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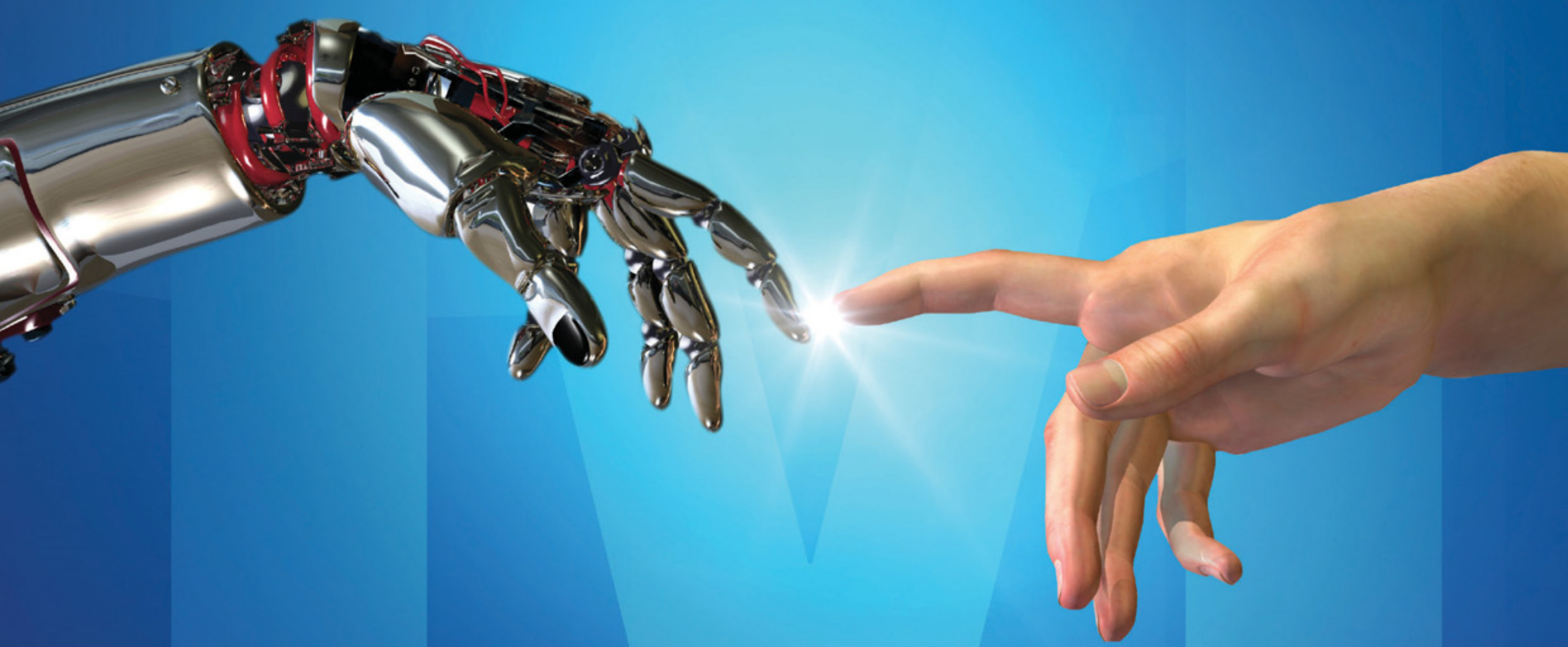

Technology

Britain's first new "greenfield" university in 40 years launched

Embedded Design Series

Adding sound to your embedded design

Features

Transforming industrial user interfaces with multi-touch displays

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eXtreme Low Power MCUs Extend Battery Life

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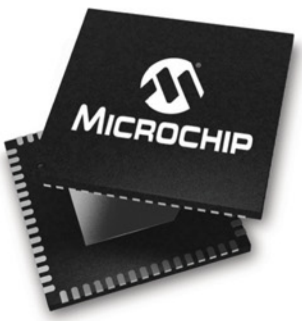

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EMERGING TECHNOLOGIES: ARE THE LATEST NECESSARILY THE GREATEST?

Levels of technology innovations are perhaps at the highest ever seen. From agriculture and the environment to medicine and healthcare, engineers are now using a wide range of multifaceted technologies to address some of the most complex challenges. It is therefore a shame to sometimes see genuinely exciting and interesting innovations not be widely adopted, with little insight into why.

To find out, element14 recently commissioned a global survey of 3,500 consumers, aiming to unearth their attitudes toward technological development generally, but also toward current trends such as the Internet of Things (IoT), wearables and other 'must have' technologies.

The research, carried out in the US, the UK, Germany, France, China and India, revealed a wealth of regional statistics, but it was immediately apparent that healthcare was regarded the top priority for technology and innovation across all regions. Technologies that enhance people's quality of life were also highly attractive, with universal high-speed Internet appealing to 68% of respondents, and flexible or foldable screens to 40%.

The IoT is the most high-profile of the emerging technology trends, blending the physical and online worlds and connecting a range of everyday objects to the Internet. By enabling devices to communicate with each other, IoT can offer consumers a range of applications: from connected burglar alarms and 'smart' heating, to pollution monitoring.

Med-Tech For Healthier Lifestyles

Medical technology has the ability to encourage healthy lifestyles, increase productivity and ensure that people live independently for as long as possible. It is therefore unsurprising that 79% of respondents believe technology should fundamentally work toward improving lives, whilst almost 70% said they believe medical technology should be the primary focus of future technological development.

