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ELECTRONICS WORLD

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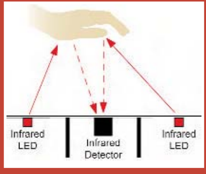
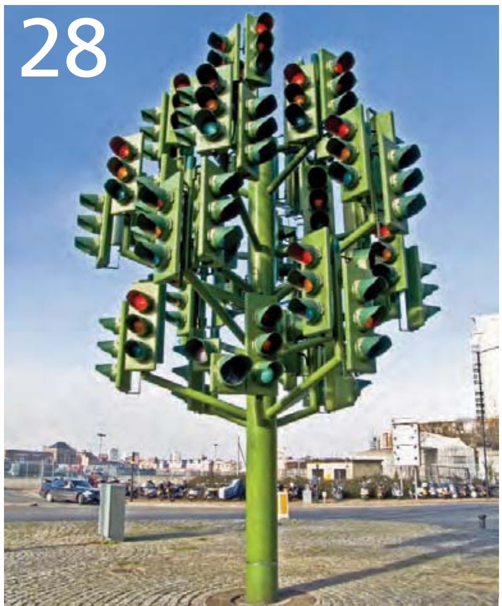


DESIGN
IMPLEMENTING A TOUCHLESS SLIDER WITH IR

ALSO IN THIS ISSUE: THE TROUBLE WITH RF: DEAR SANTA, I WANT....



REGULARS

Cover supplied by *Linear Technology*; more about the *Isolate to Communicate* on pages 18 and 19

FEATURES

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Z-WAVE TAKES STOCK

What this piece states is that interest in wireless smart metering solutions has increased enormously

This is the conclusion drawn by the Z-Wave Alliance (**www.z-wave-alliance.org**) after its appearance as an exhibitor at the 11th Metering & Billing/CRM Europe in Barcelona.

BY MARY MILLER

With the development of its Advanced Energy Control (AEC) framework, Z-Wave has managed to unite the smart metering sector with modern domestic automation in a convenient way. The Z-Wave wireless standard now forms the basis of nearly 350 home control devices produced by leading manufacturers worldwide. These offer functions ranging from intelligent monitoring of electricity, gas and water meters to in-home displays, as well as intelligent gateways and web interfaces. Such devices allow energy consumption and CO_2 emissions to be reduced in a sustainable manner, as consumers can keep an eye on their electricity, water and gas consumption and know how much energy various appliances require.

Mary Miller, Z-Wave Alliance marketing director, said: "Homeowners are becoming increasingly energy conscious, which has resulted in continually increasing interest in automated smart metering and monitoring solutions in recent years. Consumers have seen that the options for measuring and actively controlling their energy and electricity consumption have become simpler and easier to use. Studies have already shown that when consumers have access to real time information about their energy use their consumption drops immediately up to about 15%. The Z-Wave monitoring devices that take information from the meter and display it in the home for the consumer to see and act upon is becoming a 'must have' for energy conscious consumers."

"Businesses such as Kamstrup, Horstmann, Modstrœm, Flex Control and Danfoss market solutions that offer considerable added value to energy suppliers and consumers alike as they provide transparency and control with regard to energy consumption," added Miller.

Examples of Z-Wave type appliances include Kamstrup's fully electronic meter systems, which allow consumption figures to be easily read off, and Horstmann's range of products, which are a combination of electricity and gas meters and consumption display units. Horstmann demonstrates how consumers can make use of smart metering solutions to obtain an overview of energy consumption every 30 minutes, every day and every month.

Modstrœm 's Z-Wave based electricity meter for displaying energy use, shows that energy consumption figures can, if required, be read via a digital camera mounted on the meter or via a website. In addition, a Danish manufacturer Flex-Control has an intelligent "House Control" Z-Wave monitoring system, which allows the wireless monitoring and management of all Z-Wave compatible devices (e.g. heating, temperature, lights etc) in houses, apartments and holiday homes via a central web-interface.

> "STUDIES HAVE ALREADY SHOWN THAT WHEN CONSUMERS HAVE ACCESS TO REAL TIME INFORMATION ABOUT THEIR ENERGY USE THEIR CONSUMPTION DROPS IMMEDIATELY UP TO ABOUT 15%"

Danfoss offers energy-saving thermostats with its Z-Wave ECO-system. This consists of heating and room thermostats, transmitter and receiver modules and timers. Consumers can centrally manage their entire heating and cooling systems and how the system automatically regulates the temperature remotely, when away from home.

NorthQ has a new low-cost pulse meter developed in cooperation with Denmark's biggest utility, Dong Energy, that lets consumers see their electricity consumption on a laptop or iPhone/iPod touch.

Milcom is another manufacturer with a range of Z-Wave devices ready for the market.

Miller said: "With the hundreds of Z-Wave products from thermostats, to lighting, sensors, appliance and shade controllers readily available in the market, consumers can easily do load-shedding either with a touch of a button at home, or remotely through PCs and smart phones. This also results in a sustainable reduction in CO2 emissions, not just a drop in the home energy bill. Z-Wave technology is an affordable, bi-directional wireless communication protocol, and is especially suited for the control and networking of smart metering products for the mass market, not just the wealthy."

Mary Miller, Z-Wave Alliance marketing director

EDITOR: Svetlana Josifovska
Email: svetlanaj@stjohnpatrick.com
PRODUCTION MANAGER: Tania King
Email: taniak@stjohnpatrick.com
DISPLAY SALES: Neil Coshan
Tel: +44 (0) 20 7933 8977
Email: neilc@stjohnpatrick.com
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VENAHUB DEVELOPED TO KEEP CONNECTED PATIENTS ON TRACK

UK-based Cambridge Consultants has developed a data collection and aggregation system that promises to simplify personal health management in a connected health environment.

Dubbed VenaHub, the system employs a small pocket device to capture data from a user's ecosystem of wireless medical devices, which it then integrates into a customisable online health information portal.

The VenaHub's web interface is much like an app-enabled phone or PDA where users can customise different applications to suit their own needs and conditions. For example, an asthmatic patient could tailor their portal to see various types of information – charts of their recent inhaler use, reminders for refilling prescriptions or doctor's appointments, lung function data via a peak flow chart – all juxtaposed against the coming week's pollen forecast.

The wireless technology at the core of VenaHub is based on Cambridge Consultants's Vena wireless healthcare device platform, which implements the standards selected by the Continua Health Alliance to "empower patients to manage health and wellness anytime, anywhere", including the IEEE 11073 standards for compatible exchange of information between health devices.

Cambridge Consultants's VenaHub medical data collection system

The system embeds the Bluetooth Health Device Profile (HDP), optimised for the secure transport of medical data, onto a single chip at an affordable price.

"Current solutions in the telehealth space are expensive, which means none of the parties involved want to pay for them, whether they are an insurer, hospital or patient," said Mike Dunkley, Vice President at Cambridge Consultants. "But the novel, compact and portable VenaHub is cheap and can plug into the USB port of any PC. Critically, it can also collect data from devices even when it's not plugged into a computer."

Anticipating growing consumer demand for low-cost home health management devices, this launch addresses the need for a simple, consumer friendly and cost effective means to enable proactive self-management of chronic diseases.

"The VenaHub technology could not only disrupt the current medical home market, but could overcome the reimbursement barrier that has prevented connected health solutions from being widely deployed," added Dunkley.

Super Low-Profile OLED Developed in Research Project

Osram Opto Semiconductors has developed organic light emitting diodes (OLED) prototypes that are only a few hundred micrometers thick. These OLEDs do not need separate encapsulation and can be made incredibly thin in any layout, which will enable the development of various types and sizes of transparent displays.

According to Osram, the OLEDs thickness is now defined only by the substrate as the carrier material – which is between 300 and 700µm at present; their luminous area is 210cm². Further development work will lead to an even thinner carrier material and, hence, thinner OLEDs, leading to their easier use and integration. They can be made in any shape, take up very little space and can be integrated so discreetly that they are only noticed when they are switched on.

"Transparent OLEDs and flexible OLEDs at a later date will add an entirely new aesthetic dimension to lighting solutions," said Dr Karsten Heuser, head of the OLED division at Osram Opto Semiconductors. "The possibilities range from light sources that can be integrated in room dividers and furniture, for example, to entire windows that would allow natural light in during the day and flood the room with light at night."

The OLED panels can be made transparent without any detracting structures. This can be achieved through new developments in electrode design, a special component architecture and a new approach to thin-film technology. Without any additional conductor path structures on the light-emitting surface, the current is distributed evenly over the active surface, which in turn leads to uniform luminance.

The new technology also simplifies the manufacturing process, whether OLEDs are produced on a small molecule or polymer basis. Irrespective of the material of the active layers, the technology can be used for coloured, warm white and cold white OLEDs. The next stage is to integrate the processes

New development at Osram will lead to super-thin, transparent OLED displays

into a stable manufacturing operation.

The Osram test samples were developed as part of the TOPAS research project funded by the Germany Ministry for Education and Research (BMBF). The aim of the project is to produce 1m² large transparent OLED modules and will run until 2011.

CAN YOU AFFORD TO CUT THE COST OF PCB ELECTRICAL SAFETY TESTING?

Chris Turl, Engineering Director, Seaward Group, says that although the current economic climate may encourage many involved in the PCB industry to rein back or defer investment in their testing regimes, this could be false economy

THE NEED FOR testing by PCB manufacturers who use populated boards in their products is paramount. They have an obligation to ensure that their equipment functions in a correct and safe fashion, meeting quality and performance standards and, ultimately, living up to the expectations of customers.

In many cases these test and measurement obligations may be enforced by legal requirements, technical and quality standards. However, in today's climate, where the global economy is challenging and the future uncertain, electrical testing can provide a range of benefits for PCB manufacturers.

This of course includes overall cost efficiencies but can also increase productivity, reduce production time, increase reliability and avoid costly and damaging product recalls, which can be potentially devastating to any company, even when finances are not under severe pressure as they are currently.

Even the best designed and produced PCBs can have their performance or safety compromised during the production, service and repair process. Carrying out electrical testing is an ideal way of making sure that the original design parameters are maintained and the product delivers what it was originally intended to do.

In the manufacturing environment, however, time is money and the justification for the incorporation of automated instrumentation is rarely made on technical grounds alone. Improving productivity, efficiency and quality are the driving force behind new smarter testing solutions – with these factors also providing a very quick payback period on any capital investment made on process improvement.

In this respect the time taken for completion of the test cycle is critical. Enforcing just in time manufacturing with unit production times of five minutes is clearly of little value if the end of line test station takes 10 minutes to complete all tests.

Another significant productivity improvement is that by automating the test process, test operator time and cost can be removed from the process. In response, new test control and instrumentation systems are available which enable the quick and easy flash testing of PCBs in timescales as fast as 2-3 seconds per product. In addition, as a means of streamlining test stations and matching productivity rates, specially designed holders or jigs allow for the testing of multiple products at the same time.

In this way fully programmable electrical safety and functional test instruments can be adapted and integrated for use in bespoke test systems using proprietary control and instrumentation software, running on low cost rugged industrial touch screen PCs.

Another efficiency benefit is that most of the test process can be de-skilled and operator safety maximised. Although testing should always be undertaken by competent staff, in many cases the use of pre-set test parameters, protected by password and/or failsafe devices, means that the use of highly skilled or experienced test staff may not always be a pre-requisite, allowing greater flexibility in the use of production or assembly line personnel.

"THERE IS A GLOBAL SKILLS SHORTAGE IN THE HIGH-TECH AND ELECTRONICS INDUSTRY TODAY. THIS SHORTAGE IS ONLY GOING TO GET WORSE AS THE WORKFORCE AGES"

Although the current economic climate may encourage many involved in the PCB industry to rein back or defer investment in their testing regimes, this could be false economy as it can be seen that the implementation of a more rigorous testing campaign can bring significant financial benefit. Electrical safety testing represents a small investment both in terms of capital equipment and time and yet the potential benefits can be enormous.

Clare, part of the Seaward Group, has a long track record of providing a wide range of electrical test equipment and its purpose-built electrical testing production facilities allow a large degree of customising to clients' particular requirements. ■

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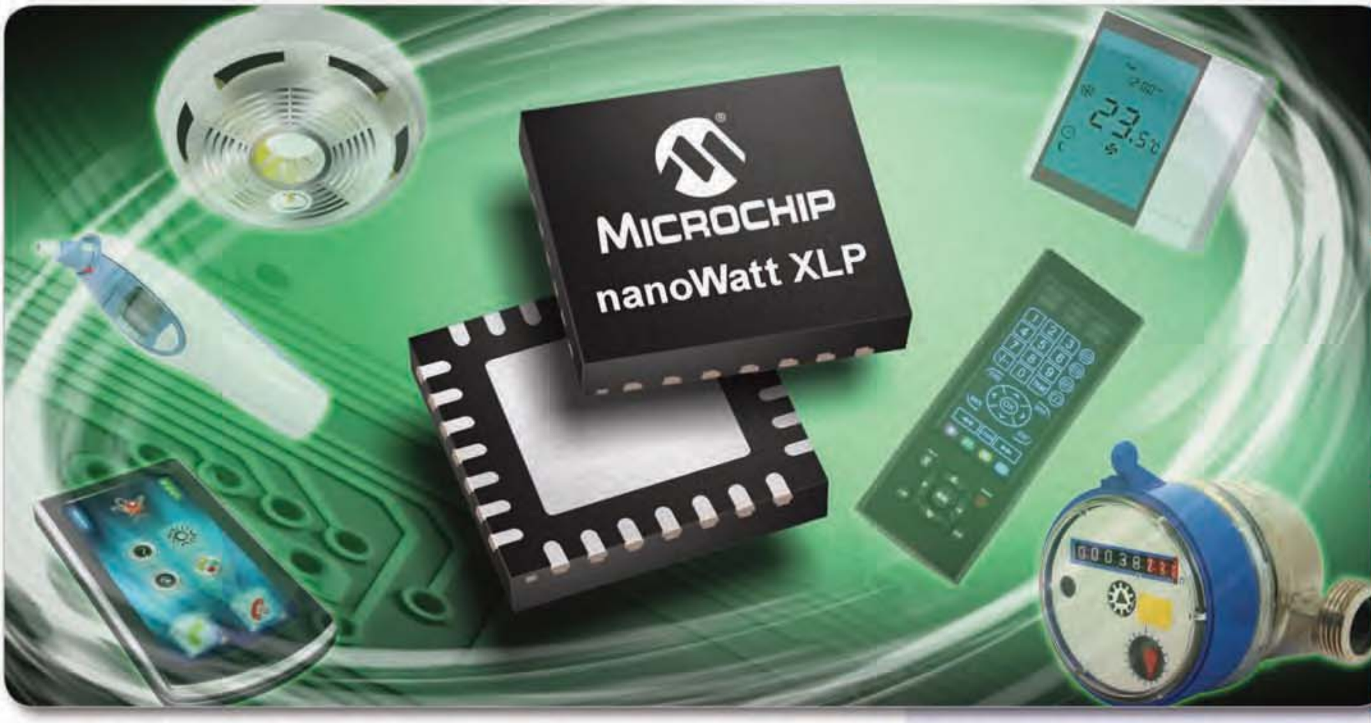

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Dear SANTA...

Myk Dormer

ALL YEAR I'VE TRIED to be a good little engineer. I've been to meetings and listened politely while my superiors recite slabs of their MBA textbooks at me. I've spent valuable time filling in time schedules and project plans that no-one will ever read and I've learned to say words like "paradigm" and "solution" without recoiling. And I've tried – ever so hard – to never advance a new idea when it might upset anyone's preconceptions.

So, Santa, this Christmas can I have:

- An industry where actual technical ability is not a block to advancement in the hierarchy of what are supposed to be 'engineering' companies. Where decades spent perfecting engineering skills count in an individual's favour, and where 'still on the bench at forty' is a credit, not a board-room insult.
- Financial organizations who can see beyond the next month's profit figures and who can understand the need for a company to invest in its future (in terms of research, design, raw material stock levels or capital investment), not just to economize and down-size in the bleak, hopeless present.
- Managers who actually understand what they are supposed to be managing, to whom an "executive summary" really is a short, technical description rather than a collection of unconnected buzzwords in a very pretty typeface.
- Graduates who are actually interested in what they are doing and who have been taught a wide enough spread of real-engineering skills to be able to do real, useful work from Day One; people for whom engineering is a career, not an embarrassing delay on the climb up the corporate ladder into middle-management; people who can actually code, or even solder.
- Suppliers who manufacture sufficient numbers of their products for the demands of their market, so shortages and allocations are occasional accidents, rather than a regularly used technique to hold artificially high prices and excuse long lead-times.
- Distributors who apply modest mark-ups, while holding real on-the-shelf stocks of parts for which they can supply real technical support, rather than operating as nothing more than back-to-back purchasing offices, with minimum order quantities and lead-times identical to an order direct from factory, but at twice the unit cost.
- Sales and marketing executives who treat a new design as a new possibility for valuable new orders, rather than looking on it as an attack on their self-created, comfy, well-ordered, artificial, little worlds.
- Samples that have the same functional parameters as the following bulk-order parts.
- New parts in packages that can be seen with the human eye, which can be assembled onto the PCB using the existing production line machinery, and which have pad spacings that don't require a microscope (or an X-ray machine) to inspect or rework.
- Currency exchange rates that don't bounce up and down like yo-yos.
- Manufacturers who will guarantee continuity of supply for useful, successful designs beyond the first year or two of their introduction, rather than dogmatically "rationalizing" their product range every few years and making half their products obsolete.
- A reliable, easy to use desktop computer which, when replaced by a model with twice the memory and four times the processing power, isn't supplied with 'upgraded' operating system software that results in the net performance going down (while also refusing to run your existing base of installed software tools).

"DEAR SANTA, THIS CHRISTMAS CAN I HAVE PEOPLE FOR WHOM ENGINEERING IS A CAREER, NOT AN EMBARRASSING DELAY ON THE CLIMB UP THE CORPORATE LADDER INTO MIDDLE-MANAGEMENT; PEOPLE WHO CAN ACTUALLY CODE, OR EVEN SOLDER"

But most of all, Santa, can you please give me three more days in every week, and thirty hours in every day. Then I'd have a ghost of a chance of finishing in 2010 all the things I was supposed to have done in 2009.

Happy Christmas? Bah! Humbug!

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

WIN A MICROCHIP MPLAB ICD 3 IN-CIRCUIT DEBUGGER!

Electronics World is offering its readers the chance to win the new MPLAB ICD 3 In-Circuit Debugger System from Microchip. MPLAB ICD 3 is Microchip's most cost effective high-speed hardware debugger/programmer for Microchip Flash Digital Signal Controller (DSC) and microcontroller (MCU) devices. It debugs and programs PIC Flash microcontrollers and dsPIC DSCs with the powerful, yet easy-to-use graphical user interface of MPLAB Integrated Development Environment (IDE).

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Key features include up to 1,000 software breakpoints, 2-5.5V operation, a ruggedised target interface for increased protection from over-voltage and over-current, internal memory for program storage, and 100mA of target current support. Future Microchip device firmware support is easily added through updated versions of the MPLAB IDE.

The MPLAB ICD 3 (part # DV164035) includes a diagnostic Test Interface Module to assist users with system troubleshooting and failure isolation, RJ-11 and USB 2.0 cables, a CD containing the MPLAB IDE with full documentation and a reference poster.

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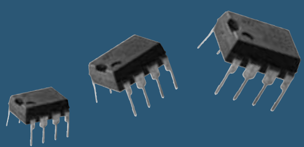
UNDERSTANDING X-MACROS

Vicky Larmour from Cambridge Consultants gives an overview of X-macros, and when and how to use them



X-MACROS ARE a way to use the C pre-processor to provide tuple-like functionality that would not otherwise be easy to implement in C.

Although X-macros can appear hard-to-understand at first, it is worth taking the time to understand them; when used properly they can lead to cleaner code that is easier to maintain and extend.

When to use X-macros?

Any time when you find yourself writing a comment that says something like "These values must be kept in sync with the primitives defined in typedef enum prim_t", or adding a new item to a list and then copying and pasting existing chunks of code to provide handling for it, then X-macros are probably a better way to implement the behaviour you want.

How to use X-macros?

Begin with the main definition of the table of tuples. This can be directly in the header file, or in a separate #included template file. This example is from some real-life hardware revision reporting code (the board uses different values of resistors on an AIO pin to signify different hardware revisions).

```
/* Board revisions:
 * Upper bound resistor value, hardware rev, hardware rev string
 */
#define HW_REVISIONS \
 X(0, HW_UNKNOWN, UNKNOWN_HW_VER) \
 X(8, HW_NO_VERSION, "XDEV") /* Unversioned, e.g. a dev board */ \
 X(24, HW_REVA,  "REVA") \
 X(39, HW_REVB,  "REVB") \
 X(54, HW_REVD,  "REVD") \
 X(71, HW_REVE,  "REVE") \
 X(88, HW_REVF,  "REVF") \
 X(103,HW_REVG,  "REVG") \
 X(118,HW_REVH,  "REVH") \
 X(137,HW_REVI,  "REVI") \
 X(154,HW_REVJ,  "REVJ") \
 /* add new versions above here */ \
 X(255,HW_H2_REVX,  "REVX") /* Unknown newer version */
```

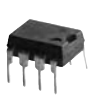
Now, any time you need to use the contents of this table, you can redefine the X(a,b,c) macro to give the behaviour you want.

In the hardware revision example, the first thing we need is an enumerated type giving the possible options for the value of the hardware revision, so that this can be saved and checked by application software to determine the behaviour.

```
#define X(a,b,c) b,
typedef enum {
HW_REVISIONS
} hardware_revision_t;
#undef X
```

The next thing we need in this example is some code to extract the hardware revision from the value of the version resistors.

```
static hardware_revision_t interpret_board_revision(
 board_aio_id_t identifier,
 board_aio_val_t value
 )
{
 hardware_revision_t hw_rev;
```



```
#define X(a,b,c) if (value < a) {hw_rev = b;} else
HW_REVISIONS
#undef X
 {
  hw_rev = HW_UNKNOWN;
 }
 return hw_rev;
}
```

Now, in this example, we have two different places that need to extract the hardware revision information and present it as a string. One is to display on the device info screen, and the other is to return the string over a serial interface.

