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Digital Power System Management for Every Occasion

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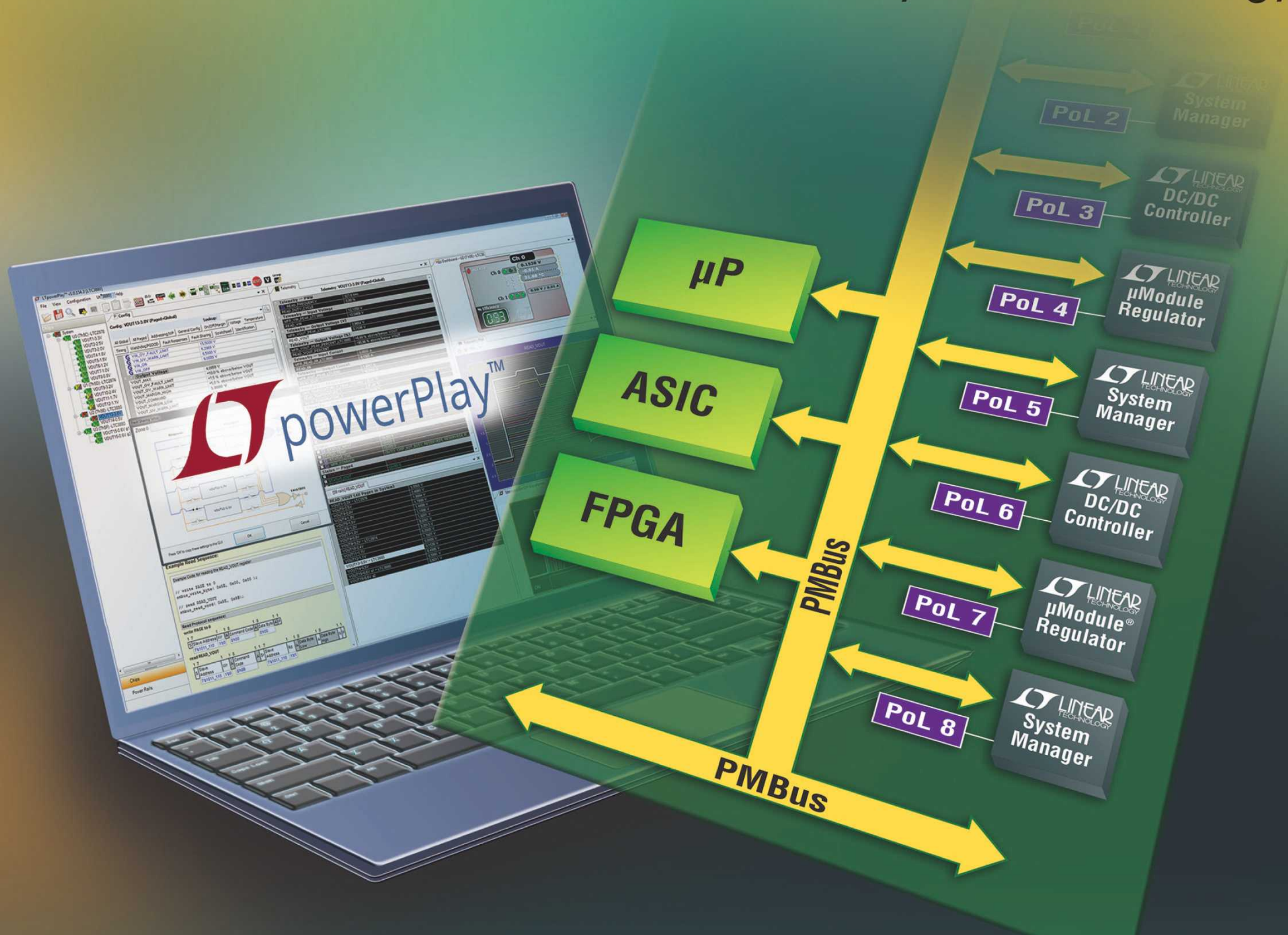

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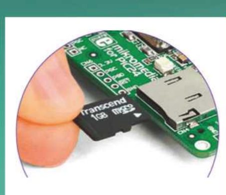

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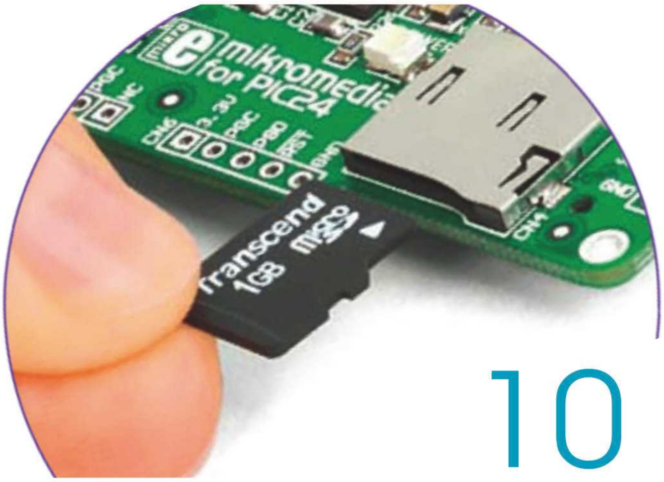

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SIX KEY TRENDS IDENTIFIED AT MWC 2015

> "MWC 2015 also confirmed the re-emergence of virtual reality and a growing interest in augmented reality

Imagination Technologies has identified six main trends driving industry momentum at the recent Mobile World Congress 2015 (MWC) event in Barcelona, which focused on security, IoT interoperability, wearables, computer vision, communications infrastructure and ultra-low power connectivity. The trends are:

1. Proliferation of highly integrated, ultra-low power communications.
It was clear at MWC that the mobile device category now includes an enormous number of products beyond mobile phones and tablets – from wearables to automotive to the huge range of IoT devices. Low-power Wi-Fi, Bluetooth Smart, Cat 1 and Cat 0 LTE and other short-range wireless technologies are at the heart of these devices, which are finding their way into every industry, every product category and everyday life.

2. Expansion and virtualization of the network infrastructure.
To accommodate the exploding number of connected devices and the growing cloud infrastructure, 4G buildout continues around the globe. At MWC, 5G was a hot topic, despite the lack of a definition. Companies are already looking to the advantages it will provide in the 2020 timeframe. The next generation of infrastructure will require advances in communications and embedded processing to support software-defined networks (SDN) and network function virtualization (NFV).

3. Security is crucial.
In an increasingly connected world, where any system is only as secure as its weakest link, embedded security has become a critical issue for the next generation of connected devices. At MWC 2015, numerous companies announced security initiatives and technologies, including secure payments, secure mobile operating systems, virtualized solutions for BYOD (bring your own device), encryption and key management technology, security-enhanced phones and smartwatches, and even privacy glasses designed to protect against facial recognition technologies.

4. IoT interoperability is key.
The number of connected IoT devices will continue to grow, as will the number of vendors and the array of features and functions. As such, high-volume success and consumer satisfaction will be dependent on a level of interoperability not previously seen in the industry.

5. Wearables are entering the mainstream.
At MWC 2015 it was clear that wearables have become an integral part of any OEM product lineup. Numerous smart bracelets, smartwatches and specialized products such as fitness bands were introduced by established and emerging companies. The next wave of wearables will be defined as 'electronics meets fashion'.

6. Computer vision and VR/AR (virtual reality/augmented reality) applications represent huge opportunities.
Vision-aware technologies are increasingly being incorporated into smartphones, IoT devices, cars, robotics and other systems. MWC 2015 also confirmed the re-emergence of virtual reality (VR) and a growing interest in augmented reality (AR). To create devices that support computer vision, computational photography and new user and social experiences, companies need processing solutions that go beyond CPU/DSP cores to deliver sustained video-rate processing of HD content.

In addition to these trends, there was a growing prominence of LTE chipmakers at MWC2015, where the opportunity for growth has increased tremendously, as LTE migrates from operator-controlled mobile phone technology to a communications standard for M2M and IoT devices. Companies that develop LTE chipsets achieve competitive advantage by using multi-threaded MIPS CPUs in their designs.

The trends listed here have confirmed Imagination's vision for the future of mobile devices and the technology roadmaps it is aggressively pursuing across its entire IP portfolio to meet them.

"Imagination's technology roadmaps anticipate and increasingly drive these trends, as we focus on providing not only the cutting-edge PowerVR GPUs and MIPS CPUs that we are known for, but also the communications engines, video and vision processing engines, and secure heterogeneous processing platforms that deliver interoperability through open standards," said Tony King-Smith, EVP of marketing at Imagination Technologies. "We're excited to work with our partners to deliver the technologies that will form the backbone of tomorrow's mobile society,"

Imagination Technologies has a broad range of silicon IP (intellectual property), including key processing blocks needed to create SoCs (Systems on Chips) for mobile, consumer and embedded electronic devices (www.imgtec.com)

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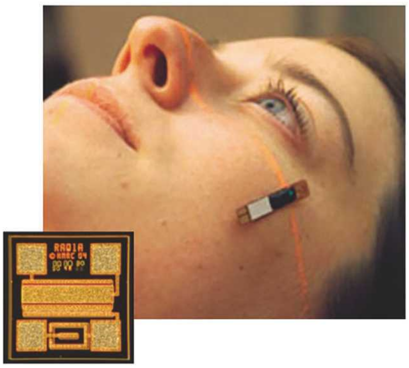
GATEONE INNOVATION ACTION LAUNCHED

In the effort to boost smart system innovation for small to medium size enterprises (SMEs), a new initiative called Gateone was set up in Grenoble, France, earlier this year. This is a European project with some 200 innovative product concepts offered to SMEs to boost their innovation, ranging from energy management, connected devices and smart cities, to mobility, assisted living and security and safety among others.

"The innovation inception phase represents the first gate in a New Product Introduction (NPI) process.



Gateone promises to encourage innovation for SMEs, such as this novel implantable electronic device for diagnostics and therapy by Tyndall

This initiative has the potential to make a difference in the innovation cycle for SMEs. Our vision is that smart systems are a huge opportunity," said Régis Hamelin from market analysts Yole Développement, who is a scientific coordinator of Gateone.

Smart systems, also called 'More than Moore' applications, are expanding much faster than the semiconductor industry. Their compound annual growth rate (CAGR) is already higher than 15%, with a total market in 2015 expected to reach $60bn, according to Yole Développement. To capitilize on such applications, Gateone gives easy access to recognised expertise from many renowned European R&D organisations, including CEA-LETI (France), Fraunhofer IPMS (Germany), VTT Technical Research Centre of Finland, IK4-Ikerlan (Spain), Teesside University (UK) and others. Access to the portfolio of innovative product concepts and demonstrators is free of charge, and some SMEs are already following up on these opportunities.

"Initiatives like Gateone are sponsored by the European Commission to provide relevant support to European SMEs. Gateone is considered an attractive approach to meet SME requirements for agile and reactive processes. We are strongly encouraging European SMEs to take advantage of this new initiative, which can make a big difference in Europe," said Javier Bonal from the European Commission.

GRAPHENE RUBBER BANDS COULD STRETCH THE LIMITS OF CURRENT HEALTHCARE

Research from the University of Surrey and Trinity College Dublin has identified a new type of sensor that will monitor body movements and help revolutionise healthcare.

Although body motion sensors already exist in different forms, they have not been widely used due to their complexity and high cost. The new research has focused on treating common elastic bands with graphene (right) to create inexpensive flexible sensor, sensitive enough for medical use. By fusing rubber with graphene – which generates electrical response on movement – the material can measure a patient's breathing, heart rate or movement, alerting doctors to any irregularities.

"Until now, no such sensor has been produced that meets needs and that can be easily made," said Dr Alan Dalton from the University of Surrey. "It sounds like a simple concept, but our graphene-infused rubber bands could really help revolutionise remote healthcare."

IT'S A (LUXURY) DOG'S LIFE

Samsung Electronics has unveiled a technology-laden Dream Doghouse – an ultimate in canine luxury. The futuristic structure was inspired by the growing trend to merge technology and pet care.

The prototype indoor kennel consists of areas dedicated to rest and relaxation, dining and fun, and an outside astro-turfed leisure area.

Research by Samsung involving 1,500 dog owners found that 64% believe their dogs would benefit from more technology and gadgets, with a quarter (24%) admitting they would like their dog to have a treadmill, and a similar

Samsung Electronics's Dream Doghouse kennel offers techy mod-cons for doggies

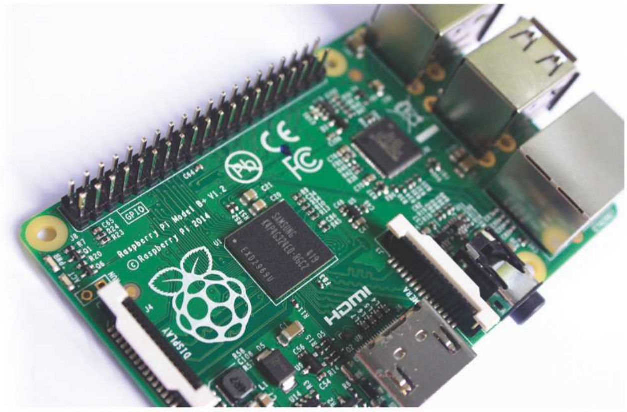
number (24%) a TV. A further 22% found the idea of a dog-operated feeder the most appealing.

Based on these requests, Samsung's Dream Doghouse includes tech features such as a wall-mounted Tab S TV viewing and a two-way communication, including distance video calls, a push-to-woof call bell to summon the attention of their owner, and a dog-operated snack dispenser.

The study also showed that this high-tech lifestyle may not be so far off, with a quarter (24%) of owners having a social media profile for their dog.

THIS SERIES PRESENTS THE RASPBERRY PI SINGLE-BOARD COMPUTER, ITS FEATURES AND BENEFITS, AND HOW TO USE IT FOR VARIOUS PROJECTS

Configuring Raspberry Pi As A Home Theatre PC



BY **GARETH HALFACREE**

One of the most popular tasks for the Raspberry Pi is a home theatre PC, or HTPC. The Broadcom BCM2835 at the Pi's heart is specifically designed as a multimedia powerhouse, originally developed for use in set-top boxes.

The graphics portion of the BCM2835 system-on-chip (SoC) design, a Broadcom VideoCore IV module, is capable of full-speed, high-definition video playback using the popular H.264 format. The chip is also able to play back different audio file formats, both through the analogue 3.5mm audio output and digitally via the HDMI port.

Its small size, low power draw and silent operation combine to make the Raspberry Pi an attractive platform for home theatre enthusiasts. A variety of distributions and software packages designed to turn the Raspberry Pi into a user-friendly home theatre PC have appeared since its launch, but there's no need to give up an existing operating system to get started.

Playing Music At The Console

The Pi supports a powerful text-based music playback package called moc (music on console), which – unlike other tools, such as LXMusic for example – can be installed and used even when there is no graphical user interface (GUI) installed on the Pi.

To get started, the moc package has to be installed from the distribution's repositories. For the Raspbian distribution, this is simple – just type this command at the console or in a terminal window:

sudo apt-get install moc

If you spend a lot of time outside the GUI and working at the console, moc is a great choice for music playback. Unlike other tools, it runs in the background, so there's no interruption to the music if you start doing something else.

To load moc, use the command mocp rather than moc. This is because there's another tool which uses the command moc, so a different name was chosen to prevent the operating system from getting confused between the two.

To get started, just enter the console – or a terminal window if you're using a desktop environment – and type **Mocp**.

The standard mocp interface is split into two panes (see Figure 1); at the left is a file browser (allowing the selection of music), while the right pane shows the playlist.

Where the power of mocp becomes apparent is when you exit the application by pressing the Q key. Running the mocp command again restores the interface, allowing songs to be changed, paused or stopped. Mocp can be also directly controlled from the terminal, without having to use the interface.

Running the mocp command with flags – the options that follow a command, prefixed with a hyphen character – allow start, stop, pause, skip and change of playback without having to go into the software.

The most common mocp flags are:

- -s is to stop playback;
- -G is to pause or resume playback;
- -f is to skip to the next song in the directory or playlist;
- -r is to return to the previous song in the directory or playlist;
- -i is to print information on the current song to the terminal or console;
- -x is to stop playback and quit mocp altogether.

For more information on controlling mocp, type **man mocp**.

Dedicated HTPC With Raspbmc

Being able to play music on the Raspberry Pi is one thing, but the BCM2835 can do much more than that. Using its VideoCore IV GPU, it can decode and play back full HD 1080p H.264 video, making the Pi a powerful media centre in a tiny package, with extremely low power demands.

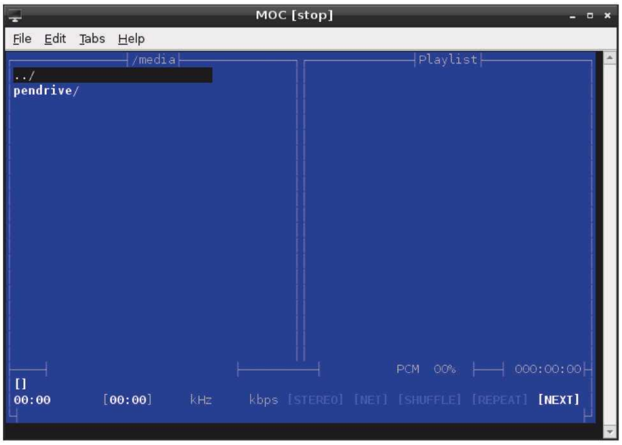


Figure 1: The standard interface of the mocp console-based music player

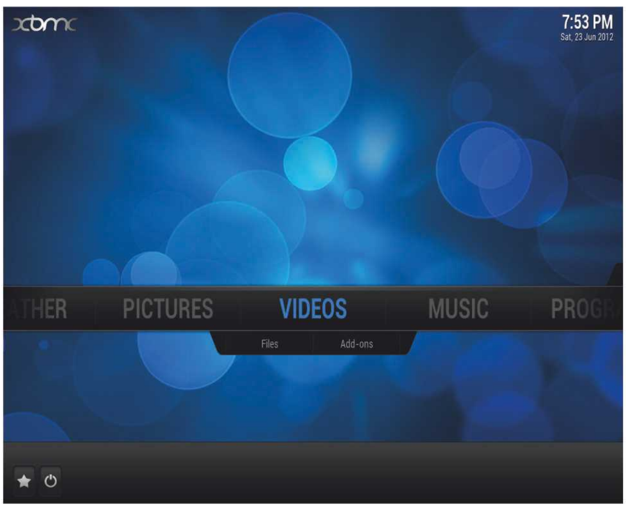


Figure 2: Raspbmc automatically starts the XBMC service

To get the most from the Pi as a home theatre PC, however, some additional software is required. This can be installed in the Raspbian distribution, but there's an easier way to get started: switching to the Raspbmc distribution.

Raspbmc, created by Sam Nazarko, is a distribution aimed specifically at turning the Raspberry Pi into a full-featured media centre system, complete with video and music playback, photo viewing and Internet streaming capabilities. It's based on the popular XBMC distribution, which has been chosen by several device manufacturers to power their commercial set-top box systems.

If you plan to use the Pi's high-definition video output and H.264 decoding capabilities in your home theatre setup, Raspbmc is an excellent choice and no more complicated to get up and running on the Pi than any other Linux distribution. First, download the installer from the official website at www.raspbmc.com/download. This is the easiest way to get Raspbmc up and running.

Installers for Linux, OS X and Windows are provided, which automatically download the image file for Raspbmc and write it to an SD card connected to the system. Although you can also download an image file and use the instructions from Chapter 1, "*Meet the Raspberry Pi*", it's not necessary to do so.

However, if you already have an SD card you use with the Raspberry Pi, be aware that installing Raspbmc on it will delete its contents. Back up any files you want to keep, or if you want to be able to switch between the two distributions, buy a second SD card specifically for Raspbmc use, or install it alongside Raspbian using the NOOBS tool described in Chapter 2, "*Getting Started with the Raspberry Pi*".

When the Raspbmc installer finishes, insert the SD card into the Pi and reconnect the power supply, but make sure the Ethernet cable is connected as well, because Raspbmc needs to download some data from the Internet when it first loads.

The initial load of Raspbmc can take 10-15 minutes as it downloads updates and partitions the SD card, but subsequent loads are significantly faster. Don't panic if the first boot seems to hang at the formatting partitions stage – a long pause here is normal.