Similarly, wearable technology that tracks overall fitness and diet and measures functions such as heart rate, sleeping patterns and blood pressure, is already used by consumers. The next phase would be in blending these together, with sensors incorporated into clothing and accessories.

However, despite the clear interest in medical technology, the research revealed privacy concerns – particularly in Europe, and in particular for those applications that relate to children. To this end, only 29% of consumers said they would be willing to adopt technologies such as smart plasters that can take readings of their child's temperature. Similarly, there are significant concerns over more extreme examples of medical technology, with fewer than half saying they would want a chip to be implanted into their body, even if it offered proven health benefits. Continuous biometric assessment is considered more intrusive than beneficial. As such, whilst there remains a demand and significant opportunity for innovation within the health sector, designers will need to first address privacy concerns and ensure preventative technologies remain unobtrusive.

> "Almost 70% of respondents said they believe medical technology should be the primary focus of future technological development

Environmentally-Friendly Technology

There is also a global desire to protect the environment, with 85% of consumers agreeing on the importance of clean energy, and two thirds believing renewable energy should be the main focus of technological development. Respondents from China and India were the two most concerned countries about the environment, despite ongoing criticism of their governments' efforts in this area.

Over 90% of consumers say they want renewable energy to become more affordable and this is what environmental technology needs to address if it is to see mass adoption. A good example is the adoption of electric cars, with 51% of respondents wanting them to become a 'mainstream' purchase in 2015.

Overall, it is clear that consumers have a strong interest in technology to enhance their daily lives. However, people are looking for low-cost, practical technologies that can enhance their existing routines and lives, rather than exciting and adventurous IoT applications that revolutionize them. Ultimately, technology that improves existing features – such as automatic car engine maintenance and smart TVs – is driving consumer demand.

By Dianne Kibbey, Global Head of Community, element14 (www.element14.com)

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BRITAIN'S FIRST NEW "GREENFIELD" UNIVERSITY IN 40 YEARS LAUNCHED

The first new "greenfield" university in Britain launched in March in Hereford, the first new university in the UK in 40 years. The New Model In Technology & Engineering (NMITE) has the support of several leading universities, engineers, businesspeople and politicians. It will open its doors to 300 students in September 2017.

The university was set up specifically to change the way engineering and related technologies are taught in Britain. The inspiration came from the well-known – and considered "radical" by some – Olin College of Engineering in the US.

"[NMITE] will be the first university in Europe to fully adopt the tried and tested approach of America's highly innovative Olin College of Engineering. Graduates will be equipped additionally with the broader business, innovation, entrepreneurship and leadership skills that British employers need but find to be in very short supply," said Karen Usher, co-leader of the Development Team at Olin College, who was involved with NMITE since its inception.

Artist impression of the new UK university campus

Among NMITE backers are the Universities of Bristol and Warwick. Sir Eric Thomas, Vice-Chancellor of the University of Bristol, said: "All universities have a responsibility to equip their students with the skills needed for their future lives, and we will be working with NMITE to see how these methods can be used for the benefit of their students, the engineering and technology sector, and the UK."

Olin College of Engineering will continue to provide consultation and advice to NMITE. The College is a unique institution, offering selective courses through a privately-funded national laboratory for STEM education. It was founded in 1997 with a $500m investment from the F. W. Olin Foundation for the purpose of 'becoming an important and constant contributor to the advancement of engineering education in America and throughout the world'.

OPTICAL FIBRES MAY LEAD TO BRAIN-LIKE COMPUTING

Computers that function like the human brain could soon become a reality thanks to new research using optical fibres made of speciality glass.

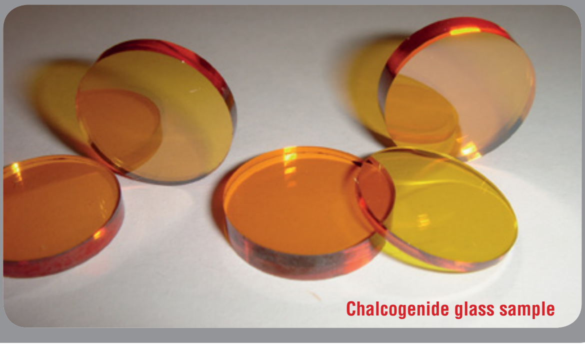
Researchers from the Optoelectronics Research Centre (ORC) at the University of Southampton, UK, and the Centre for Disruptive Photonic Technologies (CDPT) at the Nanyang Technological University (NTU), Singapore, have demonstrated how neural networks and synapses in the brain can be reproduced with optical pulses as information carriers, using special fibres made from glass materials sensitive to light, known as chalcogenides.

"Since the dawn of the computer age, scientists have sought ways to mimic the behaviour of the human brain, replacing neurons and our nervous system with electronic switches and memory. Now instead of electrons, light and optical fibres also show promise in achieving a brain-like computer," said ORC's Professor Dan Hewak.

In the last decade, neuromorphic computing research has advanced software and electronic hardware that mimic brain functions and signal protocols, aimed at improving the efficiency and adaptability of conventional computers. However, compared to biological systems, today's computers are more than a million times less efficient. Simulating five seconds of brain activity takes 500 seconds and needs 1.4MW of power, compared to the small number of calories burned by the human brain.

Chalcogenide (glass materials based on sulphur) microfibers possess a variety of broadband photo-induced effects, allowing the fibres to switch on and off; the glass's changing properties act as the varying electrical activity in a nerve cell. This optical switching can be exploited for a variety of next-generation computing applications capable of processing vast amounts of data in a much more energy-efficient manner.

The team led by Professor Cesare Soci at NTU has already demonstrated a range of optical equivalents of brain functions, including holding a neural resting state and simulating the changes in electrical activity in a nerve cell as it is stimulated.