In the info screen code:

```
 strcat(buf, "H/w rev: ");
 switch(hw_rev)
 {
#define X(a,b,c) case b: strcat(buf, "c\n"); break;
 HW_REVISIONS
#undef X
 default:
            strcat(buf, UNKNOWN_HW_REV);
            break;
 }
```

```
/* in the serial interface code: */
 switch(hw_rev)
 {
#define X(a,b,c) \
 case b: \
  dblk_write(&p_data, c, strlen(c)); \
  break;
 HW_REVISIONS
#undef X
 default:
  dblk_write(&p_data, UNKNOWN_HW_VER,
strlen(UNKNOWN_HW_VER));
  break;
 }
```

Another Example

Another common example use-case is auto-generation of accessor and mutator functions for a list of storage keys.

Again, we start off defining the tuple table:

```
/* Configuration items:
 * Storage key ID, name, type, min value, max value
 */
#define CONFIG_ITEMS \
 X(1234, DEVICE_ID,             uint16_t, 0xF000, 0xFFFF) \
 X(1235, NUM_CONNECTIONS,       uint8_t,  1,      8) \
 X(1236, ENABLE_LOGGING,        bool_t,   0,      1) \
 X(1237, SECURITY_KEY,   uint32_t, 0,         0xFFFFFFFF)
 /* add new items above here */
```

And again we need an enumerated type listing the keys:

```
#define X(a,b,c,d,e) CONFIG_ITEM_##b = a,
typedef enum {
 CONFIG_ITEMS
 } config_item_t;
#undef X
```

Now we can use the pre-processor to generate accessor functions like this:

```
#define X(a,b,c,d,e) \
 int get_config_item_##b(void *p_buf) \
 { \
  return read_from_key(a, sizeof(c), p_buf); \
 }
CONFIG_ITEMS
#undef X
```

And mutator functions like this:

```
#define X(a,b,c,d,e) \
 bool_t set_config_item_##b(void *p_buf) \
 { \
  c val = * (c*) p_buf; \
  if (val < d || val > e) return FALSE; \
  return write_to_key(a, sizeof(c), p_buf); \
 }
CONFIG_ITEMS
#undef X
```

We can also add a logging function to dump all the stored keys:

```
void log_config_items(void)
{
#define X(a,b,c,d,e) \
 { \
  c val; \
  if (read_from_key(a, sizeof(c), &val) == sizeof(c)) \
  { printf("CONFIG_ITEM_##b (##a): 0x%x\n", val); } \
  else { printf("CONFIG_ITEM_##b (##a): Failed to read\n"); } \
 }
 CONFIG_ITEMS
#undef X
}
```

With this arrangement, when you need to add a new item to your list of configuration keys, you don't need to update the enumerated type and copy-and-paste new get-and-set functions for each new key; you simply update the table of tuples and the pre-processor takes care of the rest.

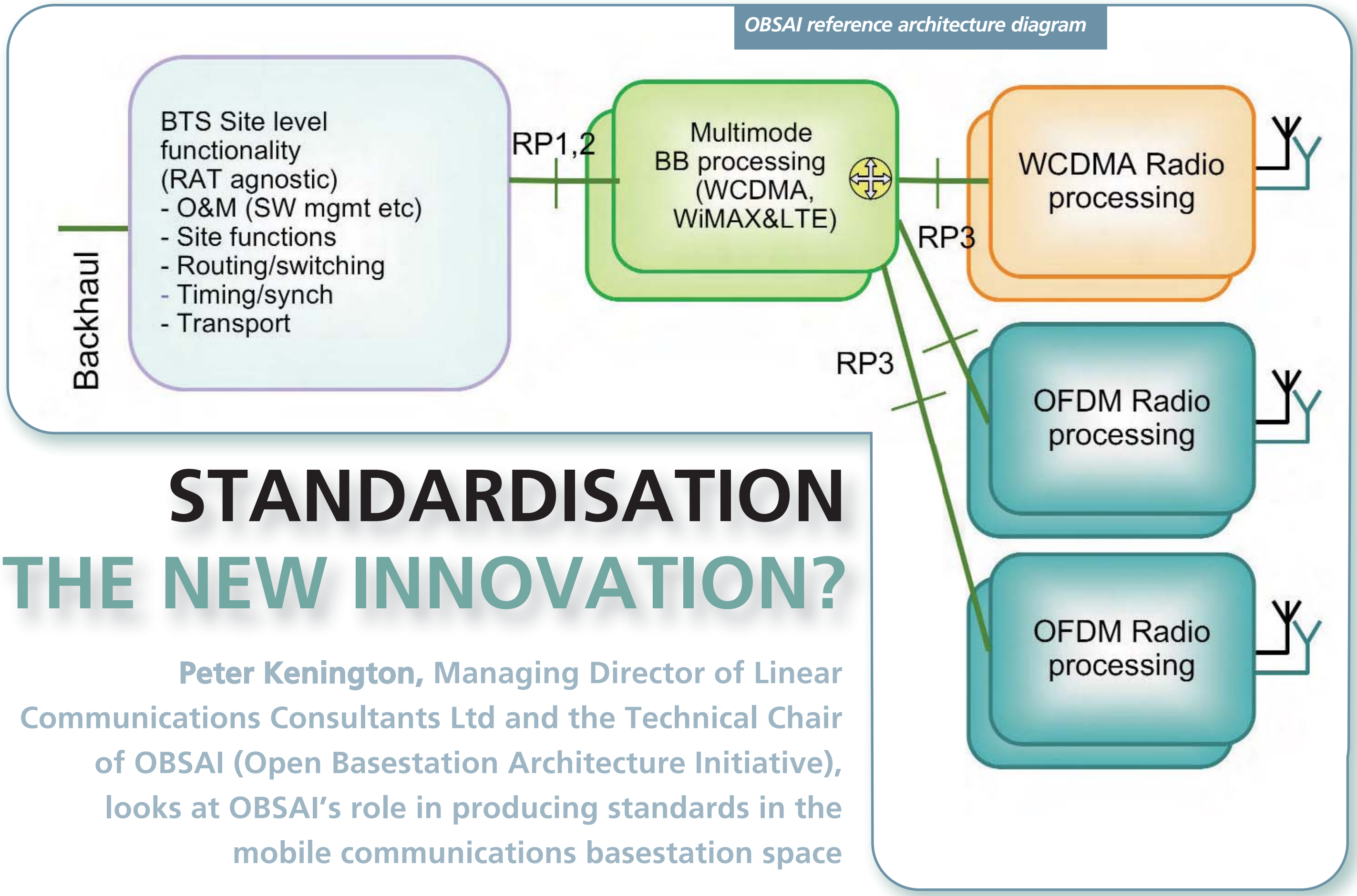
Take Care Over Line Length!

The one area you need to be careful of is that when the pre-processor expands the set of X-macros into real C code, the entire implementation will be generated on one line of code. With some compilers you can end up hitting a line length limit, and you may need to split the functionality into multiple places or split the list of tuples into smaller sections.

Maintainability and Scaleability

As you can see, once you have learned the basics of writing X-macros you will find that your code becomes much more maintainable (any bug in the accessor functionality, for example, only needs to be fixed in one place) and scalable (it is simple to add new items to the configuration store).

So, next time you find yourself copying and pasting functionality to handle a list of similar items… have a go with X-macros! ■



STANDARDISATION THE NEW INNOVATION?

Peter Kenington, Managing Director of Linear Communications Consultants Ltd and the Technical Chair of OBSAI (Open Basestation Architecture Initiative), looks at OBSAI's role in producing standards in the mobile communications basestation space

ONE OFTEN cited maxim in the communications world states that standardisation is the enemy of innovation: its premise is that once something is standardised there is, by definition, no room to alter or improve it and, hence, no remaining freedom in which to innovate.

Indeed, this is frequently cited as an argument against standardisation – the 'fact' that it kills innovation. What is perhaps more relevant is that once something is standardised, the market for that product can become more commoditised; this is generally good for the customer or consumer and not so good for the profit margins of the supplier. This 'fact' is conveniently overlooked by those opposed to standardisation in a particular area.

The Open Basestation Architecture Initiative (OBSAI) has produced a set of standards for the internal interfaces within a mobile communications basestation. Far from killing innovation, the advent of the OBSAI standards and their widespread adoption in the industry has actually stimulated innovation and is enabling groundbreaking infrastructure solutions to find their way into OEM products, much more quickly and easily than would otherwise have been the case.

In an OBSAI-based basestation, such as the Flexi basestation platform from Nokia Siemens Networks, all of the interfaces are defined and these definitions, along with comprehensive test specifications, are publicly available for anyone to download, free of charge. This enables an innovative start-up company to design to a set of requirements for which it knows there is a potential end-market and with which it is able to comprehensively demonstrate compliance (by means of the test specifications). Such a start-up can therefore design a product, confident in the knowledge that it can quickly and easily be incorporated into any OEM basestation, which follows the OBSAI standard, either to offer a niche solution which the OEM may not have thought of, or to offer a significant benefit in a mainstream product area (e.g. improved PA efficiency). Since OBSAI is not restricted to a single OEM, this also helps to diversify the product development risk somewhat; a further important benefit to a start-up.

From an OEM perspective, it simplifies the testing of a potential new product from a third-party supplier in a real basestation scenario, as it eliminates the need to spend months educating said supplier in the details of a proprietary interface. In many cases, the OEM simply doesn't have the time or spare resources to undertake such an activity and this represents a significant barrier to entry for new technologies in the infrastructure marketplace.

The advent of the OBSAI specifications has allowed a number of start-up companies to develop innovative products for the basestation space. One area, in particular, has benefitted greatly from OBSAI's success: remote radio heads. Two start-ups that would probably not exist but for the success of the basestation standardisation process are: Ubidyne and Axis Network Technology.

Taking Digits to the Antenna

Ubidyne, a venture-backed start-up company with offices in Ulm, Germany, and Tempe, Arizona, is a pure-play basestation radio company that aims to take full advantage of the standardised partition between the baseband and radio portion of wireless network infrastructure. Ubidyne's solution consists of a novel integration of the entire RF/remote radio head function with the antenna structure using an all-digital approach.

Ubidyne's digital antenna embedded micro-radio technology completely eliminates the need for coaxial feeder cables and additional equipment on antenna towers and masts. Eliminating the need for a high-power RF feeder cable is a key benefit of remote radio head solutions as it significantly reduces energy consumption, whilst simultaneously improving receiver sensitivity and overall deployment flexibility. Coverage improvements can also result, if some of the efficiency improvement is sacrificed for greater RF output power.

The Universal Ubidyne Antenna Embedded Digital Radio (uB) integrates a digital RF unit into the antenna housing and external to the conventional Base Transceiver Station (BTS) cabinet. It is connected via an optical interface to the OEM BTS Radio Server and provides digital control of the multiple individual antenna elements. This unique approach leads to a fundamentally different site architecture compared to conventional basestation architectures. The combination of the RRH (Remote Radio Head) functionality, with the possibility to individually address each antenna element, allows significant improvements in downlink (DL) and uplink (UL) performance and provides a maximum level of beam control and flexibility. This control is provided entirely electronically, thereby eliminating the mechanical components associated with traditional RET (and similar) technologies.

The Company's first product, the uB900, incorporates a UMTS 900MHz, W-CDMA FDD compliant transmit and receive signal between the digital radio interface and the individual active antenna elements. The system is characterized by its Effective Isotropic Radiated Power (EIRP), resulting from its total RF PA output power, instead of describing any passive antenna gain, due to its unique modular active antenna architecture. The solution includes:

- Digital up-conversion from baseband to RF and a digital down-conversion from RF to baseband, as well as digital power amplification for transmission, and digital low noise amplification for reception.
- Built-in full electronic tilt adjustment in the range of 0°-14°.
- Capability for remote configuration and monitoring via an OMC (Operator Maintenance Centre).
- Support for three-sector operation with up to 35MHz bandwidth in each sector.
- Receive diversity and support for two-branch transmit diversity.
- Optional MIMO with a maximum of two transmit and receive branches per sector.
- -48V DC input voltage.
- Software upgradability to allow, for example, 3GPP LTE (long-term evolution) support in the future.

Ken Hawk, CEO of Ubidyne, summarises OBSAI's key role in the genesis of the organisation: "At Ubidyne, we believe that standardisation of the optical interface between the basestation server and radio portion, enabled by organizations such as OBSAI, has allowed us to take RF 'out of the box', both literally and figuratively."

"TAKING THE RADIO 'OUT OF THE BOX', I.E. OUT OF THE TRADITIONAL BASESTATION CABINET, AND CONNECTING REMOTE RADIO HEADS VIA A LONG DISTANCE FIBRE CABLE CAN LOWER THE OPEX COSTS OF WIRELESS NETWORKS BY AS MUCH AS 50%"

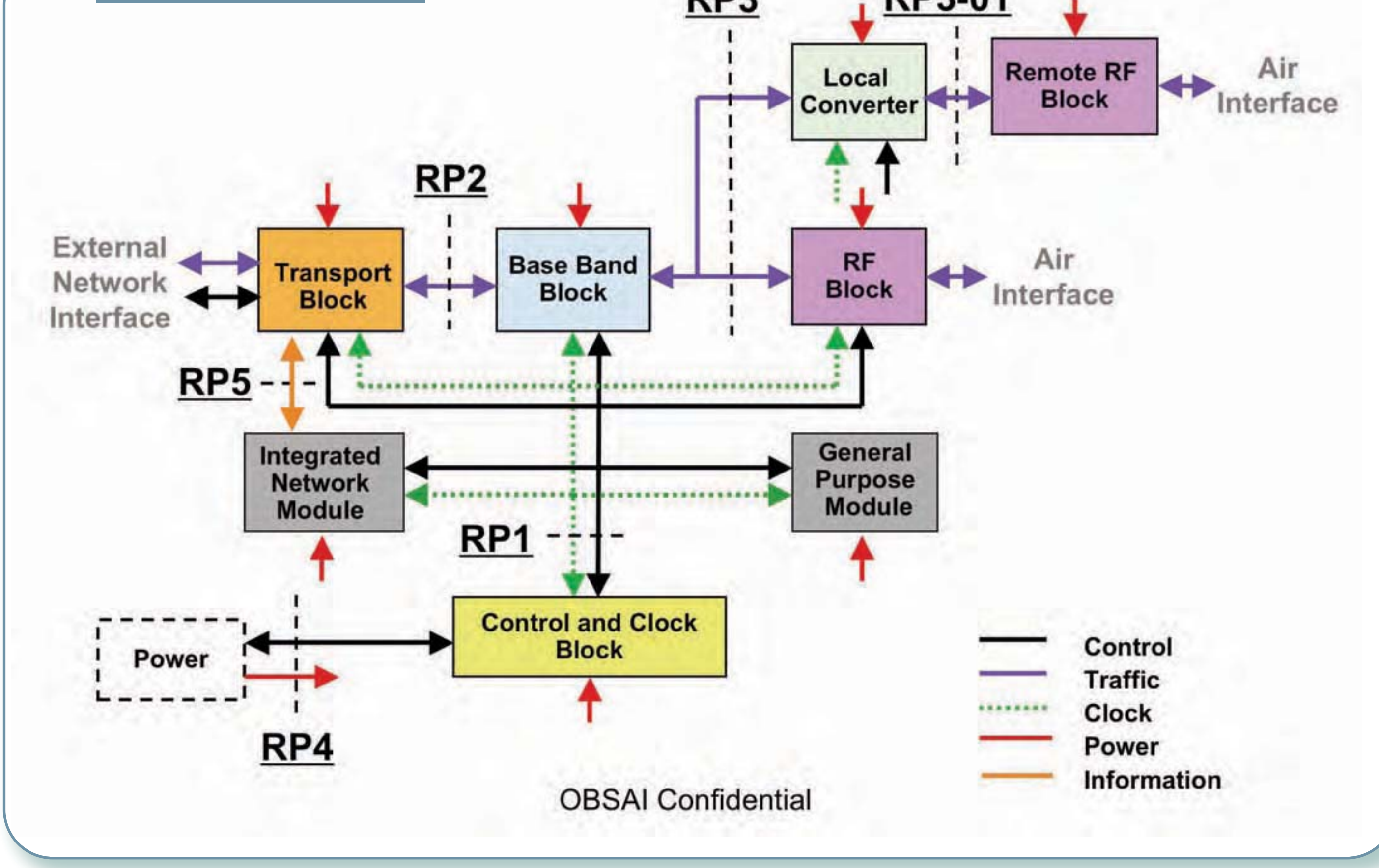
"Literally, by allowing the physical separation of the radio and baseband portion the cellular network through a long distance fibre optic cable, and figuratively, through standardisation, creating an environment where innovative companies can focus on the radio portion and develop truly novel solutions to address cellular operators' concerns about increasing cost and complexity."

He added: "At its inception, our company was created in direct response to two urgent wireless market needs: The need to reduce the OPEX and CAPEX costs of existing wireless networks, and the need to find a cost-effective way to transmit and receive broadband signals to mobile consumers in networks of the future. What we were seeing was that the core network architecture was evolving in order to reach an increasingly mobile, Internet-dependent client base and the radio technology needed to support future WiMax, TD-SCDMA, LTE and UMB networks was evolving only incrementally. Innovation was focused on increasingly complex antenna array systems like MIMO and beam-forming techniques and modest power amplifier efficiency improvements, but failed to address the fundamental radio hardware elements that would make these advanced antenna arrays economically viable."

Taking the radio "out of the box", i.e. out of the traditional basestation cabinet, and connecting remote radio heads via a long distance fibre cable can lower the OPEX costs of wireless networks by as much as 50%. This dramatic reduction results from the significant reduction in the output power required from the RF power amplifier, since RF power is no longer wasted in the long length of coaxial cable, running from the hut to the antenna.

So what does the adoption of OBSAI mean for the future of wireless networks? Is it a key ingredient of future systems? Ken Hawk thinks so: "In our view, 'out of the box' thinking, enabled by the standardisation of the optical fibre interface between the radio and baseband portion of the network, is the ingredient that will drive the next leap in network radio system performance and cost reduction. Specifically, standardisation of the RF to baseband interface has created the opportunity for much greater economies of scale than were possible in the past. Vendors like Ubidyne can now, with the common standardised interface, design radio systems that can be re-used across multiple baseband platforms and potentially, as in our case, re-use the same radio architecture across multiple bands and standards. This ability to scale a single radio solution across multiple applications was not possible before and created the opportunity for a venture-backed company like ours to attract sufficient capital and talent to break the mould of legacy analogue systems and create a truly novel all digital antenna-embedded radio system that provides both immediate and longer term benefits for wireless network operators."

OBSAI's multimode architecture



A 'Head' of the Competition

An alternative approach to Ubidyne's fully-integrated remote radio head product concept is to maintain separation of the High Power MIMO RF electronics from the passive antenna system; this is the approach adopted by Axis Network Technology in the UK. Both the Ubidyne and Axis approaches have their place in the network infra-structure marketplace and will probably continue to do so for the foreseeable future.

Upon its foundation, Axis Network Technology fully embraced both the Open Basestation Architecture Initiative and the new business models that OBSAI has enabled.

"The OBSAI business models have allowed the growth of a number of highly focused sub-system suppliers, each of whom adds significant value to their areas of expertise," comments Steve Cooper, CTO of Axis.

Axis Network Technology has been able to use the standardisation of the IQ data interface to focus on creating a leading technology solution and associated intellectual property (IP), around the highly efficient conversion of IQ data to high power RF.

By having a standardised and formal I and Q interface, Axis Network Technology has been able to focus its efforts on the research and development of highly efficient linear power amplifiers, digital radios and the IP associated with these technologies. By focusing solely on the OBSAI RP3-01 interface and the equally well standardised RF air interface, Axis Network Technology has innovated to create a market leading, highly-efficient WiMAX remote radio head.

In addition, the OBSAI interface has allowed Axis and others to greatly "leverage" their respective innovations as it enables horizontal applications and transfer of those benefits across multiple markets and customer solutions. This leverage has enabled Axis Network Technology to invest research and development effort knowing that a market exists for standardised hardware solutions. This has had the effect of reducing the risk associated with the R&D investment decision, allowing Axis to make fast, focused progress in its area of expertise.

Axis Network Technology has been able to partner with both OEMs and baseband suppliers to demonstrate interoperability and system interworking. In addition, by using a standardised OBSAI logic core from Xilinx – another OBSAI member company, Axis Network Technology has accelerated the integration and system acceptance of its radio products.

Cooper concludes: "Axis Network Technology has only concentrated on one section of the complete standard (RP3-01), however OBSAI provides a general BTS architecture roadmap that is guiding the direction of the industry's innovation; being part of this momentum and ecosystem is very rewarding."

Kill Bill?

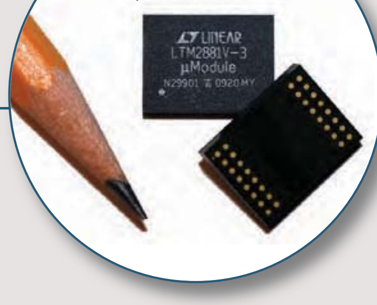
So does OBSAI, as a set of interoperation specifications, kill innovation? No – as the above examples show, it does quite the opposite. It is an enabler for innovative companies to gain access to the previously-closed world of the OEM vendor.

One thing it certainly does do, however, is to save OEMs, operators and, ultimately, consumers, money; the thing it does kill, therefore, is bills. ■

Have your say – write to the Editor at the address on page 3, or email Svetlana.josifovska@stjohnpatrick.com

Isolate to Communicate

Figure 1: LTM2881
Isolated µModule® Transceiver



Jeff Marvin, Design Center Manager • **Brian Jadus**,
Senior Design Engineer • Mixed Signal Products
Linear Technology Corporation

Wired networks, including RS485 and Controller Area Network (CAN), provide the backbones for communications in applications ranging from industrial control systems to automobile networks and roadside traffic message boards. In environments where high voltages are present, including in hybrid electric vehicles, electrical isolation from the communication bus to logic controllers is regularly employed for human safety and equipment protection.

Often overlooked are the benefits of isolation affecting system performance rather than simply protecting it from dangerous voltages. These benefits come in the form of uninterrupted, error-free communication in the presence of harsh ground perturbations and other system level noise that would otherwise render a non-isolated system inoperative.