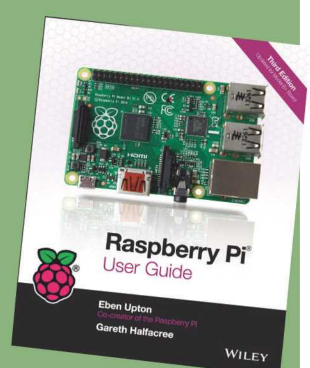
When loaded, Raspbmc automatically starts the XBMC service (see Figure 2), which provides a custom user interface specifically designed for living-room use.

Everything is accessible through the keyboard or mouse, with large and easily readable text, and categorized menus to make it easier to find things.

You can also purchase infrared remote controls, which come with a receiver that plugs into the Pi's USB port, and a handheld transmitter that allows for a true home theatre experience with no bulky keyboards or trailing wires. ●

This is an edited extract from the 'Raspberry Pi User Guide', 3rd edition, by Eben Upton and Gareth Halfacree

RASPBERRY PI USER GUIDE



Gareth Halfacree is co-author of the '*Raspberry Pi User Guide*' with project co-founder Eben Upton.

Halfacree often reviews, documents and contributes to projects such as GNU/Linux, LibreOffice, Fritzing and Arduino. He is also the creator of the Sleepduino and Burnduino open-hardware projects, which extend the capabilities of the Arduino electronics-prototyping system.

We have copies of the '*Raspberry Pi User Guide*' to give away at the end of the series. Register your interest by writing to the Editor at svetlanaj@sjpbusinessmedia.com, mentioning the title of the book in the heading.

Storage

LUCIO DI JASIO, ELECTRONICS ENGINEER AND TECHNICAL AUTHOR, PRESENTS THIS SERIES ON EMBEDDED USER-INTERFACE DESIGN ON A BUDGET

One of the greatest challenges to providing a modern user interface in embedded control applications is the limited amount of RAM and flash memory available.

As discussed in the previous articles, fonts and graphic images in particular tend to gobble up all the available space very quickly. A single 16-bit colour QVGA (320 x 240) background image takes up 150kbytes of storage space (which is more than 50% of the PIC24's flash memory hosted on a typical Mikromedia board) – unless compression methods are used. It comes down to a compromise between compression and performance.

The Microchip Library for Applications (MLA) offers both: lossless compression algorithms (like bitmap RLE and GIF) that are most effective on "artificial" images; and lossy compression algorithms (like JPG), most effective on "photographic" images. In both cases, there's compromise between compression time and performance on the one hand, and storage on the other.

Even upgrading the processor to a newer generation with on-chip flash memory of couple of megabytes (PIC32MZ, for example) might not help much, although it might significantly impact the budget. It is therefore becoming clear that, even for the simplest of applications, alternative solutions need to be found for the problem, outside the microcontroller.

There are two basic options to carefully evaluate: using a serial flash device and/or a mass storage device. Serial flash devices are the natural extension of good old serial EEPROMs. Typically accessible via a simple SPI (which is a synchronous serial) interface, they represent the easiest and most reliable way to add a few megabytes of storage to the application. A serial memory device is usually soldered directly next to the MCU, which provides short connections for high-speed communication and excellent resistance to mechanical vibration.

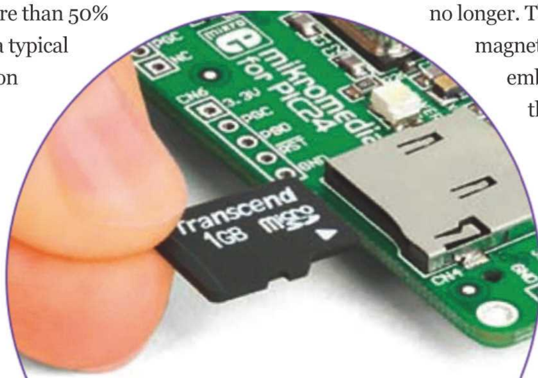


Figure 1: MicroSD card connector detail

Outer Space

As mass storage devices go, we could be looking at Compact Flash (CF) cards, memory (flash) sticks and MMC/SD cards. A few years ago I could have mentioned hard drives as well, but no longer. The world has changed, and rotating magnetic memory (if it ever had a role in embedded control) is pretty much off the menu today.

Still, hard drives and CF cards have a lot in common, the IDE parallel interface kind at least (SATA is a different story). An 8- or 16-bit Parallel Master Port (PMP) is all it takes to talk to them; one such interface is found on most 8- to 32-bit PIC microcontrollers.

MMC/SD cards, or rather the microSD card latest incarnation, are popular as ever and interface with most microcontrollers thanks to a compatibility access mode that once more is essentially relying on the SPI interface.

Flash memory sticks are USB devices, requiring only a microcontroller with a USB interface and host capabilities, both quite commonly available on modern 16- and 32-bit microcontrollers.

All three technologies (CF, USB sticks, and microSD) provide very low cost per megabyte (or even per gigabyte nowadays), with the added feature of being removable, a bonus in some applications but a curse in others. The connector itself can be a source of reliability issues in some harsh environments and vibrations a concern in others.

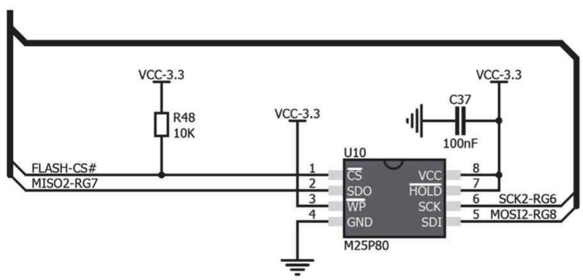


Figure 2: Serial Flash (25P80) PIC24 Mikromedia – schematic detail

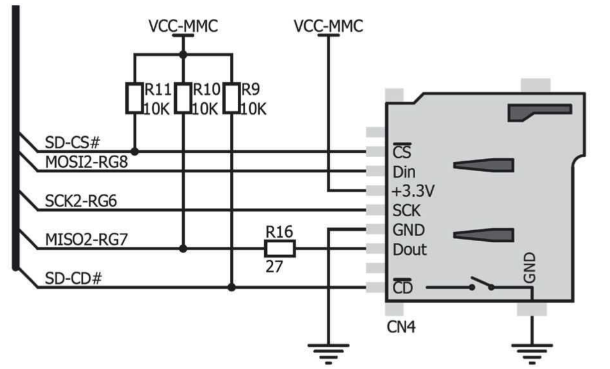


Figure 3: MicroSD card – PIC24 Mikromedia schematic detail

Learning To Share

Mikromedia boards feature both a serial flash mounting a 1MB 25P80 device, and a mass storage option mounting a microSD connector. Although a USB connector on the Mikromedia board permits the use of flash memory sticks (through an adaptor), we will postpone covering the USB interface to a future article due to its complexity and wide scope.

Figure 2 shows the serial flash connected directly to the second SPI port of the PIC24 and how a simple GPIO (FLASH-CS#) controls the Chip Select (/CS) line. However, Figure 3 shoes that the same SPI port (#2) is used by the microSD interface, although the Chip Select is in this case controlled by a different GPIO (SD-CS#), and a third GPIO (SD-CD#) is used for the Card Detect signal. This is a normal arrangement when sharing an SPI interface among multiple devices.

Driving Into Space

The MLA supports serial flash devices via one of the Board Support Packages. The M25P80 module handles the serial memory as a special case of the larger class of devices known as "superflash", and prefixes most functions with the SST25_ code common among such devices. But the actual low-level interface to the SPI port is achieved from the module drv-spi.c contained in the same folder. Both files (M25P80.c and drv-spi.c) need to be added to the project's Source Files logical folder.

Access to microSD cards is instead provided by the MDD File System, a library that provides full compatibility with FAT16 and FAT32 formatted cards of any capacity. This is very important, because thanks to such file system support, data files can be written to and read from most card types (XC, HC...), and shared directly with any personal computer running Windows, OSX or Linux.

To include the MDD File System in a project, two files need to be added to the Source Files logical folder in MPLAB X:
FSIO.c and sd-spi.c

As you may have guessed by now, both the serial flash support module and the MDD File System eventually rely on the Hardware Profile to abstract some of the hardware details (GPIOs used, speed, SPI mode used, etc).

```
*****************************************************************
******
 * IOs for Serial Flash
 *****************************************************************
*******/
#define USE_M25P80
#define SPI_CHANNEL_2_ENABLE
#define SST25_CS_TRIS _TRISC2
#define SST25_CS_LAT _LATC2

#define ERASE_SECTOR_SIZE 65536
#define SPI_FLASH_CONFIG { 2, 3, 6, 0, 1, 0, 0}
// chn, pri, sec, cke, ckp, smp, mode16
```

Listing 1: Hardware Profile, serial flash segment

```
/*****************************************************************
*******
 * IOs for the microSD card interface
 *****************************************************************
******/

#define USE_SD_INTERFACE_WITH_SPI

 // Registers for the SPI module
 #define MDD_USE_SPI_2

 // MDD SPI Configuration

 // Description: SD-SPI Chip Select Output bit
 #define SD_CS _LATG9
```

```
// Description: SD-SPI Chip Select TRIS bit
#define SD_CS_TRIS _TRISG9

// Description: SD-SPI Card Detect Input bit
#define SD_CD _RA6
// Description: SD-SPI Card Detect TRIS bit
#define SD_CD_TRIS _TRISA6
```

Listing 2: Hardware Profile, MDD File System segment

Comparing Listings 1 and 2 you will certainly notice how the two modules differ in their approach to peripheral abstraction. While both eventually access the SPI2 port, for legacy reasons they do so via two separate "drivers" – drv-spi.c and sd-spi.c. This could be very dangerous if we were to share a resource that requires just a little more "real estate", but the SPI interface is actually so simple and straightforward that there is no harm in alternating access to it, as long as operations are kept "atomic" (we are not going to use those drivers in interrupt calls).

To make things even simpler, both the microSD and the serial flash use the same mode of the SPI port, and operating speeds are compatible too. It is clear that in the MLA evolutionary trajectory the two drivers will be unified in the very near future.

Integration With Graphics And Touch

In the previous month's column we complained of the constant repetition of the touch calibration routines and explained how to fix that. In our project, we can allow the touch module to access the serial flash, reserving a few memory locations for its use, by simply passing three functions (pointers) to the TouchInit() function:

```
#ifdef _USE_SERIAL_FLASH
 TouchInit( &SST25WriteWord, &SST25ReadWord,
&SST25SectorErase, NULL);
#else
 TouchInit( NULL, NULL, NULL, NULL);
#endif
```

Listing 3: Using the serial flash to store touch calibration information

Similarly, in an earlier article we considered accessing bitmaps and fonts from an external memory. This can be enabled by uncommenting a pair of "switches" in the GraphicsConfig.h file as shown below:

```
#define USE_FONT_EXTERNAL // Support for fonts located
in external memory
#define USE_BITMAP_EXTERNAL // Support for bitmaps
located in external memory
```

Listing 4: GraphicsConfig.h segment, enabling external memory storage

USER INTERFACE DESIGN FOR EMBEDDED APPLICATIONS

Lucio Di Jasio is EMEA Business Development Manager at Microchip Technology. He has held various technical and marketing jobs within the company's 8, 16 and 32-bit divisions for the past 18 years. Lucio has published several books on programming for embedded control applications, and we have three copies of his book *'Graphics, Touch, Sound and USB, User Interface Design for Embedded Applications'* to give away at the end of the series. If you want to win, please send an email to svetlanaj@sjpbusinessmedia.com, mentioning the book in the heading.

Finally, we can enable loading compressed (GIF, JPG) image files directly from a microSD card via the (MDD) file system by using the MLA Image Decoders library.

Compromises

It is understood that serial flash and microSD represent a different sets of compromises. By going outside the board we have effectively traded (storage) space for (access) time. Serial flash memories have shorter access times and require a simpler API (application interface) – very similar, in fact, to a serial EEPROM.

> "Mass storage can be surprisingly easy to obtain in embedded control, as long as we are willing to use (and share) a simple SPI port

MicroSD cards have the largest capacity and lowest cost per mega/gigabyte), but (random) access is a little slower and packetized in blocks of 512 bytes (called sectors). However, microSD cards give the convenience of a full file system and permit sharing data with a personal computer.

In Closing

Mass storage can be surprisingly easy to obtain in embedded control, as long as we are willing to use (and share) a simple SPI port. The consumer market offers the convenience of microSD cards that can provide gigabytes-per-dollar economies of scale. Where reliability matters most, serial flash technology provides an alternative. The MLA handles both options with grace and integrates them seamlessly with the touch and graphics libraries.

Next month we will explore sound and see how that too will benefit from the new-found storage space. Stay tuned! ●

Consequences

BY **MYK DORMER**

It isn't necessary to spend very long in the radio industry – or in engineering in general – before you realise what an immense amount of effort is put into (and a huge number of words written about) project management. This in itself is not a bad thing: engineering resources are scarce and expensive, and customers need to get exactly what they need when they want it, without some vital detail being missed. Without strong and effective controls and planning tools, project timescales cannot be controlled or predicted, resources go wasted or unused, and large teams cannot be coordinated and their effort focused on the task at hand.

These rigid, top-down planning methods are not without their limitations. Many of these tools and methodologies originate from the "big" industries (aerospace, military and high-volume consumer sectors), where dozens – if not hundreds – of engineers need to be formed into multi-disciplinary teams and utilised in multi-million-pound projects that might take years, or even decades, to complete. In these environments the large teams can justify several layers of technically-experienced and capable engineering management, controlling resource allocation and executing specification-driven top-down design.

On the other hand, in the small companies typical of the low-power wireless industry, the situation is very different. These companies have very small engineering departments, often just one or two people, and these engineers usually work alone, or in small teams, often working on several projects simultaneously. In this environment flexibility is key, as the actual project specification frequently exists only as a discussion between customer and engineer, and the (much shorter) project timescales are often subject to change, as new technical problems unexpectedly crop up, or better solutions are devised.

Unfortunately, we are now seeing smaller companies trying to apply project management techniques developed for hundred-engineer teams, in organisations where the whole company workforce doesn't even reach a dozen. What seems to be a crusade against "engineer-led" projects is, in smaller organisations, having some highly undesirable effects:

- **Inefficiency**. Chains of command only make sense when there are significantly more subordinates than chiefs. Assigning a "project manager", frequently reporting to a "technical director", to manage an engineering "team" consisting of one engineer makes no sense, and yet it happens. Allow the sales and production managers to get in on the project management game and that one engineer can end up being simultaneously "managed" by two or three different people, who are frequently not coordinating with each other.
- **Bad decisions get made.** In a large team, the intermediate level project management staff is usual engineers, or has significant engineering experience. System design and specification tasks get executed by technically qualified and capable people. Translate this into a small company, where actual engineers are a scarce and expensive commodity, and you'll usually end up with a project manager with no real engineering experience at all, but who undertakes to conduct "top level" design and planning, frequently with input only from customers and other managers.
- **Stifled innovation.** Working alone, or in a very small engineering group, is (from a technical point of view) a highly intense experience. The engineer has a chance to see the entirety of the design as it progresses, and understand every detail of the project. This gives a perspective from where the potential of every small innovation and solution can be seen, in the context of possible new products or future improvements to follow up designs in the product family.

Rigid hierarchical management destroys this potential. Where every task is dictated from above and ideas "from the bench" are dogmatically ignored (because "we only work on what the customer has asked for"), the engineer is turned from an innovator into a drudge. No task relates coherently to the work of the previous one, and minimum-risk, minimum-time (but minimally inventive) solutions predominate. The company's product range becomes an incoherent scatter of unrelated customer specific "specials" and, in the long run, the risk of being out-innovated by a more agile (and often – ironically! – smaller) competitor becomes increasingly likely.

I am not advocating some form of technocratic anarchy, but in a small company it is madness to stifle the natural inventiveness of engineering staff under a dung-hill of managerial dogma. Innovation is a priceless resource to be used, not a problem to be eradicated. ●

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DIGITAL POWER SYSTEM MANAGEMENT FOR EVERY OCCASION

By Tony Armstrong, Director of Product Marketing, Power Products, Linear Technology Corporation

System architects of embedded systems, networking and datacom equipment are constantly being pushed to increase the data throughput and performance of their systems as well as add functionality and features. At the same time, pressure is being applied to decrease the system's overall power consumption. For example, in data centers, the challenge is to reduce overall power consumption by rescheduling the work flow and moving jobs to underutilized servers, thereby enabling shutdown of other servers. However, in order to meet these demands, it is essential to know the power consumption of the end-user equipment. To achieve this aim, a properly designed digital power management system can provide the user with power consumption data, facilitating smart energy management decisions.

To better understand this concept, consider if you will, the real life example of an embedded system. Most embedded systems are powered via a 48V backplane. This voltage is normally stepped down to a lower intermediate bus voltage, typically 12V, and then further stepped-down to 3.3V to power the racks of boards within the system. However, most of the sub-circuits or ICs on these boards are required to operate at voltages ranging from sub 1V to 3V at currents ranging from tens of milliamps to hundreds of amps. As a result, point-of-load (PoL) DC/DC converters are necessary to step-down from this intermediate bus voltage to the desired voltage required by the sub-circuits or ICs. And, to further complicate matters, these rails have strict requirements for sequencing, voltage accuracy, margining and supervision.

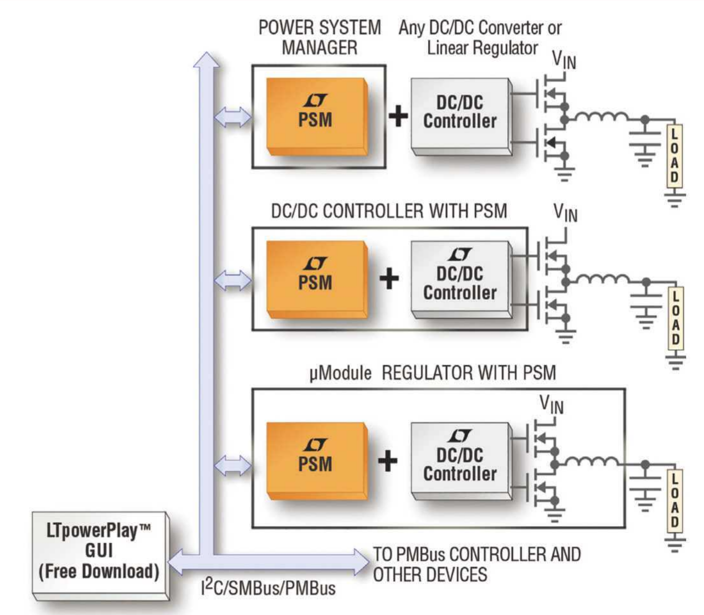

Figure 1: Typical Digital Power System Management System Configuration

Since there can be upwards of 50 PoL voltage rails in a datacom, telecom or storage system, system architects need a simple way to manage these rails with regards to their output voltage, sequencing and maximum allowable current. Certain processors demand that their input/output (I/O) voltages rise before their core voltage, alternatively certain DSPs require their core voltage rise before their I/O. To further complicate matters, power-down sequencing is also necessary. Consequently, designers need an easy way to make changes to optimize system performance and to store a specific configuration for each DC/DC converter in order to simplify the overall design effort.

Moreover, in order to protect expensive ASICs from the possibility of an overvoltage condition, high-speed comparators must monitor the voltage levels of each rail and take immediate protective action if a rail goes out of its specified safe operating limits. In a digital power system, the host can be notified when a fault occurs via the PMBus alert line and dependent rails can be shut down to protect the powered devices such as an ASIC. Achieving this level of protection requires reasonable accuracy and response times of the order of tens of microseconds.

For these reasons, digital power conversion ICs need to provide highly accurate digital power system management with their high resolution programmability and fast telemetry read-back for real-time control and monitoring of critical point-of-load converter functions. They must deliver high efficiency synchronous step-down conversion with I²C-based PMBus interface with over 100 commands and have onboard EEPROM. These devices must combine best-in-class analog switching regulator controllers with precision mixed signal data conversion for unsurpassed ease of power system design and management. Finally, it is also imperative that they be supported by the software development systems with easy-to-use graphical user interfaces (GUIs).

