one jurisdiction to another or transfer the data to other cloud providers outside the EU. From an EU data protection perspective, this cross-border data flow may become problematic if the cloud providers involved have not carefully considered on which legal basis the data will be transferred outside the EU.

The Need for an Alternative Approach

It is clear that the particular nature of data processing in the cloud, the multiplicity of stakeholders involved, as well as the difficulty of locating data in the cloud can impose considerable hurdles when it comes to applying traditional EU data protection principles. Therefore, regulators, data protection authorities, as well as cloud providers, should perhaps consider alternative ways to tackle data protection and privacy issues in connection with cloud computing services. Such alternative approach could, for example, focus on: (a) building privacy enhancing features into cloud computing services; (b) putting users in control of their own data in the cloud; and (c) simplifying the rules on personal data transfers.

(a) Cloud providers should consider building – where appropriate – privacy, security and confidentiality enhancing features into the product and service design of their cloud infrastructure, applications and software. For example, cloud providers may want to adopt encryption technologies that apply by default, reducing the risk of privacy exposure in case of a data breach. They could also implement data minimisation applications to ensure that personal data are only stored or otherwise processed if necessary, and that databases are regularly purged or anonymized.

Contrary to what the name indicates, privacy by design does not stop at the design stage: privacy impact assessments should be conducted by independent privacy experts throughout the cloud infrastructure's lifecycle to ensure that privacy-enhancing features are updated and adjusted when needed. The privacy and security by design concept is already envisaged to some extent in the current EU data protection framework and has been endorsed by most data protection authorities in the EU. Last year, the UK Information Commissioner's Office, for instance, issued a comprehensive set of recommendations for better data protection through the implementation of privacy by design. In line with the views adopted at the EU level, the UK Information Commissioner's Office recommends that both privacy and security risks should be integrated in a common risk assessment approach.

> THE TWITTER [HACKING] CASE IS YET ANOTHER ILLUSTRATION OF THE GROWING CONCERN ABOUT DATA PRIVACY AND SECURITY IN THE CONTEXT OF WHAT IS NOW OFTEN REFERRED TO AS "CLOUD COMPUTING"

(b) Users are likely to raise privacy concerns if they are no longer in control of what happens to their personal data in the cloud. It is therefore essential for cloud providers to adopt a user-centric approach to users' identity and data management. Users should be given the opportunity to provide – or refuse – their informed consent to the processing of their personal data, whenever cloud computing services require such processing. In the case of cloud computing services that involve different stages of data processing, this may imply a continuous dialogue between users and cloud providers to ensure that proper consent is in place at all times. Cloud providers should also use secure identity management systems to avoid that users' accounts are hacked (which apparently happened in the Twitter case). However, with the multiplication of users' devices and cloud computing services, and the increase in security measures for each service (including, for example, biometrics), it may become impractical for users to maintain multiple security credentials and accounts. Cloud providers should therefore consider user-friendly alternatives to effective identity management, such as single sign-on, especially when cloud computing services involve more than one provider.

(c) The current EU data protection principles on data transfers outside Europe are based a (rebuttable) presumption that jurisdictions outside the EU do not always protect personal data sufficiently. As this jurisdictional approach is difficult to apply to cloud computing services, the question rises whether there is an alternative, more suitable method for dealing with cross-border data flows in the cloud.

Canadian privacy law has opted for an organisation-to-organisation solution for data transfers that is not based on the concept of adequate data protection in the country of destination. Under Canadian law, each organization is responsible for personal data in its possession or custody and remains accountable for data sent to third parties for further processing. The organisation is required to use contractual or other means, to ensure that the third party processor provides protection comparable to the level of protection the personal data would receive if they had not been transferred. Applying this approach to cloud computing, it may not be inconceivable to have a single "responsible organisation" accountable for making certain that personal data in the cloud is protected at all times. This "responsible organisation" could, for instance, be the (first) cloud provider with whom a user enters into a service agreement. The responsible cloud provider would subsequently have to verify that third party processors (e.g. other cloud providers), have effective security measures, policies and processes in place to ensure that the data is properly safeguarded.

The Way Forward: Regulation or Self-Regulation?

It looks unlikely that in the short term European regulators will amend existing data protection rules to address the privacy and security issues posed by cloud computing. It seems more plausible that in the near future data protection authorities in Europe will publish (non-binding) guidelines on how to deal with these issues.

Such guidance may be provided at national or EU level, for instance via the "Article 29 Working Party", which is made up of representatives from the EU member states' data protection authorities, the European Data Protection Supervisor and the European Commission.

In the meantime, a group of cloud providers has joined forces through a self-regulatory initiative that has so far resulted in the publication of the group's "Open Cloud Manifesto". The Manifesto intends to start a dialogue between the cloud computing industry and cloud users, by introducing a set of principles designed to ensure that the cloud remains open and that the cloud's challenges, including data privacy and security, are addressed through open collaboration and the appropriate use of standards. Whether self-regulatory efforts will suffice to make sure that personal data are protected in the cloud, remains to be seen.

Custom Wi-Fi Enabled DEVICES

The goal of this article is to construct a prototype custom Wi-Fi enabled device that can be accessed from anywhere in the world where Internet access is available. This primer can then be used as a mechanism to create custom Wi-Fi enabled devices. By **Tony Contrada**, Research Engineer at Georgia Tech Research Institute

THE TERM WI-FI has come to mean "connectivity without wires". Wi-Fi is based on the IEEE standard 802.11 with subscripts a, b, g and now n. Each incrementing letter includes improvements in both technology and infrastructure.

Wi-Fi is attractive because it's low cost, very reliable and operates at high data rates, typically from 11Mbps to 450Mbps for the n standard. These high data rates allow almost any application to be realized using this technology.

Market research has shown that Wi-Fi has now become the sought after feature in consumer electronics. In 2010 Wi-Fi enabled products will reach 128 million, with estimated 315 million by 2014 worldwide. As we look at trade publications covering this technology, we find that new devices are hitting the market almost daily. Smart phones and handheld media devices are making use of this technology as a standard feature today.

Another new feature to Wi-Fi is Wi-Fi Direct. This technology allows Wi-Fi enabled devices to communicate with each other directly as Bluetooth devices do. Wi-Fi Direct is expected to open the door to even more applications and products soon.

Typical Wi-Fi Configuration

A typical home Wi-Fi network is shown in **Figure 1**. Most Wi-Fi networks consist of at least two parts: the broadband cable or DSL modem, which connects to a local Internet Service Provider (ISP), and the Wi-Fi router or access point.

Although these two devices make up the basic network and provide connectivity to the ISP, there must also be devices that can utilize this service. The most common are a desktop or notebook PC. Other devices include a wireless printer, smart phone, handheld media device, gaming systems, digital cameras and video streaming as well. All of these devices can share the primary bandwidth from the ISP via the broadband modem and Wi-Fi router.

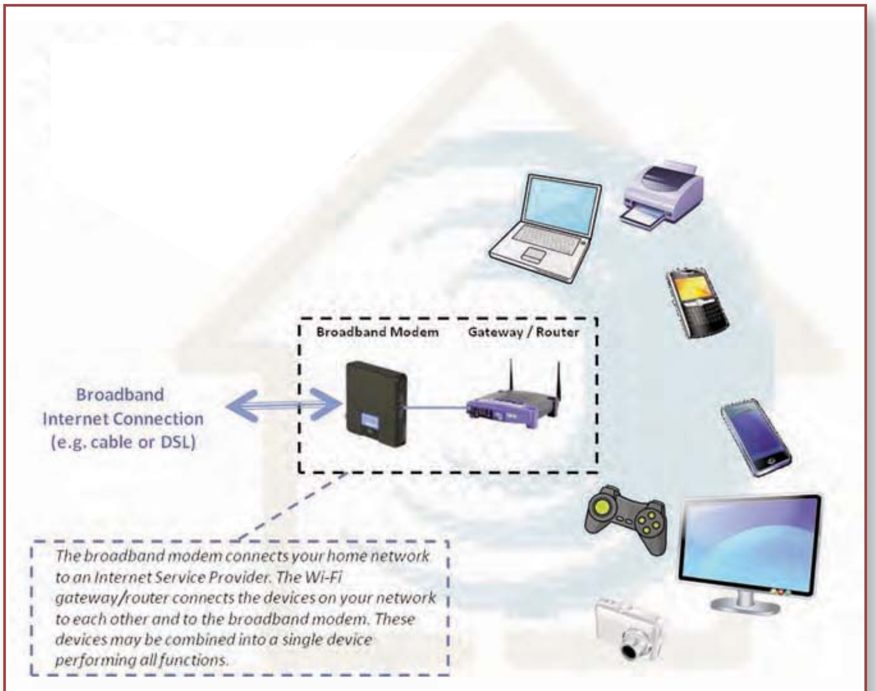


Figure 1: *Simple Wi-Fi network*

Enabling Generic Wi-Fi Devices

With future growth of Wi-Fi, in both consumer and industrial applications, a market for a generic Wi-Fi device that can function as the technology that allows a design engineer to enable a previously non-networked device onto a wireless network.

One company that makes such a device is Roving Networks. It calls its device a WiFly module and it is a self-contained Wi-Fi module that uses very low power consumption (suitable for battery-powered operations), meets 802.11b/g and is designed as an embedded TCP/IP solution. The company has three versions of the product, but all use the same base Wi-Fi module. The device that I selected was the RN-134, which includes an easy way to integrate the module in a test/development environment. Listed below are some of the major features of the RN-134 WiFly module:

- UART interface with RS232 and TTL signalling
- Status LEDs to show network status and data transfer
- High throughput, 1Mbps sustained data rate with TCP/IP and WPA2
- Ultra-low power (4uA sleep, 50mA Rx, 210mA Tx)

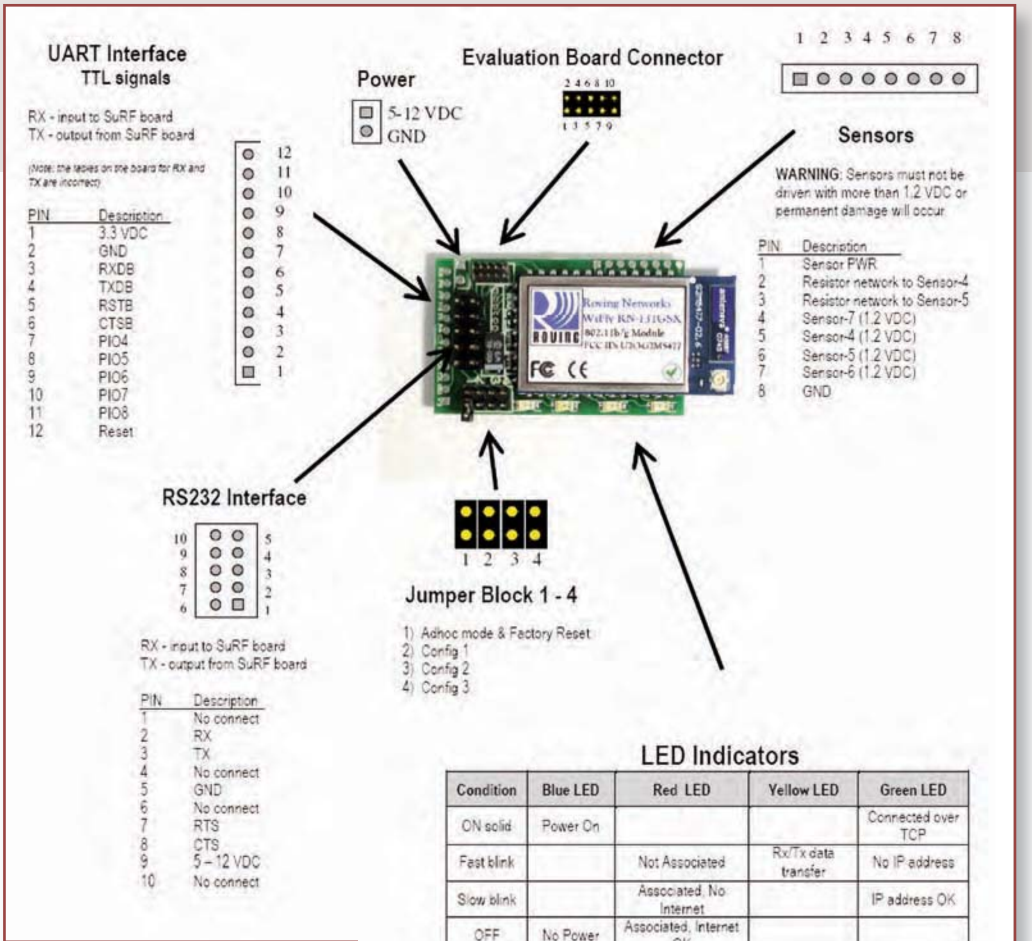


***Figure 2:** RN-134 diagram*

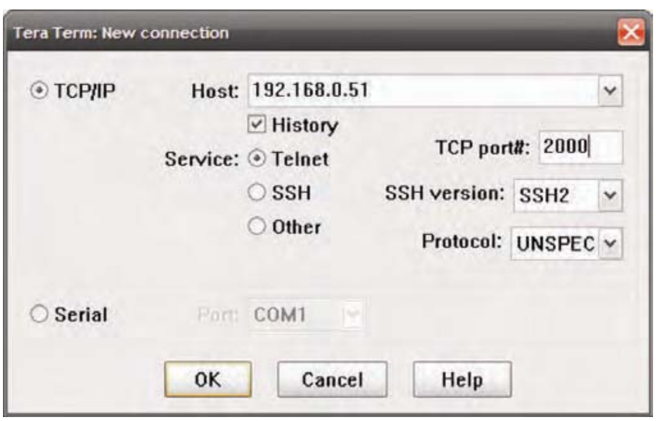


***Figure 3:** TeraTerm*

- On-board ceramic chip antenna and U.FL connector for external antenna
- Real-time clock for wakeup and time stamping
- Various general I/O (analogue and digital)
- Accepts 3-12VDC
- Wi-Fi Alliance certified for WPA2-PSK
- FCC/CE/ICS certified and RoHS compliant.

Some of the Wi-Fi enabled applications that can be realized using the WiFly module are:

- Remote equipment monitoring
- Asset tracking and telemetry
- Security
- Wireless audio
- Industrial sensors and controls
- Home automation
- Medical devices.

These are just a few applications, but in reality the applications are limited only by the imagination and the needs of the consumer and industry, both for today and tomorrow.

Figure 2 shows the RN-134 Wi-Fi module along with pin-outs of the various connectors including UART-TTL, RS232, power, sensors, jumper block and LED indicators. The WiFly module uses its serial interface either though hard-wired (TTL or RS232) or its wireless interface via Wi-Fi to either pass data or to configure its internal settings.

The WiFly module communicates via its hard-wired interface at a default baud rate of 9600 (Baud rate is configurable). Simply connect a DB-9 connector to the 10-pin header on the RN-134 module (Note: This connector is also available from RN). You can use any terminal program to connect to the device; I use TeraTerm because it also works easily with Telnet.

Out of the box there are just a few configuration settings to set in order to get the WiFly up and running on your wireless network. There is a 42-page user manual for the WiFly module on Roving Networks's website. It contains the entire command set for configuring the WiFly module.

When the WiFly module is first powered up it tries to connect to a Wi-Fi network and, if it does, it will automatically enter data pass-through mode. This mode allows data coming from the hard-wired interface to be sent over the wireless interface and vice versa. To get the WiFly module in Command mode you must enter the $$$ sequence (see manual for more info). Once in command mode, the configuration commands can be entered via the terminal interface. The commands are simple ASCII and very straight forward. For example, the primary three commands to get the WiFly module up and running on your wireless network are:

1. set wlan phrase <string> , where string is the pass-phrase for WPA or WPA2 security modes.

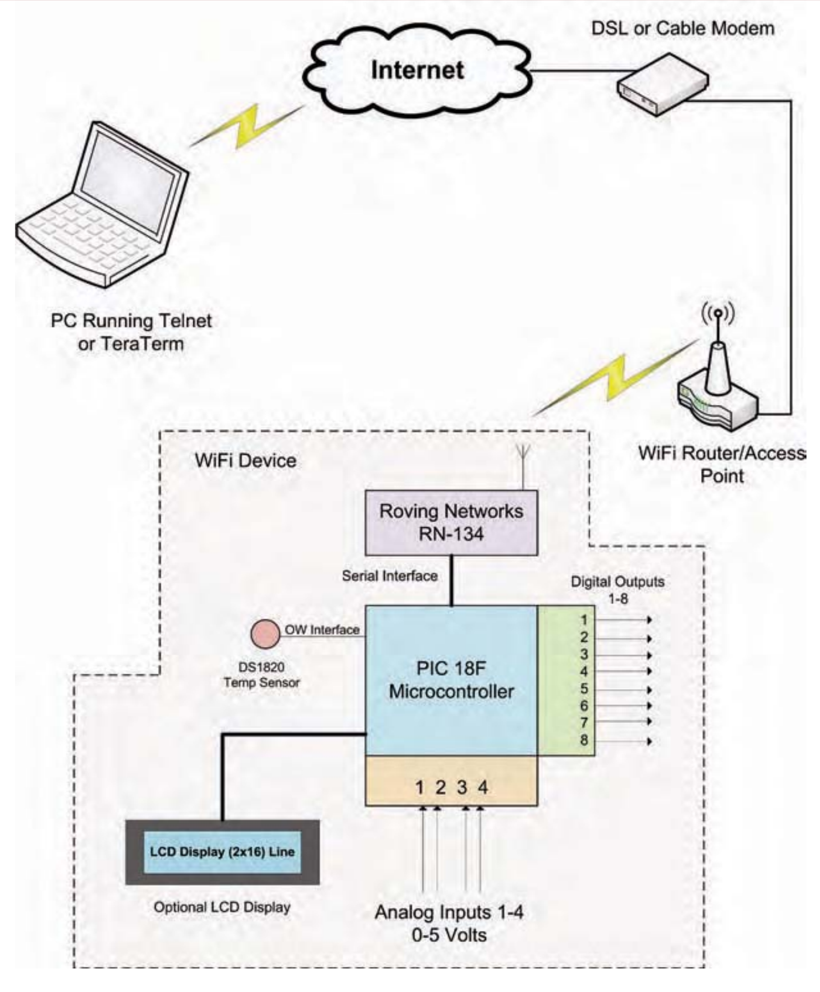


Figure 4: *Custom Wi-Fi device configuration*

2. set wlan ssid <string> , where string is the ssid to associate.
3. save – saves the configuration in the default configuration file.

You can also configure the module to automatically set its real-time clock on power-up, after it has connected to your wireless network. This will allow you to time stamp or set wake-up settings as well.

Configuring the Wireless Router

Once you have your WiFly module powered up and connected to your wireless network, the next step – if you want to be able to access your WiFly from anywhere in the world via the Internet – is to configure your wireless router and/or broadband modem. I found that this is basically a three-step process, but could vary depending on the router, modem and ISP.

When your WiFly device connects to your access point or wireless router, the router will assign your device an IP address from its local pool of addresses. This could be dynamic or static, depending on how your router is configured. This address is for your internal network only and not its IP from the outside world.

Open your router's configuration menu from your web browser. Usually it's set to 192.168.0.1, but check with your router's documentation. Then open the section that shows devices connected to your network. You should see an entry for the device.

Another way is to connect to the WiFly via the serial port, enter command mode ($$$) and type the command "get ip". The IP address and other information will be displayed. Be sure to exit command mode by typing "exit" to return to data mode.

To test your device on your local network bring up an instance of TeraTerm, set the IP address and port number (2000 is default port for WiFly), select Telnet and click OK. If it connects you will get a "*HELLO*" response from the WiFly device. Once connected data can flow in either direction. See **Figure 3** for a screen shot of TeraTerm's connection dialogue.

Now you'll want to set up a virtual server for your WiFly device. In your router's configuration, set up your device as a virtual server by entering its MAC or static IP address and port number. Check your router's documentation, but it's fairly straight forward.

The next step is to set your broadband modem to bridge mode (this may require you to consult your local ISP). But the idea is to allow your modem to pass the IP information so the router can do its job – routing data to the proper device, in this case your WiFly which acts as a host device.

Finally, you'll need to get the actual IP address of your modem on the Internet. The easiest way is to bring up a browser and navigate to **www.whatismyip.com**. You will see your public IP right from this web page.

Now that you have your public IP and you know your device is on port 2000, you would now bring up TeraTerm and enter those numbers, select Telnet and click OK. If everything is working, you should see the familiar "*HELLO* prompt from the WiFly device.

Now that your WiFly, router and broadband modem are configured, it is time to move on to building the custom Wi-Fi enabled device. Note that you can also operate within your local Wi-Fi network if you do not want to have public access to your Wi-Fi device.

Project Overview

The prototype Wi-Fi enabled project will primarily consist of the Roving Networks's RN-134 module and a Microchip 18F4620 microcontroller, along with a few external discrete components. The project will have the following features:

- Temperature sensor using DS1820 One Wire device
- 4 analogue A/D inputs (0-5VDC with 10-bit resolution)
- 8 digital output ports
- Serial interface to RN-134
- Optional 2 x16 LCD.

Refer to **Figure 4** for the system block diagram. Although the RN-134 has some built-in digital and analogue I/O, I have found that using a separate microcontroller provides more flexibility and robustness in the prototype design. In addition, the RN-134 uses some of the digital lines to control the status LEDs, which in my mind is useful.

The analogue inputs to the RN-134 are limited to 1.2 volts and saturate at around 400mV; they can be damaged if voltages exceed 1.2 volts. So the Microchip PIC seems to be a good choice as it is very inexpensive, straight forward to program and can provide added flexibility with custom software. The PIC also has additional I/O features such as SPi, CAN, One Wire, USB and I2C that can connect to many other smart devices allowing Wi-Fi capability.