Chalcogenide glass sample

The research paves the way for scalable brain-like computing systems that enable 'photonic neurons' with ultrafast signal transmission speeds, higher bandwidth and lower power consumption than their biological and electronic counterparts.

"This work implies that 'cognitive' photonic devices and networks can be effectively used to develop non-Boolean computing and decision-making paradigms that mimic brain functionalities and signal protocols, to overcome bandwidth and power bottlenecks of traditional data processing," said Professor Soci.

NEW RADIO EQUIPMENT DIRECTIVE 2014/53/EU REPLACES THE R&TTE DIRECTIVE

The EU passed a new radio equipment directive – 2014/53/EU, superseding the R&TTE directive 1995/5/EC. Member states need to implement it by 13th June 2016, when 1995/5/EC will cease to be valid.

The scope of the new 2014/53/EU is more precisely defined and only applicable to radio equipment, whereas the previous R&TTE directive covered radio equipment and telecommunications terminal equipment. Landline equipment will continue to be covered by the new Low Voltage Directive 2014/35/EU and the EMC directive 2014/30/EU,

"Affected companies and distributors should comply with the CE regulations specified in 2014/53/EU to avoid penalty payments," said Wolfram Ziehfuss, MD of FBDi, the professional association of component distributors.

The new directive requires necessary measures such as CE marking on the product, including the identification number of the notified body if applicable; a mandatory operating manual in the official language of the country of final use; and a declaration of conformity – which can be stored on the Internet in an easy-access position, which means the complete text does not necessarily need to be contained in the user information.

In this context, the FBDi points out that the EMC directive (2004/108/EC) and the Low Voltage Directive (2006/95/EC) will also be superseded by their successors (EMC directive 2014/30/EU and LVD directive 2014/35/EU) on 20th April 2016 as part of this implementation package.

EC directives continue to be rewritten and revised to increase transparency and legal clarity for manufacturers, importers and dealers.

FBDI

The FBDi (Fachverband der Bauelemente Distribution) is a professional association of German component distributors, founded in 2003. It is also a member of the International Distribution of Electronics Association (IDEA). As of January 2015, its member companies count Acal BFi Germany, Arrow Central Europe, Avnet EM EMEA (EBV, Avnet Abacus, Silica, Avnet Memec, MSC Technologies), Conrad Electronic SE, Farnell, Future Electronics Deutschland, MEV Elektronik Service, Mouser Electronics, RS Components, Rutronik Elektronische Bauelemente, TTI Europe and many others; EPCOS and FCI Electronics are supporting members.

THE WORLD'S FIRST CROWD-CONTROLLED ROBOTIC BAR DEBUTS ON A CRUISE SHIP

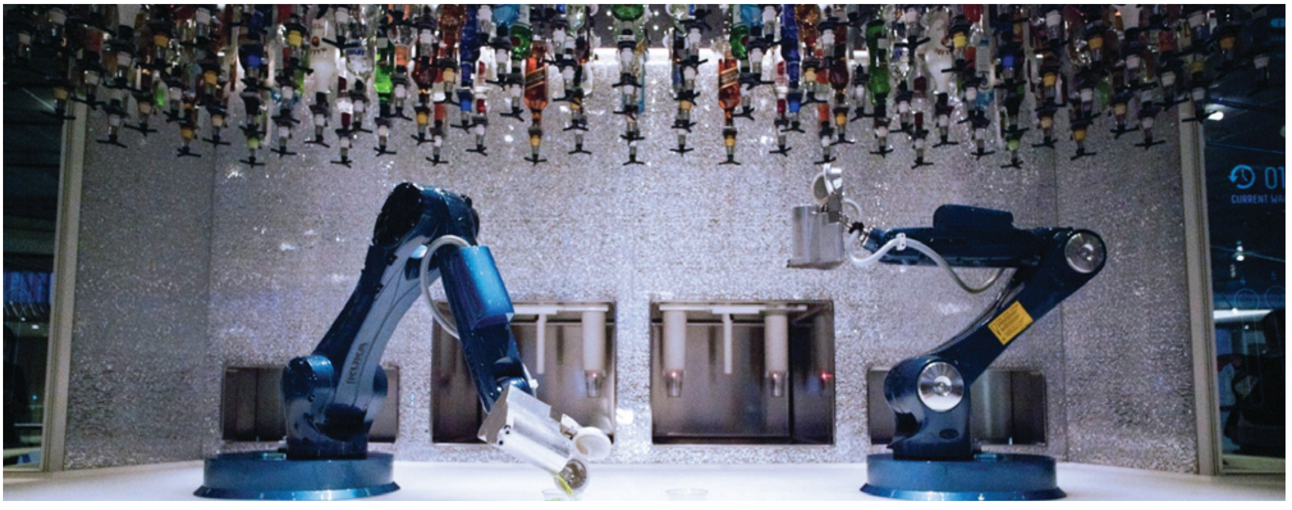
The world's first robotic bartending system, called Bionic Bar by Makr Shakr, started to mix cocktails for the first time onboard the Royal Caribbean's new 'smart' cruise ship, Anthem of the Seas, in Southampton.

The bar's robotic arms (pictured), designed by renowned architect, engineer and inventor Carlo Ratti, allows users to create personalised cocktail recipes in real time through a smartphone application and even transforming them into crowd-sourced drink combinations.