Smaller is Faster

Analog power advances are usually the result of circuit concepts that are developed. Very few of these cross manufacturer boundaries and rarely end up used by multiple companies in multiple products. This is unlike digital advances in process which tend to be proliferated across the industry. Analog IC design concepts that have proliferated over time include chopper-stabilized amplifiers, delta sigma A/D converters, BurstMode® voltage regulators, band-gap references and 3-terminal regulators. However, the accumulated knowledge of making complex functions in different processes continues to advance. This accumulated knowledge allows still higher functionality mixed signal ICs to be generated each year.

The continuing push for smaller line widths in digital ICs has had its effect on analog as well. These processes continually get faster and enhance the speed of analog ICs made on these processes. Analog to digital (A/D) converters are a good example

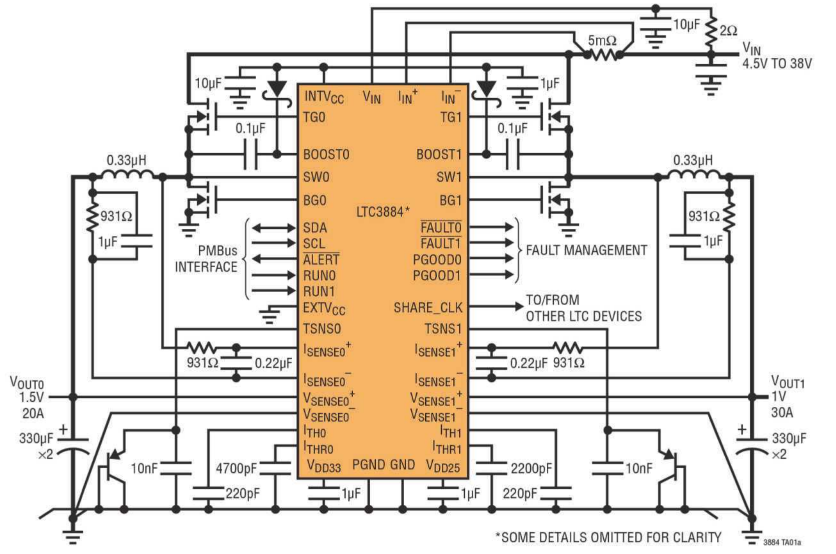

Figure 2: LTC3884 Schematic Delivering 1.5V at 20A & 1.0V at 30A

of where smaller line widths have led to faster A/D converters. Circuit advances improve the resolution as well as the speed, and new devices convert at 200 megabits per second with 16 bits of resolution. There's no reason to think that they will not continue to accelerate in speed and precision as techniques are developed to go faster and be more accurate.

These smaller line widths make practical some digital functions that were previously impractical in analog ICs. Power supply controllers with digital read back of voltage, current and status are achieved on the same chip as the power functions. A side benefit to these smaller line widths is the inclusion of DMOS transistors on the small feature digital process. These DMOS devices can handle high voltage as well as high current and allow the complete integration of power converters, switching regulators with both power and control on the same device.

Circuit advances in bipolar technology yield incrementally better references, amplifiers, and RF ICs. These enhancements are due to refinement in the circuitry and optimization rather than any type of breakthrough due to process. The competitive landscape for analog ICs keeps all manufacturers on their toes in trying to improve their products. However, it should be noted that since analog IC performance is based on real world parameters, the ICs can end up at the theoretical limits of performance. Once the theoretical limitation is approached, further improvements are just not possible. That's why some of today's best-selling and most widely used ICs were designed over 20 years ago and have not changed in the interim.

Digital Power System Management (DPSM)

With this background, what does the system architect have to do in order to configure a digital power system management solution for their end product? One of the primary objectives will be to design a system so that it can be easily configured and monitored via a digital communications bus. This will be achieved by utilizing one of the following; I²C, SMBus or PMBus. Either of these buses can enable on-demand telemetry capability to set, monitor, change and log power parameters of any PoL converter configuration within the system. A simplified snapshot of such a system is shown in Figure 1.

As can be seen in this example, the PoL converters illustrate 3 different topology configurations. At the top of the figure, a power system manager chip is used alongside a conventional DC/DC converter. The DC/DC converter can be of any topology and have any degree of integration since it is the power system manager that will allow it to be interfaced, controlled and monitored via the communication bus. The middle PoL converter demonstrates an increased level of integration, namely, that the DC/DC converter has the power system management built-in (in the same package). And finally, the bottom PoL converter is a compact module which incorporates the power system manager, the DC/DC converter and all its associated external components into a single form factor (Linear calls these a µModule® regulator).

Linear Technology offers a broad selection of devices to allow systems designers a choice of how to configure their digital power system requirements from system managers and their associated PoL DC/DC converters, to a single digital power µModule regulator. Figure 2 shows the schematic of the LTC3884, a dual output PolyPhase® step-down controller for ultralow DCR sensing with digital system power management.

The LTC3884 provides two high-current outputs from a wide 4.5 to 38V input voltage range with an I²C-based PMBus compliant serial interface. The controller employs a constant-frequency current-mode architecture, together with a unique scheme which enhances the signal-to-noise ratio of the current sense signal to provide excellent performance in ultralow DCR applications. Programmable loop compensation allows the controller to be compensated digitally. Switching frequency, channel phasing output voltage, and device address can be programmed both by the digital interface as well as external configuration resistors. Additionally, parameters can be set via the digital interface or stored in EEPROM. Both outputs have independent power good indicators and fault functions. Finally it is supported by Linear's LTpowerPlay™ software development tool with GUI.

Conclusion

Having digital power management capability in datacom, telecom or storage systems provides the system architects with the necessary tools to develop "green" power systems that meet target performance with minimum energy usage at the point of load, board, rack and even installation levels. This reduces infrastructure costs, as well as the total cost of ownership over the life of the product, while the software programmability of DPSM significantly reduces the debug time.

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FIBRE OPTIC CLEANING – THE KEY TO RELIABLE COMMUNICATIONS

BY **SEAN SHEEDY**, AUTHOR AND CONSULTANT TO THE TELECOMS INDUSTRY, AND FORMER FIBRE OPTIC SYSTEMS INSTALLER

Over 40 years ago, a technology was born that revolutionized the way the world communicates – fibre optics. Although thinner than a human hair, this technology is now an important medium that enables fast and reliable delivery of telecommunications. It eliminated many previous network limitations and expanded the capabilities of networks significantly, enabling real-time experiences, including mobile communications and video downloads, for business as well as personal use.

Fibre Optic Signals Are Under Threat

Perhaps the biggest downside of this high-speed data transmission is its fragility compared to its copper wire predecessor. There are really only two threats to a fibre signal: too much bending and too much dirt. One example is a major telecoms company which rolled out a new FTTH (fibre to the home) service. It found that 16% of all connectors on its expensive new network were sufficiently contaminated to cause performance problems. This proves that cleaning is not merely important, it is critical to the long-term reliability of any network and at the heart of the profitability of successful fibre deployment.

Figure 1: A close-up of a clean end-face, to illustrate the objective of what has to be cleaned

Figure 2: A photograph taken with a JDSU inspection scope of dust accumulating on a fibre end-face

Today's world of intensive communications, including the deployment of technologies such as WDM (wavelength-division multiplexing), DWDM (dense wavelength-division multiplexing), CWDM (coarse wavelength division multiplexing), WWDM (wideband wave division multiplexing) and others, have made fibre optics even more vulnerable, without the knowledge of how to clean the delicate fibres. Using these technologies, companies can accommodate multiple generations of communications within their optical infrastructure, without the expense and delays of having to constantly rebuild their networks. The capacity of a network can be expanded, almost infinitely, simply by changing the multiplexers/demultiplexers at each end. These capabilities were not a concern in the early days of fibre, when networks were slow and relatively rare, but today fibre is everywhere, and cleaning is critical.

Multiplexers and demultiplexers are greatly affected by reflectance and dispersion within the fibre link, and one of the biggest variables causing back-reflection and signal loss is debris on the connectors. Another major interference is heat dissipation from high-powered lasers, resulting from material mismatches and contamination. So, if the splices and connectors are not clean, the networks will not run at their best.

Cleaning Fibre

Cleaning is still the primary operational problem in the industry today, so being aware of its importance is essential; it should be a standard operating procedure, but it must be done correctly for best results.

The tools available to most technicians are the standard box of cellulose wipes and a pump bottle of isopropyl alcohol. However, even these tried-and-tested tools can cause problems.

For example, the lint-free wipe must be truly lint-free. Many wipes are made of cellulose, held together with glue or binders. These fibres are extremely weak and can easily shred. The glues that hold the paper together are dissolved by liquids such as water and alcohol, so glue often leaches out onto fibre surfaces.

A common problem is when companies buy high-quality wipes, and because they are more expensive, they tend to be reused.

Wipes should never be re-used, because contamination migrates; effectively the dirt is simply being moved from one fibre to another.

Then, there's the cleanliness, performance and packaging of the liquid used to dampen the lint-free wipe – also a crucial aspect of cleaning fibre. Isopropyl alcohol (IPA) is very popular, used in both the termination and splicing of fibre. It has many good characteristics: it's inexpensive, dissipates static, doesn't freeze, it's safe to use and very gentle.

The original Bell Labs specification was for water-free 'reagent grade' alcohol which is far more pure and more expensive than the cheap, diluted isopropanol most commonly found. IPA of this quality is very hard to find outside laboratory supply distributors, which means that most alcohol being used on fibre today is not reagent grade and is generally too dirty to properly clean fibre surfaces.

Another problem of today's high-powered lasers is the possibility of baking trapped moisture (and other residues) left on connector surfaces. Very often this creates additional reflectivity in the network and can be blinding to the transmitting devices. For best results, technicians should be provided with cleaning liquids in spill-proof, non-refillable containers so the cleaning fluid is not contaminated by dirty packaging.

Lastly, modern cleaning fluids have a very quick evaporation rate. A rapid rate of evaporation allows technicians to work faster, making it almost impossible for any residual fluids to be trapped inside alignment sleeves or baked onto an end-face.

Dealing With Static

One characteristic of IPA is its exceptional ability to dissipate static. With a static charge, particulate binds to surfaces surprisingly aggressively. For example, a large 500µ particulate takes twice the force of gravity (2G) of 'scrubbing' (mechanical action) to remove. But a 5µ flake of solid residue takes 20,000G to break loose from the intermolecular grip of the particle on the substrate. How do you get 20,000G of scrubbing force inside an LC connector? It's not that easy, but solvents help by neutralizing the static charge.

In the past decade there have been at least two studies looking at static on end-faces. It was observed that wiping an end-face with a dry wipe did not dissipate the static on it and may have even added a triboelectric charge to it, making it even more likely to attract particulate.

By using a wet-dry cleaning process, in which a cleaning fluid was used to dissipate the static and then a dry wipe to polish away any residual fluids the problem is solved. This is an excellent procedure and should be used by everyone in the fibre industry.

As technology progresses and lasers become more advanced, such as for example WDM that uses lasers that are extremely sensitive to reflectivity and contamination, the importance of cleaning is reinforced. It also means using the correct cleaning procedures by migrating to the next generation of cleaning materials and not just exchanging one issue for another.

Cleaning During Splicing

A common misconception is that cleaning is not necessary in splicing and connectorisation, except at the very end of the assembly process. This is not correct. When all the coatings have been stripped off the fibre, it must then be cleaned with a damp, lint-fee wipe to remove any remaining debris. If the fibre is going to be spliced, the cleaned fibre will be placed in a cleave tool, cleaved, and then placed in the v-grooves of a fusion splice machine or inserted into a mechanical splice. All of these tools must be cleaned properly or the splice could be optically defective or mechanically weak.

If a robust connection is required, the strand of cleaned fibre will be inserted through a connector body and ferrule. Given that single-mode ferrules have a tolerance of ±1 micron, and multi-mode ferrules are only slightly more generous, any debris or moisture has the potential to clog the ferrule, creating a number of problems.

When a dirty fibre is inserted through a connector, the contamination on the fibre exceeds the tolerances of the connector. This makes the path obstructive and the fibre fails

Figure 3: The optimal method for cleaning exposed fibre end-faces is to use a strong, clean, lint-free wipe dampened with a fast-drying, residue-free cleaning fluid. The end-face is dragged across the wipe, from the wet spot to the dry area. Properly executed, cleaning results will be perfect 99%+ of the time

Figure 4: It is absolutely essential the bare fibre be perfectly clean before inserting into a ferrule during connectorisation. Here the operator is preparing to clean with high-quality lint-free wipe that does not contain any glues or cellulose. The cleaning fluid evaporates quickly and the canister cannot be refilled, which ensures the cleaning fluid will remain pure and uncontaminated

Figure 5: An essential element in the cleaning process is to inspect every end-face properly after cleaning. Here the operator has installed a new connector on the fibre optic cable and is inspecting with a simple, handheld scope. Every technician who touches any fibre must be equipped with at least a low-power inspection scope

to pass freely through the ferrule. In most instances, the fibre binds and breaks off within the ferrule.

During the connectorisation process, the target connector is always prepared with very quick-curing anaerobic epoxy. If the bare fibre still has debris on it when it is inserted into the connector, the debris will mix with the adhesive, clogging the ferrule. This can result in slowing down the insertion of the fibre into and through the connector and ferrule. If this delay exceeds the allotted curing time, the epoxy will cure before the process is successfully completed.

Lastly, some cleaning materials have the potential to be corrosive. With today's more intricate fibres this can be a concern. Damage caused by corrosive cleaners can destabilise

Figure 6: The "wet-dry" cleaning technique is important for cleaning ports, as well as cleaning exposed end-faces. First, a technician dampens a cleaning swab with a nonflammable, fast-drying cleaning fluid. Then he inserts the cleaning tool into the port to ensure no residues remain on the end-face

the bonds of epoxies used to terminate connectors and cause pitting of newer ferrule materials. There is also the significant issue of chemically-sensitive users and the evolving regulations affecting chemical handling, storage and shipping.

If these issues occur, it will not only waste a technician's time but also have the knock-on effect of wasting money. However, if proper cleaning is introduced throughout the process these problems can be avoided.

Importance Of Cleaning

Cleaning is essential for today's fibre networks, and it should be at the forefront of considerations when handling fibre. There are quality companies offering a wide selection of connector and splice cleaning products that address all of these issues.

Though IPA is commonly used to clean bare fibres for splicing, insufficiently pure IPA can leave a reflective film of the end-face, has a slow evaporation rate and can be corrosive to connectors. To combat this, a cleaning fluids that dries quickly (without allowing any moisture to remain on the connector or trapped in the alignment sleeve), does not have corrosive properties, is nonflammable, easily transported, environmentally friendly and vapour-free, should be considered.

Care must also be taken when selecting the correct wipes. Wipes made with synthetic fibres, without cellulose or glues, are essential for proper cleaning. They should also be small and easily disposable, so there is no inclination by the technician to re-use the wipe, and therefore to re-contaminate.

By following these simple steps, fibre optic networks and the way they perform will be significantly improved, reducing the time and money needed to ensure they run without a fault.

ARCHITECTURE OF OPTICAL COMMUNICATIONS AND SYSTEMS

STOJCE DIMOV ILCEV FROM DURBAN UNIVERSITY OF TECHNOLOGY IN SOUTH AFRICA INTRODUCES THE ARCHITECTURE OF OPTICAL COMMUNICATIONS IN CIVILIAN AND MILITARY APPLICATIONS THAT REQUIRE HIGH QUALITY AND HIGH SPEED SIGNALS

Since its invention in the early 1970s, the use and demand for optical fibre have grown tremendously. With the explosion of information traffic due to the Internet, electronic commerce, computer networks, multimedia, voice, data and video, the need for a transmission medium with bandwidth capabilities large enough to handle such vast amounts of information is paramount.

Fibre optics technology, with its nearly unlimited bandwidth, has proven to be the solution for today's telecommunication networks. Terrestrial telecommunication companies today use optical fibre cable to carry plain old telephone service across their nationwide networks. Local telephone service providers use fibre to carry this same service between central office switches at more local levels and sometimes as far as the neighbourhood, small business or individual home.

Optical fibre is also used extensively for transmission of data by large corporations, banks, universities, business firms and others with their own private networks, all requiring secure and reliable systems to transfer information between buildings, to desktop terminals and around the world. Cable television companies find fibre useful for modern video services; the high bandwidth of fibre makes it the perfect choice for transmitting signals to subscribers, and the security inherent in optical fibre is a major benefit.

Increased Data Rates

Fibre optic systems can maximize overall connectivity and efficiency. Optical cable with 50μm Optimized Multimode (OM) fibre, such as OM3 and OM4, provides bandwidth capabilities that support transmissions up to 10GB/s for existing applications, as well as future applications requiring 16-100GB/s and beyond. Transmission performance, data-rate scalability, pathway and space utilization, electronics port density, power and cooling efficiencies and ease of installation and testing are factors that make optical connectivity a serious competitor to 10GBase-T and copper connectivity in the data centre.

The optical 10Gbit Ethernet standard of 2002 (802.3ae), with 10GBase-SR Physical Media Dependent (PMD) for short-range links up to 300 meters, is emerging as the dominant and best-suited 10GB connectivity solution using OM3 fibre.

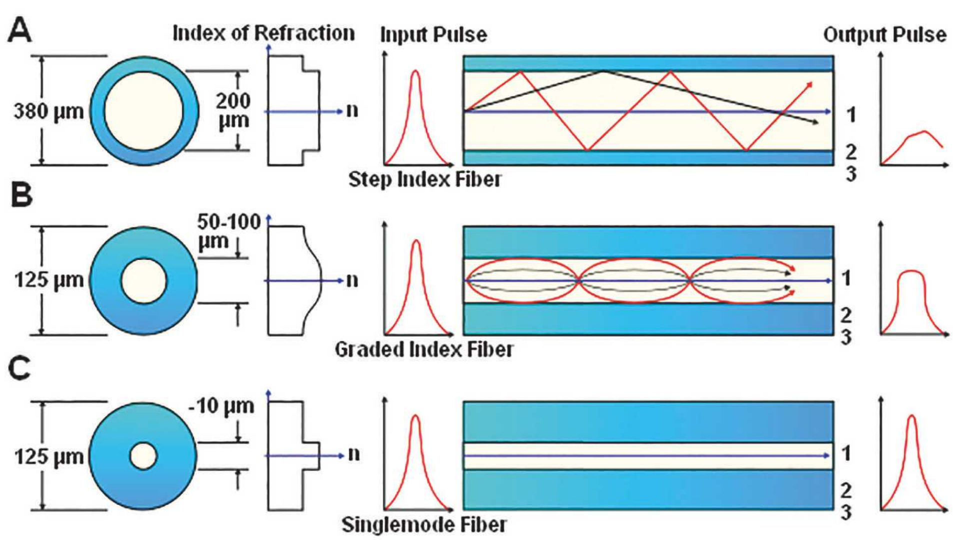

Figure 1: SDR scheme

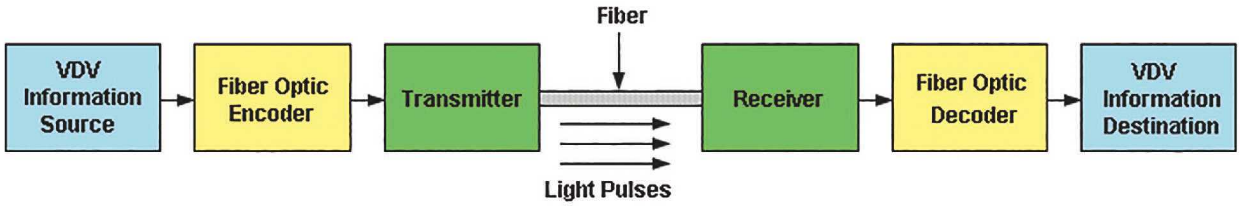

Figure 2: Primary elements of an optical fibre network

Optical Fibre Communication Benefits

The 'fibre' world began in the early 1980s in the US. At that time, systems operated at 90MB/s, a data rate at which a single optical fibre could handle approximately 1300 simultaneous voice channels. Today, systems commonly operate at 10GB/s and above, which translates to over 130,000 simultaneous voice channels.

> "Anyone with a vested interest in telecommunications would be wise to learn more about the tremendous advantages of fibre optic communication

Over the past 15 years, new technologies such as Dense Wavelength Division Multiplexing (DWDM) and Erbium Doped Fibre Amplifiers (EDFA) have been used successfully to further increase data rates to over a terabit per second or > 1000GB/s over distances above 100km. This is equivalent to transmitting 13 million simultaneous phone calls through a single hair-size glass fibre.