Figure 5 shows the schematic diagram of the prototype project. The prototype was built using a PIC Ready board from mikroElektronika. These boards are very handy with their built-in power supply regulator, 8MHz crystal, reset button, I/O headers and prototyping area. I have utilized many of these boards for various PIC projects. **Figure 6** shows a

Figure 5: *Wi-Fi prototype schematic*

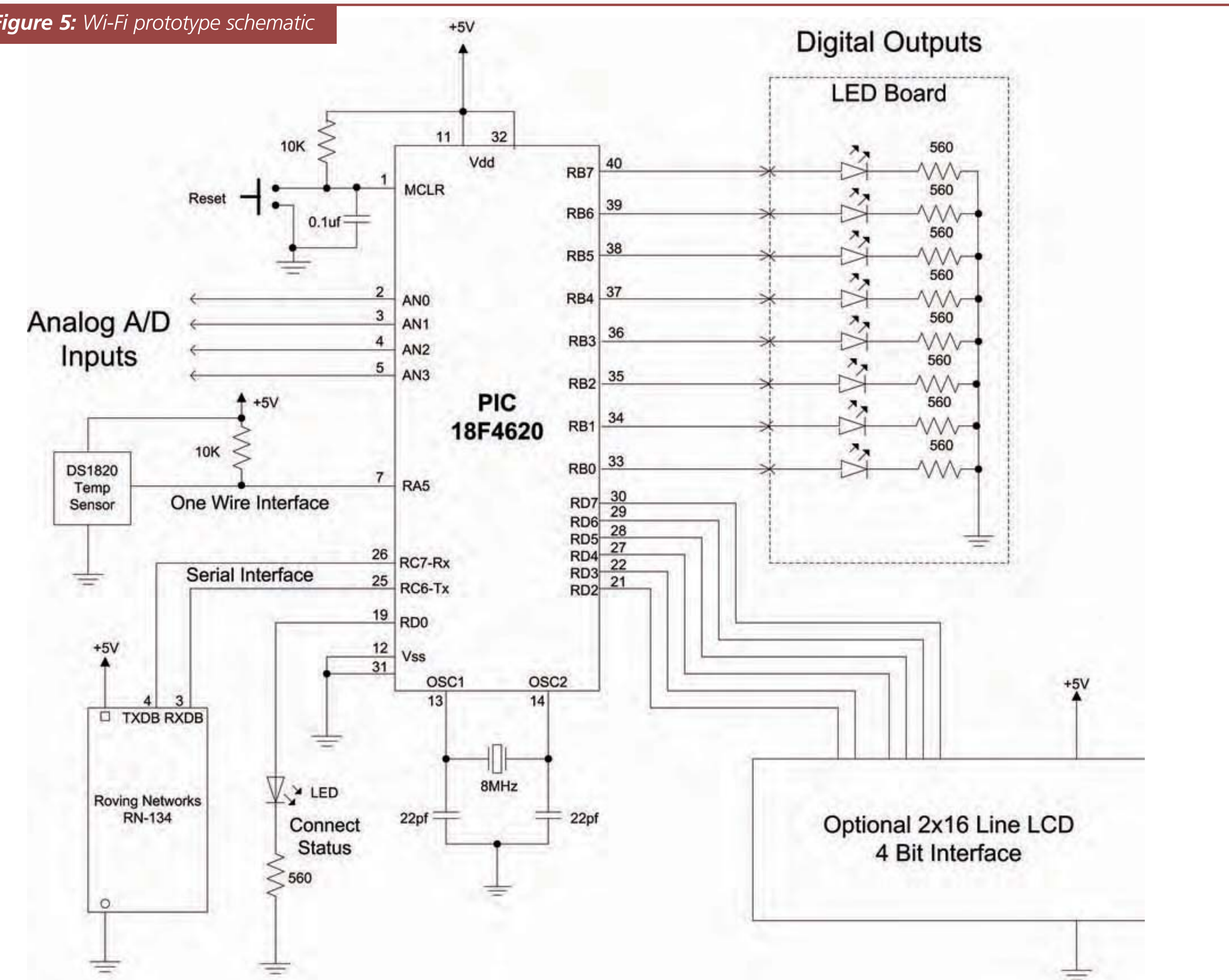


photo of the prototype project with the PIC Ready board, RN-134 and a small board with 8 LEDs.

The really nice thing about the RN-134 is it only takes four wires to connect it up to the PIC Ready board, +5V, Ground, Tx and Rx. All of the communication to and from the PIC is via the two-wire serial interface.

The DS1820 temperature sensor uses a handy One Wire digital interface to the PIC. The analogue inputs are connected directly to the PIC pins configured for A/D conversion. There is also a simple LED board which contains 8 LEDs, one for each output of the PIC's Port B (0-7). These are used simply as indicators for Off/On states for each output.

Finally, we can optionally connect a 2x16 line LCD to display the text commands entering the PIC via the RN-134 and for debug purposes. The prototype area of the PIC Ready board contains the DS1820 temperature sensor (TO-92 package) and an LED which is connected to the PIC's PortD.0 line to indicate Connect Status.

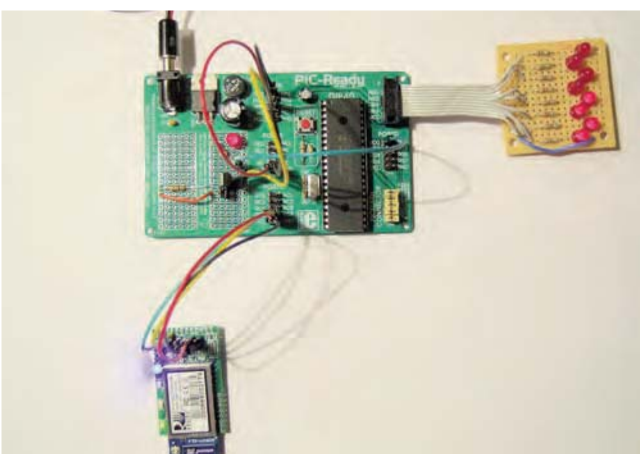


Figure 6: *Wi-Fi prototype photo*

Software Design

My approach to the software design for the prototype project was to accept simple text commands, execute each command and return a result. For example, to read the temperature from the DS1820 the command is simply "temp" followed by CR/LF characters. To read one of the analogue ports the command is "ra0" + CR/LF, this command reads the voltage on analogue port 0. To turn on a digital output port the command "p3=1" + CR/LF would turn on port 3. Setting a port equal to zero would turn it off.

I also included commands to read all analogue ports at once and turn on or off all digital output ports simultaneously. Lastly, I included both a "help" command that would display all the commands and their respective functions and a "close" command that closes the TCP connection and resets the PIC microcontroller. See **Figure 7** for a screen shot of the help command listing from TeraTerm.

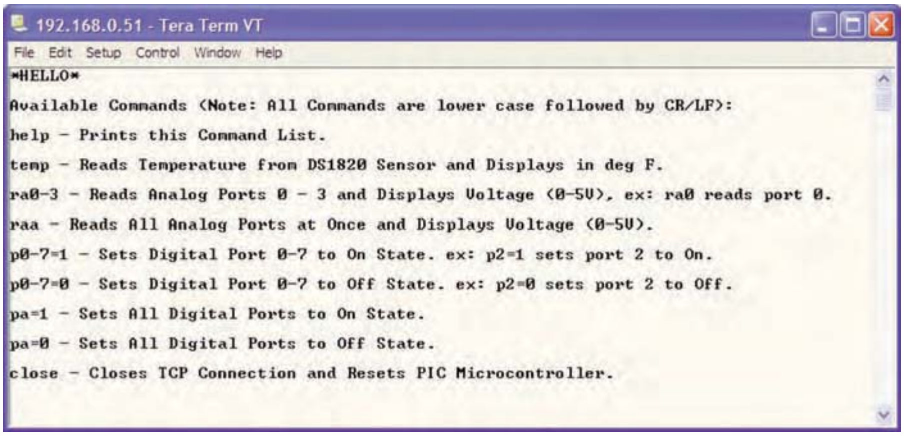


Figure 7: *Commands*

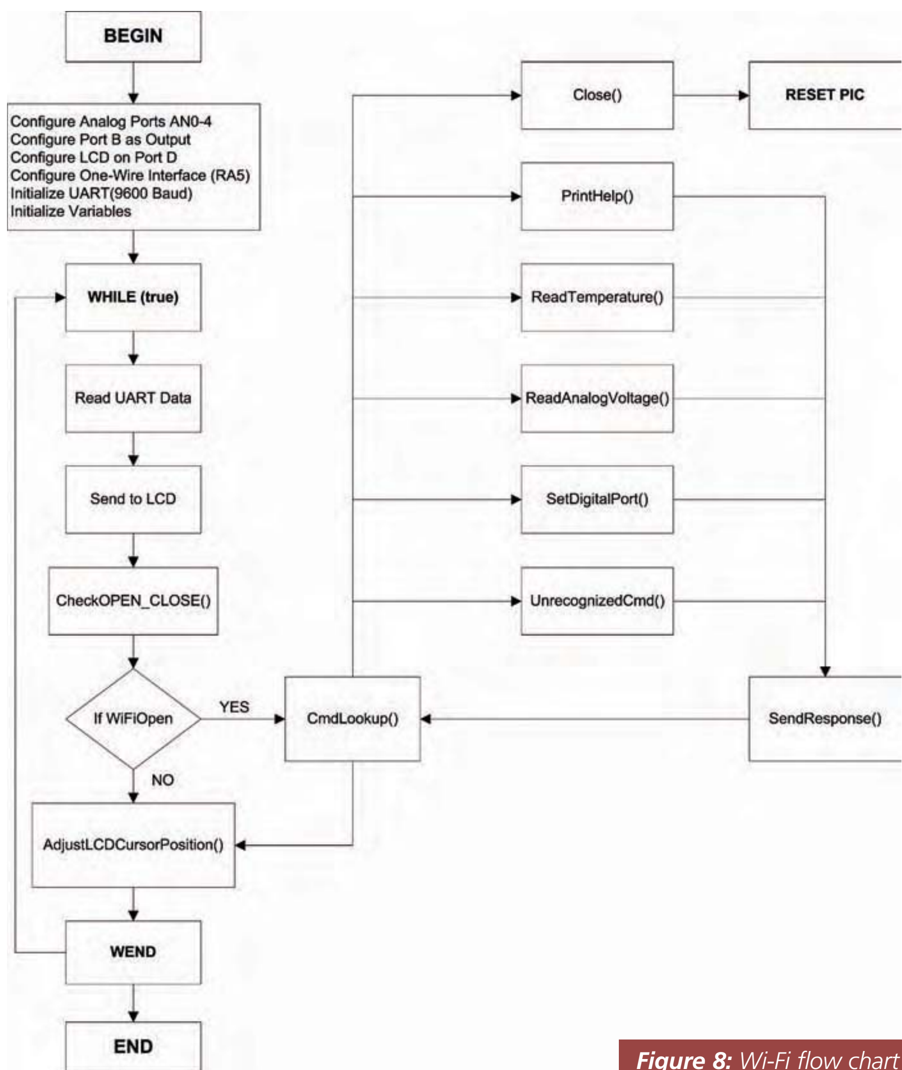


Figure 8: *Wi-Fi flow chart*

The flowchart for the software running on the PIC is shown in **Figure 8**. Both analogue and digital ports are configured along with the LCD, One-Wire and UART interfaces. The main program loop consists of a while loop that is always true. Data is read from the UART sent to the LCD and checked to see if the OPEN or CLOSE commands are entered. If the WiFly device is open, the commands are sent to the master CmdLookup() routine, parsed and further sent to their respective subroutines for command specific processing. Finally, the response text is sent back out of the UART.

This process repeats for each command entered. When the "*OPEN*" prompt is received by the PIC the LED on PortD.0 is illuminated and the PIC will accept commands. If the "close" command is detected, the PIC sends the TCP disconnect command to the WiFly device and then resets itself turning off the LED on PortD.0. In addition, if the PIC receives an unrecognized command it will return an "Unrecognized Command!" message. **Figure 9** shows the actual code of the while loop from the mikroElektronika compiler.

Testing the Prototype

The software was developed and tested in phases, in which the first phase was verifying that the commands were being received properly from the RN-134. The 2x16 line LCD was utilized as a debug monitor in order to view the incoming data. Once the data was verified, the CmdLookup() routine was built to parse the incoming commands and sending the data off to the respective command routines, i.e. ReadTemperature(), ReadAnalogVoltage() and so on. Each of the specific command routines is responsible for reading data from their respective source, formatting it and then sending it to the UART.

The initial testing was done using TeraTerm by connecting to the prototype via Figure 3 and then verifying the response shown in Figure 7. Next, the "temp" command (Read Temperature) was entered followed by the "raa" command (Read All Analogue Voltages) and the result is shown in **Figure 10**.

I could have basically stopped development here and that would have completed the custom Wi-Fi enabled prototype. But I wanted something better than just a text-based communications program to control the Wi-Fi prototype. I went ahead and built a Windows application using Microsoft's Visual Studio 2008 that presents a GUI (Graphical User Interface) along with a text-based view for comparison. The application makes use of the .NET Sockets class library for TCP/IP communication which Microsoft includes with Visual Studio. **Figure 11** shows the Windows GUI application.

The user simply enters the IP address and Port number and clicks the Connect button. There are two tabs on the application one for Text Mode and the other for Control Mode. Once connected, the user will see the Help listing in the text area. **Figure 12** shows the application after the "raa" (Read All Analogue Voltages) command was entered – all of the analogue voltages are displayed in the text area. Clicking on the Control Mode tab displays the screen as

```
--------------------- Main Routine -------------------------------------------
while (TRUE)                                          ' Endless loop
  if (UART1 Data Ready() <> 0) then                   ' If data is received,
    UART1_Read_Text(s_Data,sDelimiter,10)             '   read the received data,
    Lcd Out Cp(s Data)                                '   and send data to LCD
    sLen = StrLen(s Data)                             ' Determine String Length
    if sLen > 0 then                                  ' Must be >0
      CheckOPEN CLOSE()                               ' Check for Open or Close
      if WiFiOpen = true then                         ' Connection Open
         CmdLookup()                                  ' Send to Master Command Lookup
      end if
    end if
    AdjustLCDCursorPosition(sLen)                     ' This allows scrolling lines in LCD
  end if
wend
```

Figure 9: *Sample code*

shown in **Figure 13**. The user does not require any prior knowledge of the text-based commands. Simply clicking the appropriate button will provide the result shown in the GUI.

Where Do We Go From Here?

Now that I have presented a primer on developing custom Wi-Fi enabled devices, the reader, if so inclined, can begin to apply the techniques presented in this article to ideas that merit benefit to applications that are not currently Wi-Fi enabled or even new ones that don't exist yet.

The example prototype presented in this article was configured as a host application, i.e. the client application connects to the prototype. However, we could have designed the prototype as a client device in which the prototype connects to a server that collects data from the various sensors and makes that data available to other applications or even stores the data into a database. ■

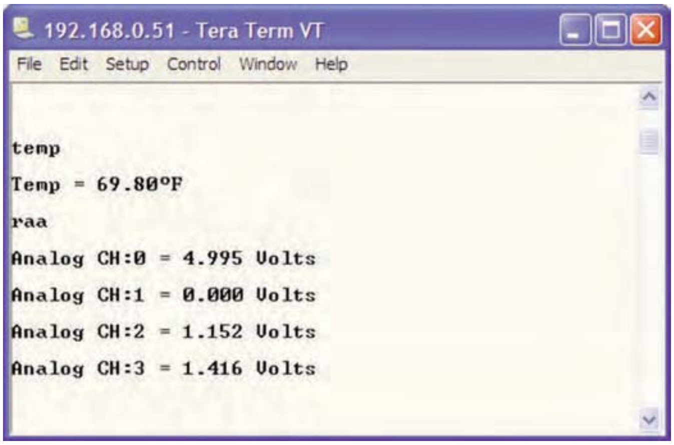


Figure 10: *Sample output*

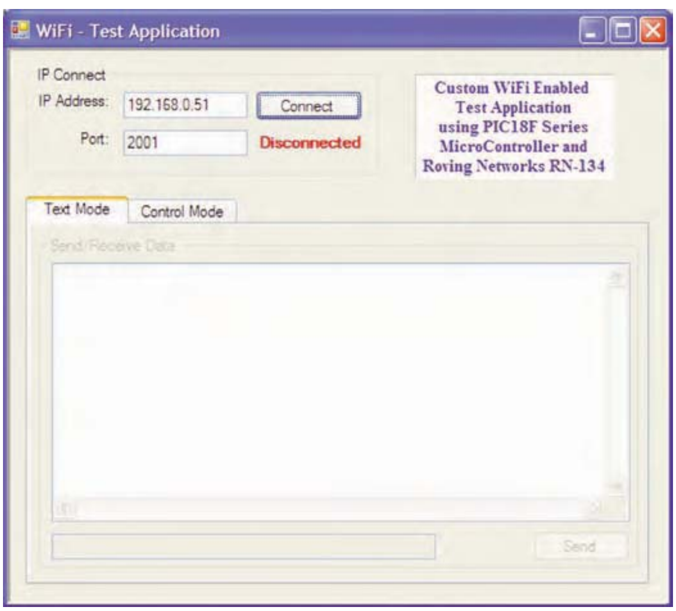


Figure 11: *Wi-Fi test app*

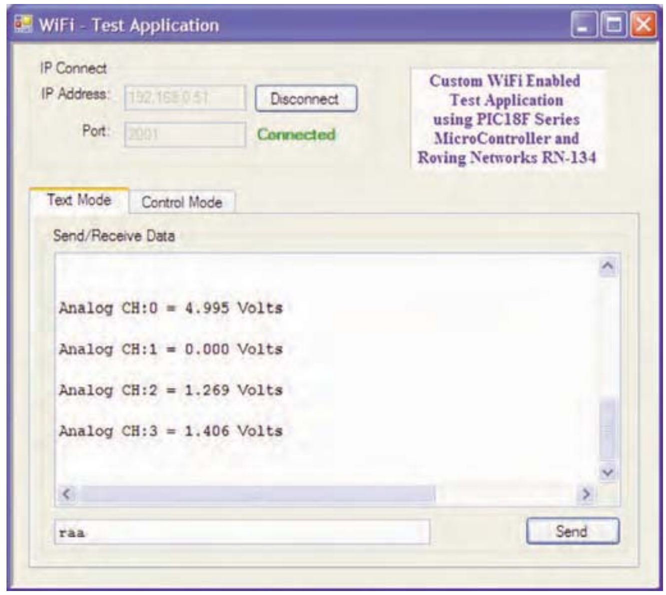


Figure 12: *Custom app1*

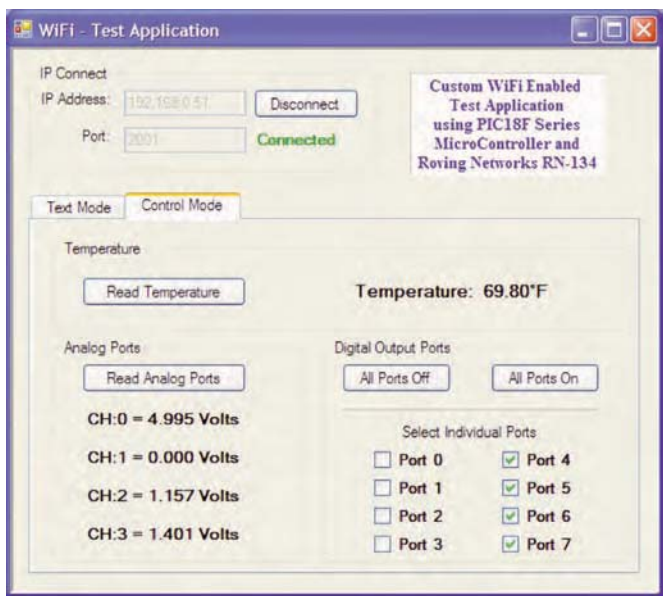


Figure 13: *Custom app2*

Professor Stojce Dimov Ilcev from the Durban University of Technology (DUT) describes the evolution and development of mobile antenna systems, classification and types, and characteristics for Mobile Satellite Applications (MSA)

This is a two-part article, with the second available in the next issue

Antenna Systems for Mobile SATELLITE Applications – Part 1

THE FIRST RADIO that was used on board ships for communication and safety purposes was developed more than one century ago. Mobile Communication Systems (MCS) were conceived for the transmission and receiving of telegraphy and telephony signals via mobile antennas at first from ships, then from cars, trains and aircraft.

The consideration of antenna transmission is inevitable, especially in Global Mobile Satellite Communications (GMSC), where their propagation characteristics are much affected by different and changeable local environments and differ greatly from those observed in fixed satellite systems.

To create adequate antenna hardware design for mobile GMSC systems, engineers have to consider all of the related factors in order to realize full mechanical and transmission potentials.

Evolution of Antenna Systems for MSC

The Russian professor of physics Popov designed the world's first radio receiver in 1895 with antenna in the shape of wire mounted on a balloon in the air, transmitter with a lightning conductor as an antenna, including a metal filings coherer and a detector element with telegraph relay and a bell. Soon after, Marconi started to commercially deploy radio and antenna equipment on board different merchant ships and to establish his own company for the production of maritime radio and antenna equipment.

Since the initial use of mobile radio more than 100 years ago for long distance wireless communications at LF, the first shipboard antennas were all made of haphazard lengths of wire strung as high as possible above the ship's topside – evidently the thinking was that the longer and higher the wire, the better the results should be.

After those, different kinds of wire and whip antennas were developed for MF/HF/VHF Maritime Mobile Satellite Communications (MMSC) and Aeronautical Mobile Satellite Communications (AMSC).

MSC systems introduced modern complexities into the design of shipboard antennas. The direct line-of-sight path between antenna and satellite requires the antenna to "see" from horizon to overhead (zenith 90º) in elevation and 360º in azimuth angle, with total hemispherical coverage. This is fulfilled in the case of transceiver antenna through the use of tracking rotatable, high-gain antennas often installed in pairs on board ships to attain full coverage, irrespective of blockage in the form of the funnel, musts, stacks and other deck objects.

The ship platform itself imposes even more stringent requirements. Therefore, in spite of constant vibrating, pitching, rolling and yawing during bad weather conditions, the MSC antenna's narrow radiation beam must be pointed accurately from any position on the high seas. The situation regarding land or aero antenna is less complicated.