Isolated RS485 (and CAN) transceivers are available from several manufacturers. Most of these solutions provide data isolation but do not provide the isolated power needed to drive the bus interface. The user is left to come up with the solution, requiring bulky, expensive discrete elements to make up the isolated DC/DC converter. The overall size, cost, power consumption, or complexity can deter the use of isolation in systems that could truly benefit from it.

New Isolator µModule® technology from Linear Technology provides a complete power and data isolation solution in one small 11.25mm x 15mm x 2.8mm surface mount package (Figure 1). The LTM2881 incorporates a robust isolated RS485 transceiver and an isolated DC-DC converter capable of delivering up to 1W of power for the bus interface circuits and auxiliary circuits. The µmodule transceiver requires no external components – even the decoupling capacitors and electrically switchable network termination resistors are built in.

Ground and Common Mode Voltage Disturbances

RS485 was developed and standardized to allow communication between transceivers with ground potential differences of up to ±7V. The signals on the bus can assume voltages of -7V to +12V with respect to the local "ground" at any node. The CAN physical layer specifies similar operation over a common mode voltage range of -12V on CANL to +12V on CANH. These ground potential differences arise from a variety of conditions including earth ground variations or voltage drops on return lines that are shared by other circuits under load.

Under some circumstances extraneous transient events can produce ground shifts that far exceed ±7V or even +/-12V. These conditions will likely introduce errors in the received data, or worse yet, damage transceivers and their associated system circuitry. Proper use of an isolated transceiver, like the LTM2881, extends the usable common mode voltage (mean voltage of the differential signal lines with respect to ground) to ±560V continuously or ±3500VDC for 60 seconds. This level of isolation offers protection and uninterrupted communication from severe voltage disturbances such as indirect lightning strikes to networks spanning multiple buildings or roadside message boards controlled from a distance. In a new hybrid electric vehicle the stacked battery pack is typically +300V and galvanic isolation will protect downstream electronics from this high voltage during a fault condition such as a high voltage short circuit or a loss of a high voltage circuit ground connection.

Repetitive ground and signal disturbances can result from coupling to AC power lines routed adjacent to RS485 bus wires. Computers, printers, fluorescent lights, variable speed motor drives and other electronic non-linear loads can introduce significant frequency harmonics into power distribution neutral, ground lines, and communication network wires. These disturbances can cause real data errors in RS485 and CAN networks which isolation can also alleviate.

Transmitted but Not Received

RS485 wiring configurations for non-isolated and isolated networks are shown in Figure 2. For simplicity, the illustration shows point-to-point unidirectional communication but the concept also applies to multi-node networks. Figure 2a shows a non-isolated, unshielded twisted pair connection implemented with low-cost Category 5e (Cat 5e) cabling. Figure 3 shows oscilloscope waveforms captured at points on this network while driving 100 ft of cable and introducing a ground potential difference between driver and receiver. The trace colors correspond to the colors of the probe locations in Figure 2. All signals are measured with respect to earth ground at the output of the receiver.

Channel 3 (green) shows the data signal into the transmitting driver at DI, while Channel 4 (red) is the data output from the remote transceiver's RO pin, which should follow the data input by only propagation delay.

The yellow trace at the top of Figure 3 is the sine wave voltage signal introduced between grounds with 7V amplitude (14VPP). Channel 2 (blue), shows the "B" signal at the negative receiver input after it has traversed the 100' cable. The digital data at "B" is

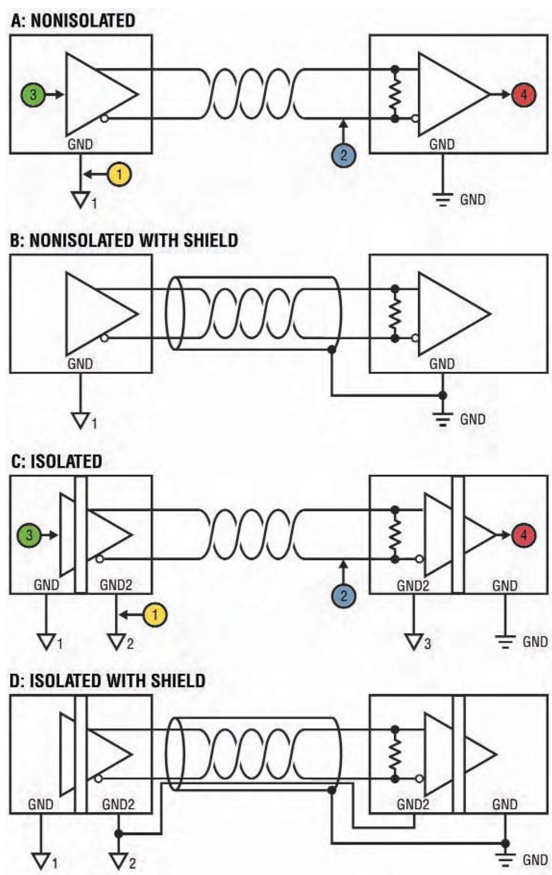


Figure 2: RS485 Wiring Configurations

nearly imperceivable compared to the large common mode voltage signal it is superimposed on.

Figure 3 shows obvious errors. There are two factors contributing to the loss of data, both relating to the finite common mode rejection capability of the RS485 receiver. First, the high frequency content of the common mode signal, here about 1.2MHz, exceeds the effective bandwidth of common mode rejection for most RS485 receivers.

Secondly, the amplitude of the common mode signals presented to the receiver far exceeds the allowed range of -7V to +12V. In this case, the signal amplitude at the end of the 100 ft wire has peaked up to ±20V even though the stimulus introduced at the near end had voltage peaks of only ±7V! This amplitude peaking is maximized at the resonant frequency of the network wiring. Note this does not refer to the differential characteristics of the bus, which behaves like a transmission line, but is a characteristic related to the common mode impedance. The resonant frequency is a function of the cable length, cable configuration (e.g., coiled or straight) and the complex impedance of the connected nodes. The interesting point is that a ±7V common mode signal was able to corrupt RS485 signal transmissions due to the frequency content and amplitude peaking. A two wire CAN network can also suffer from the same common mode peaking phenomenon.

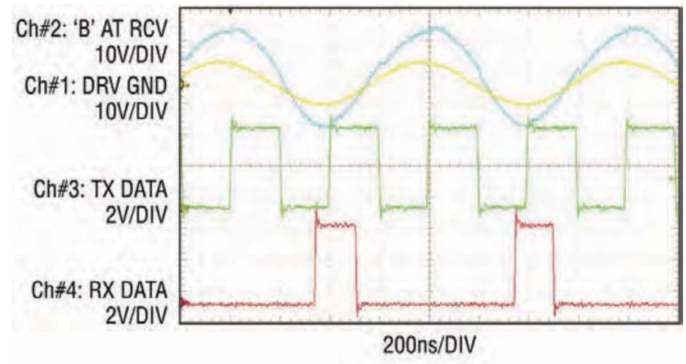


Figure 3: Non-Isolated Data Loss for network of Figure 2a

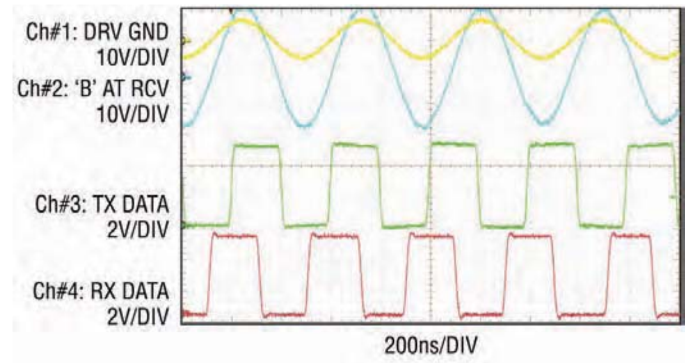


Figure 4: LTM2881 Isolated RS485
Communicating Through Severe Common Mode Voltage

Isolated Communication Works

Replacing the RS485 transceivers with LTM2881 Isolated RS485 transceivers (Figure 2c) solves the problem of data corruption as is evident in the corresponding waveforms of Figure 4. In this configuration, the common mode applied to the receiver inputs is mostly developed across the isolation barrier. The receiver isolated ground moves with the common mode voltage of the receiver inputs, simply riding on top of it. As a result, the receiver does not see this as a common mode variation and continues to reliably detect the differential data.

Notice that in Figure 4, the common mode frequency has been increased to 2MHz, which causes the signal amplitude at the end of the cable into the receiver (blue trace) to increase significantly to 40VPP. This common mode voltage amplitude is far beyond the specification called out in the RS485 standard and would challenge most non-isolated RS485 transceivers.

Wiring Improvements

Better choices for wiring include using shielded wire and a common wire that ties all isolated ground nodes together as discussed below.

Figure 2b shows the non-isolated network connected using a shielded twisted pair, such as Belden 9841 cable. The shield should only be tied at one point to avoid creating ground loops. Connecting the shield to the receiver ground provides the best shunting for system performance. In multi-node, non-isolated networks the master node is typically the shield connection location. The shield serves to shunt coupled energy to ground rather than onto the signal wires and does not reduce the effects of ground differences between nodes.

The best wiring option for use with isolated transceivers is illustrated in Figure 2d. All isolated grounds at each node are tied together with a common wire. The common connection is tied to non-isolated ground at one point to establish the nominal voltage reference level of the otherwise floating network. This prevents the bus from floating to excessive voltages beyond the isolation rating.

This configuration elicits the best performance out of the RS485 receiver because the receiver's isolated ground potential follows the common mode of the input signals and is absorbed across the isolation barrier. Since the receiver ground moves with the signals, the receiver is not taxed with rejecting common mode voltage transients. Instead, the rejection happens at the isolation boundary where the LTM2881 encodes the data into differential digital pulses before inductively coupling it across the barrier. This communication method is tolerant of extremely high common mode transient events faster than 30kV/μs with no data loss or added jitter.

Figure 2d also shows a separate shield tied at one point to earth ground to shunt coupled noise. However, some systems will not have both a shield and separate reference wiring options. In this case, the best option is to tie the shield to the common terminal of each isolated transceiver and then to earth ground at one location. If RF immunity remains a concern, a high frequency, high voltage, capacitor from each receiver common to ground can help shunt the energy away from the transceiver.

Figure 5 shows a typical usage of the LTM2881 isolated RS485 transceivers arranged in a half-duplex network with their isolated common nodes (GND2) wired together for optimal performance as discussed.

Conclusion

Isolation improves system robustness through the rejection of system level noise. Products like Linear Technology's LTM2881 isolated RS485 μModule transceiver with integrated isolated power makes it easier than ever to get the best performance out of a communication system.

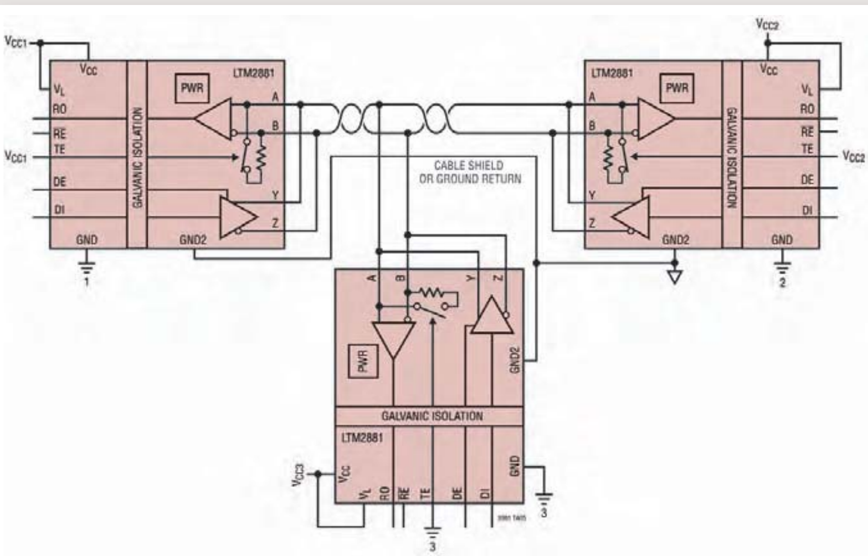


Figure 5: LTM2881 Typical Application

Multi-Spark ELECTRONIC

H. Mechergui from ESSTT, University of Tunis and **N. Kounev** from I.S.E.T, University of Tunis, present a new, patented, electronics ignition system for old and new vehicles alike

LIKE IN MOST other fields, in the automotive industry the car benefited from significant scientific progress and technological innovation. One such modern invention is the integral electronic ignition system.

Traditional ignition with mechanical contact points reached its operational limits. Indeed, the contacts points are subjected to a hard test by the cut of a very inductive circuit at increasingly high speeds. In general, the inductive character of the ignition circuit does not make it possible to obtain energy for a sufficient spark to create the combustion of air/fuel mixture.

In addition, considering the on-going energy crisis, with raising fuel prices, and the ecological concerns, we should not forget that millions of cars with traditional ignition are in use today and this causes enormous problems. There are cities which suffer from CO_2 emissions due to badly burned fuel.

To resolve these problems, equipping cars with electronic ignition systems will help; such cars consume less energy and do not emit smoke. In addition, a car equipped with electronic ignition can obtain sufficient spark energy which guaranties:
(1) 100% combustion of the air/fuel mixture;
(2) Reduction in pollution caused by the not burned fuel;
(3) Reduction in maintenance costs, as the contact point does not constitute more than one power circuit but, simply, a control switch with a current flow of 100-150mA;
(4) Flexibility of engine operation.

In this article we explain an electronic multi-spark system used at a starting- and low-speed engine. This electronic ignition system will enable the car to work in all conditions, including starting it in cold weather, with old plugs, with a rundown battery and even a worn engine.

The solution was developed and tested on cars using traditional ignition and the obtained results are very satisfactory.
The power part combines the advantages of a capacitive and inductive electronic ignition. It incorporates an electronic chopper booster.

The originality of this type of electronic ignition lies in the control circuit which allows a succession of ignition sparks at a starting and low-speed engine.

Electronic System

Figure 1 represents the diagram of the suggested multi-spark electronic system. The ignition circuit works with capacitive discharge and, following that, with inductive discharge respectively.

The capacitor C is being charged by a chopper booster controlled by a timer, which is ordered according to an instruction signal coming from the terminals of the Darlington transistor collector. The latter is put in series with the transformer's primary coil which is fed by the chopper booster to charge the capacitor C.

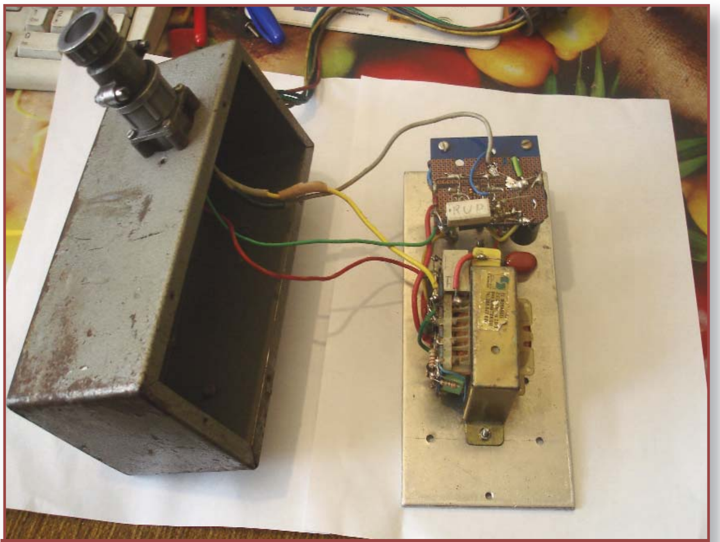


Figure 1: *Electronic system with its mechanical box*

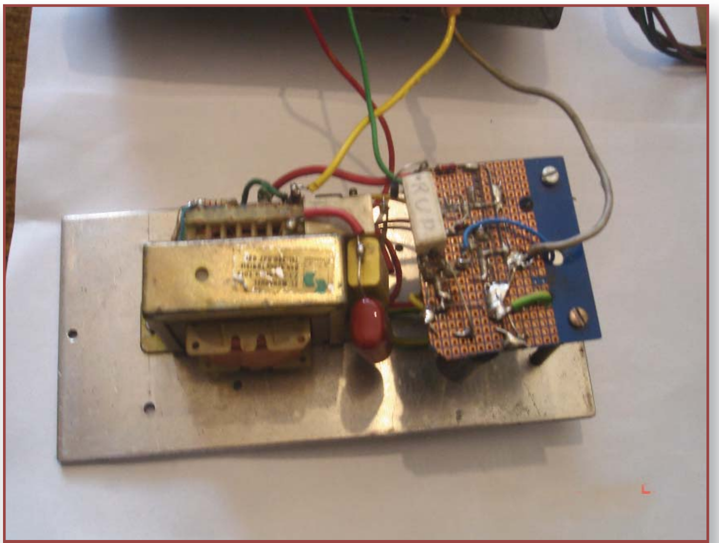


Figure 2: *Electronic components board*

Ignition

Electronic System's Contact Point

The circuit diagram of the multi-spark ignition system is given in **Figure 2**.

When the contact point is opened, the following occurs:

(1) The contact point gives instruction to the transistors T1 and T2 to be saturated. This state ensures the storage of electromagnetic energy in the primary coil of the transformer which is managed by a chopper booster.

(2) An instruction is taken at the T1 transistor collector to stop the first timer and to generate a frequency higher than that of the contact point at low speed of the car engine.

(3) The inhibition of the first also timer gives authorization to the second timer to activate the saturation of T2 and at the same time to trigger the third timer. This timer allows the power transistors T3 and T4 to be saturated in order to ensure the discharge of the capacitor C during time $t_{11} = 0.7ms$.

(4) To reduce the voltage drop across the terminals of the transistors T1, the collector of the transistor T2 is connected at 10% of the transformer primary coil turns of the chopper converter.

In this case, we have:

$V_{CE1} = V_{BE1_1} + V_{CE2} - V_{trans} \times n_1 \times 0.1 \cong 0.1V$. If the current flow across the transistor is $I = 6\,A$ there will be power losses, due to the transistor T_1, of $P = 0.1 \times 6 = 0.6\ W$.

(5) At the end of the time t_1, the second timer cuts off the transistors T_3 and T_4 in order to allow the inductive discharge during $t_{12} = 0.6ms$.

The second timer is working during $t_2 = 2ms$. At the end of this period, the timer issues an instruction (raised at the point A) to cut off T_2 and T_1. The opening of T_1 ensures the charge of C and in the same time sends information (raised at the point B) authorizing the multi-spark control device to start a new cycle. After m spark pulses, the multi-spark system is stopped by the charge of the capacitor C_f until a new cycle begins.

This system can provide 10 successive spark pulses at slow speeds and at a starting engine point, and this is independent of the battery state according to an adaptive command built-in by the second timer.

Figure 3 represents the operation cycle of the suggested multi-spark electronic ignition.

We are looking for a long duration ignition with sufficient energy, and a multi-spark ignition at the starting- and the low-speed engine.

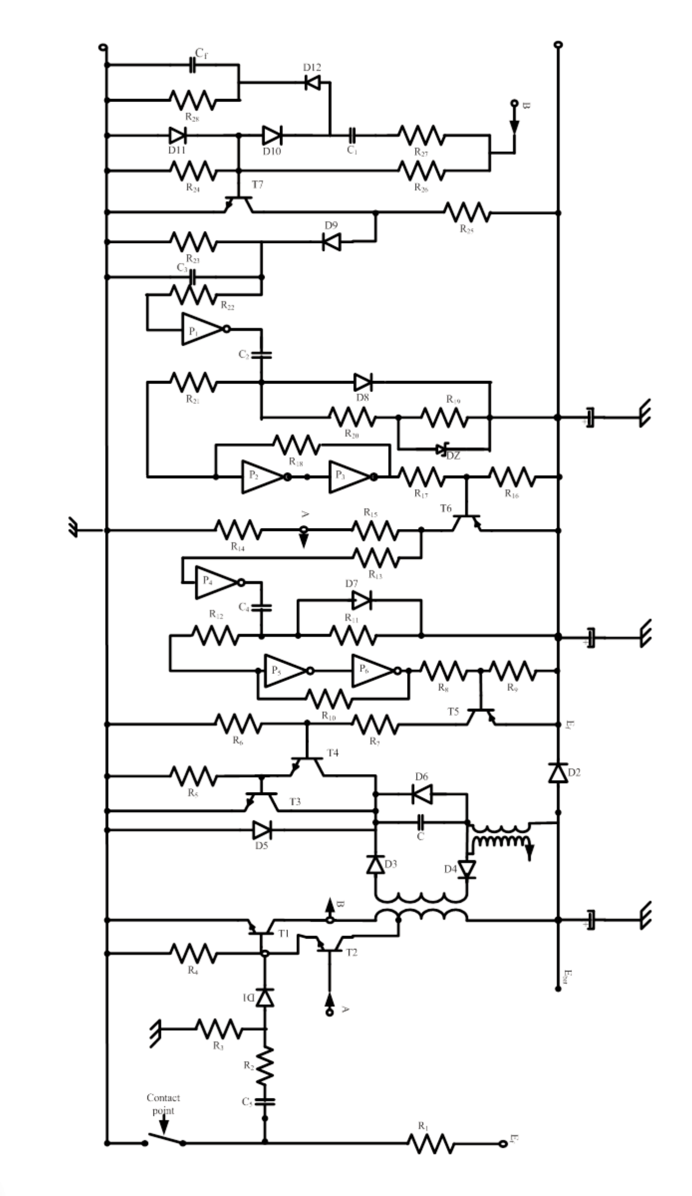


Figure 4: *Circuit diagram of the multi-spark system*

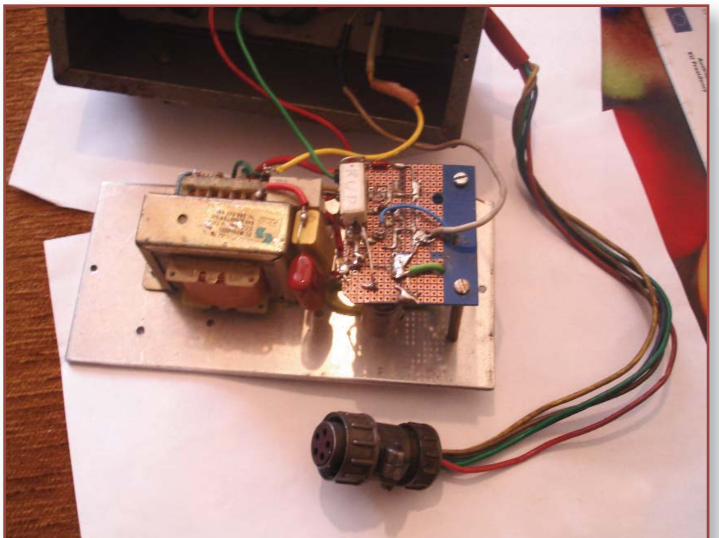


Figure 3: *Electronic system and its Bergler car connection*

Spark Production

The closed loop control circuit ensuring the production of the multi-spark ignition is composed of three stages, provided by three timers.