The growth of the fibre optics industry over the past fifteen years has been explosive, and it is expected to continue to grow at a tremendous rate well into the next decade and beyond. Anyone with a vested interest in telecommunications would be wise to learn more about the tremendous advantages of fibre optic communication, some of which are:

- Immense bandwidth;
- Total electrical isolation in the transmission medium;
- Very low transmission loss, small size and light weight;
- High signal security, immunity to interference and crosstalk;
- Very low power consumption and wide scope for system expansion.

Due to the variety of advantages optical fibre communication systems offer, they have a wide range of applications in different fields.

- Public networks that include trunk, junction and local access networks, and submerged and synchronous systems among others;
- Radio and satellite fixed, mobile and military applications;
- Civil, consumer and industrial applications, including research.

There are three primary types of transmission modes using optical fibre:

1. Step Index – It has a large core, so light tends to bounce around inside the core, reflecting off the cladding. This causes some rays to take a longer or shorter path through the core, with some taking the direct path with hardly any reflections while others bounce back and forth. The process results in light arriving at the receiver at different times, and the signal with lengthened pulses. Light emitting diode (LED) sources are used and typical core diameter is 62.5 microns.
2. Graded Index – A gradual change in the core's refractive index, causing light to gradually bend back into the core path (see Figure 1B). The result is a better receive signal than with step index. LED sources are used and typical core diameter is 62.5 microns.

   Both step and graded indices refer to multimode optical fibres and dielectric waveguides, which can have many propagation modes. In Figures 1A and B, regions 1, 2 and 3 are the core, cladding and coating, respectively. The coating is a plastic that protects the glass from abrasion. The cladding glass has a refractive index, a parameter related to the dielectric constant, which is slightly lower than the refractive index of the core glass.
3. Single Mode – It has separate distinct refractive indexes for the cladding and core, see Figure 1cC. In this case there is no pulse spreading at all, due to the different propagation time of the various modes. Light passes through the core with relatively few reflections off the cladding, thus this mode is used for single-source light (one colour) operations. It requires a laser source and the core is very small, 10 microns.

The Optical Fibre Medium

A basic fibre optic system is a link connecting two electronic circuits at a distance, and there are three fundamental parts, shown in Figure 2.

- Transmitter - This unit converts electrical voice, data and video (VDV) signals to an optical signal, using a fibre optic encoder. The light source is typically a light-emitting diode or laser diode. The driving circuit for the light source changes the electrical signal into the driving current.
- Fibre Optic Cable – This is the transmission medium carrying light between transmitters and receivers.
- Receiver – This unit accepts the light or photons and using a

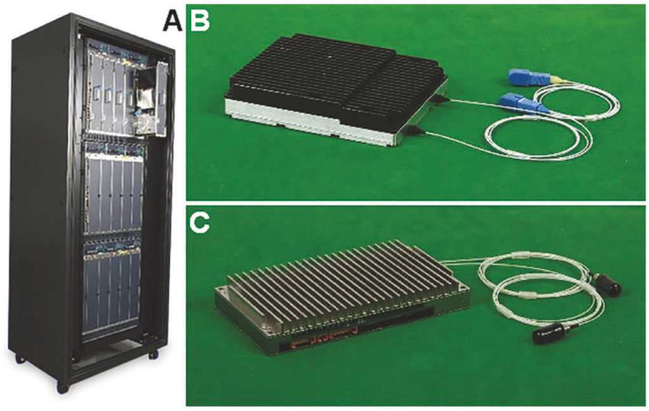

Figure 3: Transceivers for optical fibre networks

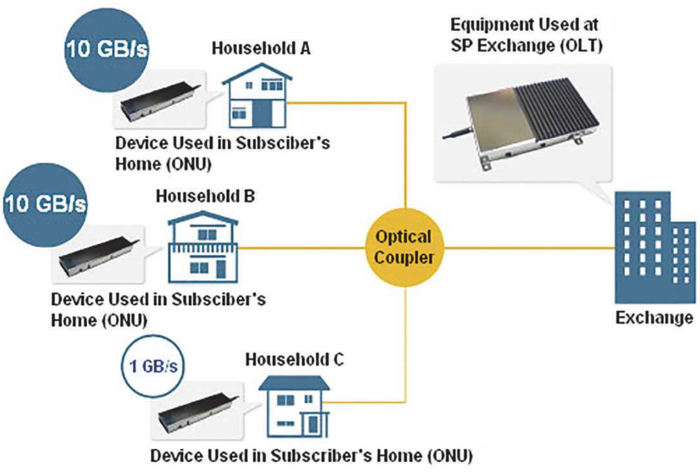

Figure 4: System architectures of 10 G-EPON prototypes

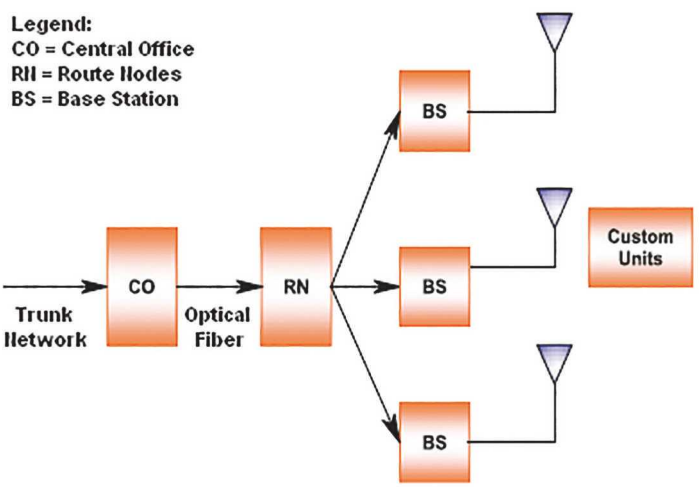

Figure 5: Architecture of a FiWi network

fibre optic decoder converts them back into an electrical signal. In most cases the resulting electrical signal is identical to the original signal fed into the transmitter. The second receiver section is the output circuit, which reshapes and rebuilds the original VDV signals before passing them to the output.

Depending on the application, the transmitter and receiver circuits can be very simple or quite complex; other components that make up a fibre optic transmission system, such as couplers, multiplexers, optical amplifiers and switches, provide the means for building more complex links and communications networks.

Beyond the simple link, the fibre-optic medium is the fundamental building block for optical communications. Many optical components have been invented to permit signals to be processed optically without electrical conversion. Indeed, one goal of optical communications is to be able to operate entirely in the optical domain end-to-end.

● Standard optical VDV communications links can span hundreds of miles with no need for amplification or external signal treatment. For an example, Optical Carrier level 3 (OC-3) used in network backbones can transmit at 155MB/s, whereas the larger OC-192 carrier can push data at nearly 10GB/s. Support for increasing broadband communication demands is provided by Mitsubishi Electric's 40GB/s optical transceiver (transmitter and receiver) system that has transmission speeds four times faster than at present, as well as key devices, shown in Figure 3A. The same company has developed the smallest optical transceiver module for short-range, up to 2km, light-wave transceivers to connect telecommunications equipment within buildings, shown in Figure 3B. An additional development is Mitsubishi's multi-wavelength integrated dispersion compensation module, to equalize the waveform distortion of up to 32 wavelengths, shown in Figure 3C. Using a special optical transponder that deploys Differential Quadrature Phase Shift Keying (DQPSK) makes it possible to reduce waveform distortion after long-reach transmission caused by polarization mode dispersion.

10G-EPON Prototype Systems

Fibre-To-The-Home (FTTH) services have overtaken Asymmetric Digital Subscriber Line (ADSL) services, which use copper telephone lines, to become the major broadband services in use today. The existence of Passive Optical Network (PON) technology that enables the realization of low-cost architectures in which a single optical fibre can be shared by multiple users, is one factor in the rapid spread of FTTH. From Synchronous Transfer Mode (STM)-PON in the 1990s to today's standard, GE (Gigabit Ethernet)-PON, Mitsubishi has been involved in the development of PON technology for a long time, and is in a pole position.

Looking toward future needs, Mitsubishi has developed a prototype 10G-EPON system that increases the transmission speed of GE-PON tenfold to 10GB/s. Existing equipment can be used in environments where GE-PON is already applied, the diagram as shown in Figure 4.

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- Automatic Bypass as standard
- Intelligent RS232 comms port
- UPS management software
- SNMP, USB or Dry Contacts optional
- LED & LCD display shows battery parameters

Xi Series Online AC UPS

- Ideal for industrial applications
- Available in either 230V or 115VAC version
- Models from 1kVA to 6kVA
- 19" rack mounting or free standing
- Dual AC feeds with auto switch over if one feed fails
- Hot swap batteries can be changed without power down
- Remote emergency power shut down
- Digital display input/output V and Hz, battery voltage and load
- Supplied with Xprotect software
- Monitoring via RS232 or Network

POWER SOLVE

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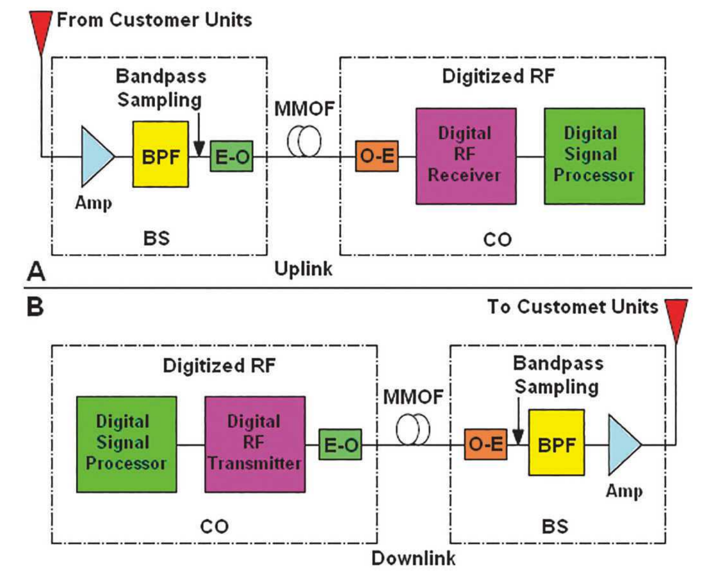


Figure 6: Digitized Radio over Fibre (DROF) uplink and downlink

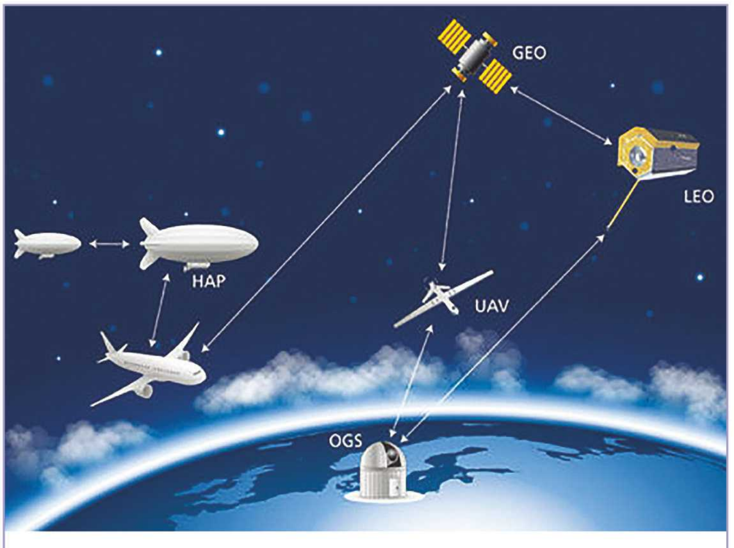


Figure 7: Atmospheric and space optical links

The PON system is a single optical fibre connected to the equipment of the Service Provider (SP), such as Optical Line Terminals (OLT). At the exchange it is split using an optical coupler and is connected to devices in subscribers' homes, known as Optical Network Units (ONU). For example, subscriber A uses 10G-EPON, but even if subscriber B is using an existing GE-PON system, it is still possible for them both to employ the same OLT. This characteristic is very important for practical purposes, because it will enable a smooth, low-cost transition to 10G-EPON, while existing systems such as GE-PON are still in use. In addition, the prototype system conforms to the global IEEE802.3av standard, with a view toward its diffusion both domestically and internationally.

Digital Radio Over Fibre Link

The Digital Radio over Fibre (DROF) system is a hybrid architecture consisting of optical fibre and wireless systems, such as Local Area Network (LAN), Wide LAN (WLAN), Worldwide Interoperability for Microwave Access (WiMAX), WiFi (Wireless Fidelity), cellular, atmospherics and space optical networks. By integrating fibre and digital wireless networks, key requirements for future generation of fixed and mobile broadband, such as large operating bandwidth and high flexibility, can easily be met.

A Fibre Wireless (FiWi) network results from the integration of optical fibre and wireless broadband infrastructures. The transmission of analogue signals requires high linearity and high dynamic range of the optical link.

A typical ROF architecture is shown in Figure 5.

The FiWi network refers to the transmission of radio frequency (RF) signals from a trunk network via central office (CO) and route nodes (RN) to the base stations (BS) over optical fibre and wireless communication to the user. The advantage of this system is that it combines the capacity of optical networks with the flexibility and mobility of wireless networks to provide broadband multimedia access.

> "Looking toward future needs, Mitsubishi has developed a prototype 10G-EPON system that increases the transmission speed of GE-PON tenfold to 10GB/s

Figure 6A shows a DROF uplink, which uses a technique based on bandpass sampling. The uplink DROF transmission path from the customer units enters via an antenna to a CO passing amplifier (amp), bandpass filter (BPF) and Electrical-to-Optical (E-O) unit. Then, the signal passes via Multimode Optical Fibre (MMOF) using a digital-to-analogue converter (DAC) in conjunction with BPF and entering the BS receiver via O-E. At the BS end, data is sampled and quantized by an analogue-to-digital converter (ADC) with a sampling rate determined by the bandpass sampling theory.

In the MMOF system data is detected by the Intensity Modulation/Direct Detection (IMDD) in CO and the uplink wireless signal is reconstructed and recovered. Figure 6B shows the opposite path of DROF downlink, where data from digital signal processor, transmitter and E-O passes via MMOF into the BS. Then data goes via O-E, BPF, amp and antenna to the customer unit.

Free Space Optical (FSO) links over long distances have been made possible by the development of different key technologies in the near-infrared domain: high-power lasers, high-speed components, high-sensitivity detectors and cost efficient optics, see Figure 7. The FSO links connect Geostationary Earth Orbits (GEO) and Low Earth Orbits (LEO) with Optical Ground Stations (OGS) directly or via High Altitude Platforms (HAP) and Unmanned Aerial Vehicles (UAV). ●

OPTICAL FEEDBACK BASED CIRCUIT FOR IMPROVED STABILITY OF AN ULTRAVIOLET LIGHT SOURCE

PENGFEI GAO, **QI HU** AND **ZHENHAO YANG** FROM THE UNIVERSITY OF SHANGHAI FOR SCIENCE AND TECHNOLOGY PRESENT A NEW CIRCUIT FOR IMPROVING STABILITY OF A UV LIGHT SOURCE

In recent years, increasing importance has been attached to the study of ultraviolet (UV) light, especially for improving measurement accuracy, but also in food safety, drug testing, environmental monitoring, climate study, Earth observation and space exploration among many other applications.

With the development of technology processes such as photoetching and nanometrology, research has honed in on UV radiation and sources of UV light used in those applications, with a particular focus on improving a UV light source's output stability and eliminating noise.

Accurate Calibration

Without a doubt, accurate optical calibration is essential for UV radiation measurement. The key point in improving the ultraviolet radiation's accuracy is to provide a source with stable optical power output. However, it is quite difficult to find such a source with both high optical power output and continuous spectrum. (When we measure the response of a UV detector, we measure the output current of the detector at many wavelengths. So, to get a high SNR signal, a high-power UV light source is needed, and if we want to measure the response at every wavelength, the source should contain not only some discrete wavelengths like a mercury lamp, but rather a range, such as 200-400nm, called "continuous spectrum".)

In research, when a continuous UV spectrum is needed, a common method is to use a gas discharge lamp. With a high optical power output over a relatively continuous spectrum, the lamp seems an ideal UV light source. However, the detected stability of its optical output is poor – less than 5% within one hour. Figure 1 shows the stability of a mercury xenon-arc lamp at 312.6nm.

> "Unstable performance of the UV light source will seriously affect measurement accuracy

Unstable performance of the UV light source will seriously affect measurement accuracy. In this article we introduce a novel approach to improve the stability of a gas discharge lamp, based on optical-feedback compensation. By designing a stable and precise control circuit, feedback intensity signals received from the UV detector are converted into voltage signals. With analog and digital conversion, the signals are used to control the current output of the switching power supply and thus stabilize the optical power the UV light source emits.

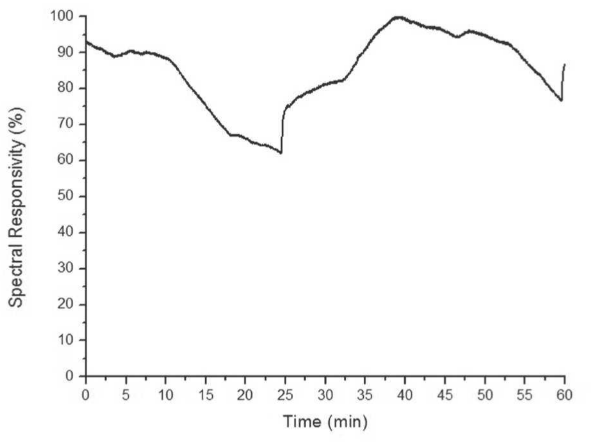


Figure 1: Stability detection of mercury xenon-arc lamp at 312.6nm

Circuit Design

Figure 2 shows the schematic diagram of the proposed system. A UV detector converts the UV light of a mercury xenon-arc lamp into current of proportional intensity. A current-to-voltage circuit provides the voltage signals which are then amplified, and the high-frequency components of the noise filtered. The voltage signals and reference voltage are then sent to a comparator, where control signals are generated. The control signals are fed back into the switching power supply of the mercury xenon-arc lamp to adjust the output current and UV light intensity.

In our experiment, a Hamamatsu G5842 photodiode was used as detector; its spectral response range is 260-400nm.

Figure 3 shows the current-to-voltage circuit designed for the detector. The photodiode works in zero bias, or photovoltaic mode, which offers the best precision and linearity. In order to measure accurately the photodiode current of a few nanoamps, we use an OPA627 op-amp, in consideration of its main features: high-gain bandwidth, low distortion, low voltage noise, JFET input and bias current of only 2pA at room temperature. The op-amp's virtual ground effect makes the bias voltage of the photodiode zero, so the short-circuit current is turned into voltage.

According to the definition of Signal to Noise Ratio (SNR):

$$SNR = V_o / e_n = \frac{I\sqrt{R}}{\sqrt{4KTB}}$$

Increasing the value of feedback resistor R2 can improve the SNR; however, R2 has to be of low tolerance (1%) and low temperature sensitivity (50ppm/°C). Capacitor C4 in parallel with R2 limits the op-amp's closed-loop bandwidth and reduces high-frequency noise. Figures 4 and 5 show the amplifier and filter circuits for processing the converted voltage signal.

The amplifier circuit (Figure 4) includes a two-stage inverting amplifier. The first stage has fixed gain of 20, while adjustable resistor RV2 sets feedback in the second stage.

The filter circuit as shown in Figure 5; it is a voltage-controlled voltage source low-pass filter with a gain of 1. The cutoff frequency $f_H = 10KHz$ and $Q = 0.707$ contribute to a flat frequency response.

Figure 6 is a reference voltage and comparator circuit. The light intensity signal is sent to the non-inverting terminal of AD822, with the inverting terminal connected to reference voltage.

By varying R12, TL431 generates a reference voltage output for the comparator. The value of the reference voltage is given by:

$$V_{ref} = (1 + \frac{R_{11}}{R_{12}}) \times 2.5V$$

When AD822 amplifies the voltage difference between the reference voltage and the converted light intensity voltage, a control signal is sent to the switching power supply through a buffer. Based on this signal, the power supply changes the output current supplied to the mercury xenon-arc lamp, so if the light intensity emitted from the lamp decreases, the converted voltage is reduced.