As the 1970s dawned, optimism and enthusiasm about satellite communications

Figure 1: *The Fleet family of antennas*

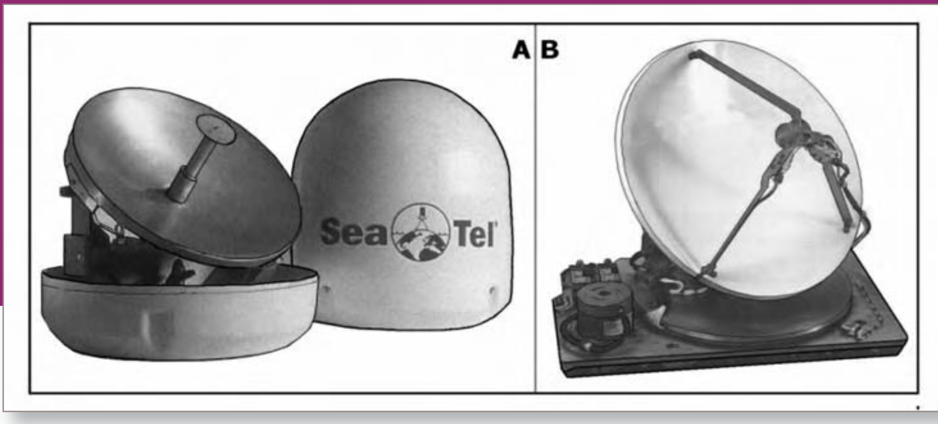


***Figure 2:** Types of antennas*

was so great with ideas to virtually replace HF radio in the Navy with the new Fltsatcom military mobile system. For instance, since this time, several types of UHF transceiving antennas developed for US naval shipboard services were used (such as the oldest crossed-dipole array), with improved versions and so-called wash-tube similar to an SBF antenna, and one type of SHF parabolic dish antenna. However, the first real global MSC system was the US Marisat military system, which employed Ship Earth Station (SES) and L-band antenna systems, similar to current Inmarsat-A and B terminals.

Types of Mobile Satellite Antennas

The general classifications of Mobile Satellite Antennas (MSA) in connection with the service operator/provider are performed on the following four major types: Satellite Communications Antennas, Satellite Broadband (Multimedia) Antennas, Satellite Navigation Antennas and Military Satellite Antennas. However, the fundamental classification of MSA according to gain values and characteristics falls into three main groups: Low-Gain Omnidirectional Antennas, Medium-Gain Directional Antennas and High-Gain Directional Aperture Antennas.

Mobile antennas have to satisfy the requirements of mechanical characteristics in relation to construction strength and easy installation. In fact, easy installation and appropriate physical shape are very important requirements in addition to compactness and lightweight. In the case of shipborne antennas, the installation requirements are not as severe compared to that of aircraft and cars, because even in small ships there is a comfortable space to install an antenna set. Otherwise, the only problem is that all types of ships satellite antennas are sometimes under stress from vibration and sloping caused by strong winds, ship's rolling and pitch or is subject to corrosion by sea salt. Owing to these problems, a ship's antenna has to be well protected by plastic radome and properly mounted on a strong mast, specially designed for a certain size of antenna.

However, in the case of road vehicles, especially small cars and buses, low profile and lightweight equipment is required. The big haulage trucks and locomotives have much space for installation of antennas, but still they need to be aerodynamically in shape. The requirements are the same for aircraft, although more severe conditions are required to satisfy avionic standards.

Low air-drag is one of the most important requirements for aircraft antennas. Vehicles and aircraft utilize smaller and more aerodynamic sizes of antenna.

Electrical Characteristics

Sometimes, the mechanical construction of antennas is perfect because of some functional or electrical characteristics; however, designers of antennas have to keep in mind that their compact design has two major disadvantages in electrical characteristics, such as low-gain and wide beam coverage. The gain is closely related to the beam width, and a Low-Gain Antenna (LGA) should have a wide beam width. Since the gain of antenna is theoretically determined by its physical dimensions, reducing the size of antenna means decreasing its gain.

Because of low-gain and limited electric power supply, it is very difficult for mobile antennas to have enough receiving capability known as a Ratio of System Gain to System Noise Temperature (G/T) and transmission power known as an Effective or Equivalent Isotropically Radiated Power (EIRP). These disadvantages of Mobile Earth Station (MES) can be compensated by a satellite that has a large antenna and HPA with enough electrical power. A powerful satellite with high G/T and EIRP performance should permit the fabrication of MES with compact and lightweight antennas.

The next disadvantage is that a wide beam antenna is likely to transmit undesired signals to and receive them from an undesired direction, which will cause interference in and from other systems. The wide beam is also responsible for several fading effects, such as that from sea surface reflections in MMSC and AMSC and multipath fading in Land MSC (LMSC) and so, a compact mobile antenna system is required to prevent fading and interference.

Accordingly, it is inevitable for mobile antennas not to have enough performance, such as gain, radiation power and receiving capability because of their small physical dimensions. Without consideration of this, the requirements of transmitting and receiving performance of mobile antennas mainly depend on the satellite transmission capability.

The first and second generations of Inmarsat satellites have a global beam and the third generation has spot and global beams to provide global coverage. The regional or domestic Mobile Satellite Systems (MSS), such as AMSC, MSAT and Optus have spot beams. The spot gives higher satellite capacity than global beams, although there are basically no big differences between requirements for mobile antennas in the global system, such as Inmarsat or the mentioned regional systems.

Basic Relations of Antennas

The basic relations of antenna systems are very important parameters to easily understand the mode of antenna functions in two-way (duplex) satellite transmission systems, such as MES transceiving antennas. Moreover, these characteristics of MES antenna systems are needed for link budget calculations and for good satellite up and downlink design, which can provide reliable and acceptable quality satellite communications. At this point, this implies that the signal transmitted via the MES transmitting (Tx) antenna must reach the receiving (Rx) antenna of other MES or Land Earth Stations (LES) at a carrier level sufficiently above the unwanted signals generated by various unavoidable sources of noise and interference.

In almost all present and forthcoming MSS using GEO satellites, the L-band 1.6/1.5GHz is used for a link between the satellite and MES. The required frequency bandwidth in L-band MSS is about 8% to cover transmitting and receiving channels. Otherwise, in using a narrow-band antenna, such as an omnidirectional patch antenna, some efforts have to be made to widen the bandwidth.

The S and L-band are allocated in WARC-92 for the Big LEO Iridium and Globalstar satellite systems, which require frequency bandwidths of about 5%.

The required antenna gain is determined by a link budget, which can be calculated by taking into consideration the required channel quality and the satellite capability. The channels are expressed as C/N° and depend on the G/T and EIRP values of the satellite and MES. Thus, in the abandoned Inmarsat-P system and forthcoming ICO system, medium gains of 7 to 16dBi are required for voice and HSD channels using a transmission speed of about 24kbit/s.

In the case of present systems such as AMSC or MSAT, Optus and similar systems using GEO constellation, a medium gain between 8 to 15dBi is required for voice and HSD channels of 24kbit/s.

On the other hand, in the case of the present Inmarsat-A and B MES, a comparative High-Gain Antenna (HGA) of minimum 24dBi is required, due to the difference in satellite capabilities. Meanwhile, Low Gain Antenna (LGA) of about 0 to 4dBi is used in the Inmarsat-C and other similar omnidirectional systems to provide Low Speed Data (LSD) of only about 600 to 1,200bit/s.

The GPS system has adopted LGA because of the extremely low data rate of 50bit/s from the satellites. Because they have the same type of LGA system, it is possible to integrate Inmarsat-C MES with the GPS receiver.

There are no exact definitions to differentiate between characteristics of Low, Medium and High-gain antenna systems, except by the gain quantum, shape of the antenna and type of service. However, in the present and upcoming L-band GMSC applications, classification of L-Band MES antenna systems by their receiving and service capabilities is illustrated in **Table 1**.

The ideal antenna gain can be defined with an isotropic (hypothetical) antenna, which has an isotropic radiation pattern without any losses and, therefore, radiates power in all directions in uniform intensities. Thus, if input power (P_{in}) is put into an isotropic antenna, the power flux-density per ideal unit area (P_{id}) at distance (r) from the antenna is given by the following relation:

$$P_{id} = P_{in}/4\pi r^2 \ \ W/m^2$$

However, if radiated power density is $P(\theta, \phi)/r^2$ in directions (θ = angle between the considered direction and the one in which maximum power is radiated, known as boresight; and ϕ = phase) at distance (r) from the antenna under elevation, the gain of the antenna can be defined by the following equations:

$$G(\theta, \phi) = P(\theta, \phi)/r^2/P_{id} = P(\theta, \phi)/r^2/P_{in}/4\pi r^2$$
$$= 4\pi\, P(\theta, \phi)/P_{in} = P(\theta, \phi)/\ P_{in}/4\pi \ \ dBi$$

The above-defined gain is called an absolute gain or directive gain, which is determined only by the directivity (radiation pattern) of the antenna without taking account of any losses in the antenna system, such as impedance mismatch loss or spillover loss. Thus, if direction is not specified and the gain is not given a function of (θ, ϕ), it is assumed to be maximum gain. There is a general relationship between absolute gain and the physical dimensions of the antenna and this is given by the equation as follows:

$$G = 4\pi/\lambda^2\ \eta a$$

Type of Antenna	Gain Class	Typical Gain [dBi]	Typical G/T [dBK]	Typical Antenna (Dimension)	Typical GMSC Services
Omnidirectional	Low	0 – 4	–27 to –23	Quadrifilar Drooping-dipole Patch	LSD (Messages) Ship (Inmarsat-C) Vehicles & Aircraft
Semidirectional (Only in Azimuth)	Medium	4 – 8 8 – 16	–23 to –18 –18 to –10	Array (2–4 elements) Helical, Patch SBF (0,4m Φ) Phased Array (20 elements)	Voice/HSD Ship (Inmarsat-M) Vehicles Aircraft (Inmarsat-Aero)
Directional	High	17 – 20 20 – 24	–8 to –6 –4	Dish (0,8m Φ) Dish (1m Φ)	Voice/HSD Ship (Inmarsat-A, B)

Table 1: *Classification of L-band antenna systems in GMSC*

where η = aperture efficiency and a = physical aperture, which will denote the effective aperture of the antenna. According to the above relation, it can be realized that compact antennas with small apertures must have low gain. If an antenna aperture is a dish with known diameter (d), the equation can be written in normal and in decibel expression as follows:

$$G = (\pi d/\lambda)^2 \eta = 10 \log \eta (\pi d/\lambda)^2 \text{ dBi}$$

Thus, it can be calculated that the gain in the Inmarsat shipborne antenna with a diameter of d = 1m operated at 1.5GHz is about 21dBi.

The directivity of the antenna $D(\theta, \phi)$ does not include dissipative losses and is defined as the ratio of $P(\theta, \phi)$ to the power per unit solid angle from an isotropic antenna radiation, the same total antenna radiated power (P_r). The antenna directivity can be expressed by:

$$D(\theta, \phi) = P(\theta, \phi)/P_r/4\pi$$

The definition of antenna directivity does not take the efficiency of the antenna into account because $Pr/4\pi$ is related to the actual power launched into space. The ratio of $G(\theta, \phi)$ to $D(\theta, \phi)$ is termed the radiation efficiency of the antenna.

Compact and Lightweight

The design and configuration of MSA needs to be compact and lightweight, especially for LMSC systems. On the other hand, the physical characteristics for MMSC and AMSC applications may be quite different, but both have to be designed compact for harsh environments and very extreme operating temperatures. These requirements will be difficult to achieve because the compact antenna has two major electrical disadvantages, such as low gain and wide beam coverage, and because directional antenna has very heavy components for satellite tracking and getting satellite in the focus. However, a new generation of powerful satellites with high EIRP and G/T performances should permit the design of compact and lightweight MSA. As such, new physical shapes and less weight are very important requirements in connection with compactness and lightweight, permitting easier installation and maintenance.

Shipborne antennas still have very big dimensions, especially those integrated in Inmarsat Standard B and Fleet 77. The new Inmarsat antenna for FleetBroadband is getting smaller in dimensions and can be employed for communications and multimedia transmissions. The Swift64 airborne antenna is well suited for large jumbo jets, which installation requirements are not as limited, compared to very small aircraft and helicopters. However, new aeronautical SwiftBroadband can be installed even on small jets with reduced space on fuselage. A phased array MSA is considered to be the best prototype for aircraft and helicopters because of it's very low in profile, has convenient mechanical strength and allows for easy installation. ■

Components for WIRELESS Applications – To Integrate or Not Integrate

Jacques Lavernhe, System Engineering Manager at ON Semiconductor, looks at the design considerations when engineering portable devices

CONSUMERS ARE ALWAYS looking for a smaller but more feature-rich handset that integrates more functionality. However, they are reluctant to sacrifice battery life and, in fact, have longer duty cycles high on their wish list.

Battery technology is not advancing as quickly as the development of new functionality and its integration into the handset. And so semiconductor technology has to provide handset designers with more sophisticated power management solutions in order that battery duty cycles are not truncated to an unacceptable level. One of the trends is to integrate more functions into increasingly complex Power Management ICs (PMICs) with many voltage regulators, DC-DC converters, as well as other power management related functions. System-wise, it can also make sense to integrate audio CODEC and amplifiers plus other non-RF related analogue functions.

This approach can result in a three-chip highly-integrated solution, comprising the RF chip, baseband digital signal processor and application processor, and PMIC. Although this solution may require external components such as extra memory, the core of the system is highly integrated. The main advantages of this solution are a low component count, reduced cost bill of materials and highly reliable manufacturing.

Although the benefits of integrating several components and elements of functionality into a single IC seems a logical approach to save space and cost, there is a question mark over whether it is always feasible. Several potential drawbacks that may lead designers to adopt different integration schemes have to be considered.

Besides power consumption and power dissipation, other potential issues linked to integration include the layout of power rails and the optimal localization of power management and power generation functions on the PCB.

From a marketing and sales standpoint, the most important parameters are fast design cycle times and platform flexibility to enable the release of derivatives as soon as the market demands them. Clearly, highly integrated solutions are not flexible enough to accommodate new feature-rich functional modifications that may be required by fast changing market trends. They also may not always satisfy the demand for short design cycle times.

Integration Considerations

Lithium Ion batteries (Li-Ion) are the most popular source of power in the large majority of consumer and professional portable devices. These cells have a typical voltage of 3.6V but they can reach 4.2V when fully charged and drop down to 2.8V~3.0V when fully depleted. Usually, the device powered by the cell switches off when the voltage drops down to about 3.3V, to keep enough headroom and avoid safety issues associated with highly depleted batteries. To offset the relatively slow advances in battery technology, the logical and straightforward way to increase battery life in an application would be to increase their size. But, of course, this would also directly impact the overall size of the piece of portable equipment; something that would be totally unacceptable to consumers.

Another option designers can consider is to extend the battery operating range by reducing the low voltage safety margin and operating the system at a voltage lower than 3.3V. Some new battery technologies are expected to be able to support this approach. However, this leads to a need for more sophisticated power management techniques, higher control granularity and an increase in the amount of power

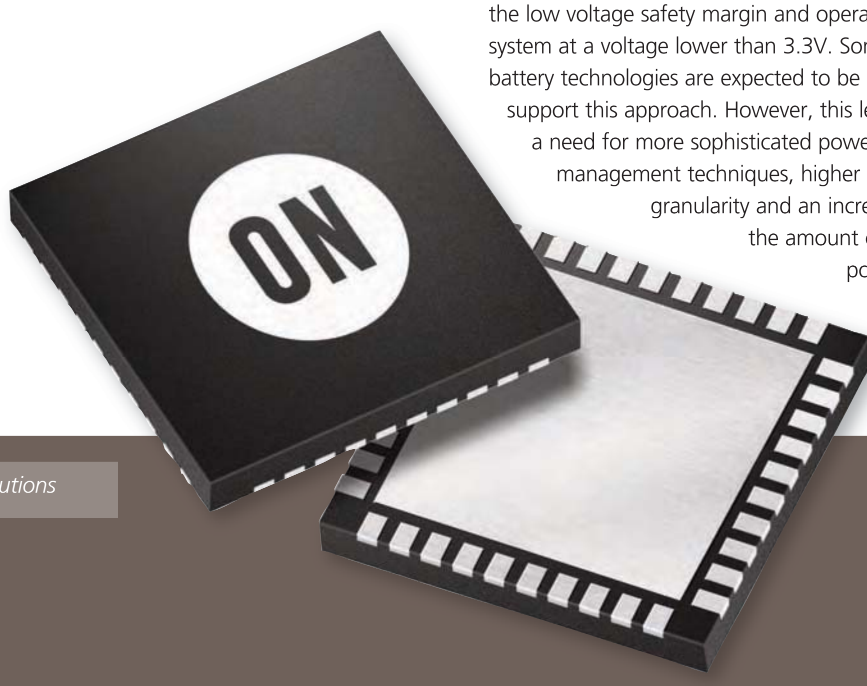


Figure 1: *Highly-integrated RF solutions*

Figure 2: *Modern handsets require all types of specific design considerations*

domains in which the electronics will work. This can be achieved but at the price of higher complexity and higher cost, especially if implemented with off-the-shelf highly integrated PMICs.

An example wireless application powered by a Li-Ion cell may feature a processor controlling main functionality, memory extensions, peripherals such as display, keyboard, connectivity (USB, Bluetooth, Wi-Fi, WiMAX), a baseband processor controlling voice communication and also analogue functions such as RF, audio, video and battery charging. Each function of this system is optimised to operate from a different power supply rail and has to be controlled, enabled and disabled separately. Digital functions such as baseband and processors may require at least two supplies each: low voltage for core and higher voltage for I/Os to interface with other devices. Each analogue function and display may need higher voltage to provide powerful enough drivers.

Constraints, such as available PCB real estate, cost and manufacturing considerations could drive designers to use very highly integrated ICs. However, this approach brings up additional design challenges such as thermal management and signal routing issues. These may lead to the use of a separate IC on top of the main PMIC, or perhaps a different level of integration with a sub-system partitioning approach.

Thermal Management

When using very high integration level ICs with several regulators, DC-DC converters and other analogue functions, designers should be aware that the maximum power dissipation of the package is much lower than the potential power the silicon may have to evacuate in order to remain within an acceptable operating temperature range when all regulators are operating at their maximum current.

For instance, let's consider a handset application with the main power functions supplied by a highly integrated PMIC. In this example application, the PMIC integrates two 90% average efficiency DC-DC converters, five LDOs and a white LED driving a dedicated boost converter, able to supply five LEDs in series with 85% average efficiency, plus other functions such as DC-DC converters or regulators for extra functions, battery charging, audio ADC/DAC and power stages. If we consider that the example application is powered by a typical Li-Ion 3.6V cell, it is possible to evaluate the IC dissipation when the power supply functions are switched on and the battery charger and audio functions are turned off. **Table 1** summarises the power supply system, whilst **Table 2** considers the power dissipated in each element of the PMIC.

Most highly-integrated PMICs are supplied in either BGA or QFN packages. The central area of the package is usually interfaced to the PCB ground plane in order to conduct as much heat as possible away from the device and keep the silicon at an acceptable temperature. In the case of a BGA, approximately 1/3 of the balls located in the centre of the matrix are utilized as ground connections. QFN packages have a large exposed metal pad located in the centre of the device that occupies more than 2/3 of the package area that can be 'connected' to the PCB using a suitable, thermally efficient, interface material.

These approaches provide a low thermal impedance path to ground, allowing good heat drain from the package. With this technique and an optimised PCB layout, the package thermal resistance ($R\theta JA$) can be as low as 40ºC/W.

If we consider the previous example, with just the main processor regulators operating at maximum current, we can expect to see a silicon temperature elevation of approximately 90ºC, bringing the silicon up to a maximum operating condition for an ambient temperature of 35ºC. Although 25ºC is a typical operating temperature, the internal temperature of a densely populated portable design might reasonably be expected to reach 35ºC.

A high temperature operating mode will jeopardize portable device reliability and, at worst, lead to system failure. The need for thermal management increases design complexity, requiring the designer to calculate and monitor, for each system power domain, the maximum current each regulator will have to supply and the maximum heat the PMIC will have to dissipate. This influences PCB layout and component placement as thermal failure may affect the operation and integrity of nearby components.

Even if the thermal management concerns are taken into consideration and kept under control by the designer, IC power supply functions may still dissipate too much heat. In this situation, other functions should be either switched off or at least switched into a 'heat save' mode with lower performance. For instance, during video playing, display brightness and audio sound level can be decreased to drop the PMIC temperature. Whilst main functions such as video, audio decoding and streaming performance are kept running as normal.

Depending on the system specification and architecture, one solution to help in solving thermal issues is the splitting of a large PMIC into several smaller ICs, or at least separating high dissipation regulators and putting them into a sub-PMIC. From a system standpoint this can make sense with each separate IC being dedicated to a given function. For a mobile phone that also integrates video and gaming functions, the designer may find benefit in supplying each module of functionality as an independent sub-PMIC controlled by the main processor.

If the main PMIC power dissipation is still too high, designers can consider putting other analogue user-interface related functions, for instance audio power stages and ADC/DAC, display supply and backlight, in a separate 'heat safe' sub-system IC to make sure they always operate at maximum performance.

Location on the PCB

In order to give users an improved video or gaming experience, the size and viewing quality of displays has greatly improved during the last few years. It is now possible to watch TV on a portable device with an Active Matrix OLED. As the sizes increase, the space available inside the handheld device increases and the geographical location of functions can be quite far away from the main PMIC.

The parasitic components related to the PCB layout will become more predominant. Let's consider the DC-DC converters in the previous example, supplying a processor located 50mm away from the PMIC and connected with a 5mΩ/mm track. The parasitic resistance will be 50mm x 5 = 250mΩ. Assuming that the thermal concerns are under control, the voltage drop in the parasitic resistance will be 250mV under 1A and 125mV under 500mA.

If we now consider the processor core power-supply range being 1.2V ±5%, as a worst case to operate at maximum clock frequency, 125mV drop in the tracks corresponds to about 10% of the operating voltage. This means that even for half of the maximum current, the voltage at the processor edge will be out of its operating range.

To overcome this issue, the designer has several options, these are:

1. Set the DC-DC converter output voltage higher than processor typical operating range to compensate for the drop. Considering dispersion between components; this is risky as the voltage will be uncontrolled and will depend on the processor operating mode and current.
2. Connect the converter feedback node as close as possible to the processor. In this case, the drop will be automatically compensated. However, the feedback pin is high impedance input, so input current will be very small (several nA) and the track could pick up a lot of noise. This can be overcome by careful attention to layout, but this is not always possible due to the track density.
3. Use of a separate sub-PMIC to supply this processor as well as related hardware. This makes design more flexible and simplifies layout.

Of course, this third option increases the Bill of Material (BOM) and the manufacturing costs slightly, but it may lead to higher reliability, a simpler design and improved design flexibility.