"Makr Shakr is a great example of how robotic technologies are changing the interaction between people and products – a topic that we have been exploring in great depth" said Ratti, professor at the Massachusetts Institute of Technology (MIT) and co-founder of Makr Shakr. "The system explores the new dynamics of social creation and consumption – 'design, make and enjoy' – allowing users to design their own cocktail creations, while digitally-controlled machines transform these designs into reality."

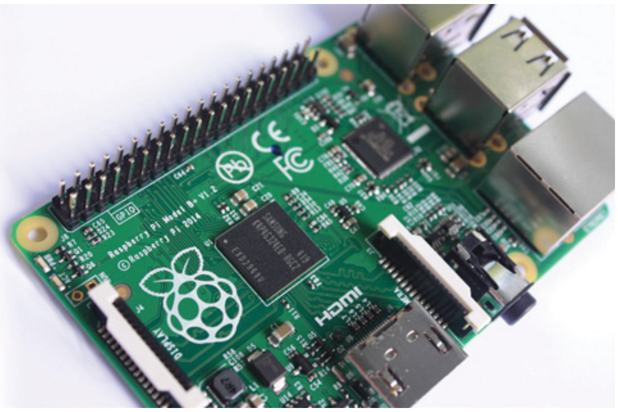
The two robotic arms that prepare the drinks mimic the actions of a bartender, from the shaking of a martini to the thin slicing of a lemon garnish.

"Makr Shakr does not suggest replacing the bartender with a robot, but rather was conceived as a social experiment that looks at how people might embrace the new possibilities offered by robotics and digital manufacturing" said Saverio Panata, COO of Makr Shakr.



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

Using PyAudio To Add Sound To The Computer



BY **GARETH HALFACREE**

PyAudio is the best module for simply and quickly introducing audio into a computer. Once added, anything can be done with it, but if you want to use it in other programs, then a format is needed that other software will understand.

WAV is a simple lossless format that's great for simple audio data (although it can produce huge files for long recordings). A USB microphone is also needed for the sound, since the Pi's output jack is for sound only.

First, the modules need to be installed with the following terminal commands:

```
sudo apt-get install libportaudio0 libportaudio2
libportaudiocpp0
\portaudio19-dev python3-setuptools python3-pip
sudo pip-3.2 install pyaudio
```

To get sound, the code (which can be also found on the website as chapter 9-record .py) is:

```
import pyaudio
import wave
def record_sound(seconds, chunk_size, sample_rate,
filename,
channels, format_type):
p = pyaudio.PyAudio()
stream = p.open(format=format_type,
channels=channels,
rate=sample_rate,
input=True,
frames_per_buffer=chunk_size)
print("Speak now")
frames = []
for i in range(0, int(sample_rate / chunk_size *
seconds)):
data = stream.read(chunk_size)
frames.append(data)
if i%int(sample_rate/chunk_size) == 0:
print(seconds - round(i/(sample_rate/chunk_size)),
"seconds remaining")
print("Finished")
stream.stop_stream()
stream.close()
p.terminate()
wf = wave.open("filename", 'wb')
wf.setnchannels(channels)
wf.setsampwidth(p.get_sample_size(format_type))
wf.setframerate(sample_rate)
wf.writeframes(b''.join(frames))
wf.close()
chunk_size = 1024
sample_rate = 44100
seconds = 15
filename = "output.wav"
channels = 1
format_type = pyaudio.paInt16

record_sound(seconds, chunk_size, sample_rate,
filename, channels, format_type)
```

There are a number of properties that can be adjusted to influence the recording. Some control how data is captured and stored (for example, chunk_size and sample_rate), while others are of higher level (like determining recording length in seconds, or the number of channels). For now, it's best to stick with the defaults, unless there's a good reason to change them. Some are limited by the hardware, so PyAudio will throw an exception if they are changed.

Recording Sound

The record_sound() function does all the hard work (it could be inline code rather than a function and it would work fine, but we make it a function here so it's easier to include in other programs). The first and second lines create a new PyAudio object and then to open a stream; audio data is obtained from this stream. The main work of recording the sound is then done by the 'for' loop:

```
for i in range(0, int(sample_rate / chunk_size *
seconds)):
data = stream.read(chunk_size)
frames.append(data)
```

This introduces the data in correctly-sized chunks and saves it into a list, with each chunk being byte-sized.

Now that the audio data is presented as a string of bytes, the simplest thing is to store it as a WAV file using the wave module, and that's what the second half of the function does.

When you run the program, you'll first notice a string of errors, but don't worry; it's just PyAudio's way of showing updates. (They're thrown as PyAudio detects the audio hardware on the device. As long as there are no Python exceptions, everything's fine.) You'll then find a file called output.wav in the directory you ran it from. This is a 15s recording that can be played back with any audio software.

Speaking To The Pi

All manner of things can be done with the recorded audio, but one of the coolest is that it doesn't require any musical talent is voice control. To do this, some way of processing the sound is required to extract the content, which is a surprisingly hard task. Unfortunately, there are no modules to make this process easy.

However, Python modules aren't the only way of getting extra functionality for your program. Web services are another great source of features that can easily plug into the software. Google has an excellent speech-to-text web service we can use here. It does have a couple of limitations though. For instance, the speech sections are limited to a maximum lenght of 15s, and the audio clips have to be uploaded in FLAC format with a sample rate of 16,000.

The first rule shouldn't cause too many problems for voice control systems (although it does rule out dictation software). However, the second restriction is a little awkward, since there isn't a standard FLAC module for Python. There are a couple of options, none is particularly suitable for our purposes. Here, we can turn to yet another source of extra features from the Linux command line. This allows running regular Linux programs and controlling them from inside the Python code.