The fist timer ensures the production of the sparks. This circuit is made of a capacitor C_1 having an instantaneous charge which is coming from the transistor T_1 collector and making it possible to cut off or to saturate transistor T_7. This, in turn, orders the second timer and a Schmitt trigger (formed by P_1 and P_2).

A capacitor C_f placed in series with the capacitor C_1 and having a value of 6-10 times higher than the latter, ensures the production of the multi-spark. The number of sparks depends on the ratio of $\frac{C_f}{C_1}$.

The second timer starts working when transistor T_7 is cut off. Indeed, this state authorizes the capacitor C_2 to be charged through $R_{19}//R_Z$ and R_{20}, which makes it possible to determine the charging equation. If we put $R_{\tau 2} = R_Z // R_{19} + R_{20}$, $E_F = R_{\tau 2}.i_c + v_{C_2}$, $C_2 dq = idt$ and $q(t) = C_2.v(t)$ we can write:

$$E_F = R_{\tau 2}\frac{dq}{dt} + \frac{q}{C_2} \qquad (1)$$

From this equation, we deduce:

$$C_2 E_F = \tau_2 \frac{dq}{dt} + q \qquad (2)$$

where $\tau_2 = R_{\tau 2}.C_2$ and E_F is the battery supply voltage.

The resolution of **Equation 2** gives:

$$v_{c2}(t) = E_F(1 - e^{-t/\tau_2}) \qquad (3)$$

When $v_{C_2}(t_1) = \frac{E_F}{2}$, the trigger changes its state and the transistors T1 and T2 are cut off.

This condition makes it possible to calculate the time-constant for a chosen fixed time $t_2 = 2ms$.

The resolution of equation (3) gives: $\frac{t_3}{\tau_2} = 0.693$. The chosen time t_2 is also $t_2 = 0.693 \times \tau_2$ where $\tau_2 = \frac{2ms}{0.693} = 2.88 ms$. For a capacitor value $C_2 = 150nF$, we determine the value of R_t.

The third timer is authorized to work when the second timer is on. Indeed, the third timer contains a monostable and a Schmitt trigger (using P_3 and P_4) which ensures the saturation of T_5 via the transistor T_6 (actuated by the trigger of the second timer).

Consequently, we obtain the saturation of T_3 and T_4 during a time $t_3 = 0.7ms$.

The calculation of the time-constant τ_3 is similar to that of the preceding timer. If $t_3 = 0.693 \times \tau_3$, we obtain $\tau_3 = \frac{0.7ms}{0.693} = 1.01\ ms$. For a capacitor value $C_3 = 100\,nF$, we determine R_{11}.

According to the experiment results, the frequency of the multi-spark is given by the ratio of $\frac{C_f}{C_1}$. With every positive pulse transmitted to C_1, the charge of C_f increases. This process continues until the voltage drop at the terminals of the transistor T_7 reaches a value which is maintained as a constant. This state stops the working ignition system until a new cycle is triggered by the contact point.

Experimental Results

The graphs in **Figure 4** show the obtained multi-spark ignition and the voltage drop across the collector of the Darlington power transistor T1.

Figure 5 represents the electronic multi-spark model which is installed in a Renault R4 that is 16 years old. It has given excellent features. In any new car, it can be managed by a hall sensor.

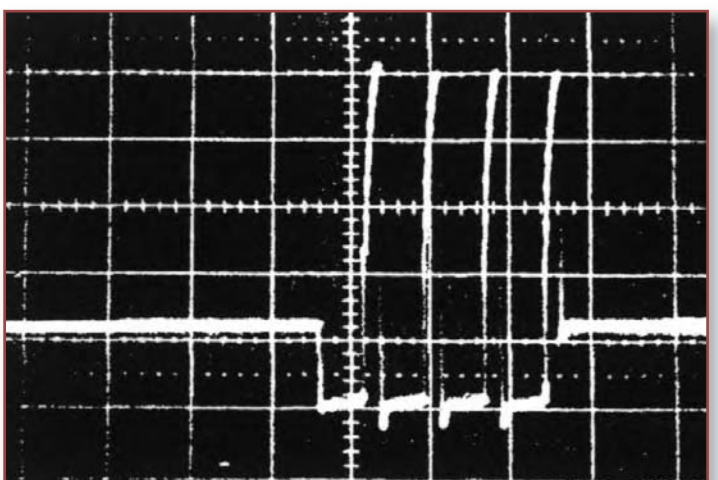


Figure 5: *Creation of five ignition sparks at low speed engine*

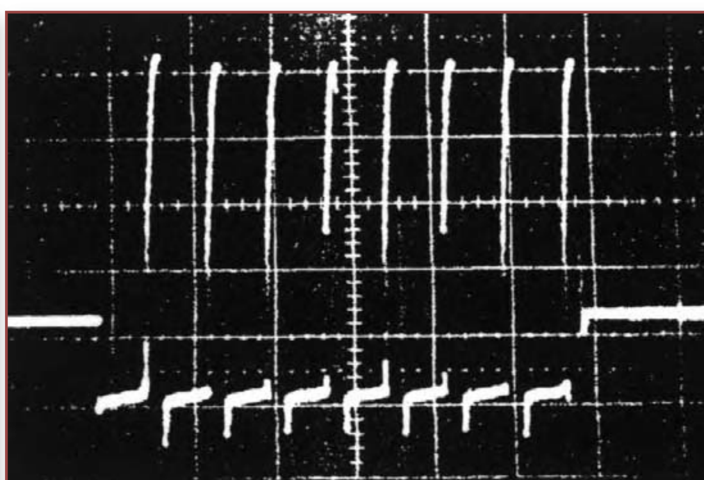


Figure 6: *The creation of eight ignition sparks at engine start*

System Advantages

The advantages of the suggested automotive multi-spark ignition include:

(1) The facility to start a car engine in all circumstances including a car with old plugs, worn engine, and severe winter conditions among others;

(2) Improved engine efficiency and economy of fuel;

(3) Improved CO_2 emissions rate; increased battery life;

(4) Decreased maintenance costs and frequency of adjustments.

This system ensures the starting of the engine as it generates succession of ignition sparks and this will avoid the missed ignition sparks to burn the fuel in the engine's combustion chamber. At raised speed it produces a strong spark energy which is provided by a capacitive discharge during time $t_1 = 0.7\ ms$ and extended by an inductive discharge during time $t_2 = 0.6\,ms$ that means on the whole $1.3\ ms$. This time is sufficient to ensure the combustion of the air/fuel mixture and to avoid the possibility of the sparks' failure. This will reduce harmful CO_2 bursts. This electronic model with multi-spark ignition can be adapted to all fuel car models.

The used energy converter has the advantage of having few components and an economic architecture for the powers not exceeding 200W. The proposed system is now a patent.

Design Features

- Number of sparks ignition: up to 10 at the point of a starting engine.
- Battery supply voltage: from 8V to 15V.
- Stored energy: more than 120mJ.
- Capacitive inductive ignition system. ■

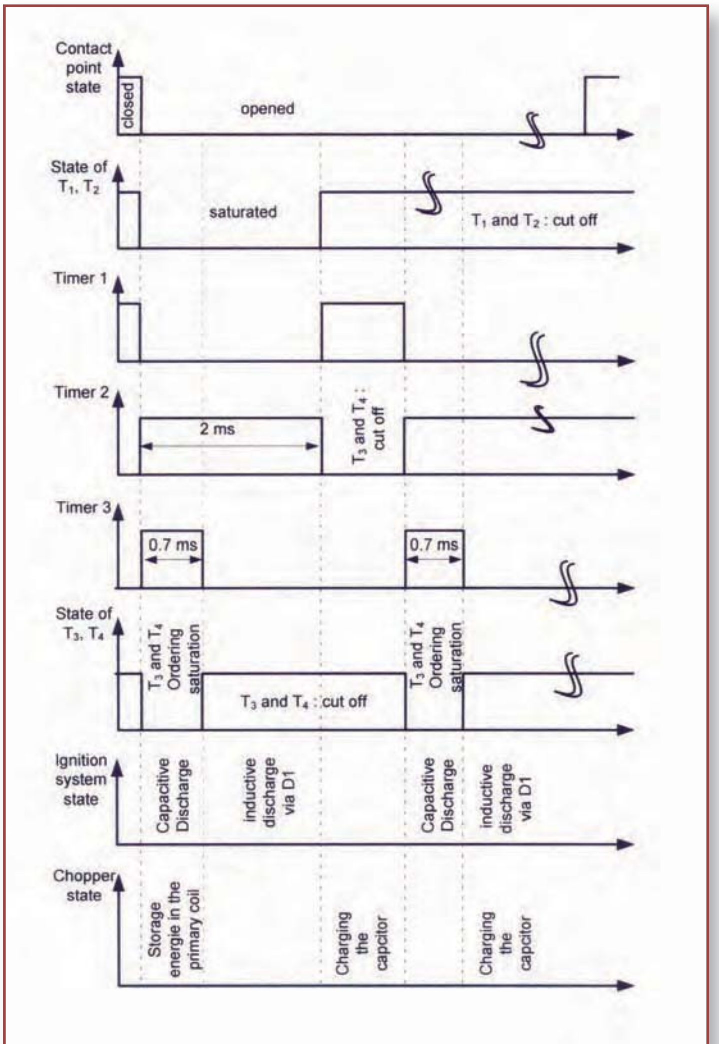


Figure 7: *Multi-spark ignition cycle*

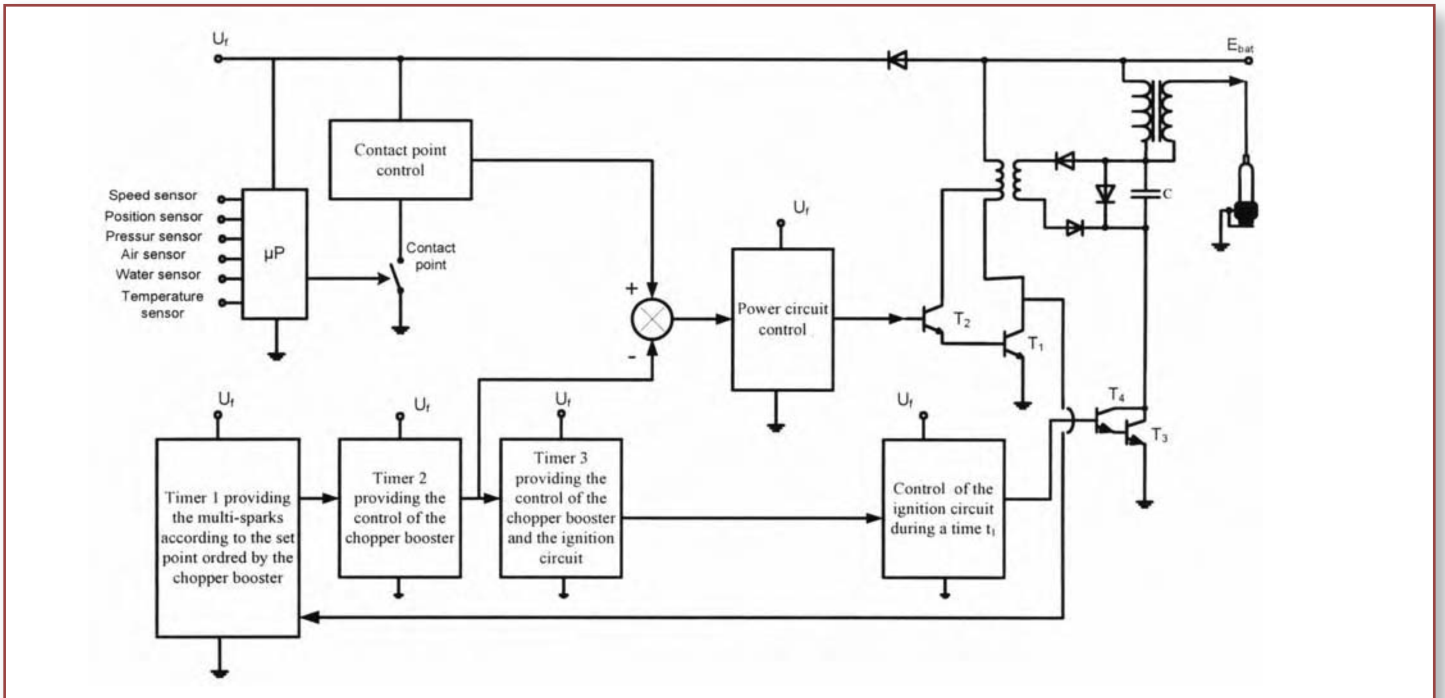


Figure 8: *Basic schematic diagram of the multi-spark ignition system*

Hüseyin Kusetoğulları from the Department of Electrical and Electronic Engineering, Eastern Mediterranean University, Turkey, and **Turgay Celik** from the Faculty of Science, Department of Chemistry at the National University of Singapore present a system for real-time vehicle detection and warning of erroneously parked cars

Real Time VEHICLE DETECTION and Driver Warning System Using Computer Vision

IN THIS ARTICLE, we present a system for real-time vehicle detection and warning of erroneously parked cars. It is mainly based on image processing techniques and wireless transmission.

Images captured from surveillance cameras are used to detect vehicles in a parking area, by employing the background subtraction method where each frame is subtracted from the reference frame. If a parked vehicle is wrongly positioned, the driver is warned.

Wrongly parked vehicles are then guided to park correctly by using three different light colours (red, yellow and green).

Avoiding Wasting Time Parking

Upon entering a large parking area, drivers often waste a lot of time and energy in trying to find an available car parking lot. Equally, a driver may be unable to park as some vehicles can be wrongly parked within adjacent lots.

Parking camera-systems are widely used to detect vehicles in a parking area to count or classify them. Different techniques such as magnetic loop, fibre-optic and microwave detectors have been

Figure 1: Four control violation lines for a single parking slot

Figure 2: The configuration of the suggested system

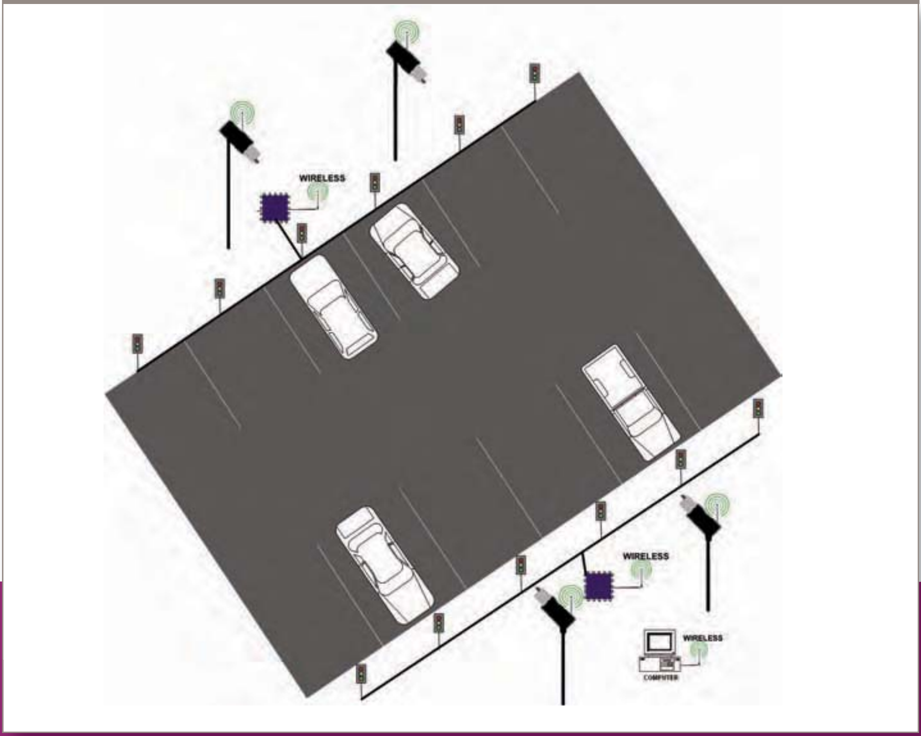


***Figure 3:* (a)** *Current frame;* **(b)** *Background frame;* **(c)** *Resulting difference image;* **(d)** *Binary image obtained by using thresholding value on the difference image*

applied to detect vehicles. In the proposed system, detecting vehicles is based on image processing techniques that are developed and implemented successfully and where any adverse effects normally associated with magnetic loop, fibre-optic or microwave detectors are avoided.

Image processing techniques are proving popular as they are also used in other applications including traffic security and safety, queue detection and estimating vehicles' speed.

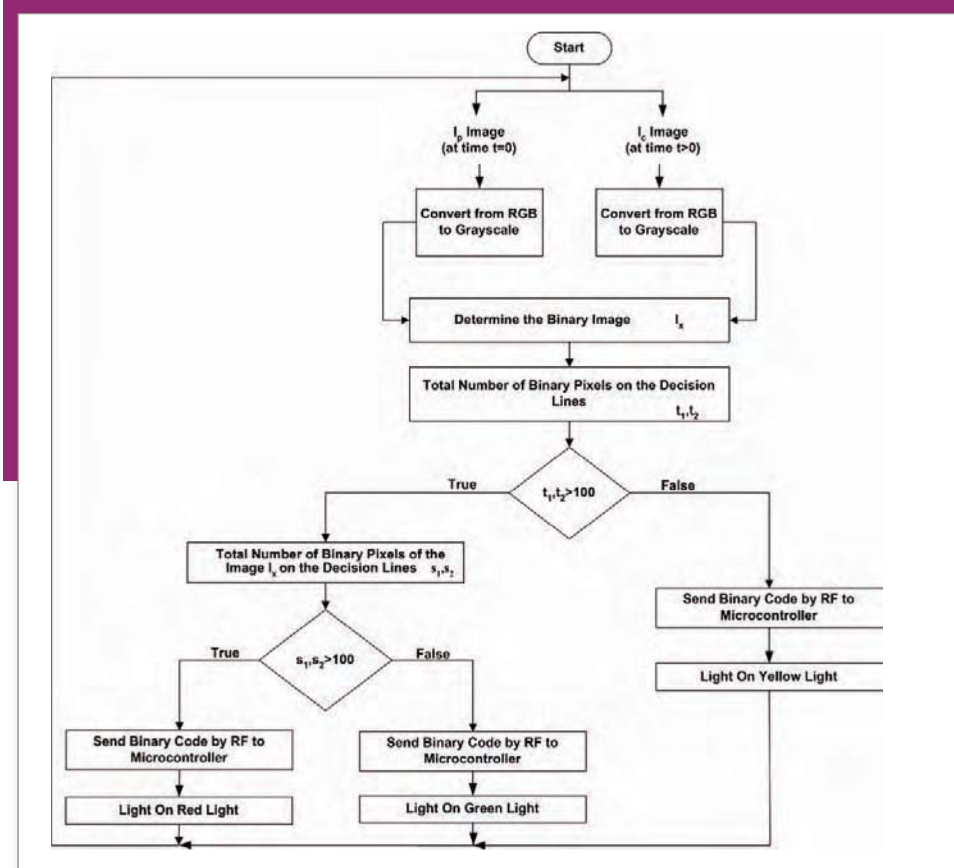
With our system, images captured by surveillance cameras were processed in real time to help drivers park correctly and to indicate if parking lots are or aren't occupied. The occupancy information is further processed by a central control unit and distributed to display panels or signalization lamps located prominently in the parking area. Drivers can easily find a vacant parking lot and they can check whether their parking is properly done based on the information displayed on the panels or signalization lamps.

The motivation behind this system is the fact that minimum costs are involved as an image processing technique rather than sensor-based one is used. As surveillance cameras are readily available in most car parks, this technique is much more cost-effective than installing sensors on each parking lot.

Detecting Vehicles

In the suggested system, the parking vehicles are automatically detected using background subtraction technique. In the background subtraction method, a sequence of empty parking scene is used to form a reference frame. Consequently, each following frame is subtracted from the reference frame to determine the

Figure 4: *Flowchart of the proposed system*



difference frame which is then converted into a binary form by using the thresholding method. The detected parking vehicles are analyzed automatically to warn the driver related to parking position in the lot. Similar to the traffic lights, three different coloured lights are used for each parking lot to warn the drivers about their parking position. The lights are switched on red, yellow or green according to whether the vehicle is in between the boundaries of the corresponding lot (two parallel lines) or not.

In the suggested system, four 'violation' lines – s1, s2, t1, t2 – (see **Figure 1**) are used to detect whether the vehicle is parked rightly or wrongly. One violation line, t1, is used to detect a vehicle when it starts to enter a parking place; two of four violation lines (parking slot boundaries), s1 and s2, are used to determine whether the vehicle is parked rightly or wrongly; and the last violation line, t2, is used to determine whether the vehicle is parked in the lot or not. In addition, the light is switched on the yellow when there is no vehicle in the parking place. The light is switched on red when a driver is parking erroneously, otherwise it is green. The concept of the whole system and its initial – positive – experimental results, are presented here.

System Configuration

In this system, two different types of monitoring techniques are achieved: the first is to detect the vehicles in parking lot for driver warning, and the second is to check the presence of a vehicle in each parking lot.

Numerous methods have been employed to monitor individual parking cell using ultrasonic or magnetic sensors placed within each cell, or cameras placed above cells. The first method requires many sensors, while the second method requires only one camera, since it can cover relatively wide area, but in practice four positioned cameras could be sufficient.

In our system, we will work on camera-based approach used in a parking place.

It consists of four USB cameras for the parking area, which capture the frames; a PC used to detect the vehicles using image processing techniques; RF is used to transmit data between the microcontroller and the PC; and three different light colours are used to guide drivers with their parking (see **Figure 2**).