Other Considerations: Flexibility and Time-to-Market

In order to help illustrate this topic, we have discussed the advantages and drawbacks of a highly integrated PMIC versus a less integrated approach using sub-PMICs. This demonstration can be easily extended to other functions in the handset device, introducing a

CONVERTER	VOLTAGE (V)	CURRENT (MA)	COMMENTS
DC-DC 1	1.8V	800	Processor I/O
DC-DC 2	1.2V	1000	Processor Core
LDO 1	2.8	300	Analogue functions group 1
LDO 2	2.8	300	Analogue functions Group 2
LDO 3	1.8	200	Digital peripheral functions group 1
LDO 4	1.8	200	Digital peripheral functions group 2
LDO 5	2.5	200	Peripheral
WLED Boost	15V	20	5 LED with 3V forward voltage at 20mA

Table 1: *Summary of the power supply systems*

CONVERTERS		POWER DISSIPATED (MW)
DC-DC 1	(1.8* 0.8)*((1/η0 – 1)	160
DC-DC 2	(1.2* 1)*((1/η0 – 1)	133
LDO 1 / 2	2 * (3.6 - 2.8) * 0.3	480
LDO 3 / 4	2 * (3.6 - 1.8) * 0.2	720
LDO 5	(3.6 - 2.5) * 0.2	220
WLED Driver	(15 * 0.2)*((1/η0 – 1)	530
TOTAL DISSIPATED POWER		**2243**

Table 2: *The power dissipated in each element of the PMIC*

different level of integration with different partitioning in sub-systems.

With a highly integrated solution, any modification of system requirements identified by marketing will lead to heavy design modifications to each level of the design, including the software and hardware. Additionally, the modifications may affect the core of the system and make it risky from a business perspective.

Using a less integrated approach may lead to a more modular core design that is easier to maintain, modify and release with different options in a short timeframe. In today's very fast moving market, modular design might be a key factor to success and there is significant value in being the first to market with new, high value-added features.

A High Number of Options

In the handset, we cannot get away from using a highly integrated system for the core functions. The solutions described combine high levels of integration with high efficiency in a simple cost-effective design. However, in the feature-rich high-end handset market, other considerations such as reliability, heat dissipation or long PCB tracks may make the benefits of integration less clear. In addition, poor flexibility, long IC and chipset development cycle times, compared to the fast 'churn' rate of new handset designs, may make separate sub-systems a good alternative. They combine the advantages of integration and simple design with high flexibility and improved reliability. Assuming that the silicon vendors can provide cost-effective, size-effective and high-efficiency solutions, the handset designers will have a number of options when selecting the most appropriate solution. ■

Propagation Study of GSM Power in Two Dimensions in Indoor Environments – *Part 1*

This article is in two parts. Here, **José Carlos Gamazo**, **Juan Blas**, **Rubén Lorenzo** and **Jaime Gómez**, from the Department of Signal Theory, Communications and Telematic Engineering at the University of Valladolid in Spain, present the objectives, hardware and software developments of a propagation study of GSM-emitted power in two dimensions, in indoor environments

The second part will be published in the next issue and it will include the material, methods, results and conclusion of this study

THIS ARTICLE IS BASED on the application of an experimental system to measure the power of an electric field in indoor environments.

A robotic system is used to position automatically an antenna in a fixed grid within an environment. The collected data is processed, analyzed and demonstrated graphically in order to explain the 2D and 3D pattern of the electric power signal. Finally, a concrete environment is studied and the measured data evaluated in order to characterize the electric field radiated by a GSM base station and to analyze the impact on the human body. The results show that the measured signals have space and temporal variability in a concrete point of their propagation, which produces slow and fast variations with the distance.

Wireless Transfer of Information

Wireless communication is the transfer of information over a distance without the use of electric conductors or “wires”. The distances involved may be short (a few meters such as television remote controls) or very long (thousands or even millions of kilometres for radio communications). When the context is clear, the term is often shortened to “wireless”.

One of the most common wireless communications is GSM (Global System for Mobile Communications). GSM networks operate in four different frequency ranges. These networks operate in the 900MHz or 1800MHz bands.

The modulation used in GSM is Gaussian Minimum-Shift Keying (GMSK), a kind of continuous-phase frequency shift keying. In GMSK, GSM uses a 25MHz bandwidth, subdivided into 124 carrier frequency channels, each spaced 200kHz apart. Besides, it has eight radio timeslots (giving eight burst periods), grouped into what is called a TDMA (Time Division Multiple Access) frame. Some 82% of the global mobile market uses this standard.

GSM is used by over 2 billion people across more than 212 countries and territories. Consequently, the study of this technology and its propagation in indoor environments is a very important area to analyze. A great amount of studies have been done on this technology, including indoor propagation models or its influence on the health of users. This article shows the spatial and temporal variability of power for GSM-900 electromagnetic fields in indoor environments.

The Objectives

The main objective of this article is to analyze, investigate and apply an automatic system (robot) for measuring the power of an electric field, such as the field radiated by a mobile telephony base station.

The first stage is to develop a methodology for measuring the power of the signal in indoor environments and to optimize the performance of our system in order to automate and simplify the characterization of such environments.

Secondly, in order to determine the electric field distribution and propagation in a specific environment, the collected data is analyzed, and general conclusions and theories are obtained, which could be applied to other environments too or even to other investigation fields, such as study the influence of electromagnetic fields or just the electric field on the human body, for example.

Indoor Propagation and Signal Losses

The analysis of the state-of-the-art propagation prediction models of electromagnetic signals go from simple empirical formulas to modern models based on ray tracing. It demonstrates that the ray tracing method (or ray theory) can provide important parameters to explain the behaviour of the signal waves for their propagation in complex environments, such as arrival time, incidence angle and even statistical parameters. However, the appearance of new techniques as smart antennas or MIMO (Multiple Inputs Multiple Outputs) systems leads to the

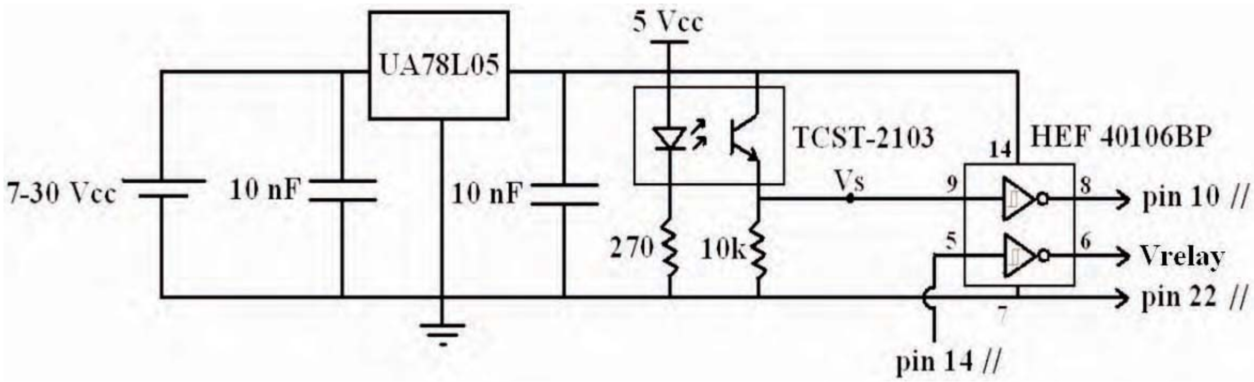


Figure 1: *Robot kernel hardware used for detecting sampling marks in the platform with rails*

development of new theories of predicting the propagation.

Specifically in indoor environments, temporary-space models can be used to evaluate the joint behaviour of all the rays, since these can arrive in groups (or clusters). Another tendency is to put more attention on the characterization of the wall structures that constitute the environment with the purpose of developing more accurate models.

In this study some parameters have been considered, for example reflection, refraction or absorption indexes of some materials that constitute the walls of buildings, such as ceramics or bricks.

In particular, due to reasons of traffic and capacity on mobile telephone systems in urban environments, the coverage areas of base stations are smaller, which have coverage radiuses of a few hundred meters, called "microcells". In addition, the situation and direction of the terminals with respect to the streets and buildings are important in the propagation, as well as the urban topography, like the width of streets for example.

Then, two modalities of propagation exist: LOS (Line of Sight) and NLOS (Non-Line of Sight). Also, there are prediction methods with models taken from COST 231 and ITU-R 8/1.

Propagation Attenuation

The propagation in indoor environments is a very complex phenomenon, so that there are sometimes LOS passages, but generally, the trace is NLOS (the direct ray is blocked by walls, grounds, screens or other objects). In this case, the signal arrives at the receiver through multipath with dispersion, diffraction and reflection. Due to the complexity that involves classic models in terms of rays, most of the indoor models have been obtained from experimental measurements, which are what have been realized in this study.

Some of the most important models studied to analyze the propagation attenuation are indicated here.

Model 1

This is the simplest model, and it is based on determining the adjustment line by means of regression to the measurements, and only taking into account the frequency and the distance. It is expressed in **Equation 1**:

$$L(dB) = L_0 + 10 \cdot n \cdot \log d(m) \quad (1)$$

where L_0 is a constant that represents the losses in a reference distance (generally equal to 1m), *d* is the distance and *n* is the power variation index with the distance.

Model 2

In this model the attenuation due to the walls and ceilings is considered explicitly. For this reason the analysis is a bit more complex, as the planes of the building and information of its materials are needed. In return, more accurate predictions are provided. This is shown in **Equation 2**:

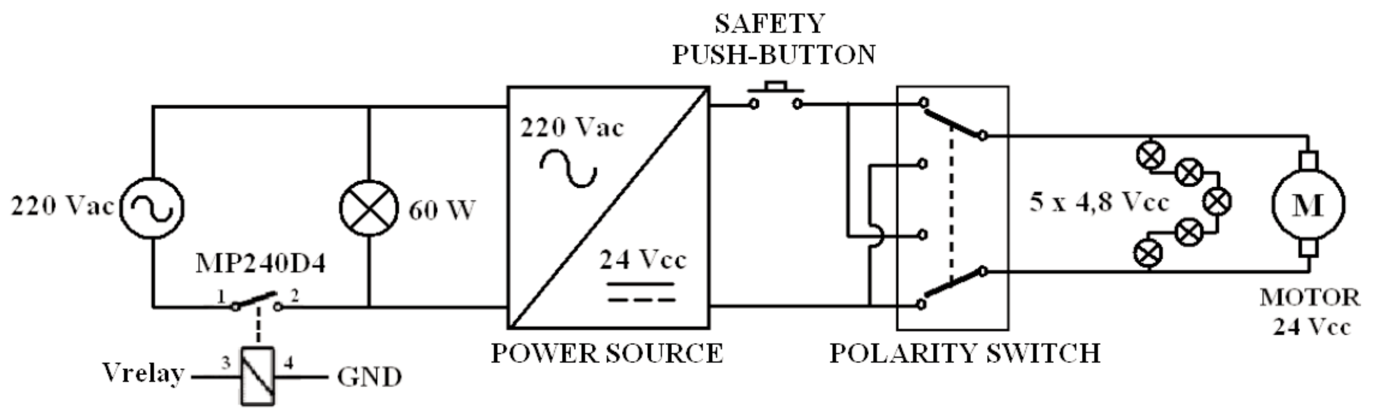
$$L(dB) = L_0 + 10 \cdot n \cdot \log d + \sum_{i=1}^{I} k_{fi} \cdot L_{fi} + \sum_{j=1}^{J} k_{wj} \cdot L_{wj} \quad (2)$$

where *d* is the distance (m), *n* is the power variation index with the distance, L_0 is the loss in a reference point (1m of distance), L_{fi} is the loss factor for a floor of type *i*, L_{wj} is the loss factor for a wall of type *j*, k_{fi} is the number of floors of type *i* crossed, k_{wj} is the number of walls of type *j* crossed, *I* is the number of types of floor and *J* is the number of types of walls.

Model ITU-R

With the purpose of simplifying calculations, the Group 8/1 of ITU-R has proposed a model synthesis of the previous two, as the **Equation 3** demonstrates:

Figure 2: Robot platform hardware used for moving the mobile component (antenna) of the measurement robot



$$L(dB) = 38 + 30 \cdot \log d + L_f(n) \quad (3)$$

where $L_f(n)$ is the factor that represents the penetration loss through walls and floors, as it is illustrated in **Equation 4**:

$$L_f(n) = 15 + 4 \cdot (n - 1) \quad (4)$$

where *n* is the number of floors existing between the base station and the mobile station.

Statistical and Frequency Variations

Statistical variation

In indoor NLOS paths, the variability of the signal can be modelled with a Rayleigh distribution. In LOS paths, the most suitable model is the Rice distribution. In reality, it is not always possible to carry out the distinction between LOS and NLOS conditions, for this reason the Rayleigh distribution is usually adopted for being more 'pessimistic'.

The slow variations (Long-Term Fading) caused by the shade of walls and obstacles are modelled with a Gaussian distribution with a standard deviation between 8 and 11dB.

Frequency variation

A remarkable characteristic of the variation of the indoor propagation losses with the frequency (see Equation 2) is that the theoretical variation of the L_0 term with the frequency is 6dB/octave. Also, the *n* factor usually decreases with frequency. Nevertheless, when other loss elements are included, the value of *n* is 2 in order to include the frequency dependency in those terms.

Losses L_f for 900MHz are considered between 2.8 and 6dB. For L_W these differences are approximately 1dB in walls or thin elements (walls made of wood, doors and so on) and 1.5dB in heavy walls (walls made of bricks, cement, etc).

Building-penetration losses

These models are applied to paths between an exterior transmitter, such as the telephone base-station of this study, and a receiver within a building, such as the isotropic antenna of the robot. With this analysis, the service of mobile telephone can be emulated, so that the propagation attenuation is given by **Equation 5**:

$$L = L_0 + 10 \cdot n \cdot \log d + k \cdot F + p \cdot W_i + W_e \quad (5)$$

where L_0 is the reference loss (a typical value for 900MHz is 31.6dB), *n* is the attenuation variation law with the distance (n = 2, generally), *k* is the number of ceilings or grounds crossed by the signal (k = 0, if the signal emitted by the transmitter does not cross any ceiling or ground, but only the building's facade and walls), *F* is the unitary loss due to ceiling or ground (F = 8 for 900MHz), *p* is the number of inner walls in the building between the transmitter and the receiver, W_i is the unitary loss due to an inner wall ($0.4 < W_i < 8$) and We is the penetration loss through the building facade ($3.8 < W_e < 10.5$).

Designs and Developments

The robot is a rail-guided vehicle and the rails have narrow slots at centimeter intervals. The function of this hardware is detecting sampling points (slots) and conditioning the signals that are transmitted to the control computer (using the parallel port) and the DC motor (by means of a solid state relay). **Figure 1** shows the schematic of the designed circuit.

When a slot is detected, a high voltage level ('1' or 5V) is obtained (using a Texas Instruments UA78L05 voltage regulator powered by a 9V battery) at the output of the optical sensor (Vishay Telefunken TCST 2103), but this signal is inverted by a Schmitt trigger (Philips HEF 40106BP) before it is received by the pin 10 of the parallel port (PP) of the computer, with the purpose of stabilizing it and eliminating noise.

When a change of value in pin 10 takes place, an interruption of PP is generated (IRQ7), which is used by the control program to detect in a more efficient way (against polling) that the robot has crossed a slot (two consecutive slots are separated 1cm).

For example, if the sensor detects that it is on a slot (pin 10 of the PP is '0'), it sends a low voltage level through pin 14 of the PP (bit *C1* of the control registry). This signal is inverted to '1' by a Schmitt trigger, obtaining V_{relay}, which acts on a solid state relay (Crydom MP240D4) with the purpose of switching this device and stopping the motor (the relay switches off the 24Vcc power source). If the computer transmits '1' (pin 14), the motor will start and the robot will advance until the next sampling position.

So, the PP of the computer has three functions: to control a relay to switch on and to switch off the motor (pin 14 of the PP and bit *C1* of the control register), to receive the information of the slot detector circuit (pin 10 of the PP and bit *E6* of the state register) and to switch the three-probes antenna to measure in each one of the three space directions (a sequence of bits is written in the data register, being used for such effect from pin 2/bit *D0* to pin 9/bit *D7*).

Robot Platform Hardware

The robot's objective is to power and to control the motor which moves it, obtaining a speed of approximately 1cm/s. **Figure 2** shows the circuit that realizes this function.

The first element in the schematic is a solid state relay (Crydom MP240D4), which is activated from the PP with V_{relay} (pin 14) with the purpose of controlling the ignition of the motor, switching the power source 220Vac/24Vcc.

The relay is connected before the power source for controlling its ignition/shutdown, but this is a problem for the operation of the relay (the source introduces an inductive load in its output). This makes it to remain oscillating when the control voltage cuts out the current, if the residual energy at the output of the relay is not consumed.

In order to solve this problem, a 60W lamp was introduced as a resistive load in parallel to the input of the power source. When the relay is driven the lamp switches on, warming itself up and increasing its resistance (the resistance of the lamp increases proportionally to the increase of temperature), whereas the quantity of current consumption is reduced. Thanks to this solution, when the relay is switched on, the residual energy is consumed almost instantaneously, so that the power source is turned off rapidly enough, in the process not influencing the measurement of the electric field power.

On the other hand, a series of five 4.8Vcc/300mA lamps in parallel to the input of the motor are connected (4.8Vcc x 5 = 24Vcc), which is its supply voltage (150mA of maximum consumption). Altogether, a load of 450mA is obtained, which is sufficient to consume all the current that provides the power source (with a nominal current of 420mA and a peak current of 650mA). These lamps have the function of shutting down the motor fast when a sampling slot is crossed (the residual energy stored in the output capacitors of the power supply is consumed when it is switched off). Also, they have the objective of compensating the dynamo effect of the motor when the voltage source turns off (they absorb the electromotive force generated by the motor due to the mechanical inertia of the movement that it had before disconnecting the power supply).

Other elements of this circuit include a switch to change the rotation direction of the motor (inverting the polarity of the power source) and an end of stroke switch (security device if the control program fails).

The Control Software

Software is used to manage the operations of the measurement hardware. Its primary objective is the speed; however it has other important characteristics such as scalability, reliability and robustness among others.

Two programming languages for the accomplishment of the control program have been analyzed: LabVIEW 7.1 and Visual Basic 6.0. Owing to the fact that run-time is one of the most important parameters in this application, the measurement of this time has been realized using both languages, acquiring samples from a GSM signal in the three space directions. The results were very similar for both programs (run-times between 400ms and 500ms). This is due to the main loss being the sweeping time of the spectrum analyzer (between 300ms and 400ms). Due to the fact that a reduced quantity of commands, between consecutive measures, are transmitted (for example, commutation orders for the three-dimensional probes), they have a very low influence in the total execution time.

In addition, two solutions were considered to manage the detection of slots, to stop the motor and to start a new measurement. Firstly, a bit far from the concept of real-time, the technique of sampling the PP during a time interval (in milliseconds), so that when a slot is detected, it is necessary to shut down the motor (pin 14 of the PP to '0'). Secondly, nearer to the idea of real-time, another option is to use the interruptions generated by the operating system when a change of logical level in pin 10 is detected. In order to manage this interruption, the "Interrupt.sys" driver has been used, using the functions of the Win32 application interface.

Finally, Visual Basic was chosen as the programming language due to several factors. One of them is the greater simplicity for handling interruptions, that is, detection of sampling slots to switch off the motor that moves the robot.

Data Processing Software

In order to realize the processing of the measured data by the robot, programs (.m) and data files (.mat) have been developed in Matlab 7.0. These programs are able to read the measured data from text files, to make their processing (separation in data matrixes, computing mathematical operations with the data and so on) and finally obtain the graphical representation in 2D contours or 3D. In addition, thanks to the creation of Matlab data files, the variables can be stored with their respective values and the process of graphical visualization can be automated (it is only necessary to load a data file in the Matlab program for starting an analysis). ■

SMS-Based GSM/GPRS Remote Data-Logging System

Dogan Ibrahim, lecturer at the Near East University Cyprus, describes the design of a microcontroller-based remote data logging system, where the collected data is sent as SMS using a GSM/GPRS modem

A DATA LOGGER is an electronic instrument used to collect information about physical quantities in the real world. Data loggers incorporate sensors which convert physical quantities into electrical signals that can be stored on a computer or on any other digital medium. Among the commonly used sensors are temperature, pressure, force, sound level, flow, speed, position, relative humidity, wind-speed, angle of rotation and so on.

In general, data loggers are either standalone or PC-based. Standalone sensors are usually small dedicated instruments with low power operation and some form of non-volatile data storage (e.g. an SD card). These data loggers store data unattended over a period of time and then the stored data are loaded into a PC for offline analysis and graphing.

Some standalone data loggers incorporate wireless communication modules such as RF communications. The collected data in such instruments can be uploaded to a PC in real-time for analysis. Alternatively, the data can be collected over a period of time and then the complete package of data can be sent remotely to a PC.

Standalone data loggers have the advantages that they operate independent of a PC and, because of their low power consumptions, they can be powered from solar or wind energy sources. In addition, they do not suffer from PC breakdowns, communications noise or communications failure.

GSM operator	Carrier Frequency (MHz)	Ownership
Orange/T-Mobile	1800/2100	France Telecom
02	900/1800/2100	Telefonica
Vodafone	900/1800/2100	Vodafone

Table 1: *GSM operators in the UK*

PC-based data loggers rely on a local PC to store the collected data. In such systems a data logger instrument, equipped with required sensors, collects data and sends it to a local PC for storage. The data logger is under control of the PC at all times. PC-based data loggers are well suited to controlled environments such as homes, offices and factories where the operating conditions can easily be controlled and the system can be attended to in case of failure.

This article describes the design of an SMS-based data logger system. An example project is given in detail in the paper where the ambient temperature is read every hour and is sent to a mobile phone as an SMS message. The described system is a standalone data logger and offers the following advantages:

- The system is independent of a PC for its operation.
- Data collection is ubiquitous, where data can be collected at any place and at any time as long as a mobile phone service is available.
- Data is sent without any loss using the reliable SMS messaging service.
- Data can be sent to any number of recipients by simply changing the mobile phone number or by adding more numbers.
- Both the data logger and the recipients can be mobile.
- Data sending period or the amount of data sent can easily be changed in the program.
- The system is low power and can easily be operated from a solar or wind energy source in fixed location applications.

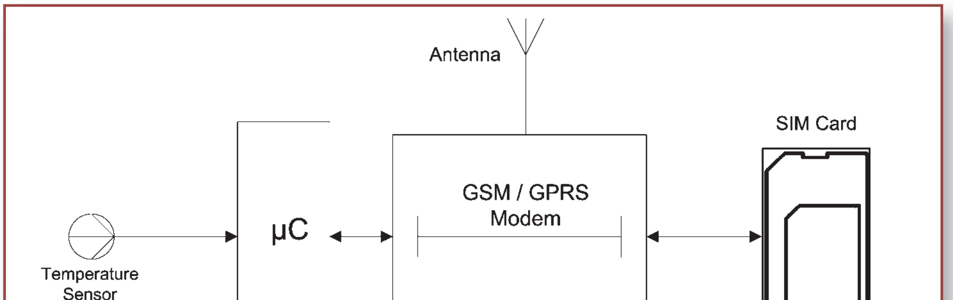


Figure 1: *Block diagram of the system*

The GSM System

GSM (Global System for Mobile Communications) is currently the most widely used standard for mobile telephone systems in the world. It is estimated that over 80% of the mobile market uses the GSM standard, with estimated 3 billion people across over 200 countries.