> Similar results were also found at other wavelengths, with the maximum fluctuation lower than 1% there, as well

As the difference between the reference voltage and the converted light intensity voltage increases, the output of the comparator will increase and boost the current signal output from the switching power supply. As a result, the light intensity of the mercury xenon-arc lamp will increase in response.

After stabilization, the reference voltage is kept equal to the converted light intensity voltage, thus the light emitted from the

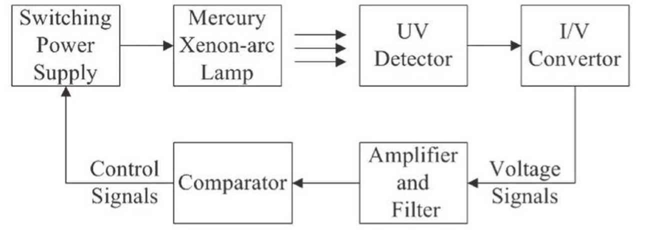


Figure 2: Schematic diagram of stabilizing ultraviolet source output

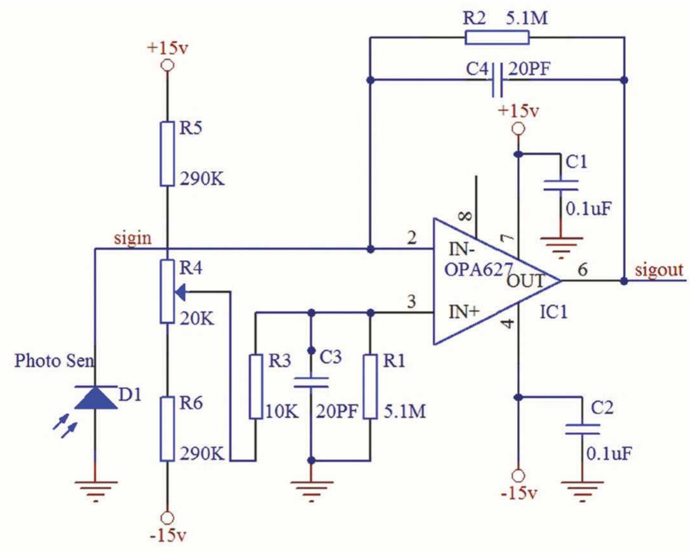


Figure 3: Current-to-voltage circuit

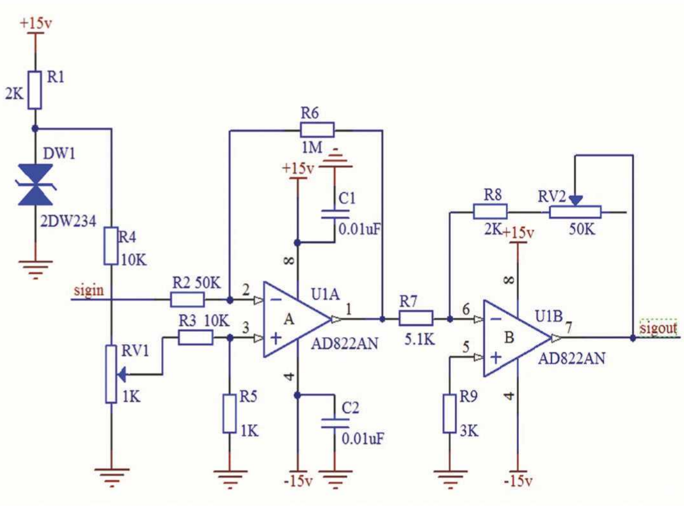


Figure 4: Amplifier circuit

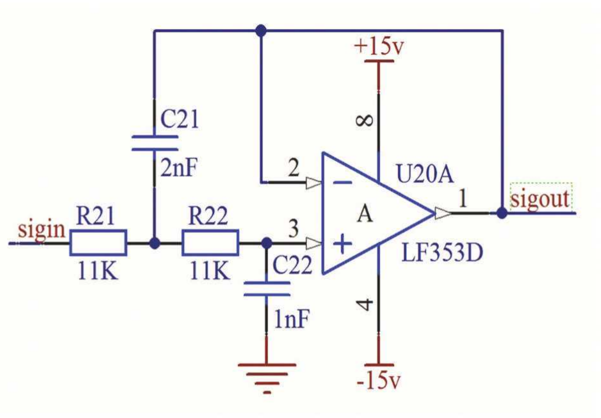


Figure 5: Sallen-key filter circuit

mercury xenon-arc lamp can be controlled by adjusting the reference voltage.

2DW234 is a bidirectional Zener diode that keeps the absolute value of the control signal lower than 10V.

Results

Stability of the UV light source can be monitored by analyzing the ultraviolet spectrum changing with time. Figures 7 and 8 show the changes of light intensity of the UV light source at 312.6nm within one hour, with the lamp lit for three hours before we started to record – four hours in total. As seen in the figures, the maximum fluctuation is less than 1%, a significant improvement over the no-optical-feedback condition.

Similar results were also found at other wavelengths, with the maximum fluctuation lower than 1% there, as well.

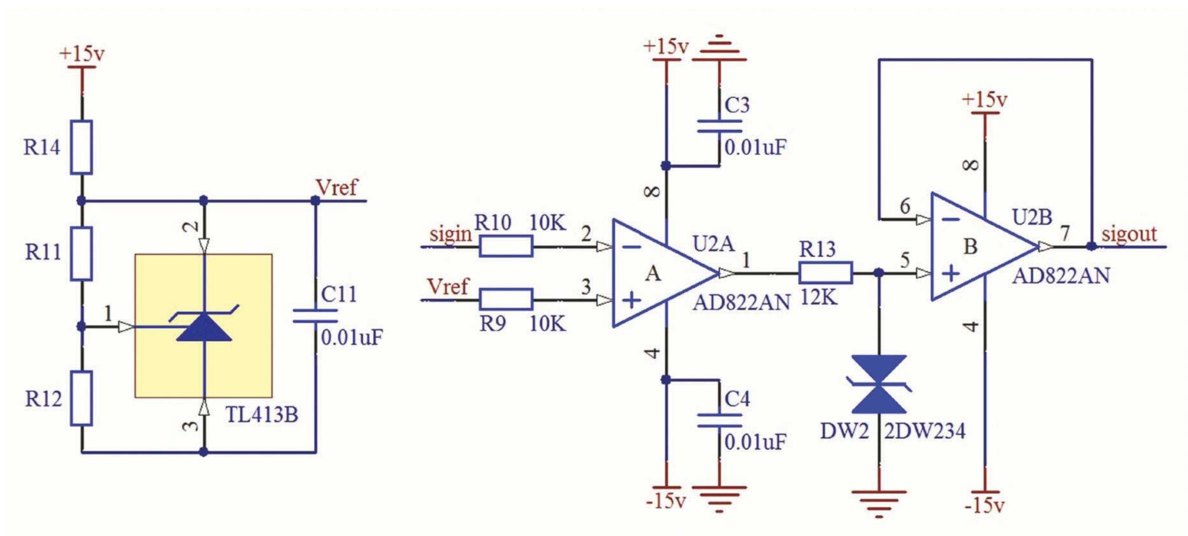


Figure 6: Reference voltage and comparator circuit

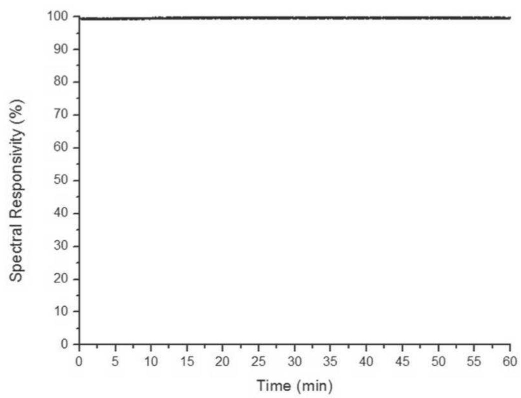


Figure 7: Stability detection of mercury xenon-arc lamp at 312.6nm after adding optical feedback

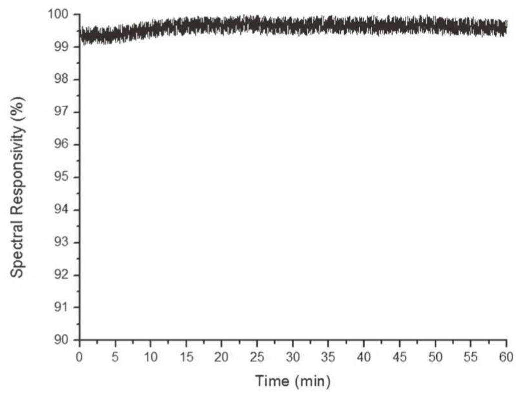


Figure 8: Enlargement of Figure 7

INVESTIGATION OF A NANO-SCALE COMPOUND METAMATERIAL FOR THE DESIGN OF OPTICAL FILTERS

SHAHAB SHAHRABADI FROM THE ISLAMIC AZAD UNIVERSITY IN GUILAN AND **M. K. MORAVVEJ-FARSHI** FROM THE TARBIAT MODARES UNIVERSITY IN TEHRAN, BOTH IN IRAN, ANALYZE THE TRANSMISSION AND REFLECTION SPECTRA OF DNG-MNG METAMATERIALS WITH PERIODIC STRUCTURE FOR THE DESIGN OF HIGH-PASS AND BANDPASS OPTIC FILTERS

Metamaterials are artificial materials, engineered to have properties not found in nature. Metamaterials with negative parameters, such as dielectric permittivity, magnetic permeability, refractive index etc, were developed to enable unique and useful structures such as Magnetic Metamaterials, or MNG ($\mu < 0$), and Negative Index Metamaterials ($n < 0$) Double Negative, or DNG ($\varepsilon < 0,\ \mu < 0$) with specific optical properties suitable for building optical devices.

The magnetic permeability (μ) for naturally occurring materials is always close to 1, but the MNG structure can vary this value to enhance the magnetic response, which boosts light energy transmission, of particular use in optical filters.

The refractive index of natural transparent materials such as glass is near 1, but a DNG structure with $n < 0$ can magnify and transfer images without any reversal, making the structure useful in manufacturing superlenses.

Recently, some researchers investigated periodic structures where metamaterials are layered alternately (see Figure 1), with each layer having electrical and magnetic plasma frequencies higher than the incident light's frequency. These structures are insensitive to incident angle (θ) and can transmit several waves with different frequencies, which makes them multichannel and omnidirectional. It is important that these structures' thickness (d) be smaller than the wavelength (λ) of incident light. Moreover, light is an electromagnetic wave with electric and magnetic components (TE wave and TM wave, respectively), which complicates the analysis, so for simplification we used a Bloch Wave Vector (k), a resultant vector, according to the right-hand rule in mathematics and physics, used as a common mnemonic for understanding notation conventions for vectors in three dimensions.

Finally a SiO_2 layer is added to the structure as a defect layer (called that because it makes the MNG-DNG structure non-periodic), and its optical spectra investigated. All analyses and simulations are done by MATLAB and COMSOL.

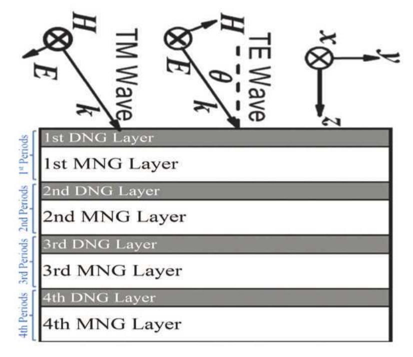


Figure 1: DNG (gray layer) and MNG (white layer) in a periodic structure

	Infrared	Visible	Ultraviolet
THz	1000 ~ 2350	2350 ~ 4710	4710 ~ 8000

Table 1: Frequency of input waves

The Model

We used the Drude model of electrical conduction to describe metamaterials and analyze their parameters (A = DNG and B = MNG):

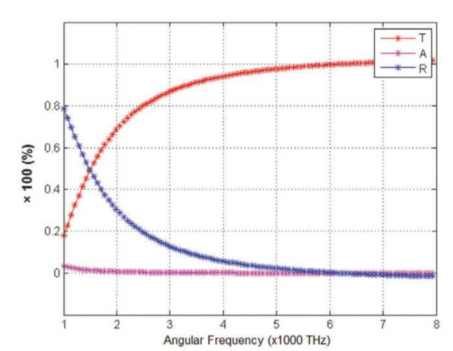


Figure 2: Transmission (T), reflection (R) and absorption (A) spectra

$$\varepsilon_A = 1 - \frac{{\omega_{Aep}}^2}{\omega^2}\ , \mu_A = 1 - \frac{{\omega_{Amp}}^2}{\omega^2} \qquad (1)$$

$$\varepsilon_B = 1\ , \mu_B = 1 - \frac{{\omega_{Bmp}}^2}{\omega^2} \qquad (2)$$

Equations 1 and 2 show that our structure acts as a metamaterial if the frequency of injected light (ω) is higher than the electric and magnetic plasma frequencies (ω_{ep} and ω_{mp}), otherwise it behaves like a natural, transparent medium.

The first condition for modeling this structure is $\omega \ll \omega_{Aep}, \omega_{Amp}, \omega_{Bmp}$. The transmission coefficient equation in +Z direction is obtained by the Bloch-Floquet theorem:

$$\cos \beta_z(d_A + d_B) = \cos(k_{Az} d_A)\cos(k_{Bz} d_B) \qquad (3)$$

We ignore the second part of Equation 3 because it includes sinusoidal functions that equal zero when $k_{Az} d_A = n\pi$.

To determine the Bloch Wave Vector (k) used in the dispersion equation (Equation 3), we use Equation 4:

$$k_z = \frac{\omega}{c}\sqrt{\varepsilon}\sqrt{\mu} \times \sqrt{1 - \frac{\sin^2\theta}{\varepsilon.\mu}} \qquad (4)$$

Although it initially appears that the k vector is dependent on θ, this isn't correct because $(\varepsilon.\mu)$ is much larger than $\sin^2\theta$ and the whole fraction reaches zero, meaning θ doesn't have any effect on the metamaterial's behaviour. Transmission (T), absorption (A) and reflection (R) are obtained from Equations 5 and 6:

$$T = |t|^2 = |\cos \beta_z(d_A + d_B)|^2 \qquad (5)$$

$$A = \log\left({}^1/_T\right)\ , R = 1 - (T + A) \qquad (6)$$

From Equation 5 it can be seen that transmission is related to the thickness of the A and B layers. The d_A parameter is used for shifting spectra and d_B is an important parameter to limit the amplitude of the transmission spectrum between 0 and 1, so the second condition for modeling is $T, A, R \leq 1$.

Results

The plasma frequencies and layer thicknesses should be adjusted according to the previous conditions, so $\omega_{Aep} = 10^{16}\ \frac{rad}{s}$, $\omega_{Amp} = \omega_{Bmp} = 8\times10^{15}\ \frac{rad}{s}$, $d_A = 2.4nm$ and $d_B = 0.5nm$.

The number of periods is 4, C is the light speed (3×10^8) and ω is in THz range (see Table 1).

As shown in Figure 2, there is a high pass filter (HPF) behavior with a cutoff frequency at 6000THz that transmits visible and ultraviolet wavelengths. The reflection and transmission swap their positions at 1500THz, which is an infrared domain.

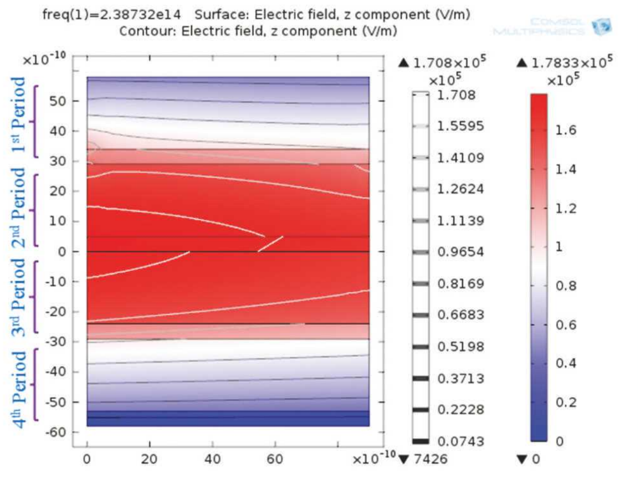


Figure 3: Incident wave attitude at 1500THz

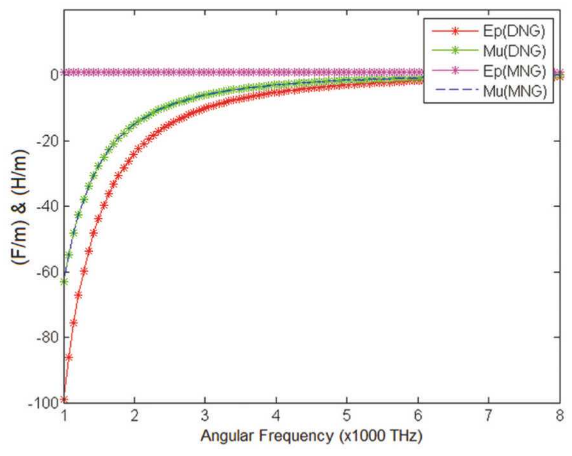


Figure 4: Variations of ε and μ

As observed in Figure 3, in the middle layers the attitude of the input wave (light) is changing from +Y (horizontal) to +Z (vertical) direction because of the strong electric field (about $1.8\times10^5\ V/m$), reflecting light without any transmission.

Permittivity and permeability of metamaterials have large negative values, depending on the input wavelengths, see Figure 4. The values of ε and μ in the THz domain usually reach -100, which appears a theoretical number but which is actually real; for instance ε of Au can reach -400 (F/m).

At visible and ultraviolet wavelengths the DNG-MNG

Figure 5: The new compound metamaterial (DNG-MNG-SiO_2)

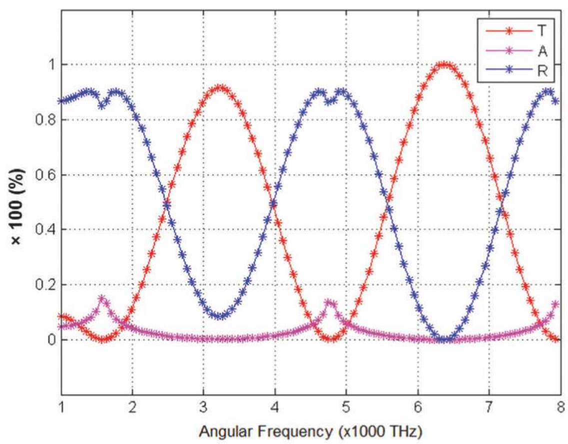


Figure 6: Transmission (T) and reflection (R) modes variations with $d_{SiO2}=240nm$

structure doesn't really help much in creating optic devices, such as a BPF or mirror, because some transmission or reflection bands are needed to transmit or reflect at certain wavelengths, see Figure 6, where transmission is at 3100THz and 6500THz.

If a thick $SiO_2(100nm \sim 250nm)$ layer is added in the middle of this metamaterial, new transmission and reflection modes will appear that can be shifted to a desired frequency by increasing or decreasing d_A (see Figure 5). These spectra are shown in Figure 6 for $d_{SiO2} = 240nm$.

Using $\lambda = \frac{C}{f} = \frac{2\pi C}{\omega}$, we can find out the wavelengths where these transmission variations appear.

$$\begin{cases} 3100THz = 608nm \\ 6500THz = 290nm \end{cases} \Rightarrow \frac{608}{290} = 2 \quad (7)$$

$$\begin{cases} 1600THz = 1178nm \\ 4800THz = 392nm \end{cases} \Rightarrow \frac{1178}{392} = 3 \quad (8)$$

It can be determined that transmission modes appear at wavelengths where the ratio is a multiple of $2m$ $(m = 0, 1, 2, 3, \dots)$ and reflection modes exist at wavelengths where the ratio is a multiple of $2m + 1$ $(m = 0, 1, 2, 3, \dots)$.

Furthermore, as seen in Figure 5, none of the reflection modes reach their maximums because of absorption.

Optic HPF

In this article we presented the investigation of their transmission, reflection and absorption spectra to understand the behaviour of DNG-MNG compound metamaterials at infrared, visible and ultraviolet wavelengths. It can be seen that DNG-MNG metamaterial acts as an optic HPF and that we need a thick layer of isolator (SiO_2) to create several transmission and reflection modes so this structure can be used in optic devices such as BPF, lasers, lenses, mirrors, etc. In addition, this compound metamaterial is tunable by varying its layer thicknesses.