The video data acquired from the USB cameras is analyzed to check where a car is parking and to count the number of binary pixels of the two parallel lines of a lot to determine if it is parking rightly or wrongly.

In order to detect and track the vehicles, the cameras are connected to the PC, where image processing techniques are

Figure 5: *Car parked differently within a parking slot:* ***(a)*** *Proper parking is given the green light;* ***(b)*** *and* ***(c)*** *A wrongly parked car is 'warned' with a red light; and* ***(d)*** *Empty parking cell has a yellow light*

used and updating the microcontrollers according to the situation of the detected vehicles in the cells via wireless transmission. The fixed lights for each cell are switching on or off, depending on the status of the vehicle in the controlled cell. In the suggested system, there are 12 parking cells (as seen in Figure 1).

Video Pre-Processing for Detecting Moving Vehicles

A background model for the car parking area is established using image processing techniques. This model is then used to detect the objects on the car park by using the difference between the background model and the object itself (see **Figure 3**). In Figure 3 you can see the current and reference frames in (a) and (b) respectively, followed by the difference image in (c) and the binary image (d) obtained against a threshold value.

After generating the binary image, the amount of white pixels indicates the level of change between the current and background frame due to moving objects. If the total white pixel count of the violation lines s1 and s2 on the binary image is lower than the threshold value, then the amount of change is enough to warn the driver with a red light that they are parked wrongly.

This threshold value (i.e. 100) is heuristically determined. When a vehicle is not detected entering the current frame while the yellow light is activated, the system assumes that a violation is initiated and waits until the vehicle enters the parking cell completely. The suggested system uses a number of image processing techniques, including RGB to greyscale conversion, image subtraction and thresholding.

After converting the image into greyscale, the current frame is subtracted from the background frame to determine the difference image. An adoptive threshold level is then applied to differentiate the changing pixels from the static ones. This process generates a binary image for further processing. The threshold value is obtained statistically.

Figure 4 shows the flowchart of how the system operates.

Table 1: *The number and type of vehicles that were and were not detected in the proposed system*

Day Time	# of detected small cars	# of detected big cars	# of not detected small cars	# of not detected big cars
Morning	162	29	6	1
Afternoon	306	46	9	3
Night	183	38	12	5
Total	**651**	**113**	**27**	**9**

	# of cars detected	# of not detected	Total
# of erroneously parked	131	1	132
# of correct parked	633	35	668
Total	**764**	**36**	**800**

Table 2: *The number of detected and not detected vehicles parked in a slot*

Wireless Transmission

The wireless transmission takes place from the computer to the microcontrollers to control the guide system (the system's lights) for the driver. The information is sent to a programmable interrupt controller – a PIC, and there are three of them: one connected to the cameras at the parking lot, one connected to the computer in the control room, and another sitting in the lighting system on the parking lot. The communication process between the PICs is done wirelessly.

The PIC on the camera side has an RF transmitter connected that can operate up to 50 meters without losing signal strength. The PIC in the nearby lighting circuit system receives and stores the data that has been sent. Then the data in the PIC's memory is sent to the computer from the serial port. The transmitter and the receiver used in the implementation of the system are the cheapest ATX – ARX – RF devices found, also used in some low-cost industrial and security applications, like controlling garage doors remotely.

Testing the Suggested System

The performance of the suggested algorithm mainly depends on the detection and correct classification of vehicles. For this purpose we perform a series of tests.

During one day, we manually counted the number of vehicles and compared that to the suggested automatic system's output and, also, we manually counted the number of vehicles that were correctly and wrongly parked in the parking cells. The suggested algorithm was applied to warn the detected vehicles that were erroneously parked, automatically.

Figure 5 illustrates different situations of a car parked within a slot: (a) proper parking is given the green light; (b) and (c) wrongly parked car is 'warned' with a red light; and (d) empty parking cell has a yellow light.

The number of different size vehicles at different times of day is shown in **Table 1**. It is obvious that our system makes correct detection and classification with 95.5% accuracy. The 4.5% miss rate is satisfactory enough to realize the proposed algorithm in real-time to detect vehicles.

Furthermore, we manually counted the number of vehicles which are correct and erroneously parked in cells during one day, which is shown in **Table 2**. It is clear that our suggested system has an accuracy rate of 99.25 % for vehicles that were correctly parked. ■

LA Traffic Controllers get the GREEN LIGHT

Greg Conley, Marketing Manager at Systems Integrated, explains the case of Los Angeles's traffic problem and how electronics stepped in to help

LOS ANGELES is infamous for its traffic jams. Traffic is a problem for everyone in the county.

According to a study conducted in 2008 on behalf of the American Automobile Association, traffic congestion costs the Los Angeles and Orange county region $9.3bn annually, and traffic accidents cost $10.85bn.

In response to this problem, LA County Public Works has been leading a multi-jurisdictional traffic coordination effort through the Regional Traffic Signal Forum Programme. Under the Programme, Public Works facilitates Intelligent Transportation System (ITS) projects in three major geographic areas, each area consisting of approximately 20 cities.

A component of ITS is LA County's Advanced Traffic Management System (ATMS) – technology that is currently providing second-by-second monitoring and control of traffic signals. The system detects traffic signal equipment malfunctions, which allows for very rapid response to traffic signal problems. It can also monitor traffic conditions and collect traffic data from loop sensors that are built into roadways and video detectors to provide real-time modification of traffic signal operational parameters.

Facing the Challenge

The challenge was to extend the ATMS to all intersections in LA County's domain and to create an electronic package that would provide a 'one size fits all' solution to integrating ITS with traffic signal control equipment from a myriad of manufacturers.

Systems Integrated proposed a cost-effective solution using the Lantronix XPort to create an Ethernet backbone to allow traffic controllers to communicate securely with LA County's traffic management centre.

When SI received the contract from the County of Los Angeles's Department of Public Works to network-enable several hundred traffic light controllers to create the framework necessary for remote management, diagnostics and control, the company recognized the challenges. The hundreds of traffic light controlled intersections were spread over a large geographic area and overlapped with the twenty municipalities contained within the county. In many cases, traffic light enabled

Figure 1: *Busy motorways need to be successfully monitored and managed*

***Figure 2:** Traffic management control room*

intersections were standalone, requiring public notification when they had become inoperative.

Reprogramming the traffic controller also required a crew visit to directly interface with the controller using a laptop PC or through a built-in programming interface. A further challenge was the diversity of vendor products contained within street-side traffic controller cabinets.

Primary Requirements

The two primary requirements of the project were: (1) create a private network connecting each traffic intersection back to LA County's ATMS, and (2) install an interface board in the traffic controllers' standard rack-based enclosure to provide a single unifying interface that could communicate via Ethernet on one end (back to the Traffic Management Centre), and serial or Ethernet to any manufacturer's traffic control computer on the other.

The original system design called for an Ethernet-based radio scheme incorporating a radio-to-T1 connection for every eight intersections. Systems Integrated proposed an alternative solution: Create an Ethernet backbone that would allow all the traffic controller-enabled intersections and their incumbent equipment – camera-based loop detection devices, pavement embedded loop devices and traffic controllers – to communicate over one private TCP/IP packet based network.

After reviewing several options, SI decided to integrate the Lantronix XPort, a compact module capable of network-enabling virtually any electronic device. The XPort was a good fit for several reasons.

As the County of Los Angeles' traffic system cabinets are very small, a size-sensitive deployment was required. Smaller than a human thumb, the XPort incorporated all essential networking and serial communication features in a 33.9 x 16.25 x 13.55mm package, which could be easily embedded on SI's universal interface board.

Since the environmental specifications of the XPort include an industrial temperature range of -40° to 85°C, it is well suited for the warmer climate of LA County.

The XPort serial interface is capable of data rates from 300bps to 921,600bps. This range is more than adequate to integrate with most vendors' traffic controller interfaces, typically communicating at 19,200bps. The XPort serial implementation supports 7 or 8 data bits, odd, even and no parity, 1 or 2 stop bits, DTR/DCD, CTS and RTS control signals. Meanwhile, flow control is supported for those traffic controllers requiring it and includes XON/XOFF and RTS/CTS.

The XPort's compact design also allowed for easy integration. Inside the traffic controller cabinet, the network interface is cabled to a small Ethernet switch connected to the LA County wireless network. The Ethernet connector consists of interface magnetics, RJ45 connector and status LEDs, all contained within the XPort device server shell.

Network Software

The XPort RTOS provides several key functions to allow the LA County ATMS system access to controller functions for both monitoring and control. SI supplied a software-based communication protocol interface at the ATMS system site to arbitrate the connection and transfer of data to and from traffic controllers through the

XPort device server. The XPort RTOS enables a raw listening TCP/IP socket where application software can connect.

Once a connection is arbitrated, any data posted on this raw socket is transferred by the XPort to its serial port for transmission to the traffic controller. A reply from the traffic controller is then routed by the XPort for transmission back to the SI communication protocol interface software.

In addition to the primary device server serial communication function, the XPort RTOS provides a full built-in web server for configuration of the unit via a standard browser. The RTOS also presents an equivalent configuration interface via Telnet protocol. Other supported network services include SNMP, UPD/IP, ARP, ICMP, TFTP, DHCP, BOOTP and AutoIP. The SNMP support, in particular, was important to the ATMS system roll-out as it provided an endpoint compatible with the LA County Public Works' network monitoring and management software. The XPort served as a proxy to the non-network-enabled traffic controllers for purposes of determining network connectivity, critical in large distributed networks.

Seamless Security

Because a security breach in the system could potentially wreak havoc on LA County's traffic patterns, security was a major concern. To mitigate this possibility, all configuration interfaces to the XPort are username/password protected. The XPort's 256-bit NIST-certified AES encryption provided security against intrusion attempts. These security features exceeded the County of LA's security requirements for their own IT applications.

The XPort removes the complexity of designing network connectivity into a product by incorporating all the required hardware and software inside a single embedded Ethernet module. This ease of implementation allowed SI to reduce the time and cost of development, a savings they were able to pass on to the County.

With the help of the Lantronix XPort, SI was able to embed network connectivity into LA County's traffic lights. Traffic officials are now able to monitor intersections from a single location, carefully analyse traffic patterns and strategically manage congestion during rush hour or any other time of day – improving traffic flow and reducing fuel costs and emissions.

Using a single radio system instead of multiple radio systems resulted in a substantial cost savings.

With 200 intersections on one T1 (as opposed to eight), the County saved upwards of $6,000 per month. Leveraging SI's approach, the Department of Public Works was able to complete the project for 38% less than the cost of a solution using telephone lines and 78% less than a fibre optics-based solution. This achievement helped the Department of Public Works earn a Top Ten Quality and Productivity Award from the County of LA. ■

Figure 3: *Traffic lights with embedded network connectivity*

GPS challenges

Hans Wiedemann, Head of Product Marketing for Positioning Products at Vincotech GmbH, highlights the design challenges for GPS arising in telematics applications

PEOPLE EXPECT nothing less than precise locations from modern positioning applications. Whereas just 15 years ago the first navigation systems were a special feature of premium-class vehicles, nowadays everyone is familiar with practical portable navigation devices. A luxury item has become a commodity. What's more, the GPS has made inroads into many recreational applications, including devices for everything from mountain bikes to digital cameras and mobile phones.

The most common commercial application is certainly telematics, and the market is growing fast. Ten years ago, truck dispatching was the main application, with SMS being the preferred means of communication. Today, more data can be sent far faster and at much lower cost via GPRS, and the number of applications has clearly increased.

In increasing number of systems providers are offering solutions that do anything, from locating stolen vehicles to supporting insurance applications and providing sophisticated diagnostic data. It would appear that GPS has advanced to the point where it can be readily used everywhere.

However, the devil is in the details, and some remaining challenges merit consideration.

The Science of Convergance

The term telematics is generally taken to mean the linking of information and telecommunication. In vehicles, this technology is used in combination with GPS – that is, the system providing information on location, speed, direction and time. The added requirements determine how complex a box will be. Is it a matter of reading outputs or setting inputs? Is it necessary to access vehicle information (frequently via CANbus)? Are there interfaces to other sensors? Is there a need to display information? Does it require driver interaction?

Telematics applications are also branching out into other fields, including personal and asset tracking applications that trace and find people and goods. All these systems have two characteristics in common: they come with a GSM/GPRS unit (and often also CDMA, rarely a satellite communication

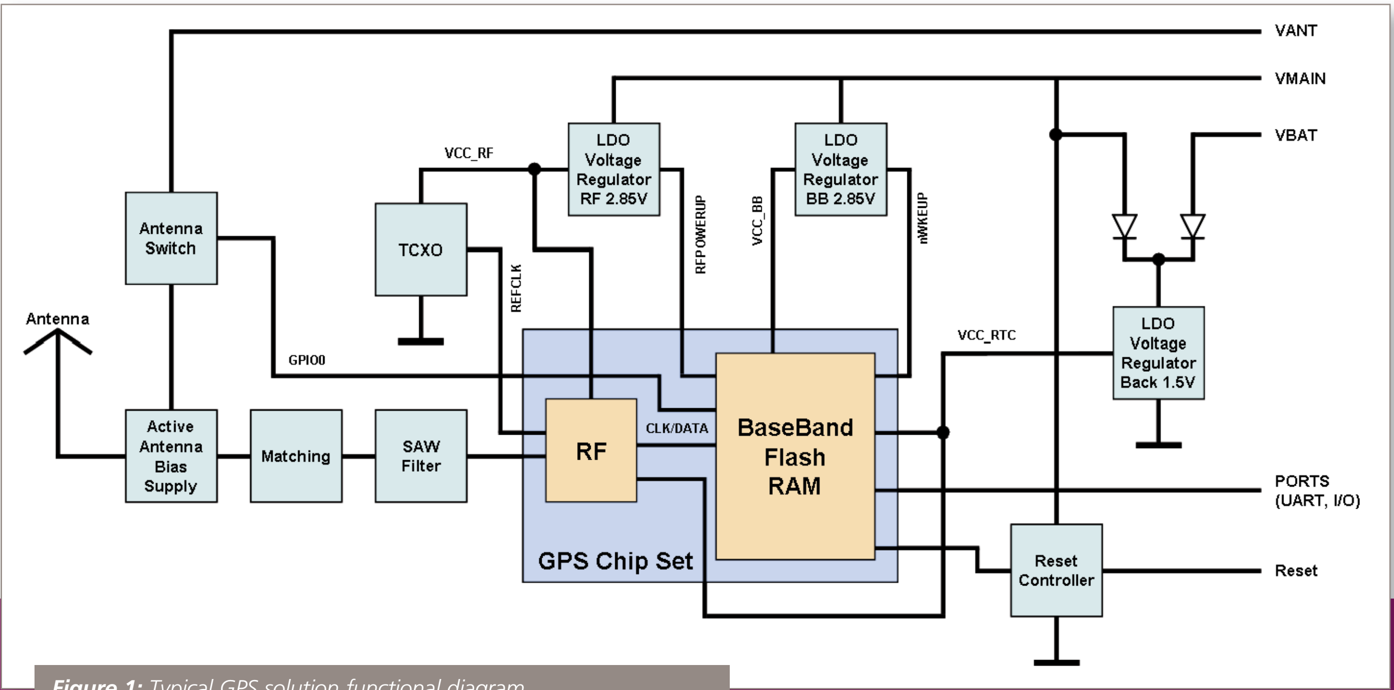


Figure 1: *Typical GPS solution functional diagram*

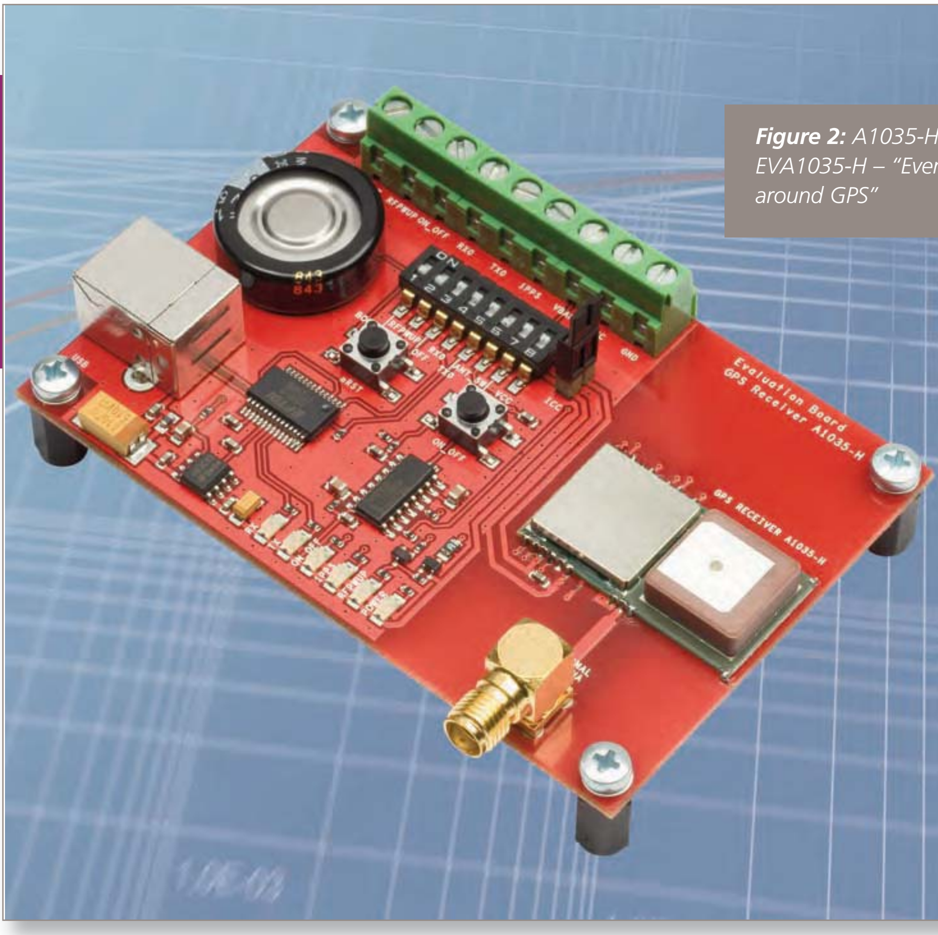


Figure 2: *A1035-H Evaluation Board EVA1035-H – "Everything You Need around GPS"*

Figure 3: *A1084 Evaluation Boards EVA1084 – "Everything You Need for Loving GPS"*

unit, and sometimes both) and are GPS-enabled.

Once a manufacturer of such telematics boxes has made the buy-or-build decision, he has to determine whether to use a GPS chipset or a module for his proprietary design. It takes quite a few unit numbers – 250,000 is the typical figure – for a chipset to pay off. Using a module, in turn, entails investing considerable effort. After all, it takes special components to provide optimum support for the chipset; first and foremost, a precision temperature-compensated crystal oscillator (TCXO). And it requires an LNA (low noise amplifier), a SAW filter (a band-pass filter with a narrow bandwidth) and an exceedingly clean voltage supply. The attendant clock quartz is a somewhat simpler matter. All these components must be precision-tuned to match the chipset and connected using a well-designed PCB track.

Of course, chipset manufacturers devote most of their design support to applications with high unit numbers. This allows a module manufacturer to get the best performance from the chipset and enable fastest integration into a telematics box. In the simplest case scenario, the effort is limited to providing power, a serial interface and, of course, a clean antenna connection. And there are other obvious advantages to using a module: while the manufacturer has to buy just one component when opting for a module, a proprietary design requires contacting, negotiating and nurturing a relationship with a specialized manufacturer or distributor. Furthermore, using a module shortens the design cycle for the overall product so it can go into production that much sooner.

Antenna Considerations

Another issue is the antenna and a tidy antenna connection. One should always bear in mind that signals sent out by the GPS are very weak – they actually "hide" among the natural background noise. The better the antenna (that is, the higher the signal amplification), the lower the noise figure; and the better the link connecting the antenna and GPS module, the better the GPS receiver's performance will be. Or, in other words, there is no way of regaining the loss caused by an inferior antenna or substandard antenna-to-satellite alignment.

Of course, today's receivers are extremely sensitive, but the installation site (e.g. in the vehicle's interior) and the vehicle's whereabouts (for example in a multi-storey car park) may weaken signals. Factor in a poor antenna and a bad connection and even the most sensitive receiver may be unable to determine any position at all. Often the issue is whether to use passive or active antennas, the latter usually being equipped with a SAW filter and an LNA.

First it is necessary to determine what type of antennas the receiver is designed for. An external active antenna's cable dampens signals. A typical attenuation value is 1dB per meter, so three meters of cable halve the signal level. It is best to avoid using plug-in connectors, or to ensure they match the GPS frequency (1575MHz). Datasheets usually provide valuable information on this.

Also, the actual signal circuit's impedance should be 50 ohms. The cable ought to be straight and as short as possible. There are three very important things to watch for when using internal – and usually passive – antennas: the antenna must be tuned to its surroundings, requires a matching ground plane and its environment should be free of potential sources of interference.

In view of the growing demand for ever more compact telematics boxes, the latter two points are often difficult to realize. Also, to select the best possible antenna position, it is important to know upfront where the box will be installed. This begs the question whether or not this position will always remain the same. Different mounting locations can influence the choice of antenna type. If the installation position is unknown, the antenna must be able to receive signals from all directions – so an omnidirectional solution is the only option.

Figure 4: *Part number A1084 – Viinctotech calls it the "Ultimate SiRFstarIII module"*

Focusing on Low Power

Low power consumption is an increasingly important consideration for a telematics box. Big truck batteries provided a steady supply of power for early applications, even when the ignition is off. Today's vehicles, however, are equipped with so many electricity-consuming devices that lowest consumption is a top priority. This demand is even more pressing for applications with their own power supply, preferably a small and light battery. So, another criterion for selecting a module is that it consumes the lowest possible power (currently, standard values for tracking satellites are around 20mA).

Many modules support power saving modes. They may be triggered via software commands. In some cases, it takes an additional hardware signal to wake the receiver up again. An example of this is push-to-fix, where the receiver runs autonomously on the lowest possible power. It is briefly activated by a hardware signal only when it has to calculate a position.