GSM is a cell-based (cellular) network where mobile phones access the network by connecting to the cell in their immediate vicinities. GSM is based on an all-digital technology. These networks operate in a number of different carrier frequencies. In Europe most networks operate at either 900 or 1800MHz. In most of Americas the carrier frequency is either 850 or 1900MHz. In the UK there are over 75 million subscribers. **Table 1** shows the main GSM operators in the UK with their frequency bands.

Other GSM operators, for example Virgin

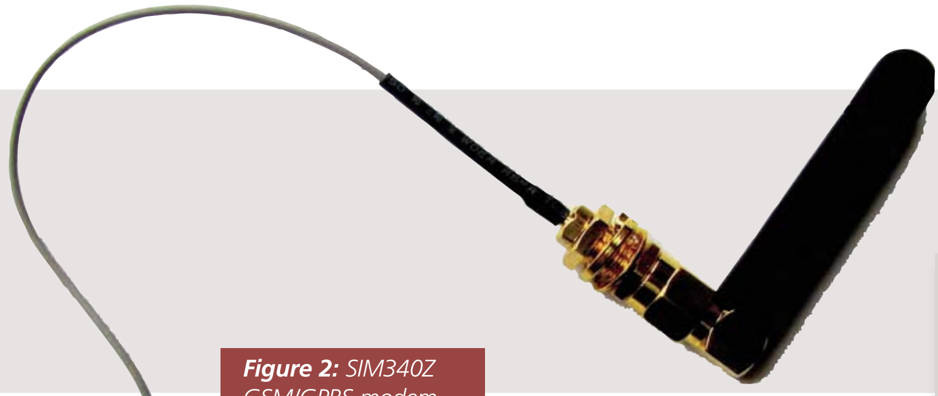


Figure 2: *SIM340Z GSM/GPRS modem*

Mobile, Asda Mobile, Tesco Mobile and others, use services of the main operators. Some mobile phones are designed to be quad-band and they cover the frequencies 800/900/1800/1900MHz. Such phones can be used in most countries. Triband phones cover the frequency bands 900/1800/1900MHz and can be used in most of Europe and Americas.

The transmission power in the handset is limited to 2W in the 800/900MHz bands and to 1W in the 1800/1900MHz bands. The new 3G standard phones use the frequency band 2100MHz. The GSM system was designed with a moderate level of security where the subscriber is authenticated using a pre-shared key and the communication between the subscriber and the network is encrypted.

The System's Block Diagram

The block diagram of the designed system is shown in **Figure 1**. A semiconductor analogue sensor is used as the temperature sensor. The microcontroller converts the sensor output voltage from analogue to digital. The GSM/GPRS modem is under the control of the microcontroller. Standard AT commands are used to communicate with the modem and to send the temperature as an SMS message to a mobile phone. A SIM card provides the subscriber details to the system.

The temperature sensor used in the design is a 3-pin LM35DZ type analogue semiconductor. This sensor can be used to measure temperatures in the range 0ºC to 70ºC. The output voltage of the sensor is given by Vo = 10mV/ºC. So, for example, at 10ºC the sensor output voltage is 100mV. Similarly, at 30ºC the output voltage is 300mV.

A PIC16F887 type microcontroller is used in the design (any other type of microcontroller could also be used as long as it satisfies the memory and I/O requirements). This is a 40-pin RISC based microcontroller having 8192 bytes flash program memory, 368 bytes RAM memory, 256 bytes EEPROM memory, 35 I/O pins, 14 channel 10-bit A/D converter, analogue comparator, USART, interrupt capability, up to 20MHz operation, 3 timers and watchdog timer, 2 comparators and low power operation, among others.

LED State	SIM340Z Function
OFF	Modem is OFF
64ms ON/800ms OFF	GSM network not found
64ms ON/3000ms OFF	GSM network found
64ms ON/300ms OFF	GPRS communication

Table 2: *LED showing the modem status*

The design makes use of the following microcontroller features: 1060 bytes (12%) of program memory, 153 bytes (41%) of RAM memory, 3 digital I/O pins, 1 analogue input pin, USART, interrupt (USART).

The modem used in the design is a SIM340Z module (see **Figure 2**) manufactured by SIMCOM. This is a quad-band GSM/GPRS modem and offers 850/900/1800/1900MHz operation, small footprint (40mm x 33mm x 2.85mm), low weight (8g), GSM 07.07 and 07.05 compatible, control via AT commands, low power operation (3.4V-4.5V), SIM card interface, keypad and LCD interfaces.

The SIM340Z modem is easily interfaced to a microcontroller using only three serial communication pins (TXD, RXD and RTS). The modem provides signals to drive a SIM card directly. In addition, an LED can be connected to the modem to show the working status of the modem (see **Table 2**). The modem also provides a buzzer interface where a buzzer or a small speaker can be connected to indicate an incoming call. In addition, the modem provides signals for a keypad and an LCD to be connected for dedicated autonomous mobile communication applications. A small connector is provided on the modem for an external antenna to be connected. **Figure 3** shows a functional block diagram of the SIM340Z modem.

The SIM Card

The SIM (Subscriber Identity Module) card is a small (15mmx25mmx0.76mm) smart-card, used to store the subscriber information and identify of a subscriber to the cellular network. A user can change handsets by simply removing the SIM card from one phone and inserting it into another phone.

The use of a SIM card is mandatory in a mobile phone as it stores the International Mobile Subscriber Identity (IMSI) number, security authentication and ciphering

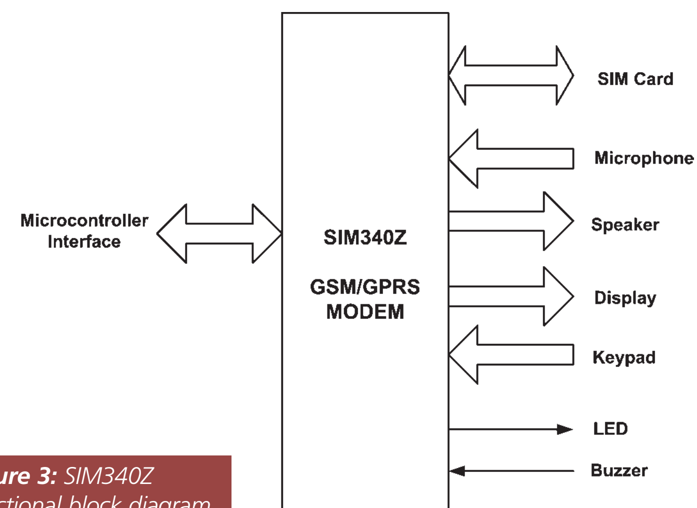


Figure 3: *SIM340Z functional block diagram*

information, password (card PIN), phone book details, log of sent and received messages, received and dialled call log and so on. The card has six pins and is usually held in a SIM card holder (see **Figure 4**). Card pins have the following definitions (as specified by the ISO 7816 standard):

Pin 1 (VCC): This pin provides the card's power supply. A SIM card is typically operated between 3V and 5V.

Pin 2 (RST): This is the RESET pin. A low-level on this pin resets the card to a known state.

Pin 3 (CLK): This pin provides the card with the clock signals. The clock is between 1 and 5MHz, with a duty cycle between 40% and 60%.

Pin 4 (GND): This is the ground pin of card's power supply.

Pin 5 (VPP): This pin is not used anymore. It was used to provide programming voltage required to write and erase the card's internal non-volatile memory.

Pin 6 (I/O): This is the input and output pin of the card. Half-duplex asynchronous serial communication is used to read and write data to the card.

When the card contacts are activated, the RST pin is held at a low level and the VCC supply is applied. After maintaining the RST signal at a low state for at least 40,000 clock cycles, it is raised to a high state and communication with the card starts by driving the I/O line while the RST is held high.

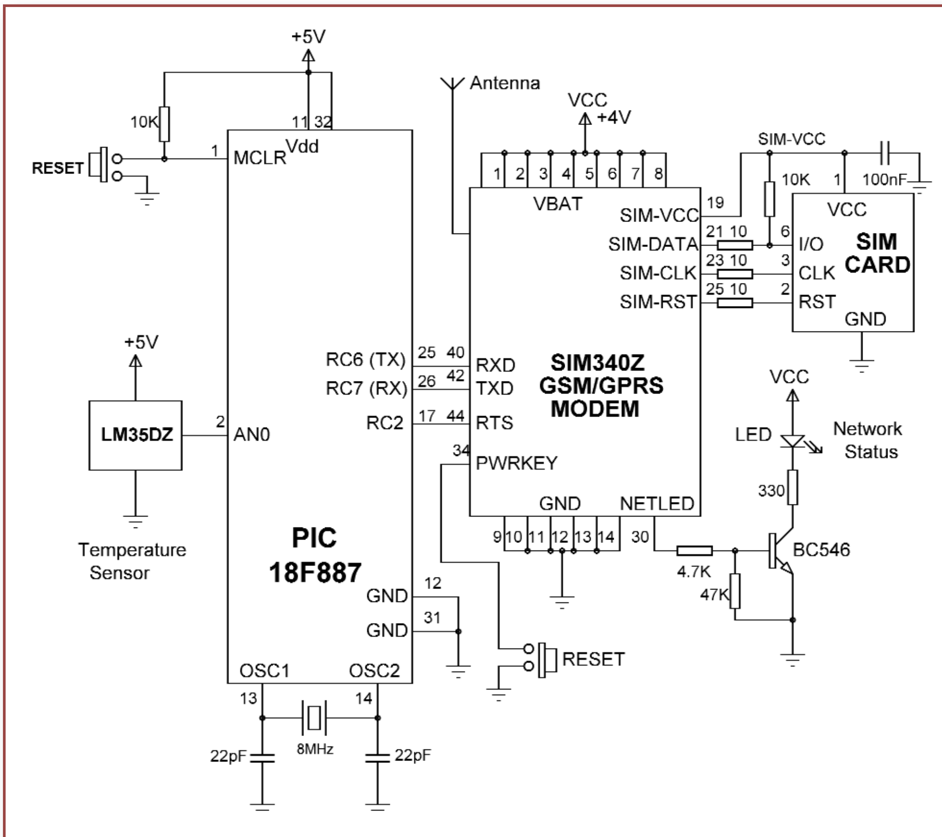


Figure 5: Circuit diagram of the system

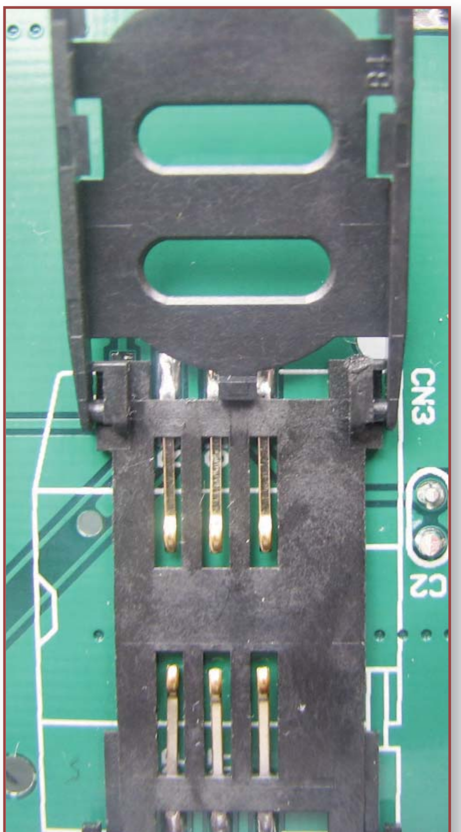


Figure 4: A typical SIM card holder

The Circuit Diagram

The circuit diagram of the designed system is shown in **Figure 5**. The microcontroller interface is extremely simple. An 8MHz crystal is used as the clock source. The temperature sensor is connected to analogue input AN0 of the microcontroller. USART serial input pin RXD (RC7) and TXD (RC6) are connected to the TXD and RXD pins of the SIM340Z modem respectively.

The RTS input of the modem is driven by port pin RC2. This pin should be forced Low when the modem is operated using only the TXD and RXD pins. The SIM card is connected to the modem via current limiting resistors where the modem provides the power supply voltage, I/O, CLK and RST inputs. The LED status output pin (NETLED) of the modem is connected to an LED through a transistor switch circuit. An RF antenna supplied with the modem is connected to the antenna socket of the modem. The microcontroller can be reset via its MCLR input using an external push-button switch. Similarly, the modem can be reset via its PWRKEY input using an external switch.

The PWRKEY input should be held Low for at least four seconds to re-start the modem. It is important to note that the modem operating voltage is between 3.5V and 4.5V, with a recommended typical value of 4V. The power supply should be capable of providing up to 2A current which may be required in transient operations.

The Construction

The system was constructed using an EasyPIC 5 microcontroller development board, together with a Smart GSM/GPRS development board. Both development boards are developed and manufactured by mikroElektronika. EasyPIC 5, shown in **Figure 6**, is a popular, highly versatile, general-purpose, microcontroller development board which offers support for 8, 14, 18, 20, 28 and 40-pin PIC microcontrollers; USB 2.0 on-board programmer via PC; mikroICD in-circuit debugger; 4 digit 7-segment display in multiplexed mode; 36 LEDs; 36 push-button switches; RS232 interface; text and graphics based LCD; touch-screen controller; USB and PS/2 connectors; and removable crystal.

The USB based in-circuit debugger (mikroICD) is extremely useful during the development and debugging of complex programs. With the help of a high-level software compiler, programmers can set breakpoints, single-step an application program, or can display the variables as the program is running.

A GSM/GPRS development board (**www.mikroe.com**), shown in **Figure 7**, was used to provide the modem functionalities. This board offers support for five different GSM modems, SIM card holder, antenna holder, audio amplifier and audio interface with microphone and speaker, RS232 interface for PC or microcontroller interface, LED showing the modem status, interface signals on 10-way connectors for easy interface to microcontroller development systems.

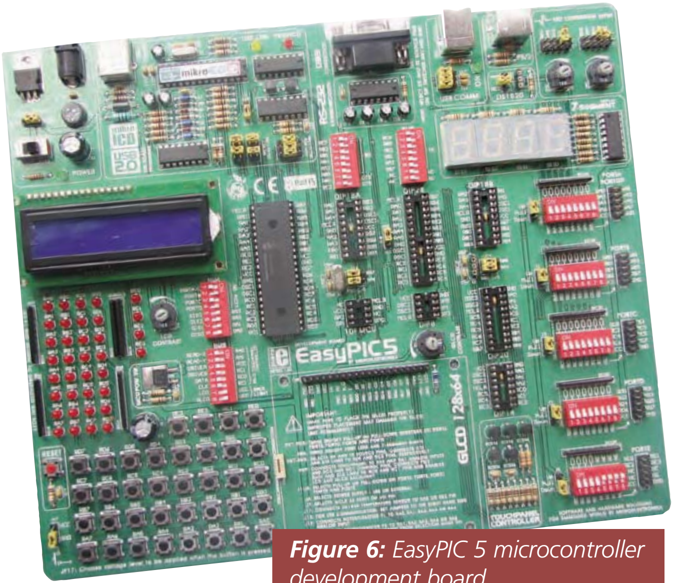


Figure 6: *EasyPIC 5 microcontroller development board*

The SIM340Z modem card is mounted on the GSM/GPRS development board (to the bottom centre part) with its antenna attached at the side of the board. PORT C of the EasyPIC 5 development board was connected to modem terminals of the GSM/GPRS board via a 10-way ribbon cable, as in **Figure 8**. Jumper J1 on the GSM/GPRS board was set to select communication with an MPU. The EasyPIC 5 board was powered from the USB port of a PC (laptop), while the GSM/GPRS board was powered from an external 12V mains adaptor.

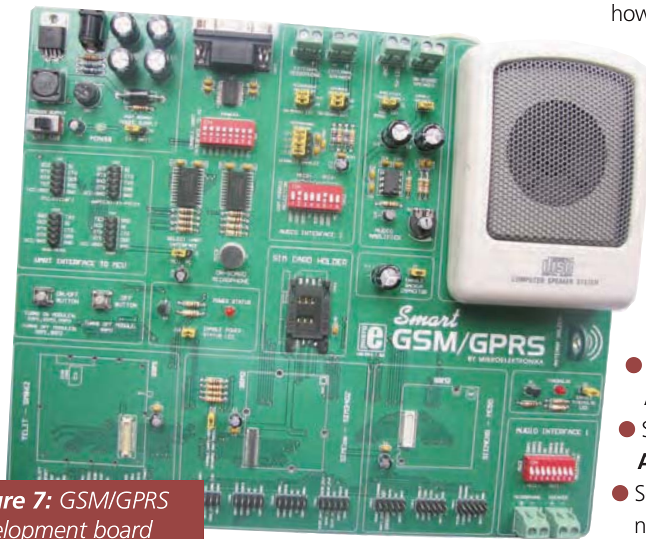


Figure 7: *GSM/GPRS development board*

The AT Commands

The AT commands are used to control the operations of modems. These commands were first developed for the Hayes Smartmodem 300 in late 1970s.

An AT command consists of the letters "AT", followed by a number of characters specifying the command tail. Some commands are used to set the configuration of modems, some are used to interrogate modems and get their configurations, while some other commands are used to dial numbers, send SMS messages and so on.

In addition to the standard AT command set, the SIM340Z GSM/GPRS modem supports commands to configure the modem and send SMS messages to mobile phones. **Table 3** gives a list of the important AT commands available for sending an SMS message (further information can be obtained from the SIMCOM SMS Application note AN_SMS_V1.01).

There are two ways of sending and receiving SMS messages using AT commands: by PDU (Protocol Description Unit) mode and TEXT mode. The PDU mode offers to send binary data in 7-bit or 8-bit mode and is helpful for sending compressed data or binary data. PDU mode data consists of hexadecimal string of characters, including the SMS service centre, sender number, time stamp etc.

AT Command	SMS Function
AT+CMGF	Select SMS message format
AT+CMCS	Select SMS character set
AT+CSCA	SMS service centre address
AT+CMGS	Send SMS message
AT+CSMP	Set SMS text mode parameters

Table 3: *SIM340Z modem SMS commands*

In this project, the easier Text mode has been used. An SMS text message can consist of alphanumeric characters with up to 160 characters long with 7-bit coding and 140 characters long with 8-bit coding. Basically, SMS is a store-and-forward type service where the messages are not sent directly from the sender to recipient but via an SMS Service Centre (SMSC). Mobile telephone networks have messaging centres that handle the delivery of messages to their destinations. There is by default no confirmation of the delivery of a message. But users can turn ON this option so that a confirmation of delivery can be sent to the sender when a message is delivered successfully.

Sending an SMS message in Text mode is very easy and an example is given below that shows how the message "Hello there!" can be sent to mobile number "123456890", assuming that the SMS service centre number has already been loaded to the SIM card, which is the case by default, and that there is no PIN associated with the card:

- Set SMS mode to Text:
  AT+CMGF=1
- Set the character mode to GSM:
  AT+CSCS="GSM"
- Set the SMS parameters:
  AT+CSMP=17,167,0,241
- Set the recipient mobile phone number and the text message:
  AT+CMGS="1234567890"
  > Hello there! [Cntrl-Z]

Note that after sending the recipient mobile phone number, the modem responds with character ">" and that the message must be terminated with the "Cntrl-Z" character.

It is worthwhile to look at briefly the meaning of the various SMS parameters set by command CSMP. The format of this command is (further information can be obtained from the AT command interface document):

AT+CSMP = <fo>, <vp>, <pid>, <dcs>

Field <fo> is set to 17, which indicates that the message is to go from a mobile device to a service centre and the <vp> field is valid.

Field <vp> selects the message validity period and a value between 144 to 167 selects the period as:

12 hrs + ((vp – 143) x 30 min)

With a setting of 167, the message validity period is:

12 hrs + (167 – 143) x 30 min) = 24 hrs

Field <pid> is used to indicate the higher layer protocol being used and is set to 0 here.

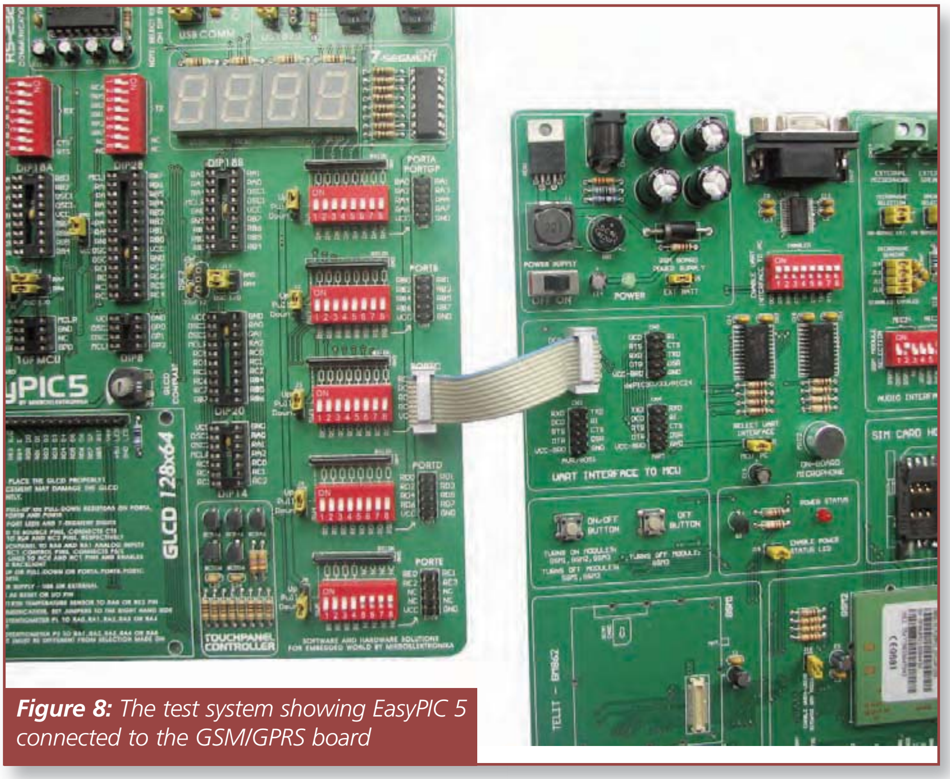


Figure 8: *The test system showing EasyPIC 5 connected to the GSM/GPRS board*

```
MAIN PROGRAM:

BEGIN
        Configure digital I/O ports
        Configure analog channel
        Configure USART interrupts
        Set USART to 19200 Baud
        Force RTS Low
        Set Modem to Auto-baud
        Disable Echo
        Set Modem to text mode
        Set character mode to GSM
        DO FOREVER
                Read temperature()
                Send SMS()
                Wait one hour
        ENDDO
END


        Send SMS:

        BEGIN
                Set Modem CSMP parameters
                Set mobile phone number
                Send SMS (temperature)
                Send Ctrl-Z character
        END


Read Temperature:

BEGIN
        Read analog channel AN0
        Convert to mV
        Convert to °C
        Store as message
END
```

Figure 9: *PDL description of the software*

Field <dcs> is used to determine the way the information is encoded. This field is set to 241 which sets the message class to 1 and uses the default alphabet. Note that setting the message class to 0 causes the message to be displayed immediately without being stored by the mobile phone, this is also called a flash message.