As a final result, we can design multichannel, omnidirectional and tunable HPF and BPF for optical applications by using the DNG-MNG periodic metamaterial. ●

ENCRYPTION OF OPTICAL INFORMATION
USING THE COMPREHENSIVE GHOST IMAGING ALGORITHM

ZHANG LEIHONG, **PAN ZILAN**, **LIANG DONG** AND **ZHANG DAWEI** FROM THE UNIVERSITY OF SHANGHAI AND **MA XIUHUA** FROM THE SHANGHAI INSTITUTE OF OPTICS PRESENT A NOVEL METHOD FOR ENCRYPTING OPTICAL DATA THAT DELIVERS GREATER ROBUSTNESS AND HIGHER RESOLUTION THAN OTHER SIMILAR METHODS

Encryption is a process of encoding messages or information that only authorized parties can read. As a secure method of sending and receiving information, it has been steadily growing in importance. Optical encryption is popular because it offers parallelism, high speed and low cost.

In an encryption scheme, the message or information, referred to as plaintext, is encrypted using an encryption algorithm, generating ciphertext that can be only read if decrypted. An authorized recipient can decrypt the message with a key provided by the originator.

An encryption scheme usually uses a pseudo-random encryption key generated by an algorithm. In principle, it is possible to decrypt the message without the key, but, for a well-designed encryption scheme, large computational resources and skill are required to do so.

There are various encryption methods, some based on fractional Fourier and Fresnel transforms, others on a joint transform correlator, off-axis digital holographic and phase shift interferometry, and some based ghost imaging algorithms. However, each of these methods suffers from some issue, including difficulty reconstructing the plaintext, or even not being sufficiently secure.

Ghost imaging is an optical technique where the imaging information is obtained through photon coincidence detection. The imaging information, which can be a real object, text information or an image, is encoded in tune with the light source's intensity fluctuations. Ghost imaging techniques use a spatial light modulator for presetting the illuminating beam's light field, and a detector is used to collect the total light intensity transmitted or reflected by the object.

In optical information encryption based on the algorithm of ghost imaging, the encryption system uses the keys to load plaintext into space information distribution of the light field, and then obtain the ciphertext. The ciphertext and key are sent to the recipient. The randomness of the ciphertext increases with the randomness of the key, which also helps increase the decoding difficulty and hence the encryption method's security.

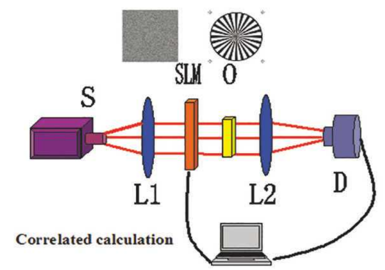


Figure 1: The optical encryption setup based on the algorithm of ghost imaging; S is a laser source; L1 and L2 are lenses; SLM is the spatial light modulator; D is the detector; and O is the object

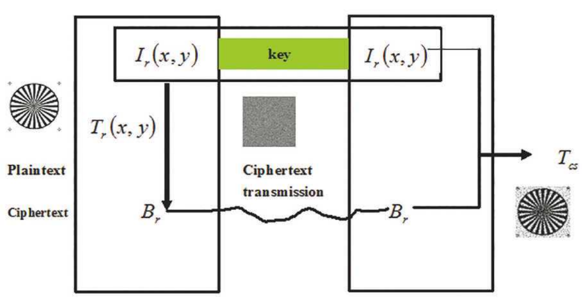


Figure 2: The optical encryption method based on the algorithm of compressive ghost imaging

The resolution of the reconstructed plaintext information obtained by this method is limited by the number of keys the receiver has, making it difficult to decrypt the ciphertext. But it cannot increase the resolution of the plaintext.

The algorithm for compressive sensing, a signal processing technique for efficiently acquiring and reconstructing signals, is used to reconstruct the plaintext. The advantage is that it obtains high resolution plaintext with lower sampling rate – well below the Nyquist sampling rate (with limited bandwidth to restore the original signal without distortion from sampling, the sampling frequency should be greater than two times the highest frequency signal).

Obtaining The Ghost Image

The object's image is obtained with a calculation using the presetting light and its total intensity:

$$B_r = \int dxdy I_r T; \forall r = 1, \cdots, N$$
$$G(x,y) = \frac{1}{N}\sum_{r=1}^{N}(B_r - \langle B\rangle)(I_r - \langle I\rangle) \quad (1)$$
$$\langle B\rangle = \frac{1}{N}\sum_{r=1}^{N}(B_r), \langle I\rangle = \frac{1}{N}\sum_{r=1}^{N}(I_r)$$

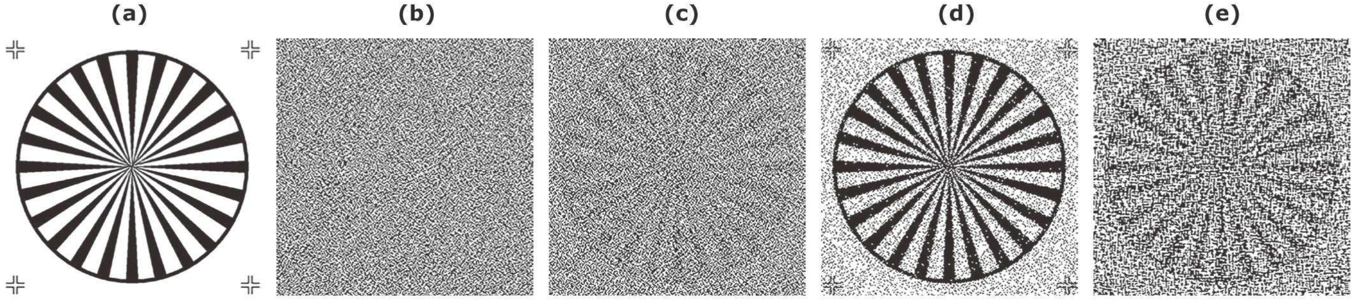


Figure 3: Reconstructed plaintext image via (1) compressive sensing ghost imaging and (2) ghost imaging: (a) the original plaintext image; (b) (c) (d) the reconstructed plaintext images by the algorithm of compressive sensing ghost imaging with 500, 1500 and 3000 measurements respectively; (e) the reconstructed plaintext image with 3000 measurements through ghost imaging

where B_r is the total light intensity picked up by the detector, T is a function of transmittance or reflectivity of the object, I_r is the presetting light field signal, and N is the number of measurements. The experimental setup for ghost imaging is shown in Figure 1.

The formula for compressive sensing ghost imaging is:

$$T_{cs} = T; \min\|\psi\{T\}\|_{L_1}$$

and is subject to:

$$B_r = \int dxdy I_r T; \forall r = 1, \cdots, N \quad (2)$$

where T_{cs} is the reconstructed image function of an object, N is the number of measurements, which is lower than the number of pixels of the object. The function $\psi\{T\}$ estimates the number of nonzero elements of the object information in the sparse vector; the image of the object T_{cs} can be determined with the minimal sparse representation.

Optical Encryption Method

The plaintext was reconstructed using compressive sensing, key and the ciphertext. The random modulating signal I_r is the key, and the function of transmittance or reflectivity of the object is the plaintext T that will be encrypted. The sender uses Equation 2 and the key for obtaining the ciphertext; the sender and receiver share the same key.

The encryption and decryption processes are shown in Figure 2.

Simulation Results

Simulations were conducted using MATLAB. The designed object T with a sparse space that has a number of nonzero elements is placed on the object plane of the imaging system. The total light intensity of each frame signal after modulation is detected. The number of measurements is assumed to be less than the total number of pixels of the object, and the modulation signal matrix of the spatial light modulator is I_r (the key); the sum of the intensity values is regarded as the measured values B_r (ciphertext).

From Figure 3 it can be concluded that:

(1) The receiver can obtain the plaintext information with the algorithm of compressive sensing ghost imaging through shared key and ciphertext;

(2) The image obtained with compressive sensing ghost imaging is much clearer than one obtained with ghost imaging with the same number of measurements. Compressive ghost imaging can reconstruct the high resolution plaintext with a lower sampling rate that the Nyquist sampling theory recommends.

From Figure 4 it can be concluded that:

(1) The clarity of the plaintext information is increased with the number of $\{B_r\}$;

(2) If the number of ciphertext and the key are below 20% of the total number of $\{B_r\}$, the key cannot be deciphered, therefore optical information encryption based on compressive ghost imaging is highly secure. ●

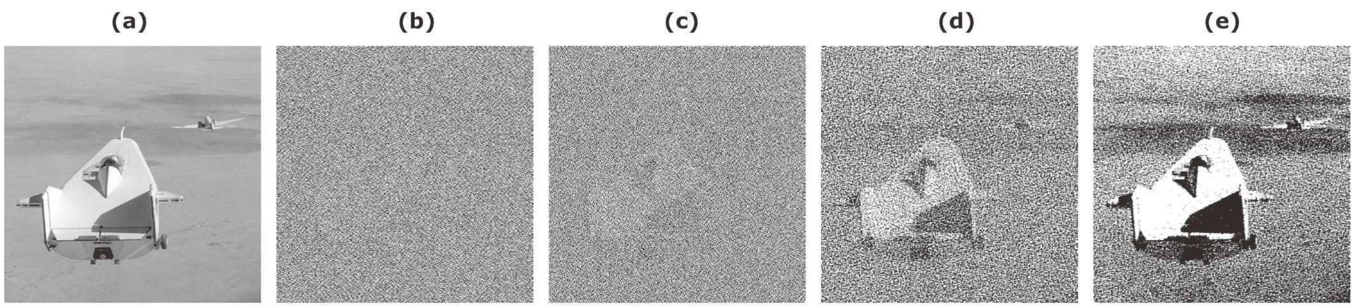


Figure 4: Reconstructed plaintext image via the compressive sensing ghost imaging: (a) original plaintext image; (b) (c) (d) (e) reconstructed plaintext image with $\{B_r\}$ of 10% 20% 40% and 60% respectively;

USING ATMOSPHERIC PRESSURE SENSORS IN WIRELESS APPLICATIONS

IN THIS SERIES, **PROFESSOR DOGAN IBRAHIM** OF THE NEAR EAST UNIVERSITY IN CYPRUS PRESENTS DIFFERENT TYPES OF RF SYSTEMS FOR EMBEDDED APPLICATIONS. IN THIS ARTICLE HE DISCUSSES THE USE OF ATMOSPHERIC PRESSURE SENSORS IN EMBEDDED WIRELESS ENVIRONMENTAL MONITORING AND CONTROL APPLICATIONS

Barometric air pressure is an important meteorological parameter, playing a key role in weather forecasting. Equally, air pressure is an important parameter in calculating the air-fuel ratio in automotive applications for controlling and optimizing engine efficiency. Car manufacturers are always interested in using low-cost, high-accuracy and yet time-reliable sensors in their designs to increase fuel efficiency.

The output of a barometric pressure sensor is measured in inHg (inches mercury) or hPa (mbar), or both. Typical ranges are 16-32inHg or 550-1100hPa. The SI derived unit of pressure is the Pascal. One Pascal is equivalent to 0.01mbar (1/1000th of a bar), or to 0.000295 inches of mercury, and 100 Pascals (a hectopascal) is equivalent to one millibar (mbar). InHg is not an SI unit and is still widely used in barometric weather reports and aviation in some countries. It is defined as the pressure exerted by a column of mercury one inch in height at 0°C at the standard acceleration of gravity.

Barometric Pressure Sensors

Barometric pressure sensors are available in analog or digital form. Analog sensor outputs are shown in millivolt, volt, or current, and the output is usually proportional to the measured pressure. These sensors usually operate from a power supply voltage of 5-10V.

Digital sensors usually operate from either 3.6V or 5V and provide digital outputs in the form of standard RS232 serial data, or SPI, or I2C-bus-compatible outputs, or some form of proprietary digital output. Some examples of barometric pressure sensors are given here.

Figure 1 shows the professional quality PX409 series analog barometric sensor made by Omega (www.omega.com). This is a high-accuracy, temperature-compensated sensor, costing around £419, offering a wide operating temperature. There are many models in the series with different pressure measuring ranges; for example model PX409-32BV measures barometric pressure in the range 0-1100mbar.

Setra (www.setra.co.uk) model 278 (Figure 2) is a barometric sensor which accurately measures atmospheric pressure in the range of 600-1100mbar, operating from a wide supply voltage range of 9.5-28V,

Figure 1: PX409 series barometric sensor

Figure 2: Model 278 barometric sensor

Figure 3: MPL3115 pressure sensor module

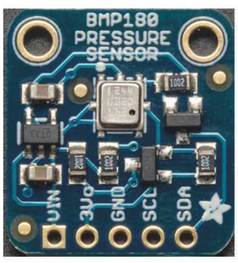


Figure 4: BMP180 pressure sensor

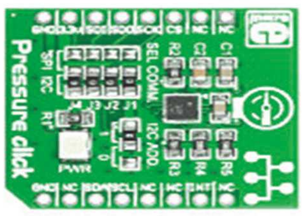


Figure 5: The Pressure Click Board with the LPS331AP sensor chip

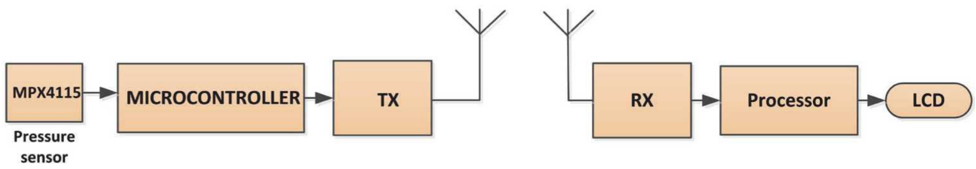


Figure 6: Block diagram of the example system

providing 0-2.5V and 0-5V analog outputs, and costing around £520. The accuracy of the sensor is quoted as ±0.5mbar @ 20°C.

There are many low-cost barometric sensors for the low-end market, especially for educational use and hobbyists. Some examples are given here.

MPL3115 is a digital output pressure sensor module placed on a small PCB (Figure 3), intended for embedded microcontroller applications. This sensor operates from 1.95-3.6V and provides 20-bit I2C-bus-compatible digital output, as well as altitude and temperature data. It costs around £13.

BMP180 is a low-cost pressure sensor module (Figure 4). It operates from 1.8-3.6V and measures atmospheric pressure in the range 300-110mbar. The sensor requires only 5μA for its operation; it provides I2C-compatible digital output and costs around £7.

LPS331AP is a digital output I2C or SPI-bus-compatible pressure sensor chip, capable of measuring air pressure in the range 260-1260mbar. It operates from 1.71-3.6V supply voltage with extremely low power requirements and wide temperature range. The sensor is housed in a 3 x 3 x 1mm HCLGA-16L type package, but because of its small size, pressure sensor modules are commercially available with the LPS331AP chip on board. An example module, the Pressure Click Board from mikroElektronika (www.mikroe.com) is shown in Figure 5.

In this article, the Freescale Semiconductor MPX4115AP analog output barometric pressure sensor chip is used in a project where ambient atmospheric pressure is measured using a microcontroller-based system and is then transmitted to a receiving station. The system uses a pair of commercially-available radio telemetry modems from Radiometrix (www.radiometrix.com).

Example System

Figure 6 shows the block diagram of an example radio telemetry system. The transmitting side consists of the MPX4115 atmospheric pressure sensor chip, the StartUSB for PIC development board (www.mikroe.com) and the TXL2 transmitting modem (www.radiometrix.com), operating in the 433MHz UHF frequency band. StartUSB for PIC development board (Figure 7) is a small development board with the PIC18F2550 microcontroller on board, operating with an 8MHz crystal clock. The microcontroller can be programmed via the mini USB port available; it is shipped pre-loaded with a Bootloader program so it can be directly programmed from a PC using a host Bootloader applications program. The development board provides access to the microcontroller I/O pins through edge connectors.

The receiving side consists of the Radiometrix RXL2 receiving modem, a processor and a display. In practice the processor could be a microcontroller, a PC, the Raspberry Pi computer, or any other digital device. The RXL2 receiving modem is fully compatible with the TXL2 transmitting modem, both operating in the 433MHz UHF band at 9600 baud rate.

The MPX4115 is designed to sense the absolute air pressure in barometer or altimeter applications. This is an analog output sensor operating from 5V power. Although the sensor has six pins (Figure 8), only three are used: power, ground and output. Pressure can be measured in the range of 150-1150mbar, with a response time around 1ms.

The relationship between the pressure and output voltage are given by:

$$V = 5.0 * (0.009 * kPa - 0.095) \qquad (1)$$

or:

$$kPa = \frac{\frac{V}{5.0} + 0.095}{0.009} \qquad (2)$$

where kPa is the atmospheric pressure (kilopascals) and V is the sensor output voltage.

Figure 7: StartUSB for PIC development board

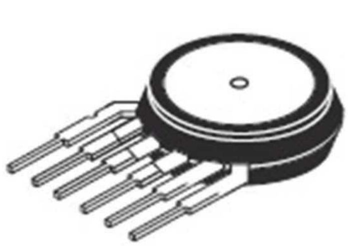


Figure 8: MPX4115AP pressure sensor

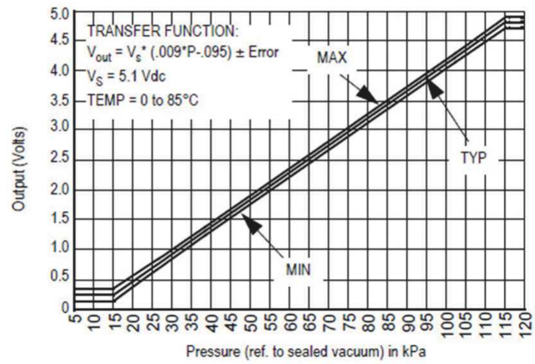


Figure 9: MPX4115AP sensor characteristics

Figure 10: The TXL2/RXL2 modem pair

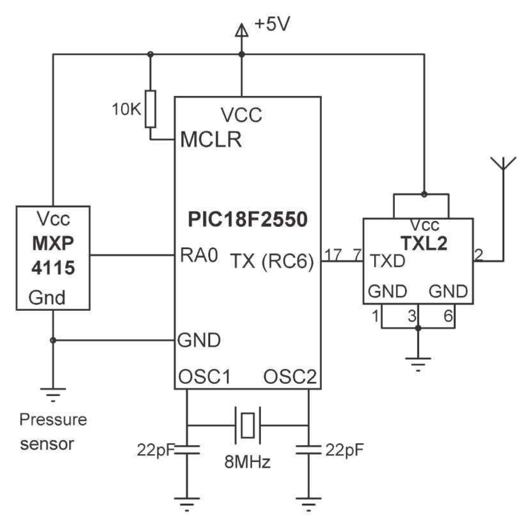


Figure 11: Circuit diagram of the transmitter hardware

Atmospheric pressure measurements are usually shown in microbars (mbar). At sea level and 15°C the atmospheric pressure is 1013.3mbar. In Equation 2 the pressure is given in kPa, so to convert kPa to mbar we multiply Equation 2 by 10 to give:

$$mb = \frac{2.0V + 0.95}{0.009} \tag{3}$$

The steps to calculate and display the pressure in mbar are:

- Read the sensor output voltage using one of the ADC channels of the microcontroller;
- Use Equation 3 to convert voltage into absolute pressure in mbar;
- Display the pressure.

Figure 9 shows the MPX4115AP sensor characteristics where the measured pressure is shown against the output voltage.

In addition to calculating the ambient atmospheric pressure, the altitude can also be calculated approximately, using the following simplified hypsometric formula:

$$h = \frac{[(\frac{P_0}{P})^{1/5.257} - 1] \times (T + 273.15)}{0.0065} \tag{4}$$

where:
h = height above sea level (m)
P_o = sea level pressure (1013.25mb on a standard day)
P = measured pressure
T = temperature

The TXL2/RXL2 Modem Pair

The Radiometrix TXL2/RXL2 modem pair used (Figure 10) consists of UHF multi-channel 9600 baud simplex radio modems requiring just an external antenna for their operation. Serial raw ASCII data without encryption is sent by the TXL2 transmitter module. The TXL2/RXL2 pair can operate on any one of five different channels, with up to eight unique addresses.