The code to convert the speech to text (once it's FLAC-encoded) is:

```
def google_speech_recognition(filename):
global url
audio = open(filename,'rb').read()
http_header={'Content-Type': 'audio/x-flac;
rate=16000'}
request = urllib.request.Request(url, data=audio,
headers=http_header)
response = urllib.request.urlopen(request)
out = response.read()
json_data = json.loads(out.decode("utf-8"))
return json_data
```

The only things new here are the extra parameters on the call to urllib.request. Request(). The data parameter sends the data, in this case an audio file, and the headers parameter sends the HTTP headers. These headers tell the web server who is requesting the data, and the type of data they are sending, if any. In this case we're telling the server that we're sending FLAC-encoded audio with a sample rate of 16,000.

This doesn't return the actual text, but rather returns JSON-encoded data that includes the text and the confidence that the text is right (with different accents and bits of slang, this is never going to be completely perfect).

For more information about what's returned, the following print line can be added: **print(json_data)**.

Processing text is far easier than processing audio, so you should now be able to integrate the output in your software. ●

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.

Sound

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

In previous columns we learned to present a compelling message using text and graphics, as well as how to manage touch in user interfaces. If we want to take our application to the next level, then we have to close the (sensory) loop by adding audio.

For every user interface "action" an immediate feedback is required. The more of our senses are involved, the more effective the interface will be. Assuming the graphical user interface provides a visual feedback, additional auditory feedback can significantly improve the user experience.

From PWM to MP3 and Beyond

The simplest way to produce sound in an embedded control application is to use one of the most popular tools of the trade – a PWM peripheral. It typically connects to a piezo-electric membrane, and generating a sound (such as a click or a beep) is just a matter of sending a few short PWM bursts with the right frequency and duty cycle.

However, in a world full of pods, pads and all sorts of smart things, clicks and beeps are no longer enough; the user expects a much gentler, modulated, tone. This still requires a PWM to be applied to a filter, and an audio amplifier, or possibly entirely replaced by a high resolution digital-to-analog converter (DAC) and amplifier integrated circuit, commonly referred to as an audio codec (CODer and DECoder; with the decoding part being used in this case).

Luckily, codecs have become very inexpensive, and the high level of integration possible today has enabled them to assume even more advanced functionalities, including compression and decompression of complex audio formats such as MP3, WMA and the friendly open-source Ogg Vorbis.

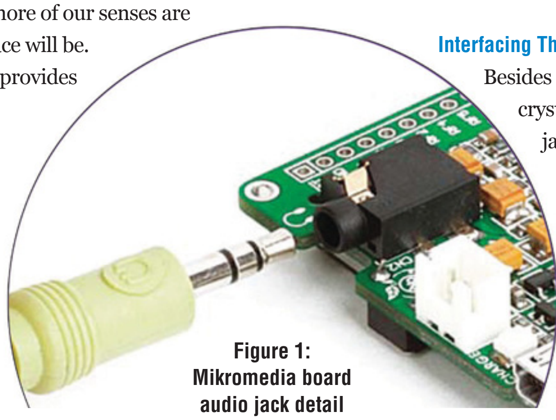


Figure 1: Mikromedia board audio jack detail

Codecs are also very easy to use and embedded-control friendly thanks to the adoption of the SPI interface both for audio streaming and device configuration and control. All Mikromedia boards feature one such codec – a VS1053 from VLSI Technologies – that can directly drive a standard pair of earphones or can be further connected to an audio amplifier.

Interfacing The VS1053

Besides a few decoupling capacitors, a crystal and the audio (stereo 3.5mm) jack, there is no need for any additional supporting components in the application schematic of the Mikromedia board.

In Figure 2 we see that the codec is connected directly to the second SPI port of the PIC24 and a simple GPIO (/MP3-CS) controls the device Chip Select (/CS) line.

You will remember from previous columns that the microSD interface and the serial flash (M25P80) device share the same SPI port. Conveniently enough, the audio codec uses a compatible SPI mode (clock polarity and speed), making the arrangement quite simple to handle, once the proper initialization sequence is followed for each device.

It should be noted that the interface to the audio codec includes three additional signals:

- DREQ, used to communicate to the microcontroller that the codec is ready to accept new data;
- /DCS, used to indicate if new data being sent over the SPI interface is to be interpreted as commands or as streaming sound samples;
- /RST, which controls the device reset.