Another aspect to consider is the receiver's sensitivity when pinpointing an initial position. The stronger the signals, the easier it is for the receiver to find a location (see the preceding paragraph). It can then quickly calculate a position and be switched off again. The receiver needs a description of satellite orbits called ephemerides to figure out the position. Reception takes 18 seconds under optimum conditions with a good signal level; 27 seconds are typical.

If the receiver is switched off for a while, these ephemerides must be reloaded because their data is already outdated. This will take the typical 27 seconds; in certain circumstances weak signals may even prevent their decryption altogether. This means the receiver stays on longer and consumes more power. Extended ephemeris data can solve this problem. They can be loaded from a server into the telematics box and fed into the receiver, where they remain valid for several days. This is a major stride towards further power savings.

Future Developments

Future chipsets are sure to bring further improvements in sensitivity and power consumption. Extended ephemeris will become commonplace, either delivered from an external server or calculated in the actual chipset.

Another trend is to continuously track at least one satellite, with lowest power consumption. This means the receiver spends less time awake and can sooner be sent back to sleep. A previously neglected aspect is the jamming of GPS signals; that is, interference caused by sending a signal in the same frequency range. For safety reasons, engineers are busy seeking – and are likely to find – new solutions that address this problem for many telematics applications. Vincotech's modules will incorporate these advances, thereby making them much easier to integrate into new solutions and improving their performance. ■

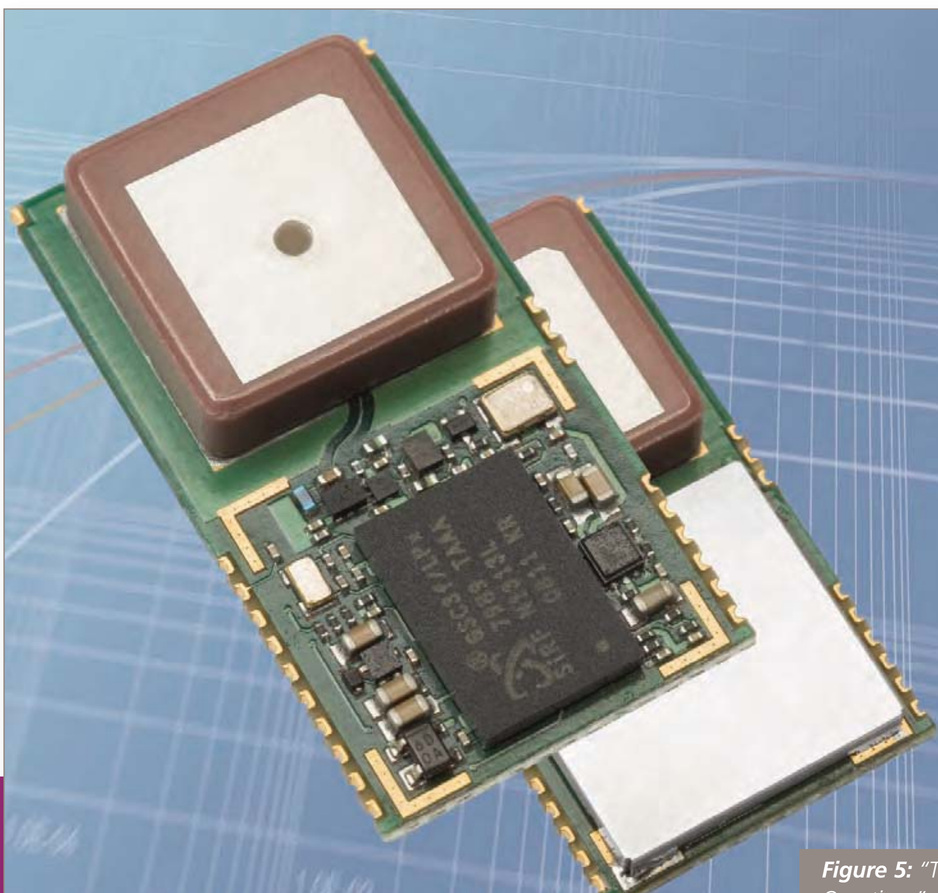


Figure 5: *"The Answer To All GPS Questions" - A1035-H*

PLC with PIC16F648A Microcontroller – Part 15

Associate 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 is the fifteenth article explaining the demultiplexer macros of the project

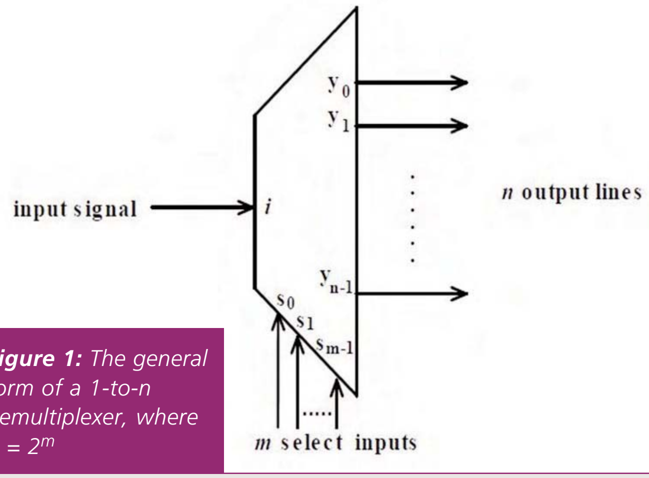


***Figure 1:** The general form of a 1-to-n demultiplexer, where $n = 2^m$*

A DEMULTIPLEXER, abbreviated as DMUX, is used when a circuit is to send a signal to one of many devices. This description sounds similar to the description given for a decoder, but a decoder is used to select among many devices while a demultiplexer is used to send a signal among many devices. However, any decoder having an enable line can function as a demultiplexer. If the enable line of a decoder is used as a data input, then the data can be routed to any one of the outputs and, thus, in that case the decoder can be used as a demultiplexer.

As the name infers, a demultiplexer performs the opposite function to that of a multiplexer. A single input signal can be connected to any one of the output lines provided by the choice of an appropriate select signal. The general form of a 1-to-n demultiplexer can be seen in **Figure 1**. If there are "m" select inputs then the number of output lines to which the data can be routed is $n = 2^m$. Although, not shown in Figure 1, in addition to the other inputs, the demultiplexer may have an enable line, E, for enabling it. When the demultiplexer is disabled with E set to 0 (for active-high enable input E), no output line is selected and, therefore, the input signal is not passed to any output line.

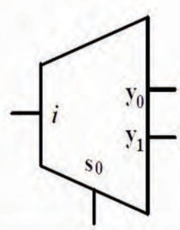
In this article, there are six demultiplexer macros, namely Dmux_1_2 (1×2 DMUX), Dmux_1_2_E (1×2 DMUX with Enable input), Dmux_1_4 (1×4 DMUX), Dmux_1_4_E (1×4 DMUX with Enable input), Dmux_1_8 (1×8 DMUX), Dmux_1_8_E (1×8 DMUX with Enable input), described for UZAM_PLC as shown in **Tables 1**, **2**…**6**, respectively. Let us now consider these macros.

The macro "Dmux_1_2" is shown in Table 1, together with its symbol and truth table. In this macro, "s_0" is a Boolean input variable taken into the macro through "regs0,bits0" and it represents the select input. "y_0" and "y_1" are Boolean output variables produced as outputs through "rego0,bito0" and "rego1,bito1" respectively and they represent two output signals. Finally, "i" is a Boolean input variable produced, taken into the macro through "regi,biti" and it represents the input signal. In this DMUX, when the select

Macro

```
;--------- macro: Dmux_1_2 ------
Dmux_1_2  macro   regs0,bits0,
regi,biti,rego1,bito1,rego0,bito0
        local   L1,L2,L3
        btfss   regi,biti
        goto    L2
        btfss   regs0,bits0
        goto    L3
        bsf     rego1,bito1
        bcf     rego0,bito0
        goto    L1
L3      bsf     rego0,bito0
        bcf     rego1,bito1
        goto    L1
L2      bcf     rego1,bito1
        bcf     rego0,bito0
L1
        endm
;-------------------------------
```

Symbol



i =	regi,biti
s0 =	regs0,bits0
y0 =	rego0,bito0
y1 =	rego1,bito1

Truth table

input	outputs	
s0	y0	y1
0	i	0
1	0	i

***Table 1:** The macro "Dmux_1_2" together with its symbol and truth table*

input is s_0 = 0, the input signal "i" is passed to the output line "y_0". When the select input is s_0 = 1, the input signal "*i*" is passed to the output line "y_1".

The macro "Dmux_1_2_E" is shown in Table 2, together with its symbol and truth table. In addition to the "Dmux_1_2", this demultiplexer macro has an active-high enable line, *E*, for enabling it. In this macro, E is a Boolean input variable taken into the macro through W. When this demultiplexer is disabled with *E* set to 0, no output line is selected and the input signal is not passed to any output. When this demultiplexer is enabled with *E* set to 1, it functions as described for "Dmux_1_2".

The macro "Dmux_1_4" is shown in Table 3, together with its symbol and truth table. In this macro, "s_1" and "s_0" are Boolean input variables taken into the macro through "regs1,bits1" and "regs0,bits0" respectively and they represent the select inputs. "y_0", "y_1", "y_2" and "y_3" are Boolean output variables produced as outputs through "rego0,bito0", "rego1,bito1", "rego2,bito2" and "rego3,bito3" respectively and they represent four output signals. Finally, "*i*" is a Boolean input variable produced, taken into the macro through "regi,biti" and it represents the input signal. In this DMUX, when the select inputs are s_1s_0 = 00 (respectively 01, 10, 11), the input signal "i" is passed to the output line "y0" (respectively, y1, y2, y3).

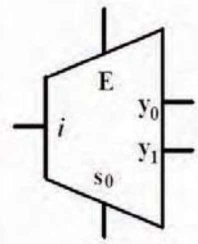
The macro "Dmux_1_4_E" is shown in Table 4, together with its symbol and truth table. In addition to the "Dmux_1_4", this demultiplexer macro has an active-high enable line, *E*, for enabling it. In this macro, E is a Boolean input variable taken

Table 2: *The macro "Dmux_1_2_E" together with its symbol and truth table*

Macro

```
;--------- macro: Dmux_1_2_E ----
Dmux_1_2_E  macro   regs0,bits0,
regi,biti,rego1,bito1,rego0,bito0
        local   L1,L2,L3
        movwf   Temp_1
        btfss   Temp_1,0
        goto    L2
        btfss   regi,biti
        goto    L2
        btfss   regs0,bits0
        goto    L3
        bsf     rego1,bito1
        bcf     rego0,bito0
        goto    L1
L3      bsf     rego0,bito0
        bcf     rego1,bito1
        goto    L1
L2      bcf     rego1,bito1
        bcf     rego0,bito0
L1
        endm
;-------------------------------
```

Symbol



W	E
i =	regi,biti
s0 =	regs0,bits0
y0 =	rego0,bito0
y1 =	rego1,bito1

Truth table

inputs		outputs	
E	s0	y0	y1
0	×	0	0
1	0	*i*	0
1	1	0	*i*

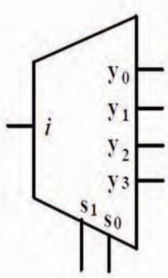
×: don't care

Table 3: *The macro "Dmux_1_4" together with its symbol and truth table*

Macro

```
;--------- macro: Dmux_1_4 ---
Dmux_1_4  macro   regs1,bits1,
regs0,bits0,regi,biti,
rego3,bito3,rego2,bito2,
rego1,bito1,rego0,bito0
        local   L1,L2,L3,L4,L5
        btfss   regi,biti
        goto    L2
        btfss   regs1,bits1
        goto    L5
        bcf     rego1,bito1
        bcf     rego0,bito0
        btfss   regs0,bits0
        goto    L4
        bsf     rego3,bito3
        bcf     rego2,bito2
        goto    L1
L5      bcf     rego3,bito3
        bcf     rego2,bito2
        btfss   regs0,bits0
        goto    L3
        bsf     rego1,bito1
        bcf     rego0,bito0
        goto    L1
L4      bcf     rego3,bito3
        bsf     rego2,bito2
        goto    L1
L3      bcf     rego1,bito1
        bsf     rego0,bito0
        goto    L1
L2      bcf     rego3,bito3
        bcf     rego2,bito2
        bcf     rego1,bito1
        bcf     rego0,bito0
L1
        endm
;-----------------------------
```

Symbol



i =	regi,biti
s1 =	regs1,bits1
s0 =	regs0,bits0
y3 =	rego3,bito3
y2 =	rego2,bito2
y1 =	rego1,bito1
y0 =	rego0,bito0

Truth table

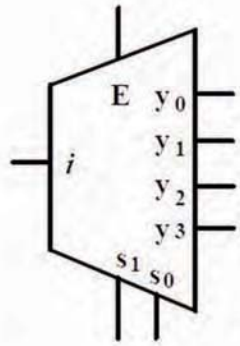
inputs		outputs			
s1	s0	y0	y1	y2	y3
0	0	*i*	0	0	0
0	1	0	*i*	0	0
1	0	0	0	*i*	0
1	1	0	0	0	*i*

Macro	Symbol	Truth table

Macro

```
;--------- macro: Dmux_1_4_E ---
Dmux_1_4_E  macro   regs1,bits1,
regs0,bits0,regi,biti,
rego3,bito3,rego2,bito2,
rego1,bito1,rego0,bito0
        local   L1,L2,L3,L4,L5
        movwf   Temp_1
        btfss   Temp_1,0
        goto    L2
        btfss   regi,biti
        goto    L2
        btfss   regs1,bits1
        goto    L5
        bcf     rego1,bito1
        bcf     rego0,bito0
        btfss   regs0,bits0
        goto    L4
        bsf     rego3,bito3
        bcf     rego2,bito2
        goto    L1
L5      bcf     rego3,bito3
        bcf     rego2,bito2
        btfss   regs0,bits0
        goto    L3
        bsf     rego1,bito1
        bcf     rego0,bito0
        goto    L1
L4      bcf     rego3,bito3
        bsf     rego2,bito2
        goto    L1
L3      bcf     rego1,bito1
        bsf     rego0,bito0
        goto    L1
L2      bcf     rego3,bito3
        bcf     rego2,bito2
        bcf     rego1,bito1
        bcf     rego0,bito0
L1
        endm
;-------------------------------
```

Symbol



W	E
i =	regi,biti
s1 =	regs1,bits1
s0 =	regs0,bits0
y3 =	rego3,bito3
y2 =	rego2,bito2
y1 =	rego1,bito1
y0 =	rego0,bito0

Truth table

inputs			outputs			
E	s1	s0	y0	y1	y2	y3
0	x	x	0	0	0	0
1	0	0	i	0	0	0
1	0	1	0	i	0	0
1	1	0	0	0	i	0
1	1	1	0	0	0	i

x: don't care

Table 4: *The macro "Dmux_1_4_E" together with its symbol and truth table*

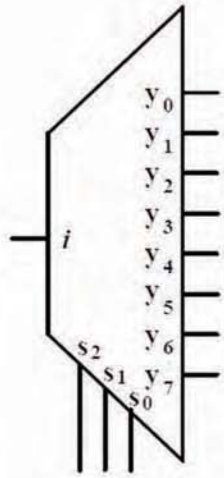
into the macro through W. When this demultiplexer is disabled with E set to 0, no output line is selected and the input signal is not passed to any output. When this demultiplexer is enabled with E set to 1, it functions as described for "Dmux_1_4".

The macro "Dmux_1_8" is shown in Table 5, together with its symbol and truth table. In this macro, "s_2", "s_1" and "s_0" are Boolean input variables taken into the macro through "regs2,bits2", "regs1,bits1" and "regs0,bits0" respectively, and they represent the select inputs. "y_0", "y_1", "y_2", "y_3", "y_4", "y_5", "y_6" and "y_7" are Boolean output variables produced as outputs through "rego0,bito0", "rego1,bito1", "rego2,bito2", "rego3,bito3", "rego4,bito4", "rego5,bito5", "rego6,bito6" and "rego7,bito7" respectively, and they represent eight output signals. Finally, "i" is a Boolean input variable produced, taken into the macro through "regi,biti" and it represents the input signal. In this DMUX, when the select inputs are $s_2s_1s_0$ = 000 (respectively 001, 010, 011, 100, 101, 110, 111), the input signal "i" is passed to the output line "y_0" (respectively, y_1, y_2, y_3, y_4, y_5, y_6, y_7).

The macro "Dmux_1_8_E" is shown in Table 6, together with its symbol and truth table. In addition to the "Dmux_1_8", this demultiplexer macro has an active-high enable line, *E*, for enabling it. In this

Macro	Symbol	Truth table

```
;--------- macro: Dmux_1_8 -----------
Dmux_1_8  macro   regs2,bits2,regs1,bits1,regs0,bits0,
regi,biti,rego7,bito7,rego6,bito6,rego5,bito5,rego4,bito4,
rego3,bito3,rego2,bito2,rego1,bito1,rego0,bito0
        local   L1,L2,L3,L4,L5,L6,L7,L8,L9
        btfss   regi,biti
        goto    L2
        btfss   regs2,bits2
        goto    L9
        bcf     rego3,bito3
        bcf     rego2,bito2
        bcf     rego1,bito1
        bcf     rego0,bito0
        btfss   regs1,bits1
        goto    L8
        bcf     rego5,bito5
        bcf     rego4,bito4
        btfss   regs0,bits0
        goto    L7
        bsf     rego7,bito7
        bcf     rego6,bito6
        goto    L1
L9      bcf     rego7,bito7
        bcf     rego6,bito6
        bcf     rego5,bito5
        bcf     rego4,bito4
        btfss   regs1,bits1
        goto    L5
        bcf     rego1,bito1
        bcf     rego0,bito0
        btfss   regs0,bits0
        goto    L4
        bsf     rego3,bito3
        bcf     rego2,bito2
        goto    L1
L8      bcf     rego7,bito7
        bcf     rego6,bito6
        btfss   regs0,bits0
        goto    L6
        bsf     rego5,bito5
        bcf     rego4,bito4
        goto    L1
L7      bcf     rego7,bito7
        bsf     rego6,bito6
        goto    L1
L6      bcf     rego5,bito5
        bsf     rego4,bito4
        goto    L1
L5      bcf     rego3,bito3
        bcf     rego2,bito2
        btfss   regs0,bits0
        goto    L3
        bsf     rego1,bito1
        bcf     rego0,bito0
        goto    L1
L4      bcf     rego3,bito3
        bsf     rego2,bito2
        goto    L1
L3      bcf     rego1,bito1
        bsf     rego0,bito0
        goto    L1
L2      bcf     rego7,bito7
        bcf     rego6,bito6
        bcf     rego5,bito5
        bcf     rego4,bito4
        bcf     rego3,bito3
        bcf     rego2,bito2
        bcf     rego1,bito1
        bcf     rego0,bito0
L1
        endm
;-----------------------------------
```



i =	regi,biti
s2 =	regs2,bits2
s1 =	regs1,bits1
s0 =	regs0,bits0
y7 =	rego7,bito7
y6 =	rego6,bito6
y5 =	rego5,bito5
y4 =	rego4,bito4
y3 =	rego3,bito3
y2 =	rego2,bito2
y1 =	rego1,bito1
y0 =	rego0,bito0

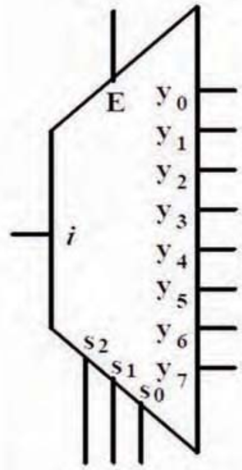
inputs			outputs							
s2	s1	s0	y0	y1	y2	y3	y4	y5	y6	y7
0	0	0	i	0	0	0	0	0	0	0
0	0	1	0	i	0	0	0	0	0	0
0	1	0	0	0	i	0	0	0	0	0
0	1	1	0	0	0	i	0	0	0	0
1	0	0	0	0	0	0	i	0	0	0
1	0	1	0	0	0	0	0	i	0	0
1	1	0	0	0	0	0	0	0	i	0
1	1	1	0	0	0	0	0	0	0	i

***Table 5:** The macro "Dmux_1_8" together with its symbol and truth table*

Macro

```
;---------- macro: Dmux_1_8_E -----------
Dmux_1_8_E  macro   regs2,bits2,regs1,bits1,regs0,bits0,
regi,biti,rego7,bito7,rego6,bito6,rego5,bito5,
rego4,bito4,rego3,bito3,rego2,bito2,rego1,bito1,rego0,bito0
        local   L1,L2,L3,L4,L5,L6,L7,L8,L9
        movwf   Temp_1
        btfss   Temp_1,0
        goto    L2
        btfss   regi,biti
        goto    L2
        btfss   regs2,bits2
        goto    L9
        bcf     rego3,bito3
        bcf     rego2,bito2
        bcf     rego1,bito1
        bcf     rego0,bito0
        btfss   regs1,bits1
        goto    L8
        bcf     rego5,bito5
        bcf     rego4,bito4
        btfss   regs0,bits0
        goto    L7
        bsf     rego7,bito7
        bcf     rego6,bito6
        goto    L1
L9      bcf     rego7,bito7
        bcf     rego6,bito6
        bcf     rego5,bito5
        bcf     rego4,bito4
        btfss   regs1,bits1
        goto    L5
        bcf     rego1,bito1
        bcf     rego0,bito0
        btfss   regs0,bits0
        goto    L4
        bsf     rego3,bito3
        bcf     rego2,bito2
        goto    L1
L8      bcf     rego7,bito7
        bcf     rego6,bito6
        btfss   regs0,bits0
        goto    L6
        bsf     rego5,bito5
        bcf     rego4,bito4
        goto    L1
L7      bcf     rego7,bito7
        bsf     rego6,bito6
        goto    L1
L6      bcf     rego5,bito5
        bsf     rego4,bito4
        goto    L1
L5      bcf     rego3,bito3
        bcf     rego2,bito2
        btfss   regs0,bits0
        goto    L3
        bsf     rego1,bito1
        bcf     rego0,bito0
        goto    L1
L4      bcf     rego3,bito3
        bsf     rego2,bito2
        goto    L1
L3      bcf     rego1,bito1
        bsf     rego0,bito0
        goto    L1
L2      bcf     rego7,bito7
        bcf     rego6,bito6
        bcf     rego5,bito5
        bcf     rego4,bito4
        bcf     rego3,bito3
        bcf     rego2,bito2
        bcf     rego1,bito1
        bcf     rego0,bito0
L1
        endm
;-------------------------------------
```

Symbol



W	E
i =	regi,biti
s2 =	regs2,bits2
s1 =	regs1,bits1
s0 =	regs0,bits0
y7 =	rego7,bito7
y6 =	rego6,bito6
y5 =	rego5,bito5
y4 =	rego4,bito4
y3 =	rego3,bito3
y2 =	rego2,bito2
y1 =	rego1,bito1
y0 =	rego0,bito0

Truth table

inputs				outputs							
E	s2	s1	s0	y0	y1	y2	y3	y4	y5	y6	y7
0	x	x	x	0	0	0	0	0	0	0	0
1	0	0	0	i	0	0	0	0	0	0	0
1	0	0	1	0	i	0	0	0	0	0	0
1	0	1	0	0	0	i	0	0	0	0	0
1	0	1	1	0	0	0	i	0	0	0	0
1	1	0	0	0	0	0	0	i	0	0	0
1	1	0	1	0	0	0	0	0	i	0	0
1	1	1	0	0	0	0	0	0	0	i	0
1	1	1	1	0	0	0	0	0	0	0	i

x: don't care

Table 6: *The macro "Dmux_1_8_E" together with its symbol and truth table*

macro, *E* is a Boolean input variable taken into the macro through W. When this demultiplexer is disabled with E set to 0, no output line is selected and the input signal is not passed to any output. When this demultiplexer is enabled with E set to 1, it functions as described for "Dmux_1_8".