The TXL2 transmitter provides +10dBm (10mW) power to a 50Ω antenna. Operation of the device is extremely simple since it requires only the TXD input pin to be driven with serial user data. Since this

```
BEGIN
        Configure microcontroller I/O ports
        Configure UART
        DO FOREVER
                Read from ADC channel 0
                Calculate pressure in mb
                Send-UART transmit buffer
                Wait 1 minute
        ENDDO
END
```

Figure 12: Operation of the transmitter program

```
BEGIN
        Configure I/O ports
        Configure UART
        Initialize LCD
        DO FOREVER
                Read pressure from RXL2
                Display data on LCD
        ENDDO
END
```

Figure 13: Operation of the receiver program

```
sbit MPX4115_Data_Dir at TRISA0_bit;
unsigned char Pressure[12];
unsigned long Vin, Pint;
float mV, V, Pmb;

void Read_Pressure()
{
 Vin = ADC_Read(0);                      // Read from channel 0
 mV = (Vin*5000.0) / 1024.0;             // in mV
 V = mV / 1000.0;                        // in V
 Pmb = (2.0*V + 0.95) / 0.009;           // Pressure in mb
 Pint = (int)Pmb;                        // Pressure in integer
 LongToStr(Pint, Pressure);              // Convert-string
 Ltrim(Pressure);                        // Remove leading spaces
}


 void main()
 {
 ADCON1=0x0E;                            // RA0 is analog channel
 MPX4115_Data_Dir = 1;                   // RA0 is input
 UART1_Init(9600);                       // Initialise UART

 while(1)                                // Do forever
 {
 Read_Pressure();                        // Read pressure data
       UART1_Write_Text(Pressure);       // Send pressure data-UART
       Delay_Ms(60000);                  // Wait for 1 minute
 }
 }
```

Figure 14: Transmitter program

pin is inverted, it can be connected directly to a microcontroller's UART output pin.

The RXL2 receiver has sensitivity of -107dBm and adjacent-channel rejection of 60dB. Received serial data is available at the RXD output, which is normally connected to a UART to capture the data.

Although the TXL2/RXL2 modem pair is used in this application, Radiometrix offers a wide range of narrowband and wideband UHF/VHF single-channel and multi-channel radio telemetry modems, ranging from RF output powers of 20mW up to 500mW.

Figure 11 shows the circuit diagram of the transmitter hardware (the receiver hardware is not shown here is it depends on the type of processor used). The sensor is connected to analog channel 0 (RA0) of the PIC18F2550 microcontroller's built-in ADC converter. The ADC has a resolution of 10 bits (1024 quantization levels) and operates with a +5V reference voltage. The TXL2 transmitting modem is connected to the UART output pin (RC6) of the microcontroller.

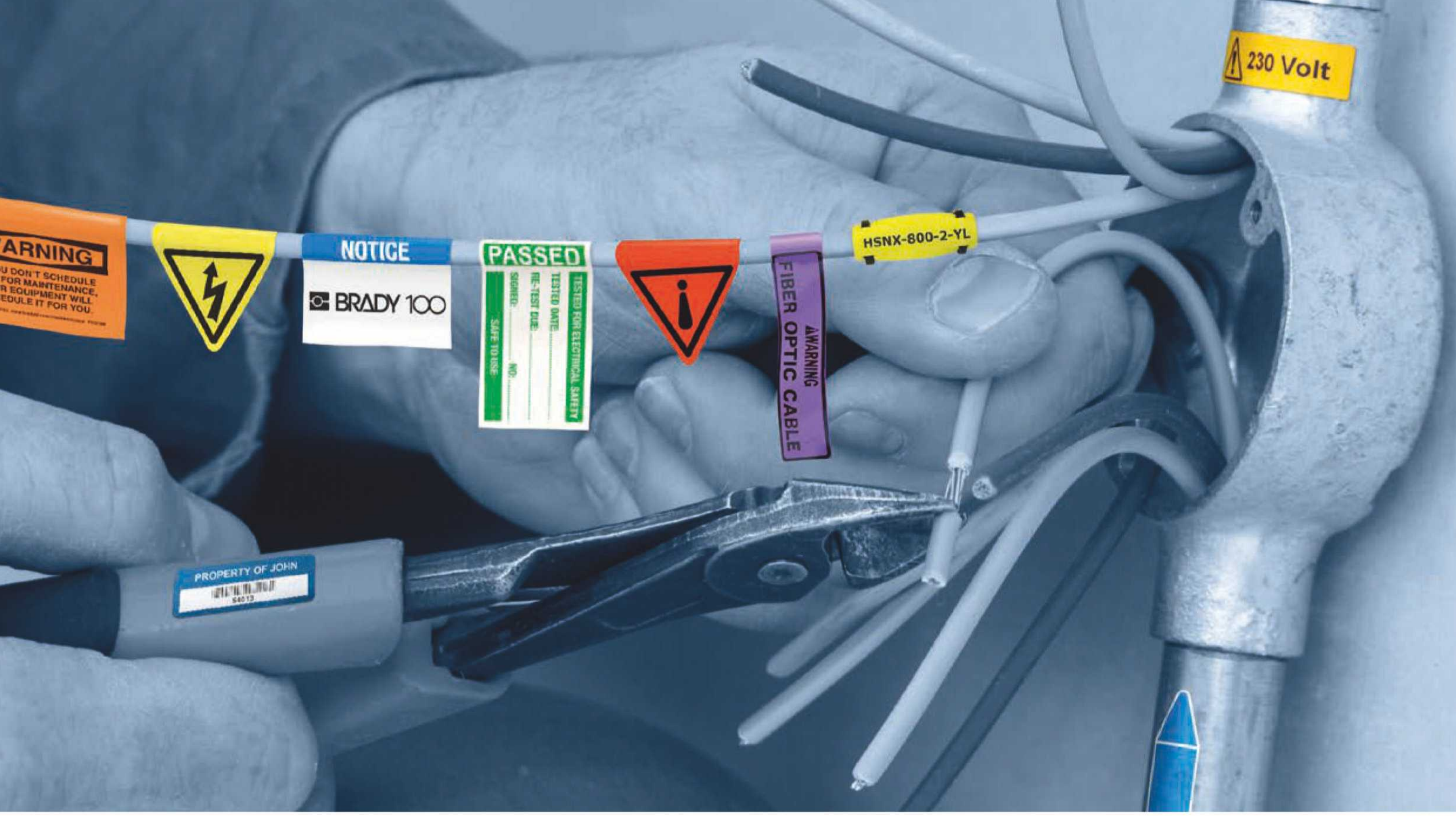
The Software

The software of the test system is based on the mikroC Pro for PIC language. This is a popular microcontroller programming language developed by mikroElektronika. Programs are normally developed and compiled on the PC and then loaded to the target microcontroller through a Bootloader program.

Figure 12 shows operation of the transmitter program which executes in an endless loop. The program reads the pressure data from the sensor every minute and sends the data to the TXL2 transmitting modem in serial format using the mikroC built-in UART functions.

Operation of the receiver program is shown in Figure 13. As in the transmitting program, this program operates in an endless loop where the pressure data is received via the RXL2 receiver and is then displayed on an LCD.

The actual microcontroller program listing is shown in Figure 14 (the receiver software is not shown here since it depends on the type of processor used). At the beginning of the program, the interface to the MXP4115 sensor and TXL2 modem are defined. The main program configures pin RA0 as an analog input port, initialises the built-in UART-9600 baud rate and enters into an endless loop. Inside this loop the pressure is read from ADC channel 0 and Equation 3 is used to convert it into millibars by calling function Read_Pressure(). The pressure data is then returned from the function as a string. The main program sends the returned data-the UART buffer so it is transmitted by the modem. ●


WARNING
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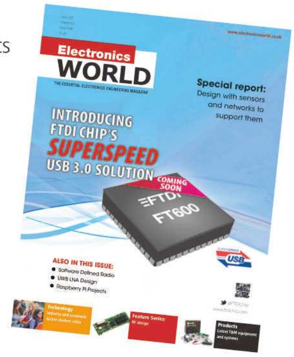
WHAT THE READERS SAY...

THE EW ARTICLES



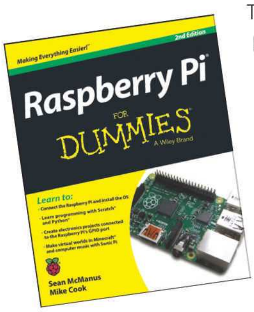
I find the articles published in Electronics World very clear, intelligible, brief and exact about their subject matter.

In many other magazines' articles there is a lot of unnecessary repetition of either general or specific nature.

I am an Electronics Engineer MSc, and your articles are great to learn what we need [in our projects/jobs].

Mehmet Şimşir
Turkey

RASPBERRY PI FOR DUMMIES



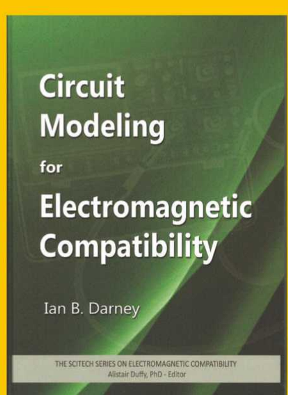
The *'Raspberry Pi For Dummies'* series in Electronics World are excellent articles!

The book of the same name will be used by several school pupils we have in our factory – we assign a project on the Raspberry Pi for them to try and do. It gets them thinking!

Philip Shaw
SureWave Technology

WIN, WIN, WIN

EMC consultant Ian Darney has written a book on electromagnetic theory called *'Circuit Modeling For Electromagnetic Compatability'*. Ideal for designers of electronic equipment, power distribution engineers, communication equipment designers, project managers, EMC consultants and students/lecturers/researchers in electrical engineering, the book shows how the analytic tools of circuit theory can be used to simulate the coupling of interference into and out of any signal link in the system under consideration. The book presents a simple, systematic and accurate technique, which enables any design to be tailored to meet EMC requirements.



We have a couple of copies of this book to give away, for a chance at one write to the Editor at **svetlanj@sjpbusinessmedia.com**, mentioning the book's name in the heading.

MAXWELL VERSUS CATT

The statement '*Classical electromagnetic theory is therefore internally inconsistent, unless we exclude the TEM Wave from the theory*' is highlighted on page 45 of the January issue of EW as though it's an important new observation. Such an assertion can command no more credibility than a report that a colony of flying pigs has been discovered in a remote region of the Andes.

The letter '*A capacitor is a transmission line*' refers to an article published in 1978 in Wireless World, which declares that, in a capacitor, there can be no magnetic field parallel to the plates. The article likens the capacitor to a transmission line. The starting point in the mathematical reasoning is a set of equations derived from transmission line theory. These equations include the parameter *Zo*, the characteristic impedance of the line. For a lossless line, this impedance is equal to the square root of the ratio of inductance to capacitance. Inductance is due to the action of magnetic field. Magnetic field exists in any capacitor when current flows, whether or not Ivor Catt acknowledges its presence.

I must admit that my initial reaction to the concept of 'displacement current' was one of disbelief. But after taking time to check out the mathematical reasoning, I came to accept that the concept is perfectly valid. Radio communication would be impossible if the phenomenon did not exist.

Since current flows in a conductor at a velocity comparable to the speed of light, it cannot be carried by electrons. The carrier must be sub-atomic particles, and the name given to these by the scientific community is 'photons'. The Wikipedia definition is '*a photon is an elementary particle, the quantum of light and all forms of electromagnetic radiation*'. Current is a measure of the flow of photons.

The electromagnetic wave propagating along the line is not an independent entity; it is caused by current flow in the conductors. Current flows radially, as well as axially, in any conductor. Contrary to the assumptions of Circuit Theory, current flows into, and out of, the surface of every conductor.

If a step voltage is applied to the mid-point of an isolated, circular-section conductor which is acting as a transmitting dipole, this pulse propagates axially in both directions along this 'send' conductor, laying charge down on the surface as it progresses. Radial current flow away from this surface lays down a charge of the opposite polarity on the surface of an adjacent 'return' conductor, acting as a receiving dipole. At either end of the transmitting dipole, axial current flow ceases. The charge on the adjacent surface of the 'return' conductor now discharges, via radial flow, into the 'send' conductor. At this instant, the voltage at the far end of the 'send' conductor doubles and the voltage on the far end of the 'return' conductor drops to zero. Then this voltage step propagates back toward the voltage source.

As far as circuit design is concerned, the Maxwell Equations are entirely consistent with all observed behaviour of currents and voltages, including the results of tests described by Ivor Catt in previous issues of Electronics World.

Ian Darney
UK

PCIM EUROPE 2015
Nuremberg
19-21 May 2015
www.pcim-europe.com

PCIM
EUROPE

International Exhibition and Conference
for Power Electronics, Intelligent Motion,
Renewable Energy and Energy Management
Nuremberg, 19 – 21 May 2015

PCIM Europe 2015 – Meeting Point For Experts From Industry And Science

From 19-21 May 2015 many international companies will present their latest products, research findings and innovations in the field of power electronics at PCIM Europe in Nuremberg. Around 400 exhibitors will demonstrate their recent developments, offering a unique sector overview to more than 8000 visitors.

Power Electronics Conference

In parallel with the PCIM exhibition, the conference will feature 29 presentations and poster sessions, giving a thorough overview of trends and developments in the industry. Among the highlights of this year's conference are three top-class keynotes on "*The State of the Art and Future Trends of Power Semiconductor Devices*", "*Packaging and Reliability of Power Modules – Principles, Achievements and Future Challenges*" and "*Electrochemical Battery Management and Applications*".

In addition, on the two days before the conference, 17-18 May, there will be nine seminars and nine tutorials, where renowned industry experts discuss their views of the industry. At the Industry Forum in Hall 6, there will be more technical presentations, expert discussions, project presentations and market overviews from associations, specialist media and companies.

The exhibitor forum in Hall 7 will offer another 50 presentations, focusing of the latest developments and innovations from the exhibiting companies.

Free Entry

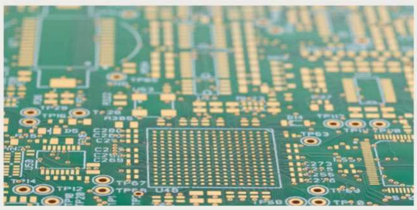
The event is free, but registration is required. Learn more at **www.pcim-europe.com/tickets**

UK'S SOLE TRAINING PROVIDER OF IPC CID AND CID+ COURSES

Quadra Solutions has been appointed as the sole UK provider of Printed Circuit Board (PCB) design training courses Certified Interconnect Design Qualification (CID). The qualification, accredited by the IPC – the association representing the global electronics industry, is to be delivered by Quadra's highly skilled and experienced trainers at their specialist training facility in Lancashire. This world-leading training programme promises to enhance and improve the skills of individuals operating within the electronic design industry.

The CID professional development programme provides delegates with the foundations of electronic design decision making and the practical application of IPC standards for the design and manufacture of PCBs. The course covers the fundamentals of component placement and track routing, and provides a wider understanding of all the various elements of PCB development, including design considerations, layout principles and component and assembly matters.

www.quadrasol.co.uk



MICROLEASE SELECTED AS KEYSIGHT AUTHORISED UK DISTRIBUTOR

Microlease is now the Authorised Distributor in the UK for Keysight Technologies, supporting and selling Keysight's full product range – from handheld instruments to the top-of-the-range bench instruments, including signal generators, sources, power supplies, RF test equipment and, for the first time, thermal imaging instruments.

Directly linked to the deal is Microlease's investment of over £1m in premises, engineering staff, stock and e-commerce capabilities. Instruments bought outright from the Microlease UK stock can be shipped the same day.

Microlease is already a Keysight Premier Rental Partner for Europe and North America, an Authorised Distributor in the Americas and Italy, as well as the Authorised Technology Partner in the UK, Ireland, and Italy.

"We have an incredibly strong reach; we touch nearly all test and measurement users in the UK," said Nigel Brown, (pictured left) CEO of Microlease.

Microlease was recently awarded the Frost & Sullivan Company of the Year accolade for Best Practise in Global Test and Measurement Rental and Leasing Services two years in a row, for 2013 and 2014.

www.microlease.com

SCHURTER HAS A NEW CEO

Christian Holzgang took over the reign at Schurter from Ralph Müller, who had been appointed CEO of the Schurter Group.

Christian Holzgang's management credo encompasses the "5Vs" which have been firmly established in Schurter's corporate culture: Vorbild (paradigm), Vertrauen (trust), Verantwortung (responsibility), Veränderung (change) and Vernetzung (networking). The new CEO plans to continue Schurter's successful track record, carrying on the company's tradition of focusing specifically on new developments – the company invests over 10% of its turnover in R&D.

Holzgang also counts Schurter's networking capabilities to be a particular strength, with a lot of potential; interdisciplinary collaboration and internal transfers of knowledge regularly result in innovative products and manufacturing systems with great market potential.

www.schurter.com

GAN SYSTEMS SEALS DISTRIBUTION DEAL IN JAPAN AND ASIA

GaN Systems has signed an agreement with Japanese semiconductor and electronic component distributor, Value Integrated Technology (Vitec) to distribute its Island Technology high-power GaN devices in Japan, Taiwan and China.

"Demand for our GaN power switching transistors is growing very rapidly as manufacturers seek to design smaller, lighter and more power-efficient products in order to gain competitive edge," said Jim Witham, CEO of GaN Systems. "We are delighted to have signed Vitec as a distributor in Japan. Vitec has a strong presence in the consumer and enterprise segments and has links with major brand name manufacturers."

Osamu Komaki, VP of Marketing for Vitec added: "Vitec is expanding into industrial and automotive markets and GaN Systems has a very strong portfolio of higher-current GaN power switches for high-power applications in these sectors."

www.gansystems.com

ASTUTE ELECTRONICS SIGNS WORLDWIDE DISTRIBUTION AGREEMENT WITH EUROQUARTZ

Astute Electronics has signed a worldwide franchise distribution agreement with Euroquartz, the independent UK-based manufacturer and supplier of quartz crystals, oscillators, filters and frequency-related products.

Euroquartz works with four strategic partners – Statek, Greenway, Axtal and Mercury – which provide complementary leading-edge technology and expertise to Euroquartz's portfolio, enabling the company to deliver a comprehensive range of frequency control components to a wide range of customers, including major OEMs covering a broad spectrum of applications such as military and aerospace, communications, computing, control systems, petrochemical and general electronics.

"We must adhere to many international procedural and component supply standards as a prerequisite for providing products that target demanding applications. Therefore, we are pleased to add Euroquartz to our growing franchise portfolio of active components," said Mike Blee, Marketing Manager at Astute Electronics.

www.astute.co.uk

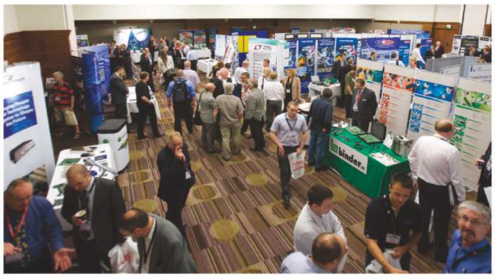
TOREX SEMICONDUCTOR ANNOUNCES NEW EXECUTIVE APPOINTMENTS

Torex Semiconductor, provider of CMOS power management ICs, has appointed Koji Shibamiya its President and Chief Executive Officer (CEO), replacing Tomoyuki Fujisaka, with Fujisaka assuming the post of Chairman. The appointments are effective as of the end of June. The nominations are subject to formal approval at a meeting of the board of directions on June 25, to be held after the annual shareholders meeting.

Koji Shibamiya was born in 1960 in the Tochigi prefecture, Japan. He has a Bachelor of Electrical and Electronic Engineering from the Tokai University (March 1983). He joined Abe Photo Printing Corporation (Now Abeism Corporation) in April 1983, followed by Nihon Precision Circuits (now Seiko NPC) in 1986. The following year he moved to Ricoh, then worked for Phenitec Semiconductor until July 1999 when he joined Torex Semiconductor. He was Director of Sales and Marketing manager from 2001 at Torex.

www.torex.co.jp

20th Anniversary TOREX



NEW, COMPACT, HIGH-POWER DENSITY AND SOLID STATE MPMS FROM TMD TECHNOLOGIES

TMD Technologies will exhibit at IMS 2015 and feature its new PTXM Series high-power density, ultra-compact microwave power modules (MPMs) and PTS6900 solid state MPM (Booth 3623).