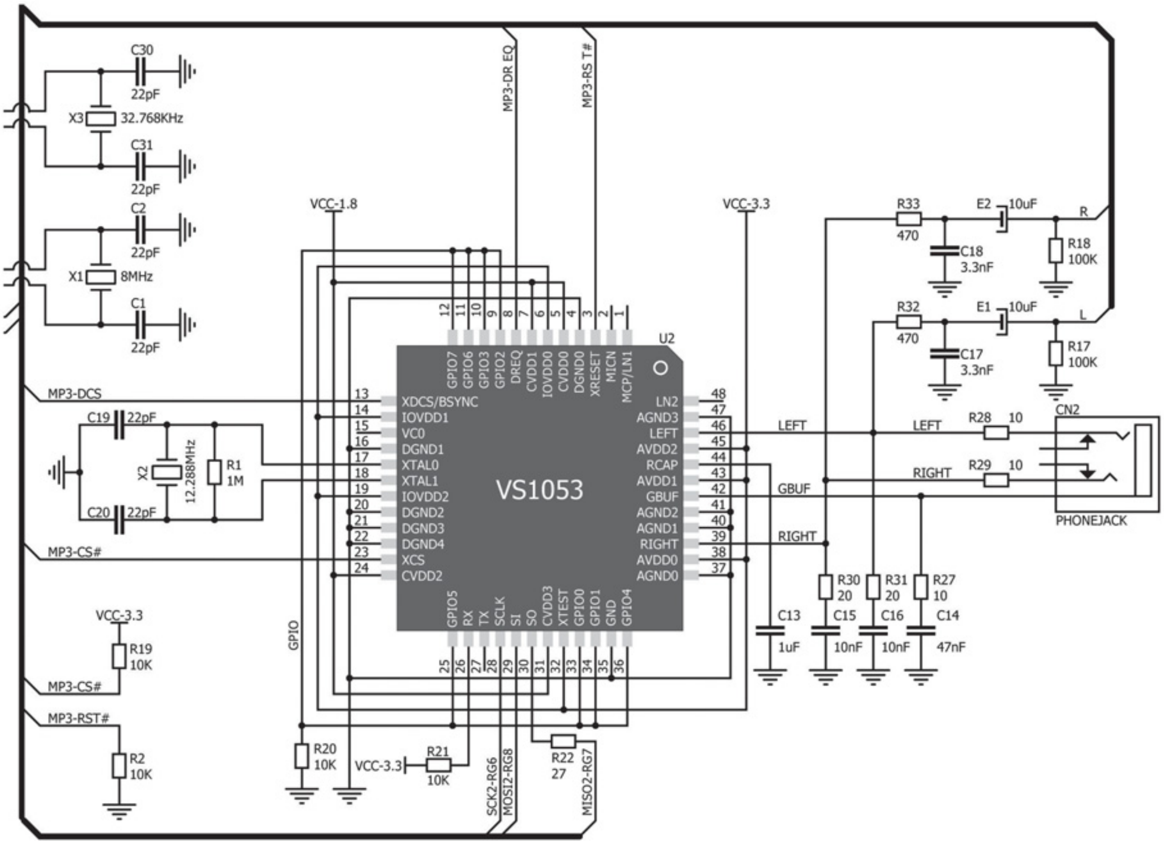


Figure 2: Schematic detail of the Mikromedia audio module

Support For Audio

The Microchip Library for Applications (MLA) does not yet include a board support package module for the VS1053, so this is a great opportunity to experiment with it. We are still able to re-use the low-level interface to the SPI port from the module drv-spi (already used by the serial flash). To start with, we should add the corresponding files (drv-spi.c) to our next project Source Files (logical folder).

Then, we add a section to the board Hardware Profile to abstract the hardware details, as shown in Listing 1.

```
/*****************************************************************
********
* IOS FOR THE VS1053 MP3 decoder
*****************************************************************
*******/
// SPI2 is shared with uSD card in "VS1002 native mode"

#define MP3_RST_Config() _TRISA5 = 0 // 0 reset decoder
#define MP3_RST_Enable() _LATA5 = 0
#define MP3_RST_Disable() _LATA5 = 1

#define MP3_DREQ _RA4 // i request for data

#define MP3_DCS_Config() _TRISG12 = 0 // 0 data select
#define MP3_DCS_Enable() _LATG12 = 0
#define MP3_DCS_Disable() _LATG12 = 1

#define MP3_CS_Config() _TRISA7 = 0 // 0 command select
#define MP3_CS_Enable() _LATA7 = 0
#define MP3_CS_Disable() _LATA7 = 1
```

Listing 1: Hardware Profile, VS1053 audio codec segment

Configuration And Playback

Dialog with the VS1053 codec is very similar to that with any serial EEPROM or serial flash device. A very small set of registers needs to be loaded initially with parameters required to inform the device of the oscillator circuit's (crystal's) frequency and the desired mode of operation. This can be covered nicely by an MP3Init() function.

We might also want to add a test function (sine-wave) before launching into a more complex exercise. This can be set up and performed by a short alternative initialization function testMP3Sine().

See Listing 2 for \ segment of the header file of the VS1053 support module.

```
/*
 * VS1053 Audio Codec
 */

#ifndef _VS1053
#define _VS1053

...
#include "HardwareProfile.h"

// basic SCI commands
#define MP3_CMD_WRITE 0x02
#define MP3_CMD_READ 0x03

// basic registers list
#define MP3_REG_MODE 0x00 // mode options
#define MP3_REG_STATUS 0x01 // main status reg
#define MP3_REG_BASS 0x02 // enable bass & treble enhancements
...

// MODE register options
#define MP3_MODE_DIFF 0x01 // differential (left channel inverted)
#define MP3_MODE_LAYER12 0x02 // allow MPEG layers 1 & 2
#define MP3_MODE_RESET 0x04 // soft reset
#define MP3_MODE_CANCEL 0x08 // cancel decoding
...
#define MP3_MODE_SDINEW 0x800 // new VS1002 native mode

// prototypes
WORD writeMP3( BYTE b);
void writeMP3Register(BYTE reg, WORD w);
WORD readMP3Register( BYTE reg);

void MP3Init( WORD mode);
void setMP3Volume( WORD left, WORD right);
void testMP3Sine( BYTE n);
void feedMP3( BYTE **pdata, size_t *plength);

//
#endif
```

Listing 2: VS1053.h codec support module snippet

Controlling the output volume is a simple matter of loading each of a pair of registers (one per audio channel) with an integer (8-bit) value. This is something we can package conveniently in one short function: setMP3Volume().

Just like with fonts and pictures, the next problem will be to determine the best strategy to handle the storage needs of the audio samples. After all, a 1/10th-second, non-compressed, 16-bit, mono sound-bite recorded at a standard rate of 44,100 samples per second already requires over 8kbytes of storage (2 x 44,100/10). That would suffice for a click, or a very short tone, but any audio message ("Hello World") would require compression (MP3) in order to fit in the microcontroller flash memory.