Modems commands normally return status and error codes in response to AT commands. It is important that any software sending control codes to a modem should check these return codes to make sure that the modem has been configured and responded with no errors. Most successful commands return the two character code "OK".

The Software

The software was developed using the mikroC compiler. This is a popular microcontroller C language compiler developed by mikroElektronika. mikroC language supports a large variety of interface devices and protocols, and provides built-in library of functions for devices such as SD card, CompactFlash card, I2C bus, RS232 and RS485, LCD, USB, CAN bus and so on. **Figure 9** shows operation of the software using a PDL (Program Description Language) type description.

At the beginning of the program the digital and analogue I/O ports are configured, various constant character strings such as the AT commands and mobile phone number used in the program are declared. The main program forces the modem RTS pin to 0, configures the analogue input channel AN0 and enables the USART interrupts.

The USART is initialised with a Baud Rate of 19200 and a loop is formed to force the modem Baud Rate to this value. The program then sets the modem into Text mode with GSM character code, 24-hour message validity period and the message class of 0. Then the program enters an endless loop where the temperature is read every hour and sent to the specified mobile phone as an SMS text message. The temperature is read from analogue channel AN0, converted into millivolts and then divided by 10 to find the actual physical temperature in ºC.

USART interrupts are used to receive the modem responses. A response can be "OK" or "RDY" and is terminated with a carriage-return and line-feed character pair. After sending an AT command, the program waits until a successful response is received from the modem.

The software developed in this project can be improved by the following modifications:

- Several temperature readings can be collected and then sent at the same time using one SMS message.
- The SMS messages can be sent in response to a request from the recipient. Thus data can be collected and received whenever required.
- A flash memory (e.g. an SD card) can be added to store the collected data.
- GPRS mode or FTP can be used to send large amount of data.
- An RTC chip can be added to the system to time-stamp the collected data. ■

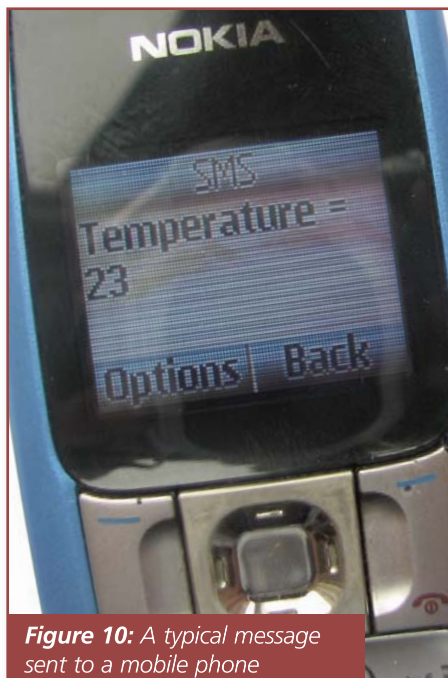


Figure 10: *A typical message sent to a mobile phone*

Getting the Most Out of Your HIGH SPEED ADC

Derek Redmayne, Applications Engineer, and **Alison Steer**, Product Marketing Manager, both at the Linear Technology's Mixed Signal Product Group, look at practical ways of achieving full performance from an analogue-to-digital converter

This is a two-part article, with the first part already published in our last issue

ACHIEVING FULL performance from an analogue-to-digital converter (ADC) with 100dB SFDR, GHz input bandwidth and SNR in the neighbourhood of 80dB can be a challenge. Board level designers need to be equipped with an intimate understanding of the clock and sampling mechanism. There are a number of issues that we see recur and which can render a design unusable:

- Believing the term "low jitter".
- Thinking the clock is a digital signal.
- Thinking that differential signalling provides noise margin.
- Squaring up the clock signal.
- Copying the demo board.
- Not thinking about GHz frequencies when designing for baseband.
- Isolating analogue and digital ground planes.

Not all of these are necessarily always bad but each requires careful consideration. Please follow these words of caution to avoid the same traps of your predecessors.

Caution 4: Squaring up the Clock

If a noisy clock is amplified by a limiting amplifier, then subsequently band limited, the damage is already done. Limiting produces commutation of the various frequency components involved, hence the generation of intermodulation components. Limiting also translates "out of band" components to in-band components, which cannot be filtered out.

The transmission of a filtered sinusoidal encode clock on a back plane that sees no band limiting upon reception will pass all the out-of-band noise acquired en route to the ADC.

By noise, we are talking about interferers; digital noise rather than thermal noise. If the clock is amplified after transmission over some distance, the amplifier must not be driven non-linear, or these out-of-band components will fold into a lower frequency, perhaps very close to the fundamental, and become impossible to remove. This situation is often overlooked in the case where PECL repeaters, CMOS to PECL translation, gates, hysteresis, comparators or any other manner of limiting device is used to "square-up" the signal.

Squaring up a polluted clock means mixing products, and filtering after this point is like closing the barn door after the horses have bolted. Amplification of the signal to increase dV/dt in order to satisfy the requirements of the clock receiver must occasionally be done, and you can use RF amplifiers to do this. You can also use transformers with 1:4 turns ratio or more, or impedance transformation in a band-pass filter. The signal must be clean before being "squared up".

Passing a good clock through an FPGA, to give some flexibility in divide ratios, then passing it to a clock repeater, which is essentially a limiting amplifier, will lock-in the loss by translating the spurious content picked up in the FPGA to lower frequencies. A limiting amplifier behaves in this respect like a mixer. Any spurs at some offset frequency from harmonics of the fundamental will appear at the same offset frequency from tones in your input spectrum.

If the crosstalk mechanisms, ground bounce and power supply noise that occur in an FPGA were primarily high frequency, following the FPGA with a low pass filter prior to using a clock repeater may work, but it is risky. If the FPGA was later altered to produce a different output spectrum, on unrelated I/O, you may get a surprise. However, if an FPGA is used to produce a programmable clock divider, or a means of gating the clock, if that clock is re-timed using a D type flip-flop clocked by the original clock source, you may get good results if you are careful.

This leads into a discussion of some of the more subtle ways of degrading the clock.

If clock management devices are used to drive multiple loads, some of these offensive loads may feed back into the clock path to the ADC. If one of the outputs of a clock fan-out device is used to drive an FPGA, an FPGA producing unrelated or sub-harmonic outputs that result in

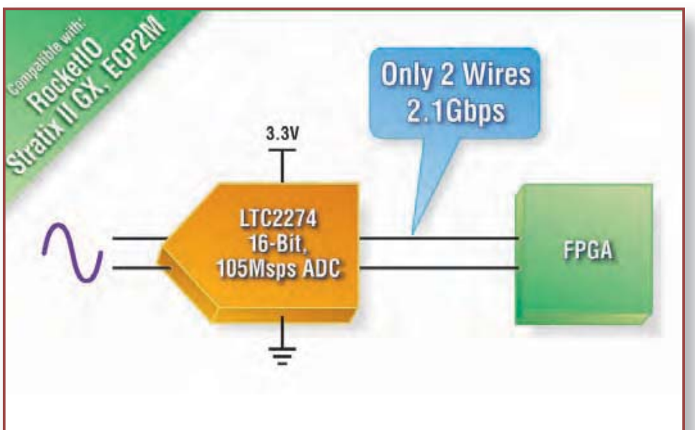


Figure 1: *New 16-bit 105Msps ADC with JESD204 2-wire serial interface*

PART 2

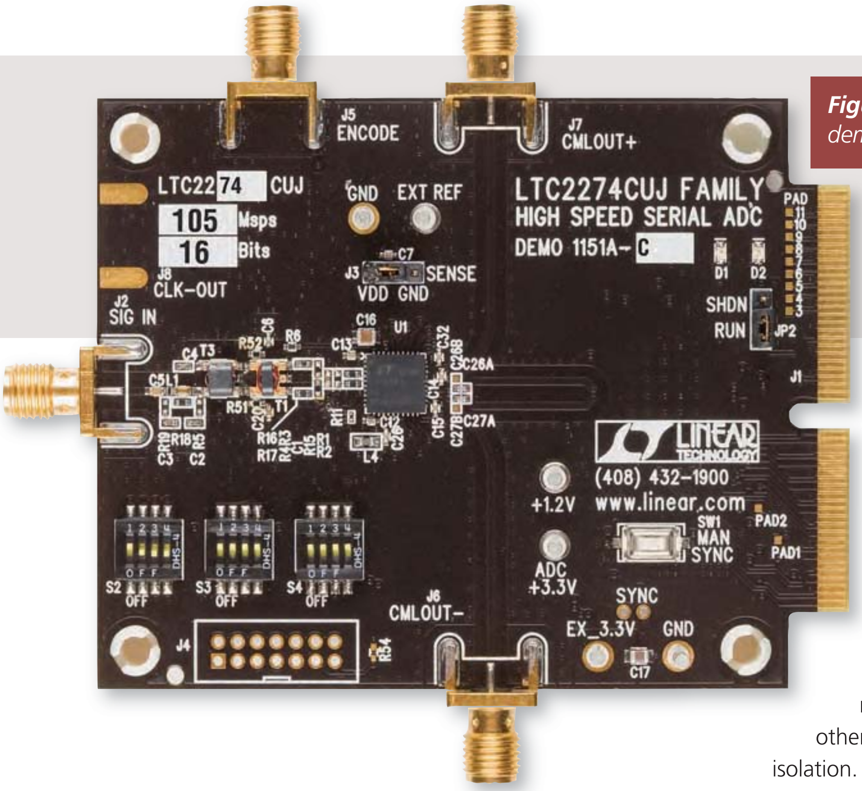


***Figure 2:** LTC2274 high-speed ADC demo board with CML outputs*

ground bounce on its substrate, some of this can reflect back into the clock fan-out device.

If this is a question of a differential clock, LVPECL for example, the reflected offenders would result in common mode to a large extent; however, asymmetry in the layout of the clock along the path from the offender through to the ADC may compromise the common mode rejection of either the ADC, or the repeater.

If an FPGA is to be used to implement the digital portions of a PLL, you must great take care. This is not impossible if an external VCO, loop filter and a re-timing stage are used. You should be aware that the output of the VCO driving the FPGA could reflect back into the oscillator. The use of a splitter to provide isolation between the FPGA and the re-timing stage, for example, may be a mistake. Splitters, either Wilkinson splitters using transmission lines, or lumped element splitters, 90-degree, 180-degree or 0-degree, all have limited isolation out of band. Resistive splitters also do not provide much isolation, although it is broad band.

The out-of-band noise reflected from the FPGA can phase modulate the clock as it originates in the VCO, and will not be recoverable. The solution is to use an asymmetrical split, sending most of the VCO output power to the re-timing stage and buffering the VCO output prior to the FPGA. The reverse isolation of the buffer will then compound the isolation from the other elements in the path. It may be advisable in this case to introduce a filter between the VCO and the buffer, such that the reverse isolation is much improved at higher frequencies, where it is likely that the bulk of the ground bounce in the FPGA will appear.

The use of, for example, 20dB gain to drive the divider input of the PLL in the FPGA would also improve reverse isolation as higher gain amplifiers tend to have higher reverse isolation due to reduced feedback, and if you attenuate by, for example 20dB into the amplifier, you will gain another 20dB of reverse isolation.

Similar issues occur in a clock architecture that involves a clock fan-out device that must drive a device with ground bounce present on its substrate. A poorly designed buffer, with only one ground pin, one power pin and multiple outputs is unlikely to be able to reject reflections from the other loads. Devices in QFN or other exposed pad packages have a better chance of providing isolation.

Current Mode Logic (CML) clock repeaters may be the best choice as the CML output stage is not as susceptible to induced ground bounce as is PECL or LVDS, and certainly CMOS single-ended clock architectures are considerably more sensitive to reflected noise from loads.

Caution 5: Copying the Demo Board

It is useful to step back and review a basic characteristic of transmission lines at this point.

If a transmission line, perhaps a coaxial cable, is linking two subsystems where there is potential difference between the two grounds, the rejection of this potential difference will only be effective if the transmission line is terminated at its characteristic impedance at both ends, over the entire bandwidth that may be observed at the receiving end.

We have seen many cases where this appears to have been forgotten. If there is a reflective filter at the driven end of the cable, and essentially wideband termination at the receiving end, any potential difference outside the pass-band, where the transmission line is misterminated at the filter, will manifest itself at the receiving end, the ADC. This is true at either the analogue input, or the clock input. Most filters are reflective; they produce their desired characteristics by reflecting the unwanted stop-band power back to the source. Absorptive filters are far better in these cases as the transmission line is properly terminated out-of-band.

The typical ADC demo board is a compromise as it must be usable over a very wide frequency range, on either the analogue input, or the clock input. In the lab, we place the filters as close as possible to the demo board, as this reduces the potential difference that is developed between the filter, and the termination on the demo board. But this is often not done in cases where the circuitry of the demo board is replicated in a design. Ideally, if a signal is to be transmitted between two boards or subsystems, the signal should be filtered on reception, not on transmission. This is not like the case of a string of two terminal devices, nor is it reciprocal like transmission and reception. If the signal is received by a filter that has good return loss in-band, and is transmitted by a source that also has good return loss in-band, or broadband, any potential difference between the grounds out-of-band will be rejected by filter, and in-band, by the transmission line. There are limitations to the rejection that occurs, and this is a question of how well matched the transmission may be. It is common practice to consider that 20dB return loss is acceptable, but if there is a potential difference at some frequency of around -80dBm, this may be apparent as a visible spur in the spectrum of the ADC.

Caution 6: Not Thinking About GHz Frequencies When Designing for Baseband

Direct sampling ADCs produce mixing products extending out to a few GHz. This is not an uncommon complaint about high speed ADCs, as it can be unanticipated by inexperienced designers, and is often found rather late in the design process to be a cause of interference in the front end of software radios, often located in the same cavity in an enclosure. If the mixer is located in the same cavity as the ADC and this cavity has reflective walls, those mixing products at GHz frequencies will be picked up by the LNA, or the RF port of the mixer, and translated to the IF band and digitized, appearing at a different frequency. Poor placement of the local oscillator or routing of the local oscillator drive to the mixer may also result in unwanted spurs picked up from that ADC.

Those frequencies that could be received by exposed antenna area prior to the mixer must be suppressed as close as possible to the input port of the ADC, or the ADC should be in a separate compartment. We often suggest that the ADC should be in the same compartment as the digital circuitry rather than in the shielded RF section. If the ADC and RF must be in the same enclosure, the antenna area in both cases and the input network of the ADC must be minimized.

This means that the driver or filter prior to the ADC must be as close as possible to the ADC. If, as is generally the case, a lowpass (LP) or bandpass (BP) filter is placed between the drive amplifier and the ADC, this filter must be designed to pass the band of interest and the stop bands in neighbouring Nyquist zones, but the layout must be designed to also suppress GHz frequencies and avoid radiating at these frequencies. The use of differential signalling may mitigate radiation or pick-up of unwanted signals to some extent, but any mismatch in components, physical layout, including asymmetry in cavities, limits the benefit. Widely-spaced differential filters in asymmetrical cavities will behave more like single-ended radiators.

The inputs of the high-speed direct sampling ADCs contain mixing products in differential form, due to commutation of the input signal by the sample switches, but they also produce common mode artifacts that can radiate more effectively than the differential components, as this network is then much like a single-ended transmission line.

These common mode components can also produce disturbances in the substrate of a driver that may be expected to have some noise immunity. A poorly grounded or bypassed drive amplifier may do little to suppress either the differential components or the common mode components. Occasionally we have seen the use of an RF power detector monitoring the path to the ADC. Quite frequently in these cases there is no isolation whatsoever. There, the RF power detector will always show indication of some nominal power level, as long as the ADC is sampling. In some cases the RF power detector and the ADC are fed with a splitter, but again, a splitter may provide minimal isolation out-of-band, and especially so if the return loss seen by the input port of the splitter is poor. Occasionally, an amplifier with rather poor reverse isolation is found to cause the same disappointment.

In these cases, the power received by the RF power detector must be taken prior to the final filters and drivers. This should probably be done in any case as the power delivered to the ADC is evident in its output, but the power delivered prior to the band limiting is not apparent and generally should be known in order to manage AGC.

Caution 7: Isolating Analogue and Digital Ground Planes

There is a long history of isolating analogue and digital ground planes. This, however, more often than not, leads to problems. The most serious blunder that we see on a regular basis is that of crossing a gap between two planes with CMOS digital outputs from an ADC.

Sometimes these planes are linked with an inductor, a ferrite bead, a resistor, or even just a trace. Sometimes they are returned to the power supply through long leads. Unfortunately, the propagation of a signal requires that ground current flow in opposition to the charges propagating on the transmission line. In differential signalling, this flows in the other signal, with little significant current in the ground plane. In the case of CMOS data crossing a gap, the ineffective path for the ground current results in a potential difference being developed between the two planes. This will be a high frequency potential difference if the detour in the ground path is short, extending to lower frequencies as ground path gets longer. If you must do this, you should use LVDS or CML outputs from the ADC.

Linear Technology offers a 16-bit 105Msps serial ADC, LTC2274 (see **Figure 1**), with CML 8B/10B encoded outputs streaming data at 2.1Gbps over the differential pair. This makes it easier to isolate analogue and digital circuitry, while utilizing the SerDes ports commonly found on FPGAs.

Otherwise, it is best to put the ADC at the edge of the digital plane and cross the gap with a 1:1 transmission line transformer similar to the M/A-COM ETC1-1-13. Also known as the Guanella 1:1 balun, this device acts like a common mode choke, while passing up to 3GHz differential. If the transformer is followed by or preceded with a low-pass filter, you can use a flux coupled transformer. As any direct sampling ADC produces transients with content out into the GHz region, this network should be devised to suppress these components before it extends any length and before crossing those boundaries.

Any application that entails transmitting differential signalling between two ground planes needs to be protected against excessive voltages developed between the ADC and the load by events such as ESD strikes, line surges etc. ■

If you missed the first part of this feature, you can order it by going on-line at ***www.electronicsworld.co.uk***

FURTHER READING

Further information on Linear's High Speed ADC portfolio can be found at **http://www.linear.com/ad/highspeed ADC.jsp**, which includes the new 1.8V lowest power, LTC2261 ADC family that consumes just 127mW at 125Msps.

Linear offers complete ADC evaluation systems comprised of clock source, signal source and ADC demo boards for use with the free Quick-Eval software tool. These systems are available through local Linear sales representatives.