Other TMD's products on show will include a wide range of microwave solutions for radar, EW, communications and laboratory applications, Ku-band travelling wave tubes (TWTs), ultra-high-power TWTs, and solid state amplifiers for EMC HIRF (high-intensity radiated fields) testing.

Operating across the 4.5-18GHz band, with output powers up to 140W, TMD's new PTXM Series MPMs have been designed specifically for airborne radar, EW and communications applications – particularly for UAVs, where low volume and weight are critical. They are extremely compact, with a typical weight of only 1.7kg and with no reduction in RF power.

TMD's new PTS6900 solid state MPM incorporates the latest GaN MMIC technology.

www.tmdus.com

TWO NEW PCIE INTERFACE PRODUCTS FROM APACER

As a quick response to market demand, Apacer launches two PCIe interface products, including mPDM+ and M.2 PCIe SSD.

The mPDM+ is a mini PCIe SSD with the dimensions in line with that of mSATA products. The 50.8 x 29.8mm size can be a perfect substitute for the storage device of mSATA attached to the motherboard. On the other hand, M.2 PCIe SSD is about 40% smaller than the mSATA SSD module in dimensions of only 22 x 42mm. It supports both the transmission signals from SATA and PCIe.

PCIe boasts transmission bandwidth and speed far beyond that of SATA, achieving higher transmission efficiency than that of SATA 6Gbps. With high compatibility, both these two PCIe SSDs match AHCI (Advanced Host Controller Interface) and have up to 128GB capacity, which ensure their competitive edge.

www.apacer.com

BOSCH'S THREE-IN-ONE ENVIRONMENTAL SENSOR NOW AT MOUSER

Mouser Electronics is now stocking the BME280 humidity and pressure sensor from Bosch Sensortec. The BME280 combines a digital humidity sensor, pressure sensor and temperature sensor in one package, providing an extremely fast response time and high overall accuracy over a wide temperature range.

BME280 is developed specifically for mobile applications where size and power consumption are of critical importance. It fits into a 2.5mm^2 package and draws as little as 100nA in sleep mode. The humidity sensor responds quickly and accurately to changes in ambient humidity from zero to 100%. The pressure sensor measures absolute barometric pressure from 300-1100hPa with an accuracy of ±1.0hPa with very low noise. The integrated temperature sensor measures ambient temperature from -40 to +85°C within one degree of accuracy.

www.mouser.com

PCB TERMINALS FROM HARWIN IMPROVE BUILD QUALITY

Harwin has announced a wide range of PCB terminals (turrets). These simple yet effective PCB hardware products are often overlooked, but can save assembly costs, improve build quality and increase design flexibility.

Turret styles are used to solder heavy gauge wire from a power supply to a PCB, for example. Generally these are swaged because a secure mechanical fix is needed. The different styles give the customer flexibility in design and the opportunity to attach several wires to the same post.

"Products such as our H3108-01 0.5mm-diameter terminal pin can be used to construct a pluggable PCB assembly – perhaps a module or daughterboard. The H2173-05 – another terminal pin – adds a swaged retention feature for extra strength. Both can be used to attach wires, avoiding soldering the wire direct to a PCB," said Paul Gillam, Harwin Product Manager.

www.harwin.co.uk

POWER INTEGRATIONS OFFERS A NEW REFERENCE DESIGN KIT FOR A USB CHARGER

Power Integrations announces RDK-420, a new reference design kit for a 10W CV/CC USB charger based on the company's InnoSwitch-CH family of highly integrated switcher ICs. InnoSwitch ICs combine the primary-side switch together with primary and secondary controllers and feedback circuits into a single, worldwide safety-rated, surface-mount package.

Innoswitch ICs leverage accurate secondary-side regulation (SSR), using Power Integrations's high-speed digital FluxLink technology to communicate direct voltage and current measurements across the safety isolation barrier. This new feedback technique permits precise control without the need for a bulky optocoupler, while avoiding the performance compromises inherent in primary-side regulation (PSR).

Other benefits include: ±3% CV, ±5% CC regulation; cable voltage-drop compensation; built-in synchronous rectification driver for high efficiency; and < 10mW no-load input power, among others.

www.power.com

OMC OFFERS THE MOUNTING OF ANY FIBRE OPTIC DIODE IN ANY HOUSING

OMC announced a new service, enabling engineers to choose exactly the right fibre optic diode for their application and have it mounted in their preferred package.

"We regularly get approached by people who have identified a diode which is a perfect match for their needs, but find that it is not available in a housing, or in a specific housing they need. The housing and the way the diode is mounted in it can have serious implications for system performance," said OMC's Commercial Director, William Heath.

OMC has even developed its own proprietary ACA (Active Component Alignment) technology to ensure that its fibre-optic data links perform consistently and reliably from link to link. The company works with various housing styles and also offers bespoke housings and pigtail options.

www.omc-uk.com

HIGH SENSITIVITY CURRENT PROBES FOR MEASUREMENTS DOWN TO 1MA/DIV

Teledyne LeCroy introduced the CP030A and CP031A high sensitivity current probes with sensitivity down to 1mA/div, allowing users to measure current from the mA range to a continuous current of 30Arms and peak current of 50A.

The probes provide a small form-factor for today's crowded boards. The small jaws can probe currents in tight spaces and still clamp onto conductors up to 5mm in diameter. The CP030A and CP031A feature a bandwidth of 50MHz and 100MHz, respectively.

The CP030A and CP031A expand the capabilities of the Teledyne LeCroy current probe family to a wider range of applications by providing the ability to measure and analyze low current waveforms.

The sensitivity of 1mA/div combined with 1% DC and low frequency accuracy allows for more precise and accurate low-current measurements on Teledyne LeCroy oscilloscopes.

teledynelecroy.com

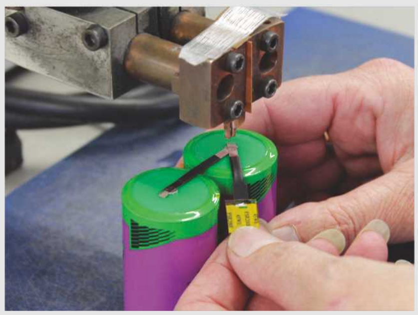
CUSTOM BATTERY-PACK ENGINEERING WITH RAPID REACTION PROTOTYPING

Cell Pack Solutions Ltd, specialist in battery pack design and manufacturing, offers Rapid Reaction Prototyping for custom-engineered battery packs to electronic device manufacturers.

With applications for remotely located and portable devices such as security and access control, smart metering, surveillance, asset tracking, environmental monitoring and data logging, battery and cell pack design is an integral part of the products' development and production.

Cell Pack Solutions Rapid Reaction Prototyping services utilises the companies skills and expertise with over 3000 unique custom battery pack designs to date. Battery test capability ensures that custom battery packs are engineered and manufactured to the highest standards in accordance with our ISO 9001:2008 accreditation.

www.cellpacksolutions.co.uk



SLIMLINE M12 CONNECTOR WITH RAPID TERMINATION TECHNOLOGY

Harting has introduced a slimline version of its har-speed X-coded M12 connector equipped with HARAX rapid termination IDC connection technology.

The new field-installable 8-pin M12 connector is the latest addition to Harting's family of products for Gigabit Ethernet applications, and is intended for scenarios in automation technology where a cable needs to be attached quickly or adapted on site.

In particular, the insulation displacement contact is designed to ensure an uninterrupted connection performance by maintaining the twisting of the STP cable for as long as possible when it is drawn deep into the mating face.

www.harting.co.uk

CUSTOMER-PROGRAMMABLE CURRENT-SENSOR IC IN SINGLE-INLINE PACKAGE

The new A1369 from Allegro MicroSystems Europe is a customer-programmable, high-accuracy linear Hall-effect-based current sensor IC packaged in a slimline 3-pin single-inline package which allows for easy integration with a magnetic core to create a highly accurate current sensing module.

The A1369 is designed for use with customer-provided steel or other ferromagnetic cores, where its programmable nature allows it to compensate for manufacturing tolerances in the final current sensing module assembly. The accuracy of the device is enhanced by the programmability of both the sensitivity and quiescent output voltage (QVO – the output with no magnetic field present) on the output pin for end-of-line optimisation without the added complexity and cost of a fully programmable sensor.

The device features one-time programming using non-volatile memory to store the desired sensitivity and QVO for a given application or circuit.

www.allegromicro.com

INDOOR SOLAR-POWERED WIRELESS MESH NETWORK WILL BE SHOWN AT HANNOVER FAIR

Linear Technology will be demonstrating its SmartMesh IP embedded wireless mesh networks, powered by Sol Chip's Solar Battery, at the Hannover Fair 2015 trade show in Hall 9, Stand G29. The use of solar energy to power industrial Internet of Things (IoT) applications provides a maintenance-free wireless solution, as no batteries are required for operation.

SmartMesh IP wireless mesh networks are built for IP compatibility, and are based on 6LoWPAN and 802.15.4e standards. The SmartMesh IP product line achieves high levels of networking resilience, reliability and scalability with advanced network management and comprehensive security. SmartMesh IP embedded wireless networks include breakthrough Eterna SoC technology that enables up to 8x lower power consumption than competitive solutions, even in harsh, dynamically-changing RF environments.

www.linear.com

LINEAR TECHNOLOGY

SOLCHIP
Everlasting Solar Battery

RITTAL'S ENCLOSURE SOLUTIONS ON SHOW AT RAILTEX 2015

Rittal will be showing its top-of-the-range PADS and LUL-approved range of enclosures at RAILTEX 2015, on stand N41.

There will be a range of double-walled CS enclosure systems used extensively in Long Line PA applications as well as on level crossing controls. Made of the lightweight aluminium alloy AlMg3, which offers exceptional corrosion resistance, the CS enclosure has many built-in features including fan and filter cooling, anti-graffiti Ri-Nano paint finish, and 19" angles front and rear.

At the show there will also be a chance to review the TS IT. These fast, simple and flexible enclosure systems feature snap-in technology, flexible internal configuration, intelligent cable management system, vented doors and multi-functional roofs.

www.rittal.com

HIGH EFFICIENCY POWER MANAGEMENT ICs

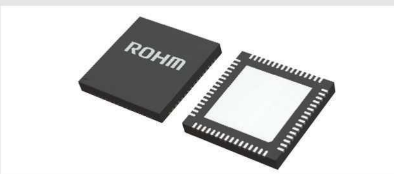
Rohm has developed a high-efficiency power management IC specifically for Freescale Semiconductor's i.MX 6SoloLite applications processor.

The i.MX 6SoloLite processor possesses a market-proven track record as an application platform for battery-driven applications where power consumption is critical, such as e-books, wearable tech, tablet PCs, portable terminals for industrial equipment, and other portable devices.

Rohm's BD71805MWV uses power supply technology cultivated for mobile applications to optimize circuit configuration for the i.MX 6SoloLite processor. The result is significantly reduced power consumption during both standby and normal operation, prolonging battery life considerably.

The BD71805MWV is based on ROHM's own analog technology for achieving an ideal power supply system for driving the i.MX 6SoloLite processor. This results in a power conversion efficiency of over 82% (during normal operation) and a reduction in standby current consumption by 45% over conventional products.

www.rohm.com/eu



NEW GOPRO HERO4 DIGITAL CAMERAS FROM RS COMPONENTS

RS Components (RS) now stocks two new professional-quality GoPro digital cameras and a wide range of GoPro accessories. The HERO4 Silver and Black are the most advanced GoPro cameras yet, offering high-end performance with built-in connectivity and waterproof durability.

While the cameras are well known for their use in action-packed video in extreme sports and many other consumer-led applications, there is also a place for these products in commercial and industrial environments. For example, site maintenance and installation engineers using cameras to monitor and record daily activities and inspections.

The new HERO4 Silver offers high-definition 1080p60 (1080p at 60 frames per second) and 720p120 video performance with lifelike clarity, as well as 12-megapixel photos at up to 30 frames per second. Other key features include auto-low-light mode, easy playback, editing and sharing and others.

www.rs-online.com

NEW WIRELESS PRODUCTS WITHIN SEVEN WEEKS

The IQRF Alliance members Protronix, CIS and Microrisc jointly developed a complete solution for CO2, humidity and temperature sensor data collection and visualization on the IQRF cloud.

The integration of the IQRF technology into the CO2 sensor, connection to the IQRF cloud through a plug-and-play GSM or ETH gateway from Microrisc, and customization of the IQRF cloud took only seven weeks thanks to the close cooperation of these alliance members.

An IQRF DCTR-52DA module was easily connected to the CO2 detector with a SIM-card holder and the UART was used as the communication interface. This resulted in a very little modification on the original sensor PCB and almost no modification on the communication protocol.

CIS's on-line graphs enable the collected data to be easily accessed and reviewed by anyone, anywhere and at any time.

www.iqrfalliance.org

NEW RF RECEIVERS OFFER BEST-IN-CLASS SENSITIVITY

Micrel introduced the MICRF229 and the MICRF230, low-power, 400MHz to 450MHz, super-heterodyne, image reject, OOK/ASK receivers. Both devices feature -112dBm sensitivity at a data rate of 1kbps and operate from 3.5-5.5V. They consume less than 6mA of current when receiving data continuously and are aimed at remote keyless entry (RKE), garage door openers, home automation and other low-power, low data rate applications. The MICRF229 and MICRF230 are currently available in volume quantities, with 1,000 quantity pricing starting at $1.6.

The MICRF229 and MICRF230 require only a crystal and a minimum number of external components to implement. The MICRF229 has an auto-poll feature that allows power consumption to be reduced to under 0.5mW while the receiver awakes and polls for a valid signal before awaking the microcontroller.

www.micrel.com

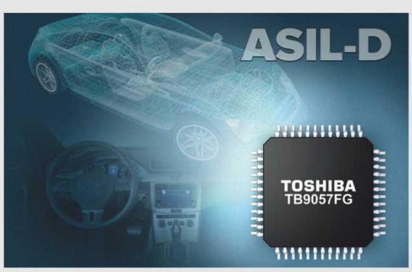
TOSHIBA LAUNCHES BRUSHED MOTOR PRE-DRIVER IC FOR AUTOMOTIVE

Toshiba Electronics Europe has launched TB9057FG, a brushed motor pre-driver IC that provides enhanced functional safety and control for automotive applications such as electric power steering systems (EPS). The new IC meets the requirements set in Automotive Safety Integrity Level D (ASIL-D).

Increasing numbers of safety-critical automotive systems are required to meet the requirements of ASIL-D standards.

The new IC integrates a pre-driver circuit, dual motor current detection circuit that converts motor current to voltage and output to MCU. It also integrates motor direction detection circuitry that detects whether external MOSFETs turn on or off normally and output the direction information to the MCU. To accommodate the possibility of a voltage drop caused by cranking after idling reduction, the battery operation voltage range has been reduced to 5V (min).

www.toshiba.semicon-storage.com



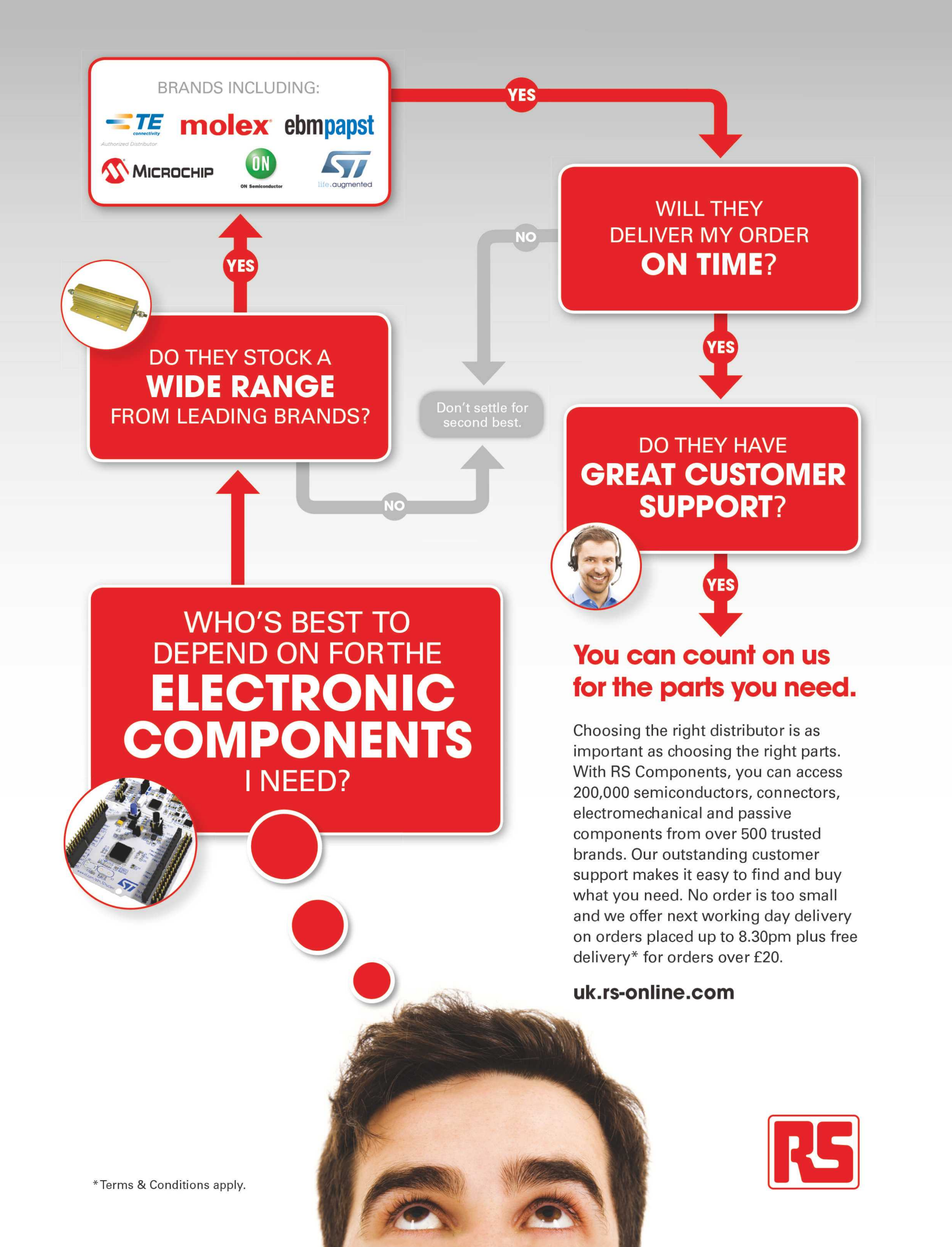
WEB REMOTE TOOLS FOR HANDHELD SPECTRUM MASTER

Anritsu has introduced the Web Remote Tools for its Spectrum Master MS2720T handheld spectrum analyzer which allows instruments to be controlled from any web-enabled device, including laptops, tablets and smart phones, over an Ethernet link. The Web Remote Tools allow greater flexibility and time- and cost-efficient measurements for RF spectrum monitoring and testing remote radio heads (RRUs) and other inaccessible radio units at 3G and 4G base stations.

The easyTest feature of Spectrum Master simplifies complex spectrum monitoring requirements and allows for one-button measurement sequences directly from the web-enabled device. Transferring test results is simplified with Web Remote Tools, as all instrument files, directories and sub-directories can be downloaded as a zip file.

Setup is very quick with the Web Remote Tools. Short-range links of up to 300 feet can be created using a pocket Wi-Fi router.

www.anritsu.com


BRANDS INCLUDING:
TE connectivity
Authorized Distributor
molex
ebmpapst
MICROCHIP
ON
ON Semiconductor
ST
life.augmented
YES
WILL THEY DELIVER MY ORDER ON TIME?
NO
YES
DO THEY STOCK A WIDE RANGE FROM LEADING BRANDS?
Don't settle for second best.
YES
DO THEY HAVE GREAT CUSTOMER SUPPORT?
NO
YES
WHO'S BEST TO DEPEND ON FOR THE ELECTRONIC COMPONENTS I NEED?
You can count on us for the parts you need.
Choosing the right distributor is as important as choosing the right parts. With RS Components, you can access 200,000 semiconductors, connectors, electromechanical and passive components from over 500 trusted brands. Our outstanding customer support makes it easy to find and buy what you need. No order is too small and we offer next working day delivery on orders placed up to 8.30pm plus free delivery* for orders over £20.
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