Lager sound files require external serial flash or a microSD card. In previous columns we learned how easy it is to provide support for such storage devices by adding the MDD File System and M25P80 support module. Actually, the VS1053 codec is so smart that we won't need to worry about understanding any of the audio file format (WAV, MP3...) details; we will simply read file contents byte by byte and pass them along to the codec SPI port (data stream).

> In a world full of pods, pads and all sorts of smart things, clicks and beeps are no longer enough; the user expects a much gentler, modulated, tone

The feedMP3() function will take care of filling the codec buffer relying on the DREQ signal to determine when the input FIFO has room for another batch of samples.

Depending on our application's needs, we can manage this process in a simple (blocking) loop or as a background task handled by an interrupt-driven state machine.

Coming Up

Next, we will explore options for USB connectivity and learn how that too can benefit from newly-found storage space. Stay tuned! ●

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 this book, please send an email to svetlanaj@sjpbusinessmedia.com, mentioning the title in the heading.

Not Where You Are Looking

BY **MYK DORMER**

Radio frequency design – even the relatively pedestrian low-power sector which I inhabit – has the reputation of being somewhere between black magic and alchemy. This is quite undeserved. While it is an area where a degree of experience and gut feeling can count for more than rigid or formal techniques, a thorough and methodical approach (relating requirement and regulatory specifications to the initial sketch design and subsequent measurements) will normally achieve the desired results. Normally!

As with nearly every other engineering endeavour, there are pitfalls, and in the design of low-power radio circuitry the dynamic (transient) behaviour is likely to prove the most troublesome.

Circuits that are apparently entirely without vices when operating in steady state can exhibit any number of misbehaviours when switching on and/or off:

- Amplifiers pass through the entire range of bias and current conditions from completely off to fully on as the supply rails ramp up during the switching process and, consequently, present a wide range of impedance and transconductance values to surrounding stages.
- Active bias circuits and current/power control loops do not always turn on cleanly and can take some time to settle, especially if the stage they control is itself not yet fully settled.
- Oscillators do not always start cleanly and can take some time to start up; in the case of some crystal oscillators this can be tens of milliseconds, longer if poorly adjusted.
- PLL sub-systems are particularly subject to timing related issues, and as well as having finite lock-in periods, they will produce a whole family of out-of-band spurii while doing so. They are also very prone to being disturbed – even completely knocked out of lock – by the switch-on transient of associated circuits.

Transient defects in a radio's performance may (to an inexperienced designer) seem relatively unimportant, as the device will frequently be seen to perform perfectly in simple steady-state bench tests, and in some real-world applications (streaming very long sequences of data or broadcast applications) they are (relatively) unimportant. However, two overwhelming issues must be considered:

1. Many, if not the majority, of low-power radio applications now involve the transmission of short bursts of data, often within network architectures that employ numerous co-sited radios. In this case a poor transient response can cause interference to the remainder of the network or loss of data in the local transmitted burst, resulting in degradation of system performance, or even complete failure.
2. The current generation of low-power wireless specification (most particularly EN300-220) now has transient behaviour specifications, so a design which still actually functions may yet turn out to be outside the legal requirements (and an investigation by Ofcom of a design already in production can have very expensive consequences). This, of course, refers primarily to transmitters or the transmit side of a transceiver, as receivers are more likely to fail to operate correctly, rather than generate appreciable interfering spurii (although particularly badly designed front ends are sometimes seen to oscillate under harsher tests).

So what can be done? As usual, in such cases, the solution comes down to extensive testing. It is possible (with experience) to avoid circuit configurations with known transient deficiencies (grounded base overtone VXOs for example can exhibit very odd switch-on behaviour), and some simulators can shed light on the characteristics of a circuit over a range of supply voltages and currents, but ultimately adding a second layer of functional testing under transient (switching) conditions to your existing steady-state radio tests is the only way to be certain.

There are dedicated test instruments (modulation domain analysers and the more sophisticated spectrum analysers) that make direct measurements of the transient spurious outputs of a radio (particularly a transmitter), but a very good initial check of switching behaviour can actually be made with nothing more than a matching receiver and a digital scope, by driving the transmitter's 'enable' port with a low frequency square wave or pulse train and observing both the AF baseband and RSSI outputs of the receiver. Any deviation from a well-behaved monotonic RF power ramp (up and down) and a clean transition from no-signal noise to signal-present quieting or modulation should be taken as a likely transient response deficiency.

And then the real work can start, finding out just what your circuit is doing. ●

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EMPOWERED BY ROBOTICS: COMMUNICATIONS, COMMAND AND CONTROL

by Warren Miller for Mouser Electronics

Borrowed from the military, Communications, Command and Control (sometimes called 3C), are the three key organizing principles that can be applied to the design of robotic distributed systems.