PLC with PIC16F648A Microcontroller

Part 18

```
#include <definitions.inc>    ;basic PLC definitions, macros, etc.
#include <cntct_mcr_def.inc>  ;Contact & Relay based macros
#include <dcdr_mcr_def.inc>   ;decoder based macros

;------------- user program starts here ------------------------
decod_1_2         I0.0,Q0.1,Q0.0      ;rung 1

ld                I0.7                ;rung 2
decod_1_2_E       I0.6,Q0.7,Q0.6
;------------- user program ends here --------------------------
```

***Figure 1:** The user program UZAM_plc_8i8o_ex30.asm*

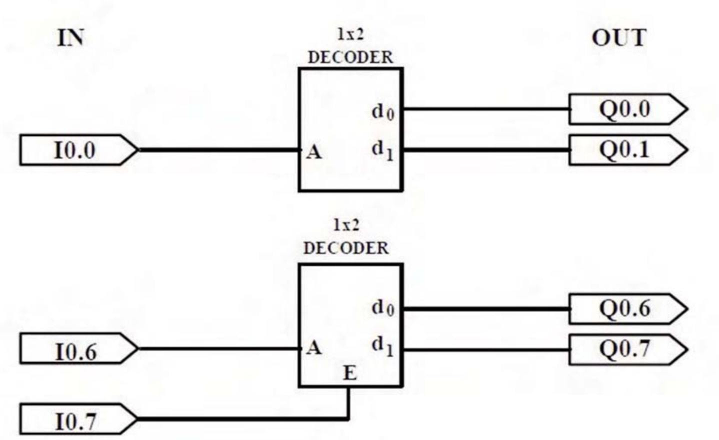


***Figure 2:** Schematic diagram for the user program of UZAM_plc_8i8o_ex30.asm*

```
#include <definitions.inc>    ;basic PLC definitions, macros, etc.
#include <cntct_mcr_def.inc>  ;Contact & Relay based macros
#include <dcdr_mcr_def.inc>   ;decoder based macros

;-------------- user program starts here ------------------------

decod_2_4       I0.0,I0.1,Q0.3,Q0.2,Q0.1,Q0.0       ;rung 1

ld              I0.7                                ;rung 2
decod_2_4_E     I0.5,I0.6,Q0.7,Q0.6,Q0.5,Q0.4

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

***Figure 3:** The user program UZAM_plc_8i8o_ex31.asm*

Professor Dr Murat Uzam from Nigde University in Turkey presents a series of articles on a project that focuses on a microcontroller-based PLC. This article he gives examples of decoder macros

IN THIS ARTICLE, four examples are provided to show the use of decoder macros described in the previous article. We will consider UZAM_plc_8i8o_exN.asm, N = 30, 31, 32, 33 to show the usage of decoder macros.

In order to test the respected example please download the files from http://host.nigde.edu.tr/muzam/ and then open the program UZAM_plc_8i8o_exN.asm, N = 30, 31, 32, 33 by MPLAB IDE and compile it. After that, by using the PIC programmer software, take the compiled file "UZAM_PLC_8i8o_exN.hex" and with a PIC programmer hardware send it to the program memory of PIC16F648A microcontroller within the UZAM_PLC.

After loading the "UZAM_PLC_8i8o_exN.hex", switch the 4PDT in "RUN" and the power switch in "ON" position, leaving it ready for test. To check the correctness of each program, check the information for each decoder macro in Tables 1, 2…6 of the previous article.

The first example program, "UZAM_plc_8i8o_ex30.asm" is shown in **Figure 1**. It shows the usage of two decoder macros "decod_1_2" and "decod_1_2_E". The schematic diagram of the user program of "UZAM_plc_8i8o_ex30.asm" shown in Figure 1 is shown in **Figure 2**.

In the first rung, the decoder macro "decod_1_2" (1×2 decoder) is used. In this decoder, the select input is A = I0.0, while the output lines are d_0 = Q0.0 and d_1 = Q0.1. In the second rung, the macro "decod_1_2_E" (1×2 decoder with active high enable input) is used. In this decoder, the select input is A = I0.6, while the output lines are d_0 = Q0.6 and d_1 = Q0.7. In addition, the active high enable input E is defined to be E = I0.7.

The second example program, "UZAM_plc_8i8o_ex31.asm" is shown in **Figure 3**. It shows the usage of two decoder macros "decod_2_4" and "decod_2_4_E". The schematic diagram of the user program of "UZAM_plc_8i8o_ex31.asm" shown in Figure 3 is depicted in **Figure 4**.

In the first rung, the decoder macro "decod_2_4" (2×4 decoder) is used. In this decoder, the select inputs are A = I0.0 and B = I0.1, while the output lines are d_0 = Q0.0, d_1 = Q0.1, d_2 = Q0.2 and d_3 = Q0.3. In the second rung, the macro "Dmux_2_4_E" (2×4 decoder with active high enable input) is used. In this decoder, the select inputs are A = I0.5 and B = I0.6, while the output lines are d_0 = Q0.4, d_1 = Q0.5, d_2 = Q0.6 and d_3 = Q0.7. In addition, the active high enable input E is defined to be E = I0.7.

The third example program, "UZAM_plc_8i8o_ex32.asm" is shown in **Figure 5**. It shows the usage of the decoder macro "decod_3_8". The schematic diagram of the user program of "UZAM_plc_8i8o_ex32.asm" shown in Figure 5 is depicted in **Figure 6**. In this example, the decoder macro "decod_3_8" (3×8 decoder) is used. In this decoder, the select inputs are A = I0.0, B = I0.1 and C = I0.2, while the output lines are d0 = Q0.0, d_1 = Q0.1, d_2 = Q0.2, d_3 = Q0.3, d_4 = Q0.4, d_5 = Q0.5, d_6 = Q0.6 and d_7 = Q0.7.

The forth and last example program, "UZAM_plc_8i8o_ex33.asm" is shown in **Figure 7**. It shows the usage of the decoder macro "decod_3_8_E". The schematic diagram of the user program of "UZAM_plc_8i8o_ex33.asm" shown in Figure 7 is depicted in **Figure 8**. In this example, the decoder macro "decod_3_8_E" (3×8 decoder with active high enable input) is used. In this decoder, the select inputs are A = I0.0, B = I0.1 and C = I0.2, while the output lines are d_0 = Q0.0, d_1 = Q0.1, d_2 = Q0.2, d_3 = Q0.3, d_4 = Q0.4, d_5 = Q0.5, d_6 = Q0.6 and d_7 = Q0.7. In addition, the active high enable input E is defined to be E = I0.7. ■

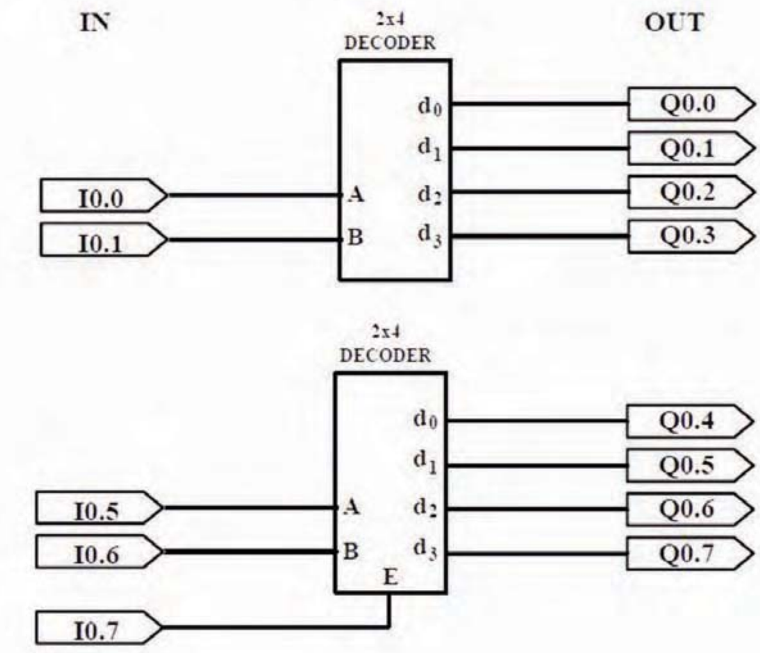


***Figure 4:** Schematic diagram for the user program of UZAM_plc_8i8o_ex31.asm*

```
.
      #include <definitions.inc>     ;basic PLC definitions, macros, etc.
      #include <cntct_mcr_def.inc>   ;Contact & Relay based macros
      #include <dcdr_mcr_def.inc>    ;decoder based macros
.
;--------------- user program starts here ------------------------
                                                                ;rung 1
decod_3_8        I0.0,I0.1,I0.2,Q0.7,Q0.6,Q0.5,Q0.4,Q0.3,Q0.2,Q0.1,Q0.0

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

***Figure 5:** The user program UZAM_plc_8i8o_ex32.asm*

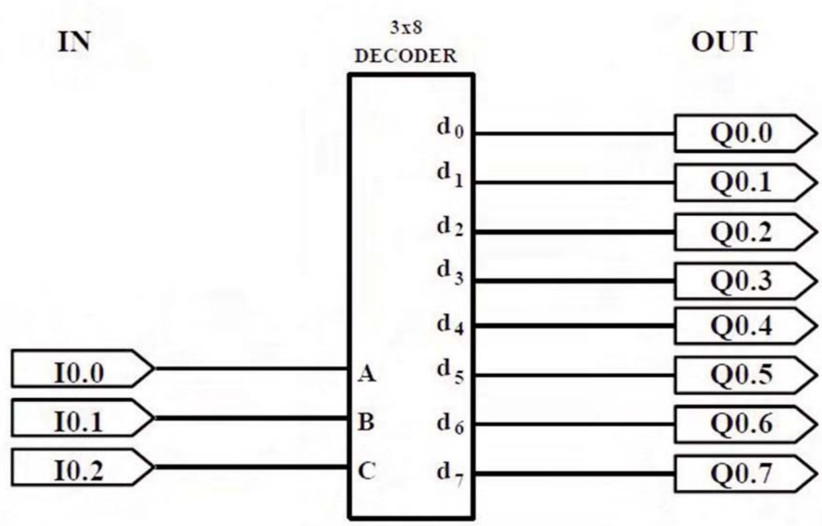


***Figure 6:** Schematic diagram for the user program of UZAM_plc_8i8o_ex32.asm*

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

  ld              I0.7                                          ;rung 1
  decod_3_8_E     I0.0,I0.1,I0.2,Q0.7,Q0.6,Q0.5,Q0.4,Q0.3,Q0.2,Q0.1,Q0.0

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

Figure 7: *The user program of UZAM_plc_8i8o_ex33.asm*

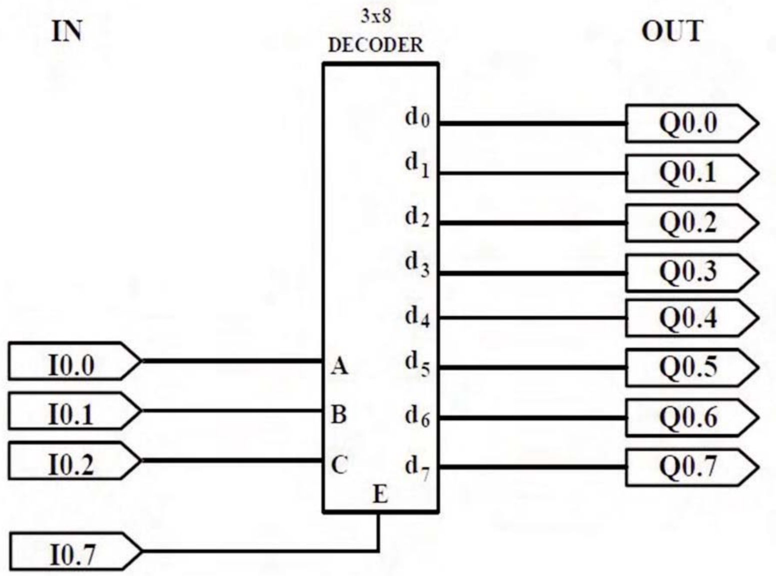


Figure 8: *Schematic diagram for the user program of UZAM_plc_8i8o_ex33.asm*

SINGLE CFOA-BASED VOLTAGE-MODE UNIVERSAL BIQUADRATIC FILTER

THE CURRENT-FEEDBACK operational amplifier (CFOA) is a very versatile active building block and is now commercially available from several manufacturers. This is due to the well-known fact that it offers some essential advantages such as wider signal bandwidth, higher linearity, larger dynamic range and smaller number of components, when compared to that of conventional voltage-mode operational amplifier (VOA) counterparts.

Moreover, it can provide the features of constant bandwidth independent of closed-loop gain and high slew-rate capability. Thus, it is beneficial to use the CFOA as a major active element in the accomplishment of various analogue signal processing circuits. As a result, several realizations of voltage-mode universal biquadratic filters using CFOAs have received great attention and have recently been reported in the literature. However, most of the previous works use large active and passive component counts, along with complex component matching constraints. It is important to keep the active component count in the circuit realization at minimum, since it is accompanied by a reduction in the power consumption and cost.

The aim of this design idea is to present a configuration for the realization of the voltage-mode universal biquadratic filter with three inputs and one output, employing only one CFOA and five passive elements. The proposed universal filter can simultaneously realize all the five standard types of the biquadratic filter functions, namely lowpass (LP), bandpass (BP), highpass (HP), bandstop (BS) and allpass (AP), without changing the circuit configuration. The filter enjoys orthogonal tuning of the natural angular frequency (ωo) and the bandwidth (BW). Also, it has low sensitivity to passive components. Computer simulation results using PSPICE program are performed to confirm the theoretical analyses.

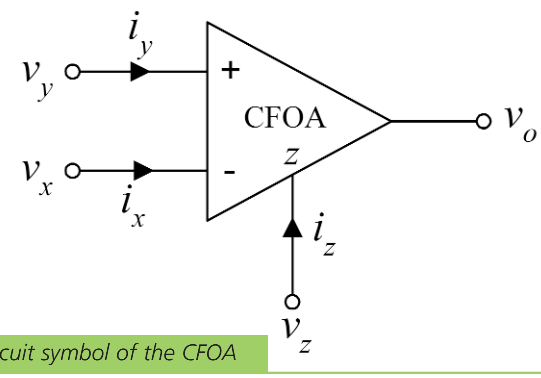


Figure 1: Circuit symbol of the CFOA

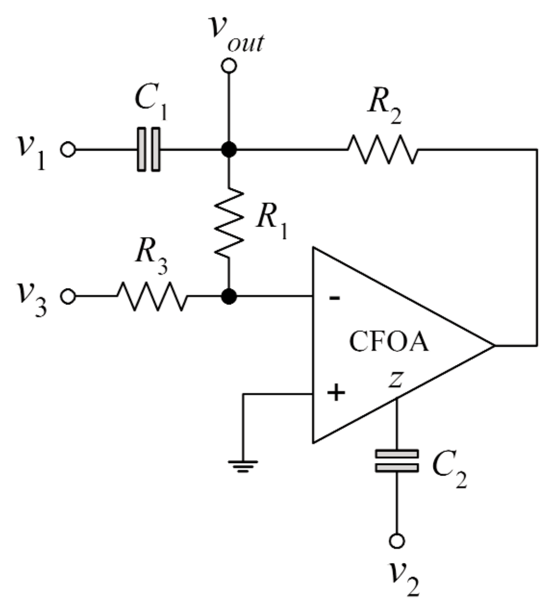


Figure 2: Proposed universal biquadratic filter

Proposed Universal Biquad Filter

The CFOA, illustrated in symbolic representation in **Figure 1**, is a four-terminal active device, characterized by the following relations:

$$i_y = 0 \,,\ v_x = v_y \,,\ i_z = i_x \text{ and } v_o = v_z \qquad (1)$$

Figure 2 shows the proposed universal filter employing only one CFOA, three resistors and two capacitors. Obviously, it is a three-input, single-output, voltage-mode universal biquad, which requires a minimum number of active and passive components. A routine analysis of the proposed filter circuit given in Figure 2 satisfies the following voltage transfer function: following voltage transfer function:

$$v_{out} = \frac{\left(s^2 R_1 R_2 C_1 C_2\right)v_1 + \left(s R_1 C_2\right)v_2 - \left(\frac{R_1}{R_3}\right)v_3}{s^2 R_1 R_2 C_1 C_2 + s\left(R_1 + R_2\right)C_2 + 1} \qquad (2)$$

From **Equation 2**, it can be observed that the proposed filter can realize all the five biquadratic filter functions indicated as follows:

- If $v_1 = v_{in}$ (an input voltage signal) and $v_2 = v_3 = 0$ (grounded), then the HP response can be realized.
- If $v_2 = v_{in}$ and $v_1 = v_3 = 0$, then the BP response with a passband gain equal to (R_1/R_1+R_2) can be realized.
- If $v_3 = v_{in}$, $v_1 = v_2 = 0$ and $R_1 = R_3$, then the LP response with the passband gain equal to (R_1/R_3) can be realized.
- If $v_1 = -v_3 = v_{in}$, $v_2 = 0$ and $R_1 = R_3$, then the BS response can be realized.
- If $v_1 = -v_2 = -v_3 = v_{in}$ and $R_1 = R_3$, then the AP response can be realized.

Also deriving from Equation 2, the natural angular frequency (ω_o) and the bandwidth (BW) for all the filters can be given by:

$$\omega_o = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}} \qquad (3)$$

and

$$BW = \left(\frac{1}{R_1 C_1} + \frac{1}{R_2 C_1}\right) \qquad (4)$$

It can be seen from **Equations 3** and **4** that the natural angular frequency ω_o can be adjusted without affecting the parameter BW by controlling the grounded capacitor C_2. Furthermore, the sensitivity of the filter parameters ω_o and BW with respect to the

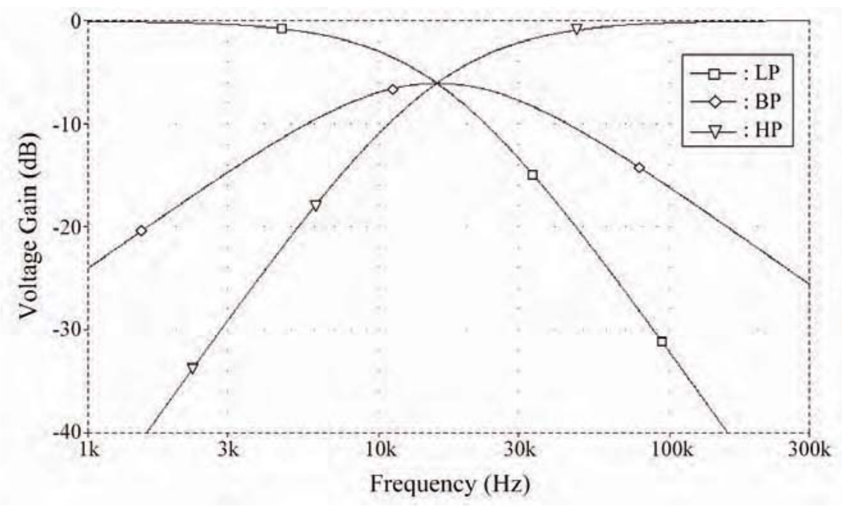


Figure 3: *Simulated frequency characteristics for LP, BP and HP responses of the proposed filter*

passive components are calculated as follows:

$$S^{\omega_o}_{R_1} = S^{\omega_o}_{R_2} = S^{\omega_o}_{C_1} = S^{\omega_o}_{C_2} = -\frac{1}{2} \quad \textbf{(5)}$$

$$S^{\omega_o}_{R_3} = 0 \quad \textbf{(6)}$$

$$S^{BW}_{R_1} = \frac{R_2}{R_1 + R_2} < 1 \quad \textbf{(7)}$$

$$S^{BW}_{R_2} = \frac{R_1}{R_1 + R_2} < 1 \quad \textbf{(8)}$$

$$S^{BW}_{C_1} = -1 \quad \textbf{(9)}$$

and

$$S^{BW}_{R_3} = S^{BW}_{C_2} = 0 \quad \textbf{(10)}$$

From **Equations 5-10**, it is clearly seen that all the passive component sensitivities of ω_o and BW are low and not larger than unity in absolute value.

Simulation Results

The properties of the proposed multifunctional circuit in Figure 2 were verified by computer simulations using the PSPICE program. PSPICE simulations were carried out using the commercial AD844 CFOA from Analogue Devices, biased with symmetrical voltages of ±12V. In this test, the passive component values were set to $R_1 = R_2 = R_3 = 10k\Omega$ and $C_1 = C_2 = 1nF$, to obtain a desired natural angular frequency of $f_o = \omega_o/2\pi \cong 15.91kHz$ and the quality factor of $Q = 1$. The simulated frequency responses for LP, BP and HP filters of the proposed filter in Figure 2 are represented in **Figure 3**. The simulation results confirm the results of the theoretical analyses. ■

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Thailand

HAMEG INSTRUMENTS PRESENTS A NEW MEMBER OF ITS HMO SERIES

The HMO series of DSO/MSO oscilloscopes is extended by a 4-channel 250MHz model of favourable price/performance ratio. Apart from the 250MHz bandwidth, the HMO2524 also offers a sampling rate of 1.25GS/s and a memory depth of 2MBytes per channel. In the 2-channel mode, the sampling rate increases to 4GS/s and the capture memory to 4MBytes per channel.

This youngest member of the HMO family has all the known functions of the other HMO systems including up to 16 logic channels, a sensitivity of 1mV/div at the analogue channels, combinations of mathematical functions, integrated FFT functions, USB interfaces for memory sticks, printers and remote control and a low-noise fan. For all instruments of the HMO family serial trigger and decoder functions for I2C, SPI and UART are available as options.

The Mixed Signal Oscilloscope offers the possibility of triggering on and decoding the most important serial buses at prices from 3,700€.

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NEW SHIELDING DEVICE ENABLES RF AND RADIATION MEASUREMENTS AT NOTEBOOK PCS

Willtek Communications announced the 4933 RF Shield, supporting radiation and quality measurements at large radio transceivers, notebook PCs and other electronic equipment. It combines a high shielding factor with easy access to the unit under test. The new device from Willtek's successful RF Shield series is immediately available.

The 4933 RF Shield attenuates signals from outside or even inside by a high degree. The attenuation, in conjunction with the RF connector, enables radio frequency and quality engineers to measure the radiation of the device under test in an EMC prequalification test, without the need to rent a large anechoic shielded chamber. Other applications include transceiver tests in a controlled environment.

Willtek's 4933 RF Shield comes with a solenoid lock and a control panel displaying the status of the lock. Thanks to a USB interface, an external PC can read the status and even release the lock remotely.

www.willtek.com/english/products/tt/4933

PICKERING INTERFACES INTRODUCES NEW LXI HIGH VOLTAGE MATRIX

Pickering Interfaces is expanding its range of LXI compliant products with the introduction of a new LXI High Voltage matrix, the 60-311.

This is a matrix designed for high voltage switching applications. It withstands voltages up to 1kV with up to 2A of carry current, and provides a dense and cost-effective solution to matrix switching solutions where high user voltages may be encountered.

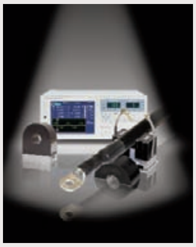
The LXI Class C compliant device uses high voltage D Type connectors ensuring connection solutions are readily available from Pickering Interfaces and other suppliers.

The 60-311 is offered in three configurations: single, dual and triple 75x4 matrices. Each individual matrix includes isolation relays on the X and Y axis that simplify configuration of the matrix into larger matrix sizes, when interconnecting the matrices together, which avoids excessive matrix loading in many applications.

The LXI Class C compliant interface allows simple Ethernet control of the matrix with local or remote access.

www.pickeringtest.com

CURRENT SENSORS ADD HIGH-CURRENT MEASUREMENTS TO PRECISION POWER METERS



A range of current sensors is now available that allows the Yokogawa family of precision power meters to be used for measuring very high currents.

Developed and manufactured by Hitec Power Protection of Almelo, The Netherlands, the new Zero-Flux current sensors allow the precise measurement of currents up to several thousands of amperes, including simultaneous measurement of AC and DC currents, while also providing accurate phaseshift information.

Other key features of these sensors include isolation from the primary circuits, very high stability and accuracy, high bandwidth, saturation detection with automatic reset after overcurrent, and the ability to switch on the devices with current already present when connected.

There are three types of current sensor in the Zero-Flux range: the MACC Plus external current sensor, the SC1000 splitcore sensor and the CURACC current-measuring system.

The MACC Plus external current sensor offers a 1000:1 current transfer ratio for maximum 850A peak current (600A RMS).

http://tmi.yokogawa.com/ea

ENHANCED AVX SOFTWARE AIDS SELECTION OF PROPER POWER SUPPLY CAPACITORS

AVX has enhanced its free SpiCalci Software that guides designers to select the proper switch mode power supply (SMPS) capacitor to match application requirements. The upgraded Spi-Calci 5.0 SMPS software incorporates AVX's newest capacitor technologies, including TurboCap, the rugged MH Series and the expanded MIL PRF 49470 product offering. In addition, the software allows the user to select critical parameters, build a part number and view charts such as ESR, impedance versus frequency, temperature change versus applied current and maximum current over frequency.

AVX's SMPS capacitors are uniquely suited for filtering capacitors on the input and output of power supplies or as snubber capacitors. The SpiCalci 5.0 software ensures customers select the appropriate capacitor and performance characteristics for their application.

AVX has an established twenty year history of SMPS stacked capacitors serving the space, avionics and military industries. In addition, AVX maintains the largest profile of QPL items and approvals for the SMPS market.

www.avx.com

NOVEC SURFACE MODIFIER COATING PROTECTS ELECTRONIC COMPONENTS

3M, the diversified technology company, has launched Novec EGC-2702, a surface modifier coating that provides economic and fast protection against moisture and corrosion in electronics manufacture and assembly.