The file "dmux_mcr_def.inc" including the 6 demultiplexer macros shown in Tables 1, 2…6 can be downloaded from **http://host.nigde.edu.tr/muzam/**. ■

*If you've missed any of the previous articles in this series, you can now order them on line at **www.electronicsworld.co.uk***

ZOBEL PEACE PRIZE

Re: "*Making a protest*" on page 38 in the November 2009 issue of Electronics World magazine; i.e. "The Battle of Self vs Kaguongo" on the correct position of the output coil and Zobel network in audio power amplifiers.

Professional designers (RCA, Amcron, Mullard, Turner) have the low pass output coil preceding the stabilising load (Zobel network of resistor in series with a capacitor across the speaker) á la Mr Kauongo.

Where Hi-Fi (the fag-end of the electronics industry) places coil after Zobel network, this amounts to a few runs of speaker cable around a bog roll with a damping resistor inside feeding free space (not terminated!) á la Mr Self.

At the point where the coil feeds the Zobel, this point may be used for refined feedback to input stages – this point does not exist the other (wrong) way round.

Similarly, where the output is capacitively coupled, the capacitor's inductance (ESL) replaces the coil and Zobel follows the capacitor, therefore correctly across the speaker.

The coil and Zobel also act as high frequency stabilising for the amplifier and must be correctly fitted to prevent h.f. parasitic oscillations, resulting in power transistor burn-out.

Russ Andrews Hi-Fi has spotted the Zobel error. In a bid to save output transistors from the hands of so-called hi-fi designers, it offers a Zobel add-on box to be connected across the speaker.

Professional Analogue Sound System Engineering vs Hi-Fi is as different as chalk is to cheese.

Design of Zobel:

The true Zobel network should be across the loudspeaker, designed to relate to speaker's inductance (Ls) and resistance (Rs). Zobel network must have values given by:

$R_Z = R_S$ and $C_Z = L_S/R_S^2$

When these two conditions are satisfied, the parallel combination of the loudspeaker and Zobel network will present a purely resistive load to the output transistors.

Without the Zobel network (or mismatched) across the speaker, the output transistor may see inductive loading taking them outside their safe operating area (SoA). Commercial hi-fi amplifiers are not designed with sufficient output transistors to handle simultaneous voltage and current dissipation across the chip on inductive loads. The Zobel attempts to make the amplifier see an easy-to-drive resistive load, cutting down on cost of output transistors. With unknown speaker values, when driven hard, the hi-fi amp is likely to "go DC" and burn out the speaker's voice coils; false economy in the long run, if you have expensive current-hungry speakers.

Electronics World (March 09) was not a safe haven for Mr Kaguongo to share his refreshing audio publication. Good to see some audio in EW!

Mike Turner UK

The publisher reserves the right to edit and shorten letters due to space constraints

PLEASE EMAIL YOUR LETTERS TO:
svetlana.josifovska@stjohnpatrick.com

THE CATT QUESTION

The website **www.electromagnetism.demon.co.uk/cattq.htm** states "The Catt Question", as it was first received by Pepper and McEwan, whose replies contradicted each other. It says that for "The Catt Question" the dielectric is a vacuum. My May letter in Electronics World said: "When a voltage step travels down a transmission line at the speed of light", which it does in the case of a vacuum. "The Catt Question" only refers to a voltage step travelling in a vacuum at the speed of light. This bears on the statement by John Ellis in the November issue; "[Catt] mis-states the problem, however, by saying that the electromagnetic pulse travels down the wire, at the speed of light. .... Only in free space will the pulse travel at the speed of light." Incidentally, "The Catt Question" always involves a single voltage or TEM step, not his "pulse".

Similarly, Ian Darney, in both his letters, in June and November, introduces a pulse and also reflections. There are no reflections in "The Catt Question". It is important to avoid bringing in red herrings and unnecessary complexity into "The Catt Question". In his letter in August, S Hassel introduced losses. The photographs with my letter in September show that losses are another red herring.

Unfortunately, there were no www addresses in my letter published in the May issue of Electronics World. All the "footnotes" to my May letter can be found via **www.ivorcatt.co.uk/91.htm**

Ivor Catt UK

TIP 1: POSITIVE-TO-NEGATIVE CONVERTER APPLICATIONS

By Victor Khasiev and Juanjuan Sun, Senior Applications Engineers, Linear Technology

THE DEVELOPMENT of efficient high voltage step-down controllers and modules has made it possible to produce high performance positive-to-negative DC/DC converters using step-down switching regulator topology, where there's no transformer required (see **Figure 1**). In fact, transformer standardization has been a major factor in increasing the popularity of the step-down topology for positive-to-negative converters.

The step-down topology has a number of advantages over traditional transformer-based topologies, with simplicity of the converter and low parts count at the top of the list. **Figure 2** shows the inherent simplicity of the power train, which includes a top MOSFET Q1, single inductor L1, diode or bottom MOSFET Q2 and output filter. The output voltage is regulated by the step-down IC controller U1. The component-count of the power train can be further reduced to two, or even one, if integrated solutions are used, as shown in **Figures 3** and **4**.

Basic Operation, Transfer Function and Component Stress

This article presents the essential topological diagrams and equations required for a working knowledge of positive-to-negative converter functionality. A more comprehensive study of operation theory (including buck-boost) is described in *Erickson, Robert, W, "Fundamentals of power electronics", 2nd edition, ISBN 0-7923-7270-0*.

The duty cycle, average inductor current can be found from the following expressions, for continuous conduction mode operation:

$$D = \frac{|Vo|}{Vin + |Vo|} \qquad I\_L = \frac{Io}{(1 - D)}$$

Although a positive-to-negative converter looks like a buck and works mostly like a buck, it is not a buck. The major difference is that in the positive-to-negative converter, the inductor does not deliver energy and current to the load continuously as in a buck converter. During the ON time, Q1 is on, Q2 is off, the Q2 body diode is reversed biased and inductor is disconnected from the load, which is supplied by the output filter (see Figure 1a). Energy and current are delivered from inductor L to the output filter when Q1 is off and Q2 is on, as shown in Figure 1b.

Average and peak inductor currents are larger in the inverting topology compared to a buck at the same output current. For example in the circuit of Figure 2, output current is 4A, but average inductor current is 6.22A and the peak is 7.32A at a 9V input voltage. This fact has major implications on components selection, efficiency and output ripple, however with proper component selection efficiency 94%-95% or higher can be reached.

$V_{MAX} = V_{IN} + |V_{OUT}|$ is the maximum voltage across transistors Q1 and Q2. The maximum current I_{MAX} through transistors Q1, Q2 and inductor L and diode D can be found based on following expressions:

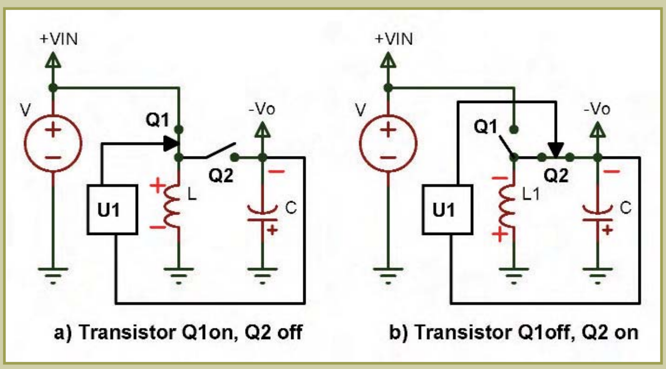


Figure 1: *Positive-to-negative converter topological diagrams*

$$dI = \frac{V_{IN(MIN)} \cdot T \cdot D_{MAX}}{L}$$

$$I_{PEAK} = I_L + \frac{dI}{2}$$

$$I_{MAX} = \frac{I_{OUT}}{(1 - D_{MAX})} + \frac{dI}{2}$$

where D_{MAX} is the maximum duty cycle of the controller. Average current through Q1 is equal $I_L \bullet D$ and through Q2 to I_{OUT}. The maximum voltage on the switching pin and current sense pins defines selection of the controller for this topology.

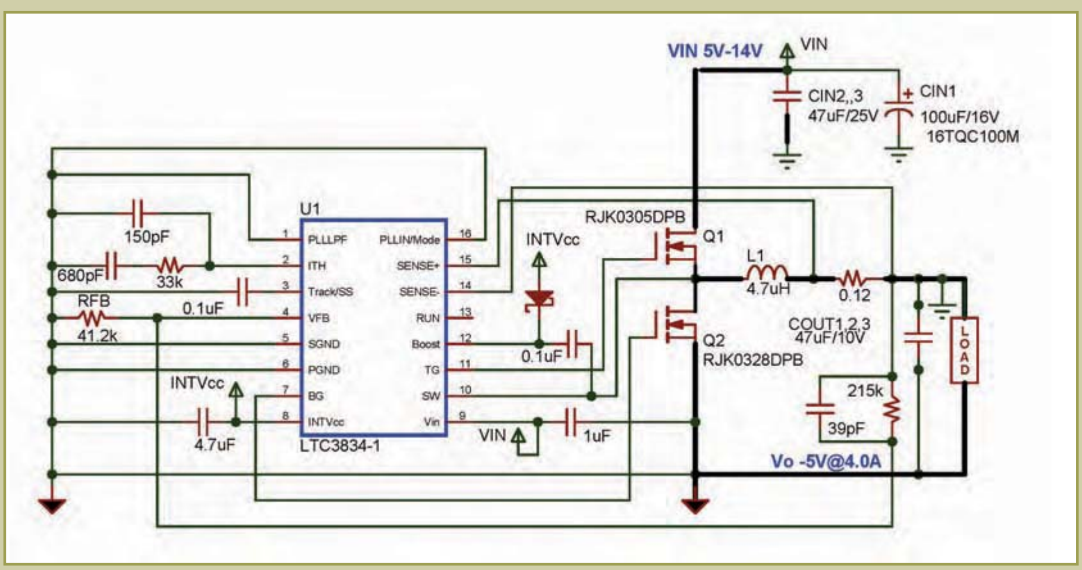


Figure 2: *Positive-to-negative converter using discrete components, V_{IN} = 5V to 14V, V_{OUT} = 5V at 4A*

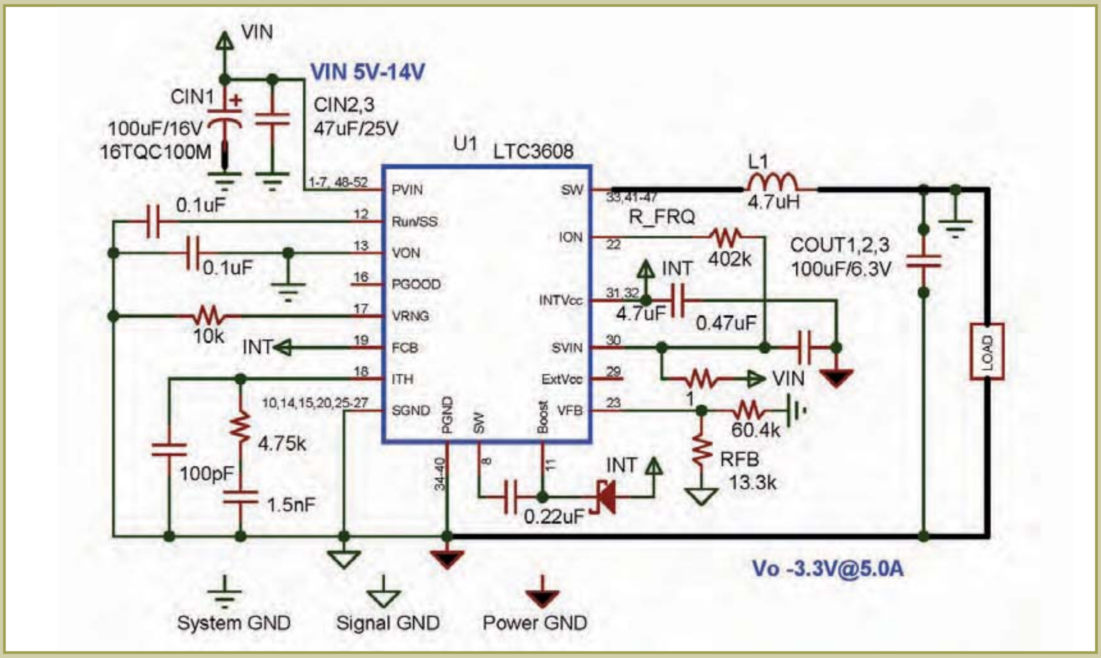


Figure 3: *Positive-to-negative converter using a regulator IC with integrated MOSFETs, V_{IN} = 5V to 14V, V_{OUT} = 3.3V at 5A*

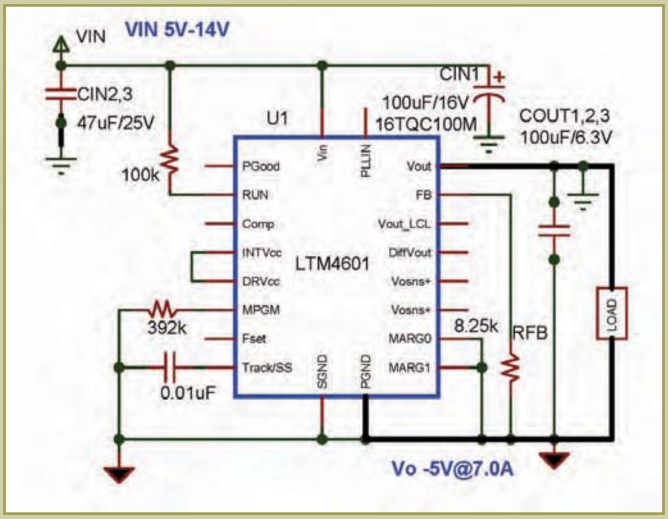


Figure 4: *Positive-to-negative converter using a fully integrated µModule DC/DC converter, V_{IN} = 5V to 14V, V_{OUT} = 5.0V at 7A*

Three Positive-to-Negative Converters

Figures 2, 3 and 4 show practical positive-to-negative converters using this topology. Figure 2 shows a discrete setup, which includes two transistors, an inductor, an LTC3834-1 controller and input/output filters. The hookup of the LTC3834-1 is straightforward, where the user can select from three fixed frequencies: 250kHz, 530kHz or 400kHz (via the PLLLPF pin) and three modes of operation: Burst Mode operation, pulse skipping and forced continuous modes (via the PLLIN/MODE pin). Circuit efficiency is as high as ~ 93%.

Figure 3 shows a more compact design, where the switching MOSFETs are integrated into the LTC3608 monolithic synchronous step-down DC/DC converter. The LTC3608 also saves space with internal current sensing. It uses valley mode control and senses current across the internal bottom MOSFET.

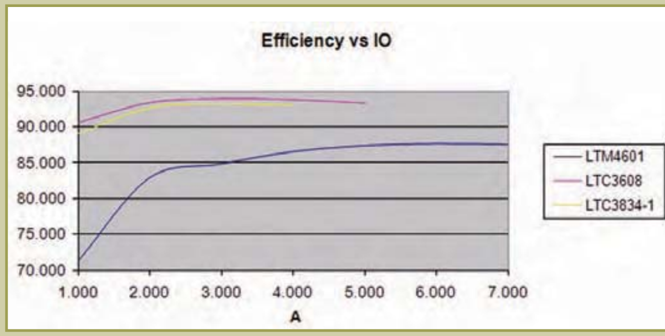


Figure 5: *Efficiency vs output load for the three applications shown here*

The operating frequency is determined by the one-shot timer that controls the on-time of the top MOSFET switch. Frequency is programmed by resistor RFRQ and it is set to 300kHz; efficiency reaches almost 94%.

The circuit on Figure 4 further simplifies and streamlines the design of the entire application by employing an LTM4601 µModule regulator. The entire application occupies only 15mm × 15mm × 2.8mm of volume and is ready to use, no component selection or troubleshooting required. This is achieved by integrating the switching MOSFETs and inductor in the package. The minimum input voltage of the LTM4601 is 4.5V with a maximum output of 20V and 12A.

All three circuits are functional in the input voltage rage from 5V to 14V, but the stated output current applies to 9V to 14V. Output current should be derated at voltages lower than 9V. The output voltages can be varied from -1.2V to -5V by changing resistor RFB. The efficiency curves are shown in **Figure 5**.

Switching-regulator-based positive-to-negative conversion is widely used in LCD devices, audio amplifiers, and industrial and measurement equipment. These three designs show that designing a positive-to-negative converter can be easy.

IMPLEMENTING A TOUCHLESS SLIDER WITH INFRARED SENSOR TECHNOLOGY

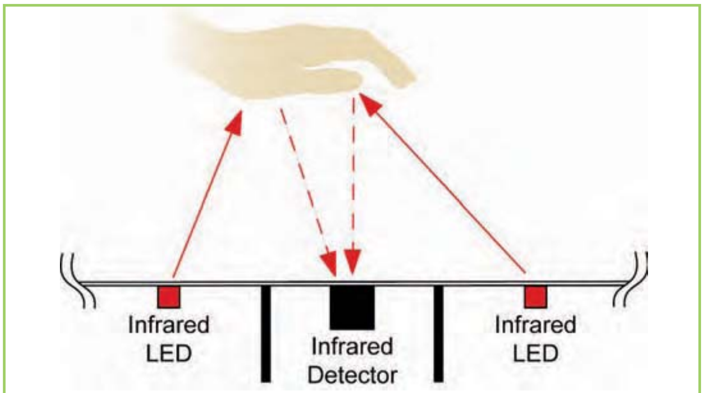


Figure 1: *Infrared reflectivity diagram*

WAKING UP AT the crack of dawn every day for work can be a cruel event. Locating the snooze and silence buttons on an incessant alarm clock can add frustration and result in a case of the morning grumps.

But, what if you could extend your peaceful sleep by simply waving your hand or tapping a virtual button to shut off the alarm? Could this eradicate world grumpiness? Probably not. Nevertheless, the wave of a hand or tap of a virtual button is an intriguing product innovation. One way to achieve this is a touchless slider and the concept can be adapted to a great number of products that we encounter every day.

The touchless slider solution comprises two or more infrared LEDs, an infrared detector and a low-power 8-bit microcontroller (MCU) based on the 8051 core.

Figure 1 depicts a simplified single-axis infrared motion sensor. Two infrared LEDs are independently pulsed, and an infrared sensor detects the reflected infrared light. A comparison of the strengths of the two reflections indicates the relative location of the object along the single axis.

An infrared slider is quite similar to mechanical and capacitive sliders. Chances are you have seen sound stage panels with innumerable rows of mechanical sliders. Capacitive sliders are implemented with a smooth surface and no moving parts. All three are capable of detecting movement and a set-location in a single axis and each provides intuitive control. The infrared slider offers additional advantages:

- The function is invisible and aesthetically pleasing;
- The axis of measurement can extend beyond the ends of the physical elements of the slider;
- The z-axis can be included in the function;
- The implementation is easy to clean and leaves behind no finger oils.

While the touchless slider function can be added to virtually any product with a human interface, all of these advantages can be adopted by our alarm clock example. A touchless slider implementation is illustrated in **Figure 2**. In this example, an 8051 MCU independently controls the infrared LEDs such that only one LED is enabled at any one time. The MCU responds to the output of the sensor, calculates the position of the hand and (optionally) displays the relative position of the hand with the visible blue LEDs at the top of the clock. The visible feedback might be useful for adjusting the time or as a volume control.

In our familiar alarm clock example, a variety of gestures can be sensed with ease. A left/right motion may be interpreted as a volume control, or possibly a snooze trigger. When an object passes from left to right over the infrared LED axis, the MCU is able to synchronize the infrared LED pulses with the output of the infrared detector. The resulting raw reflectivity data for each Ir LED is plotted in **Figure 3** versus time. The red curve represents reflected light from the Ir LED on the left, and the blue curve represents light from the Ir LED on the right end of the slider.

As the hand moves from left to right, the reflectivity of the red curve rises to a peak, followed slowly by the blue curve as the hand approaches the maximum reflectivity of the right-most Ir LED. The midpoint of the virtual slider is indicated where the two curves cross over. If the hand passes in the opposite direction, the blue curve would rise before the red.