A cost-effective high performance alternative to traditional conformal coatings, Novec EGC-2702 can be applied and dried within seven minutes, which is less than a third of the time of leading existing competitive products. It is also non-flammable and is designed to help electronics companies adhere to environmental, health and safety requirements.

Available exclusively in the UK and Ireland from distributor Acota, Novec EGC-2702 is aimed at electronics environments involving coating of sensitive components, such as circuit boards. Particular target markets include automotive, telecommunications, military and aerospace equipment.

Novec EGC-2702 removes the need to mask surface areas, such as connection points, during the coating process, so time, labour and associated costs are substantially reduced. It cures in just 40 minutes, which compares favourably with alternatives.

www.3M.co.uk/NovecCoating

HAMEG INSTRUMENTS PRESENTS A NEW MEMBER OF ITS HMO SERIES

The HMO series of DSO/MSO oscilloscopes is extended by a 4-channel 250MHz model of favourable price/performance ratio. Apart from the 250MHz bandwidth, the HMO2524 also offers a sampling rate of 1.25GS/s and a memory depth of 2MBytes per channel. In the 2-channel mode, the sampling rate increases to 4GS/s and the capture memory to 4MBytes per channel.

This youngest member of the HMO family has all the known functions of the other HMO systems including up to 16 logic channels, a sensitivity of 1mV/div at the analogue channels, combinations of mathematical functions, integrated FFT functions, USB interfaces for memory sticks, printers and remote control and a low-noise fan. For all instruments of the HMO family serial trigger and decoder functions for I2C, SPI and UART are available as options.

The Mixed Signal Oscilloscope offers the possibility of triggering on and decoding the most important serial buses at prices from 3,700€.

www.hameg.com/productronica

NEW SHIELDING DEVICE ENABLES RF AND RADIATION MEASUREMENTS AT NOTEBOOK PCS

Willtek Communications announced the 4933 RF Shield, supporting radiation and quality measurements at large radio transceivers, notebook PCs and other electronic equipment. It combines a high shielding factor with easy access to the unit under test. The new device from Willtek's successful RF Shield series is immediately available.

The 4933 RF Shield attenuates signals from outside or even inside by a high degree. The attenuation, in conjunction with the RF connector, enables radio frequency and quality engineers to measure the radiation of the device under test in an EMC prequalification test, without the need to rent a large anechoic shielded chamber. Other applications include transceiver tests in a controlled environment.

Willtek's 4933 RF Shield comes with a solenoid lock and a control panel displaying the status of the lock. Thanks to a USB interface, an external PC can read the status and even release the lock remotely.

www.willtek.com

PICKERING INTERFACES INTRODUCES NEW LXI HIGH VOLTAGE MATRIX

Pickering Interfaces is expanding its range of LXI compliant products with the introduction of a new LXI High Voltage matrix, the 60-311.

This is a matrix designed for high voltage switching applications. It withstands voltages up to 1kV with up to 2A of carry current, and provides a dense and cost-effective solution to matrix switching solutions where high user voltages may be encountered.

The LXI Class C compliant device uses high voltage D Type connectors ensuring connection solutions are readily available from Pickering Interfaces and other suppliers.

The 60-311 is offered in three configurations: single, dual and triple 75x4 matrices. Each individual matrix includes isolation relays on the X and Y axis that simplify configuration of the matrix into larger matrix sizes, when interconnecting the matrices together, which avoids excessive matrix loading in many applications.

The LXI Class C compliant interface allows simple Ethernet control of the matrix with local or remote access.

www.pickeringtest.com

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www.avx.com

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www.3M.co.uk/NovecCoating

CIRCULAR FIBRE OPTIC CONNECTOR FOR MULTIPLE FIBRE OPTIC PACKAGING SCENARIOS

ITT Interconnect Solutions has launched its PHD 38999 fibre optic connector family in response to demands for a interconnect system suitable for harsh environments that could group multiple fibre optic terminations in a rugged circular connector profile with precision alignment and optical performance features.

Initially developed for high-speed backplane systems for telecoms switching, the PHD termination and connector system delivers a high density package with superior optical signal transmission performance. Providing a common solution for all fibre sizes, ITT-ICS also designed the PHD system for packaging flexibility, suiting it to many Mil Spec and standard connector envelopes – both circular and rectangular. The PHD product family is available as complete, custom, fibre optic cable assemblies.

Suitable for very demanding harsh environment applications including defence, avionics and tactical communications, PHD metal connectors are compatible with M38999 outside dimensions and feature an all-metallic back shell with sealing grommet and a removable alignment insert assembly.

www.ittcannon.com

NEW SERIES OF FILTERED AND UNFILTERED POWER MODULES FROM TYCO

Tyco Electronics has added the CU series to its family of Corcom power entry modules. The new series includes smaller-sized versions of switched filtered and unfiltered power inlets, which are ideal for applications with panel space constraints, in particular systems designed for the popular 1U (1 ¾ inch) height equipment racks.

The CU series offers 15 filtered and eight unfiltered versions to cover a broad array of applications. Shrouded quick-connect terminals eliminate the need for soldered connections, which helps reduce installation time. The series allows higher system efficiency by contributing less heat, making it suitable for applications with power or cooling limitations.

The modules offer three different mounting styles: flush-mount, flange and snap-in. Current ratings range from 1 to 15 Amps and the product is UL recognized, CSA certified and VDE approved. The 15 Amp versions tested by Underwriters Laboratories to US and Canadian standards are VDE approved for a 10 Amp rating.

www.tycoelectronics.com

POWERSOLVE ANNOUNCES 75 TO 200W SINGLE OUTPUT POWER SUPPLIES

Powersolve continues to add to its energy-efficient power supply portfolio with the introduction of the new PAK75-200 Series. These highly efficient, single output units feature a no-load power consumption of < 0.7W, and meet relevant Energy Star requirements.

Powersolve has designed them to provide high reliability and a long MTBF with every unit undergoing a full load burn-in test.

Powersolve's PAK family consists of four series, each comprising eight models with output voltages of 5 to 48V. All units accept a wide, universal AC input with active PFC. The PAK75W/100W/150W series are convection cooled while the PAK200W series units incorporate an internal fan. An LED indicates power on status.

All units are protected against short circuit, overload and over voltage and all have an operating temperature range of -20ºC to +70ºC, which is suitable for most applications.

The units are extremely compact -157 x 98 x 42mm for PAK75/100 series and 197 x 98 x 42mm for the PAK150/200 units.

www.powersolve.co.uk

NEW PUSH BUTTON SWITCH HAS BUILT-IN TFT COLOUR GRAPHICS DISPLAY

Foremost Electronics, the Essex based specialist distributor of electromechanical components, introduces a cutting-edge, man-machine, interface solution. The TFT128 ScreenKey is a push button switch with a built-in full colour, high resolution TFT graphics display. The display is backlit by a white LED and the integrated TFT LCD display has a resolution of 128 x 128 pixels, where each pixel colour may be chosen from a palette of 65,536 colours.

The TFT128 ScreenKey is an intelligent device with an onboard microcontroller and graphical display controller. A fully implemented 4-wire SPI interface, with an expanded command set, allows designers to use simple ASCII control, full bitmap graphic display or a combination of the two. This smart switch supports downloadable display content and is designed to minimise bandwidth requirements from a host controller. This is particularly useful in a multi-ScreenKey environment.

The Foremost TFT128 ScreenKey offers two operating modes: high-level command mode and high-speed mode.

www.4most.co.uk

KONTRON ETX-DC: INTEL ATOM PROCESSOR MODULE, NOW SUPPORTING 24-BIT LVDS AND SDVO

The Kontron ETX-DC Computer-on-Module (95 x 114mm) with 1.6GHz Intel Atom processor N270 is now available with 24-bit LVDS display support. As a result of the upgrade to the ETX-DC design, especially larger display sizes (15-inch and larger) supporting 24-bit only imagery can now be implemented even more efficiently.

The new Kontron ETX-DC module ensures that both 18-bit LVDS and SDVO signals can be used together. This allows two digital displays to be simultaneously and independently controlled, enabling attractive PCI-based dual-display designs with ISA and LPC expansion options.

With the upgrade from 18-bit to 24-bit LVDS, the Kontron ETX-DC module (a long-life solution anticipated to be available for 7+ years) is a seamless upgrade from existing Intel Pentium M designs that also supported 24-bit LVDS. Thus, the new module secures the investments in existing long-life projects such as those in POI/POS, digital signage, infotainment, gaming, medical and industrial HMI vertical markets.

www.kontron.com

KONTRON BRINGS 10 GIGABIT ETHERNET SWITCHING TO COMPACTPCI AND VME PLATFORMS

The new Kontron CP6930 6U switch brings 10 Gigabit Ethernet switching to CompactPCI and VME embedded systems and communication networks.

With six SFP+ interfaces for 10Gb, two SFP interfaces for 1Gb Ethernet switching on the front and 24GbE ports on the back, the new switch boosts the performance of VME and CompactPCI systems based on the latest processor boards for intra- and intercommunication. The non-blocking, fully managed L2/L3 switch allows system designers to stay ahead of the rising transaction and traffic loads in many embedded system designs and communication networks, therefore maximizing the usage and longevity of their systems and reducing the TCO for customers' solutions.

The new Kontron CP6930 6U switch fits into both CompactPCI and VME (via the VITA 31.1 specification) system chassis and offers unmatched price-to-performance ratio by implementing the highly integrated Broadcom single-chip switching solution. The CP6930 also offers an AMCC PowerPC for individually configurable application control and a microcontroller for IPMI-based platform management.

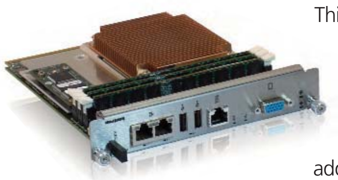
www.kontron.com

KONTRON ADVANCEDMC WITH QUAD-CORE PERFORMANCE

Kontron announced the introduction of the Kontron AM5030, one of the first Advanced Mezzanine Cards designed with a quad-core processor.

This new Kontron double-wide, full-size AMC module features the new Intel Xeon processor LC5518, which is based on the latest Intel microarchitecture and delivers with its 45nm process technology even lower power consumption and higher integration. This makes the Kontron AM5030 an attractive solution for MicroTCA platforms designed for dense server environments deployed in storage, military/aerospace and communications networks such as IPTV, VoIP, NAS, SAN and wireless radio network controllers.

The 45nm Intel Xeon processor LC5518 with integrated I/O Hub features a 4-to-1 consolidation of workload functions for greater real estate and power savings. This includes, for the first time, the integration of PCIe Gen 2.0 I/O within the processor. In addition, the new embedded processor offers up to 8MB shared Last Level Cache, Intel Hyper-Threading technology support and Intel Turbo Boost technology.



www.kontron.com

WAVELINK 25GHZ HIGH-BANDWIDTH DIFFERENTIAL PROBES

LeCroy Corporation today announced the launch of the WaveLink 25GHz high bandwidth differential solder-in probe, the fastest probe currently available. This probe expands the recently introduced 13-20GHz WaveLink probe line and is well-matched to LeCroy's WaveMaster 8 Zi oscilloscope product line, which includes bandwidths up to 30GHz. Now, engineers who find it insufficient to use SMA cables to input signals directly into their oscilloscope can use a LeCroy WaveLink D2505 differential probe and a WaveMaster 825Zi oscilloscope to achieve 25GHz of scope and probe bandwidth – an industry first. LeCroy's WaveLink high bandwidth differential solder-in probes provide superior rise-time performance, and the new probe extends this performance to 17.5ps for a 25GHz probe used with a 25GHz oscilloscope, the same as the oscilloscope-only rise-time. In addition, baseline electrical noise in the probe product line has been dramatically lowered and is only 3.1mVrms at 25GHz and only 1.6mVrms at 13GHz.

www.lecroy.com/europe

BOX PC WITH FRONT AND REAR INTERFACES FOR INTEGRATION INTO DEVICES AND MACHINES

Kontron has introduced the Kontron KIC (Kontron Intelligent Computer), a family of Box PCs with front and rear interfaces that, for the first time, can be integrated directly into the chassis of devices and machines. Thanks to its second set of interfaces, the IPC requires no additional cabling to the front of the housing and can, therefore, be faster and more easily integrated into machine designs for low installation costs. By reducing the need for cables, reliability increases and maintenance costs decrease significantly since the potential of failure from cables being disconnected over time is greatly reduced.

The small box (200mm x 85mm x 200mm) is a highly performance-scalable Kontron KIC family and it fits perfectly in compact automation solutions in which the IPC, thanks to its smaller size and greater energy efficiency, moves out of the 19-inch rack and directly into the device or machine.

www.kontron.com

RUGGED RAILWAY BOX PC WITH INTEL ATOM Z530 PROCESSOR

Kontron has introduced the Kontron MICROSPACE MPCX28R an EN50155-certified and TX-compliant Rugged Railway Box PC. By receiving certification and compliance, Kontron's latest rugged Box PC helps OEMs accelerate their time to market and reduce hardware design costs for their railway applications. The long-term available and – 1.6GHz Intel Atom Z530 processor – particularly energy efficient Box PC offers a 1.5kV isolated power supply and robust M12 interface connector for 2 x Fast Ethernet, USB 2.0 and power.

Designed for the extended temperature range from -25 to 70°C and in a rugged profiled-aluminum case, the passively cooled Kontron Railway Box-PC is based on the 1.6GHz Intel Atom processor Z530 with 533MHz FSB and supports up to 1GB of DDR2 RAM. The integrated graphics chipset offers 256MB of memory, DirectX 9 3D as well as HDTV support, and the integrated MPEG2 and H.264 decoders reduce processor load while displaying HD video.

www.kontron.com

COM EXPRESS COMPUTER-ON-MODULE WITH IMPROVED GRAPHICS

The new Kontron ETXexpress-AI COM Express Computer-on-Module offers OEMs a new level of design flexibility thanks to its 32nm Intel Core-i7/Core-i5 processor technology, high energy-efficiency, wide graphics support, customizable PCI Express configuration and ECC dual channel RAM to ensure data accuracy. Kontron's new Computer-on-Module offers improved computing and graphics performance in the high-end performance sector.

The Kontron ETXexpress-AI in the COM Express Basic form-factor features the processor-integrated 45nm Intel HD graphics with DisplayPort support. Especially graphics-intensive applications benefit from Open GL 2.1 support and accelerated DirectX 10 capabilities through better and faster visual display. Thus, the new Computer-on-Module is able to achieve up to 2.6 times the graphics performance in comparison to Mobile Intel GM45 and GS45 Express based solutions (according to 3DMark 2006). For safety-critical applications, the Kontron ETXexpress-AI integrates up to 8GB of ECC system memory and an optional Trusted Platform Module (TPM).

www.kontron.com

SECOND GENERATION OF INTEL ATOM PROCESSOR BASED COMPUTER-ON-MODULES

Kontron has launched its first COM Express Type 2-compatible Computer-on-Module with the new second-generation Intel Atom processor. With Intel's highly integrated two-chip design, dual-core option and cost-efficient processors, these new modules will accelerate the development of particularly cost-effective ultra-low-power embedded appliances. Beside these new market opportunities it is also a perfect substitute for Intel Pentium M based designs.

A highlight of this new compact COM Express compatible Computer-On-Module (95 x 95mm) is the dual-core version, which now makes it possible to implement multi-core processing features, such as asymmetric multiprocessing for dedicated 2-in-1 systems for hardware consolidation into particularly cost-effective low-power devices. In addition, due to the completely fanless operation, the new modules also open up entirely new fields of ultra rugged applications.

The new Kontron microETXexpress-PV modules are highly suitable for these cost-effective, ultra-low-power embedded devices, in particular due to their open and freely-scalable x86 architecture that offers the highest compatibility for previous processor generations.

www.kontron.com

CONDUCTIVE ELASTOMERS FOR RFI/EMI SHIELDING

Kemtron manufactures a range of conductive Elastomers as gaskets and gasket strip for EMI shielding of electronic devices. The base Elastomer is silicone for normal environments and Fluorosilicone for fuel and oil resistance, both offer a wide temperature range of -40ºC to +160ºC and up to +200ºC for some grades. The conductive fillers available are silver-plated aluminium, silver-plated copper, pure nickel and nickel-coated graphite. Other fillers, such as silver-plated nickel, are available to special order.

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

www.kemtron.com

ARV COAXIAL SWITCH

The new ARV from Panasonic is available in two versions: Pin and SMA. The pin only version is sized at 15.9 x 15.9 x 11.2mm, while the SMA connector version is a little larger at 17.8 x 18 x 13.3mm (all dimensions exclude connectors/pins); both are available in two max ratings of 8GHz and 18GHz. If you compare these to an industry standard SPDT 18GHz switch, these are typically sized at approximately 40 x 35 x 14mm. The ARV could offer as much as an 85% volumetric reduction.

Performance characteristics are very comparable to its larger rival with a VSWR of 1.7, insertion loss of 0.7dB and isolation of 40dB at 18GHz.

The ARV relay is ideal for integration in applications tight on space.

www.panasonic-electric-works.co.uk

INDAL WRTL TO CONTINUE LAUNCHING STELA LED SOLUTIONS

Stela Long is a residential side entry road lighting solution, available with 34mm to 42mm spigot, or post top with a 60mm or 76mm fixing. It is available in 10 LED to 30 LED versions and shares the latest technology improvements available across the Stela range with improved circuit efficacy up to 116 lumens per watt. Stela Long is ideal for point-for-point replacement and offers unprecedented energy performance beating all conventional solutions by reducing energy by 60% to 75% compared to 70W SON.

Stela Round offers post top, side entry and wall mounting arrangements and available in 10 LED to 52 LED versions. It has been designed to replace conventional solutions up to 150W SON with the benefit of achieving up to 80% energy savings.

www.wrtl.co.uk www.stela-led.co.uk

TRANSFORMER MANUFACTURE

WEBSITE DIRECTORY

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www.sky-pcb.com

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FURTHER £5M COMMITMENT TO **STRENGTHENING INNOVATION** IN MANUFACTURING

The Technology Strategy Board (TSB) signalled the UK government's commitment to supporting innovation in high-value manufacturing by announcing investment of £5m in 22 new R&D feasibility projects, including digital printing for the manufacture of medical implants, robot-enabled 3D precision assembly and development of special inks for security purposes among others. With a total project value in excess of £10m, the collaborative R&D funding was awarded to 22 separate consortia, with grants ranging from £60,000 to £350,000 and benefiting over 50 UK companies, about half of which are small and medium enterprises. These feasibility projects are designed to be relatively short term, requiring work to be completed by the end of 2010.

This is the third investment by the Board in high-value manufacturing during the last 18 months and brings the total invested by the government-funded organisation in this area to nearly £50m in over 80 projects.

Our panel of commentators says the following on this development:

IVOR CATT, ELECTRONICS ENGINEER, UK:
I have found that all our institutions [in the UK] are hostile to innovation. Thirty years ago I successfully went through the process of getting government financial support for an invention I had. When feasibility was proven, government sat back and waited for the relevant companies, Ferranti, Plessey and ICT, to take it up. As I predicted, they did not. I said that if a British company were to develop a new product, the government would have to give it 120% of development costs. Ten years later a maverick, Clive Sinclair, brought my invention to market. Partly due to sluggish behaviour by government and partly due to the sluggish behaviour of industry, it took twenty years to come to market, by when the underlying reasons for the invention had radically changed. Notice that all the relevant companies have disappeared because of their refusal to develop new products. In Britain, my industry – computers and microelectronics – is more or less gone!

BURKHARD VOGEL, CEO, BUVICON GMBH, GERMANY:
Recently, in a long feature, Germany's Frankfurter Allgemeine Zeitung informed their readers about the gap between the amounts of production/manufacturing activities in the UK economy vs the other 'big' economies on the continent: Germany, France and Italy.

Expressed in percentage of the gross national product of these countries, the UK's was by far the lowest, half the size of the Germany (20%) and lower than the French and the Italian ones. What matters is the fact that national economies without or with only a rather small production industry sector become less stable in the wind of financial influence from other and stronger worldwide competing players in these fields. The recent financial shockwaves have hit us all, but, to recover fast we need a stable ground that can only be built on the production of saleable goods. More shockwaves will follow. As long as Europe is still thinking and acting mainly on a national basis, the strongly service-sector-oriented economies will be hit more negatively. Today, only a few product fields in the UK are left to make a successful business on the export field.

Under this light, even as third run, the amount of money spent is a drop of water on a hot stone.

My colleagues in the production/manufacturing industry are all worrying about the decline of the production sector in the EU. Neither the service or financial sectors nor a huge public sector like in France will be able to stabilize any economy, especially when the competition wind of the fast growing Asian tigers blows.

BARRY MCKEOWN, RF AND MICROWAVE ENGINEER IN THE DEFENCE INDUSTRY, AND DIRECTOR OF DATOD LTD, UK:
Congratulations to the grant award winners, commiseration to the losers, especially for providing potential rivals with Business Intelligence. These small grants are basically window-dressing for matched funding for vested interests, not necessarily the national interest. The US [D]ARPA, founded in 1958, is the most successful innovation model, simply because it provides for failure. The TSB model is tolerant of risk not failure. Innovation derives from failure.

I truly believe that the £711m would be better spent on fundamental breakthrough research at universities, or models devised to eliminate the matched funding requirement, than give it all away as grants.

HAFIDH MECHERGUI, ASSOCIATE PROFESSOR IN ELECTRICAL ENGINEERING AND INSTRUMENTATION, UNIVERSITY OF TUNISIA:
It is encouraging that the TSB is focusing on research programs to study the conditions of innovations in medicine and other industrial sectors. This investment takes into account the following factors: it is necessary to reduce the rate issue of CO_2 emissions and to create employment.

I believe it is important that governments are investing in making their countries' projects feasible. This will help to increase the countries' efficiency and competitiveness, and to create other sectors of employment. I think that nowadays states must play a significant and main role to finance scientific research in different ways, such as experimental – applied or fundamental.

MAURIZIO DI PAOLO EMILIO, TELECOMMUNICATIONS ENGINEER, INFN – LABORATORI NAZIONALI DEL GRAN SASSO, ITALY:
It is great to learn that the British government is putting efforts into technology research. What the TSB does is definitely a positive example to learn from in other countries in Europe too, where most of the resources into such fields are very limited.

New sectors bring job opportunities to young people or whoever has passion for the technologies. A £5m could be just a start.