Mechanical and capacitive sliders have the ability to select a set-point when the finger stops moving and/or retracts from the slider. Similarly, there are several intuitive human gestures for selecting a set-point on a touchless slider. In the touchless environment, a

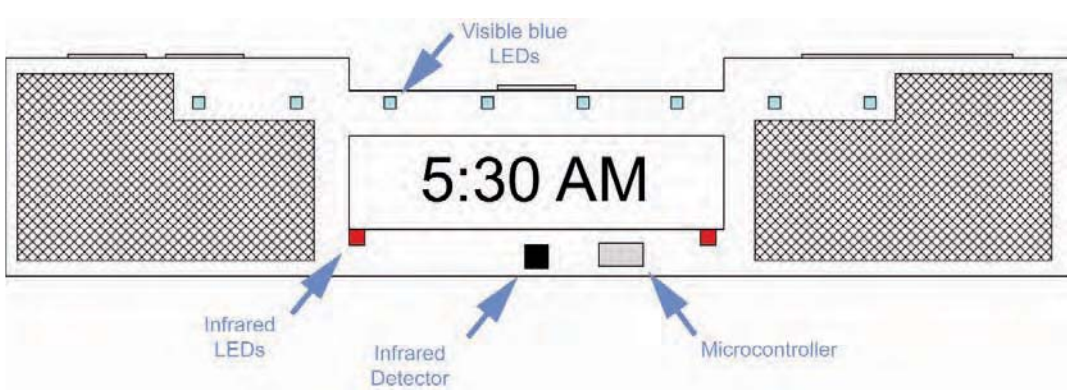


Figure 2: *A virtual alarm clock*

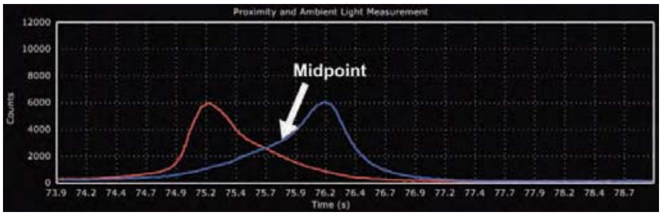


***Figure 3:** Left-right motion detection*

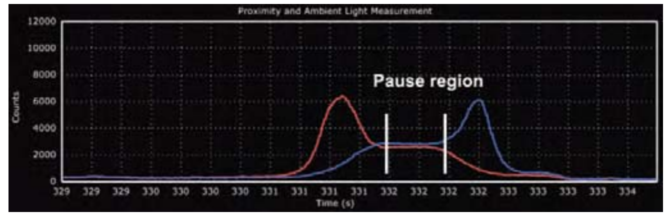


***Figure 4:** Touchless slider pause set-point*

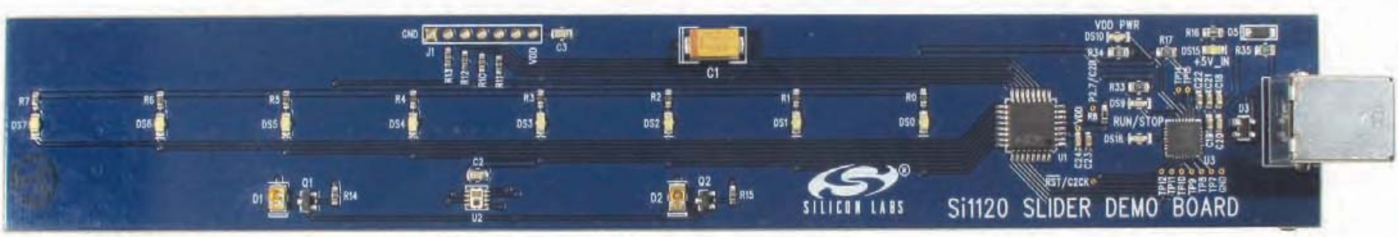


***Figure 5:** Silicon Labs IrSliderEK touchless slider demo board*

pause, or a press and/or a retract may be interpreted as set-point selection.

When we add a pause to the left-to-right-hand motion depicted in Figure 3, we experience a short period of unchanging reflectivity values as shown in **Figure 4**. The MCU logic can easily identify this as a set-point gesture and compute the location of the selection by comparing the relative values of reflectivity. Similarly, a push or retract motion on the z-axis would result in a simultaneous rise or fall in both reflectivity values and again, the MCU logic can easily identify these gestures in real-time. The z-axis capability is a distinct touchless slider advantage. A Ferris wheel scrolling gesture for adjusting the channel or volume is an intuitive motion implementation of z-axis measurement.

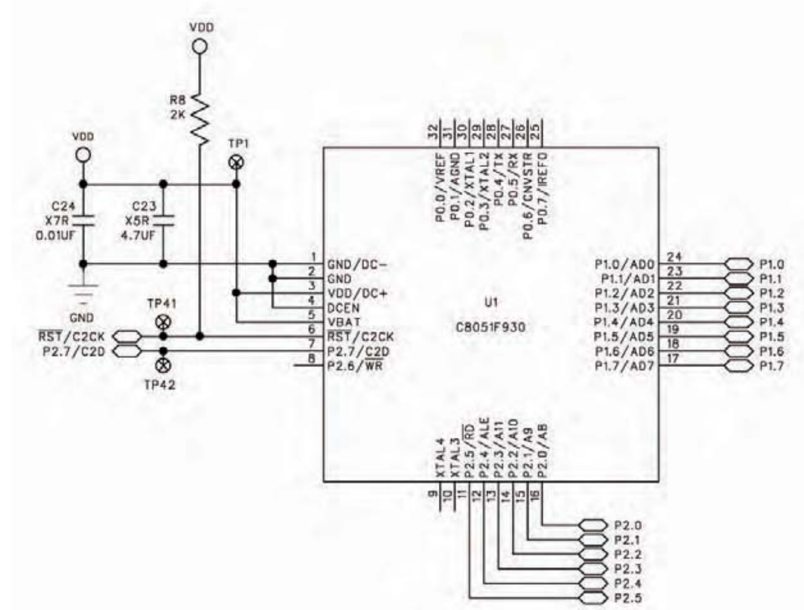


***Figure 6:** Silicon Labs C8051F930 ultra-low power MCU*

If you would like to try this for yourself, Silicon Labs has a demonstration board (P/N: IrSliderEK available at **www.silabs.com/quicksense**). The demo board shown in **Figure 5** performs reliably to a range of about 12cm. The firmware tracks the motion of a hand with visible blue LEDs and recognizes the pause set-point gesture with a single blinking blue LED. The hardware implementation is capable of flick left/right gestures.

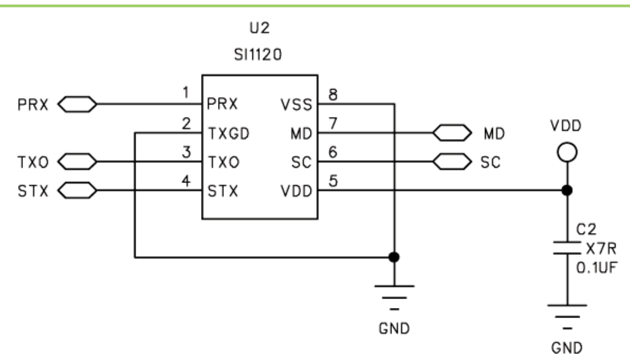


***Figure 7:** Silicon Labs Si1120-A-GM infrared proximity sensor*

The demonstration platform makes use of the aforementioned Si1120 (U2) infrared sensor, a C8051F930 MCU (U1), two Ir LEDs (D1-2) and a bank of visible blue LEDs (D50-57). The pertinent sections of the schematic are provided in **Figures 6** through **8**.

A brief video of the IrSliderEK demonstration board is available at **http://www.silabs.com/slidervideo**.

The gesture response curves in Figures 3 and 4, along with a main screen view in **Figure 9**, are screenshots from the publicly available and easy-to-use Silicon Labs QuickSense Studio development tool.

The QuickSense Studio development tool allows developers to quickly and easily configure infrared and capacitive sensors through a library of application programming interfaces (APIs). The QuickSense Studio offers a real-time monitoring and adjustment tool that enables a developer to thoroughly understand and

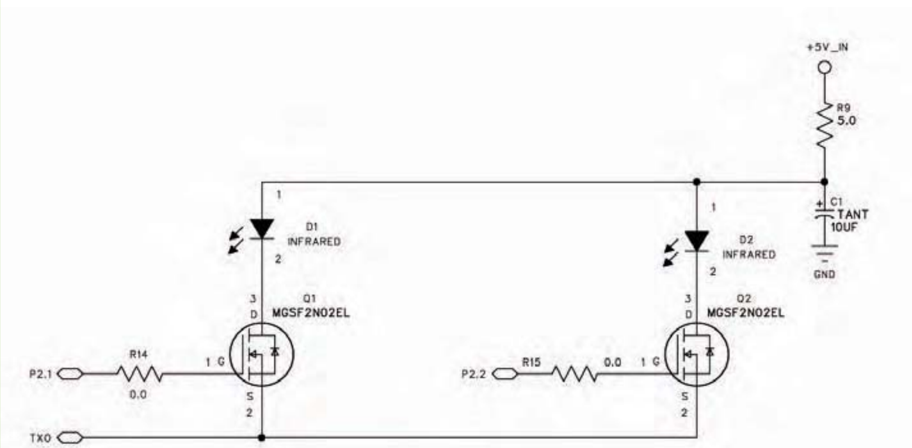


Figure 8: *Infrared LED drive circuit*

READER OFFER

We have 10 Si1120 Slider Board Demo Kits to give away. (To see what the evaluation kit can do please go to: https://www.silabs.com/products/opticalsensors/infraredsensors/Pages/IrSliderEK.aspx.)

If you'd like to win one of these kits please write to the Editor at Svetlana.josifovska@stjohnpatrick.com marking your email as 'Silicon Labs'. The first 10 names drawn 'out of a hat' will receive their prize.

Good luck!

optimize the user interface, including the touchless slider.

You may observe that the same system can be constructed with multiple sensors and a single Ir LED for ultra low-power implementations. Infrared LEDs consume a considerable level of power; however, the Silicon Labs Si1120 device has an ultra-high sensitivity photo-diode that offers a low active duty cycle Ir LED drive. The controlled 'on' time enables active infrared reflectivity sensing at just a few milliamperes, on average.

For developers with more ambitious interface requirements, a radial version of the touchless slider can be implemented by adding one additional Ir LED on a second axis. The radial touchless slider unlocks the door to additional gestures, such as circular motion or even a spiral-inward and outward motion.

With regard to the alarm clock, I eagerly await a technology-based improvement to my 5:30 AM mood. I will raise my glass to toast the developer of the first commercially developed alarm clock with a touchless slider snooze control. Once you have it developed, please email me; I would like to install an early prototype at my bedside.

Steve Gerber,
Director of Human Interface Products,
Silicon Labs
US

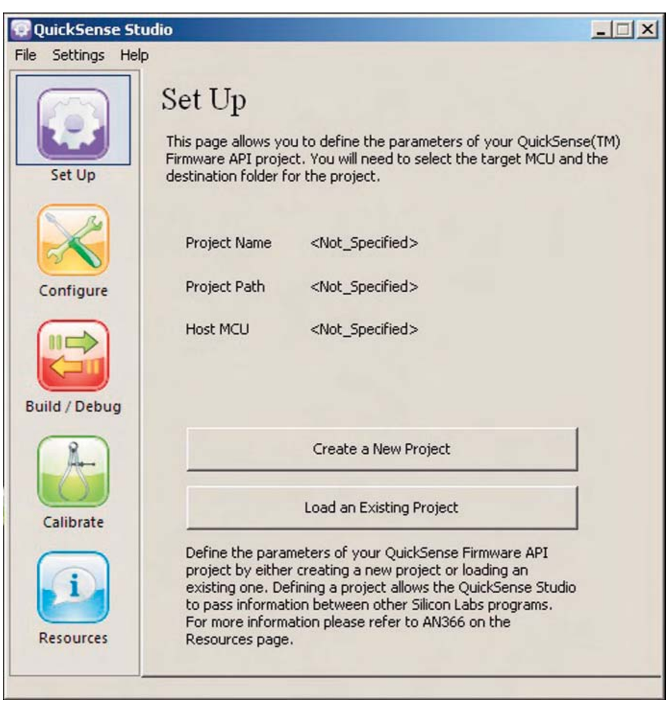


Figure 9: *QuickSense Studio design flow screenshot*

NEW PROGRAMMABLE MODBUS PSU IS DESIGNED FOR TEST AND INSTRUMENTATION

The new OPP-200 programmable Modbus power supply from Lincoln-based manufacturer VxI Power is designed for use in test and instrumentation systems where accurate control and monitoring are essential.

From its compact 3U housing the PSU delivers an output power of 200W, with voltage programmable from 2 to 20V DC in steps as small as 1mV. Output current limit can be preset in 10mA steps up to 10A.

Equipped with an RS485 serial interface, the OPP-200 is programmed by a host computer using the industry-standard Modbus communications protocol. Up to 192 of the units can be operated on the same bus, and this modular approach allows users to configure a power system with different variants of the OPP-200 to meet the precise needs of their particular application.

A dedicated 3U 19in subrack is available to enable multiple power supplies to be easily integrated into the host equipment. Incorporating a backplane, power distribution and auto address select facilities, the subrack can accommodate up to six OPP-200 units.

The PSUs are hot-swappable and individual status can be viewed locally via the backlit alphanumeric display on each unit's front panel. The parameters to be displayed are selected via the host computer.

Application support is available for customers wishing to use the power supply in a LabView environment. In addition to the standard OPP-200 unit, VxI is able to provide other voltage and current configurations to suit customers' specific requirements.

www.vxipower.com

NEW DC/DC MODULES FOR RAILWAY APPLICATIONS FROM MARTEK POWER

A new series of 120W DC/DC modules designed specifically for worldwide railway applications is announced by Martek Power. The CMS120 Series will interest designers of railway power supplies since they feature a very wide input voltage range, meet all relevant railway standards including EN50 155 and work across a broad operating temperature range without derating.

Designed to be PCB mounted, CMS Series modules are compact, measuring 92 x 45mm and just 20mm high, including an integral extruded aluminium heatsink. PCB connection is by 1.5mm diameter pins.

According to Martek Power, the new modules can be easily integrated into a customer's own power supply design using a minimum of external components. However, users can also use Martek Power to develop a custom power solution based around the CMS120 modules as "building blocks". Since the modules are available and already qualified to railway standards, this can provide a faster and more reliable route to market.

The new DC/DC modules accept a very wide range of input voltages across two versions. The low input version has range from 12 to 50.4VDC with nominal inputs of 24 and 36VDC. The high input version has a range from 43.2 to 154VDC with nominal inputs from 72 to 110VDC. Output voltages are 12 and 24V. Operating temperature range is -40°C to +85°C.

Under nominal conditions, the modules are 90% efficient and incorporate over-voltage and short circuit protection.

www.martekpower.com

NEW PIC32 32-BIT MCU FAMILIES EXTENDED PORTFOLIO VIA HIGH-PERFORMANCE CONNECTIVITY

Microchip is building on the success of its 80MHz 32-bit PIC32 microcontroller (MCU) portfolio with three new families. The new PIC32MX5/6/7 families are designed specifically for data-intensive applications running several software stacks simultaneously and are complemented by Microchip's free software stacks, making it easier for embedded designers to add connectivity to their applications.

Benchmarks continue to show the best-in-class performance of the PIC32, as published in recent EEMBC CoreMark scores and established Dhrystone scores. The new families couple the PIC32's leading performance with up to 128kbytes of RAM and extensive connectivity options, including 10/100Mbit/s Ethernet, two CAN2.0b controllers, USB Host, Device and OTG, and 6 UART, 5 I2C and 4 SPI ports. The integrated 100Mbit/s Ethernet MAC uses an industry-standard RMII/MIII interface to low-cost, commodity Physical Interface chips (PHYs), while the CAN and USB modules have a built-in DMA interface to maximise data throughput.

The new PIC32 Ethernet Starter Kit (part # DM320004, $72) was designed to enable easy Ethernet-based development, and the PIC32 USB Starter Kit II (part # DM320003-2, $55) is an upgrade of Microchip's existing USB starter kit for the new families. Owners of the Explorer 16 Development Board (part # DM240001) can purchase a $25 plug-in module for development with the new PIC32MX5/6/7 families (part # MA320003).

www.microchip.com

FOREMOST CELEBRATES 20 YEARS OF MEC SWITCH SALES

November 2009 was a milestone for Foremost Electronics, the Essex-based specialist distributor of electromechanical components, as it celebrated a twenty year association with MEC Switches, one of the leading European manufacturers of high quality switches.

Since its foundation in 1938, MEC Switches has earned a reputation for leading-edge design and the use of top quality materials combining to offer maximum reliability under all conditions.

Among the most popular MEC switch solutions available from Foremost are the versatile 3F multimec push-button switches which are available illuminated and non-illuminated, are waterproof sealed to IP67 and may be mounted using surface mount processes or through-hole soldered. The 3F switch unit has 1mm actuator travel and a 3N actuation force that gives a positive, audible tactile feel throughout its 10 million cycle mechanical life.

The 3F multimec push-button switches are available with a very wide range of cap styles offering designers thousands of options for panel design and layout. Foremost also offers a unique switch cap printing service and special LED colour options including the recently introduced white LED illumination.

Alan Cook, Managing Director of Foremost Electronics said: "Over the last twenty years we have established a great relationship with MEC. Our depth of product knowledge enables us to offer great service to our customers, we have very extensive stock holding and the most competitive prices available. We also have the most cap options in stock in the UK and offer tailor made solutions for our customers. Over the last twenty years we must have sold millions of MEC switches."

Mr Ivan Gam-Hansen, Managing Director of MEC, said: "Foremost has been our most successful distributor of MEC switches. Their commitment and dedication to promoting the MEC range over the last 20 years has been outstanding and unsurpassable".

For full information on MEC switches and accessories and all of the wide Emech product range available from Foremost Electronics, visit www.4most.co.uk or by call +44 (0)1371 811171.

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A new UK website, launched for robot enthusiasts, helps to make robot building easier by guaranteeing that mechanical and electronic components will work together.

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GENERAL MOTORS DEVELOPS TWO-MODE HYBRID POWERTRAIN USING MODEL-BASED DESIGN

General Motors Company (GM) has developed a Two-Mode Hybrid powertrain control system using The MathWorks tools for model-based design.

The Two-Mode Hybrid powertrain is part of GM's hybrid program, with multiple hybrid and electric vehicle technologies designed to meet diverse driving patterns and needs. Created to optimise fuel efficiency in both city and highway driving, the Two-Mode Hybrid powertrain combines a conventional engine with two 60kW electric motors integrated into an automatic transmission, as well as using new components such as battery and power electronics.

Using maths and simulation-based software tools, such as Matlab and Simulink, GM designed the powertrain prototype within nine months, shaving 24 months off the expected development time.

Our panel of commentators says the following on this development:

PROFESSOR DR DOGAN IBRAHIM FROM THE NEAR EAST UNIVERSITY IN NICOSIA, CYPRUS:

"This is a very good idea, especially in these days when everyone is thinking "green". The new vehicle will lessen the dependency on oil and will result in a safer and cleaner environment.

The news is also very important as it clearly shows the power of engineering-based simulation, including the accuracy and flexibility of highly respected Matlab and Simulink packages from The MathWorks."

BARRY MCKEOWN, RF AND MICROWAVE ENGINEER IN THE DEFENCE INDUSTRY, AND DIRECTOR OF DATOD LTD, UK:

"It appears to me that the dramatic reduction in this aspect of the development cycle is due primarily to the adoption of FPGA over the historical ASIC device technology incumbent of such a mass market. Assuming that this is indeed the case, it augers well for FPGA technology to which the tools sets mentioned are primarily structured to address and, as such, is more suited to collaborative ventures, between GM and other small and innovative companies in the emerging Telematics industry."

MAURIZIO DI PAOLO EMILIO, TELECOMMUNICATIONS ENGINEER, INFN – LABORATORI NAZIONALI DEL GRAN SASSO, ITALY:

"The MathWorks simulation packages and the innovative technique used by GM can also be applied in other fields of transportation to improve efficiency (including power electronics) and help R&D teams communicate with the design requirements, changes and errors in the design process, and hence saving valuable time and resources.

It seems that any application in any other technological field can benefit from such packages to reduce the cost of products and make them accessible to everyone."

HAFIDH MECHERGUI, ASSOCIATE PROFESSOR IN THE FIELD OF ELECTRICAL ENGINEERING AND INSTRUMENTATION AT THE UNIVERSITY OF TUNIS, TUNISIA:

"Electric traction dates from long time ago and was applied primarily in the field of handling. This technique was based on DC engines controlled by reversible choppers, ensuring the energy exchange between source and load.

A while ago these choppers were replaced by frequency converters feeding from the asynchronous machines that replaced the DC machines showing collector maintenance problems. With the oil world-wide crisis and the Kyoto international agreement relating to CO_2 emissions, several car companies were directed towards the marketing of hybrid cars or the completely electric ones.

We think that this is an orientation in the right direction; however if the converters are well controlled, it then depends on the level of technology used in the accumulators which still pose problems when it comes to weight, autonomy, time of refill, lifespan and cost.

Indeed, the suggested program by General Motors constitutes a challenge. This program uses design tools based on The MathWorks and simulation software such as Matlab and Simulink. This clearly helps to produce hybrid vehicles.

This program is exciting but there is certainly much work to do in this field, and it is interesting to see how various aspects continue to contribute to such developments."

IVOR CATT, ELECTRONICS ENGINEER, UK:

"Petrol is very difficult and dangerous to handle, so certain procedures developed for its handling do not apply to the electric car, but they seem to still be regarded as necessary constraints. It takes a long time to pump petrol into a car, so it must only occur every 200 miles. It would be dangerous to quickly exchange a full tank for an empty one to be left behind.

Equally, the electric car battery is conceptually trapped into the paradigm of the car starter battery, but this is a completely different problem.

Properly, the electric car's battery is rented, not bought. At the "refill" station there is a quick-change procedure. The "refill" procedure, being so quick, can occur every 20 miles on the motorway, leading to a massive reduction in battery size. It is totally wrong to aim for petrol-type, 200-mile range for an electric car. Off motorway, a larger battery will be towed behind. It seems that this is not considered, because towing a petrol car would be too dangerous.

A core idea is that very little driving is more than a few miles off motorway. Driving is either very short, or the short distance getting to a motorway and, then, the short distance at the other end off motorway. The need to tow a large battery will be unusual. At all other times, the small battery will lead to a lighter car.

Back on the motorway, a feeler from the car will try to pick up power from the road in the same way as a trolley bus used to. It will not succeed during overtaking. If this system proves successful, the battery will be even smaller.

Issues to consider: there are other means of electrical energy storage – capacitor or high speed flywheel are fully compatible with the above. All let us escape from the danger of petrol."