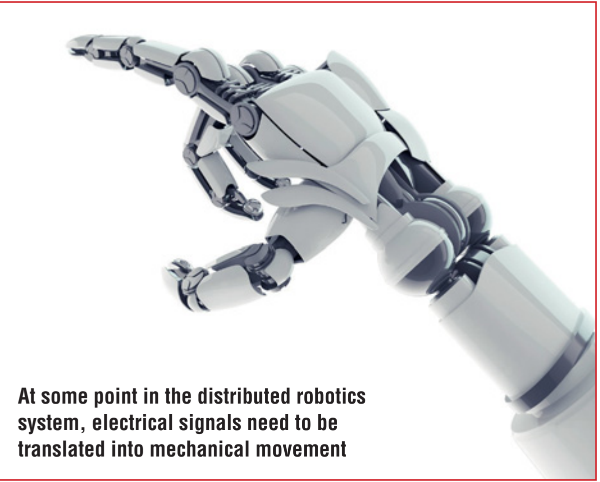
Communications

The multiple elements used for imaging, positioning, environmental sensing, power, and motor control etc, all need to communicate with each other and with a centralized controller that manages and coordinates the detailed activities to accomplish a task. Standard communications interfaces, either wired or wireless, are used to transfer sensing information from the edges of the system to the central controller. When the central controller needs to send instructions to the edge elements, perhaps to request a sensor update or advance a stepper motor, the same interface is used. Microcontrollers (MCUs) are usually the intelligence within the end nodes and they support a variety of communications interfaces to simplify data transfer.

Often it is convenient to minimize the data traffic from the edge to the central controller, and thus additional processing power is often moved to these edge nodes. This allows some functions to be done locally within the edge nodes, so that intermediate data traffic is eliminated. Only critical updates or task requests need to involve the main controller when edge devices are more autonomous. As an example, sensor data often needs to be processed to see if it is within the allowed range. If each measurement was sent to the central controller it would generate significant traffic and would require additional processing power by the controller. If the sensor can do the processing locally and then only report to the controller if the readings are out of bounds (or going in that direction), significant central controller data-transfer bandwidth and processing power can be saved.

For complex sensing algorithms, multiple data streams may need to be combined and processed to see if action must be taken by the central controller. For example, imaging information along with speed and distance measurements may show that an object is in the way of the current movement task. If these readings can be combined, perhaps using a decentralized local controller that has access to several key edge sensors, an alert can be sent to the central controller and a decision made on how to react.

Often these complex functions require advanced signal-processing capabilities that are now available in even relatively low-end MCUs. As an example, in the Texas Instruments MSP430 MCU Family, even many of the low-end devices have a hardware multiple-and-accumulate (MAC) function. This capability facilitates simple digital signal processing (DSP) algorithms that are often required when combining multiple-sensor readings, called sensor fusion, for intelligent and autonomous operation. Many MCUs offer even high-performance



At some point in the distributed robotics system, electrical signals need to be translated into mechanical movement

DSP capabilities, often used for more complex tasks such as imaging systems. The simple MAC is sufficient for a wide range of low-level tasks and can often significantly improve power efficiency over implementations that use more complex devices.

Command

Once the main controller accesses all the smart communications information from sensors and intermediate controllers, it needs to make decisions on the next task. If, for example, an autonomous robot is looking for survivors buried in rubble after an earthquake, and its infrared sensors detect heat, the controller needs to decide what to do. Should it investigate further? Should it first sense the environment for structural integrity? Does it need to get closer to determine if the heat signature is a person? Should it "ask" a human supervisor to weigh-in on the next step? These questions all need to be processed by the controller before the next command is determined.

In many cases more information might be needed since the edge nodes may only be sending an alert without the data behind the reasoning for the alert. If significant processing is required which is more than the edge nodes can handle, the central processor will need to do substantial computational "heavy lifting." A power-efficient, high-performance processor is a good choice for small autonomous robots running on battery power. The main controller also needs to interface to a wide variety of communications channels for the various edge nodes and intermediate controllers. High-speed interfaces, like Ethernet and USB, are needed for the intermediate controllers. Similarly, lower-speed interfaces, like SPI and UART, are needed for the lower-speed sensors.

A new generation of efficient embedded processors has the features required for these new applications. For example, the new Intel Quark SoC X10xx processor has a power-efficient CPU core as well as multiple communications interfaces, including Ethernet, USB, PCIe 2.0, SPI, I2C and UART. Access to off-chip memory, in the form of high-capacity DDR or lower-capacity but faster SRAM, is supported by embedded memory controller blocks. For high-reliability applications, an error-correcting code (ECC) memory can find and fix memory errors automatically. Advanced security features improve resistance to malicious intrusions, a growing concern as embedded systems are facing increasing attacks by organized hackers. The Quark X10xx family even has members with a secure boot capability that detects attempts to tamper with the start-up boot code, one of the most aggressive and effective methods for hacking into embedded networks.

Control

At some point in the distributed robotics system, electrical signals need to be translated into mechanical movement. The mechanical action may involve moving a heavy chassis at high speeds (and stopping at precisely the right place) or manipulating a mechanical "hand" to precisely grasp and lift a small object. In either case a motor is probably involved in translating the electrical signals into the required mechanical motion. The design of a wide range of motors has become much similar in recent years as MCU manufacturers have accelerated their support for motor-control applications.

The multiple elements used for imaging, positioning, environmental sensing, power and motor control etc, all need to communicate with each other and with a centralized controller that manages and coordinates the detailed activities to accomplish a task

MCUs have been used in motor control for years, and as new algorithms have evolved to improve efficiency, increase reliability, reduce wear and extend operating lifetime, MCUs have had to continually add new capabilities to keep up with these changes. For example, improved processing capabilities, including digital-signal processing and floating point, can now offload data pre-processing tasks from the main CPU. Additionally, hardware timers can implement the low-level tasks of shaping currents and voltages used for control algorithms, further freeing up the main CPU and improving system efficiency. MCU manufacturers have also expanded their software offerings to include specialized tools and proven code to simplify motor-control implementations. Some of the most advanced offerings allow control algorithms to be configured by the designer, turning a complicated design process into using an easy, guided "wizard" to create the required application code.

Reference designs that help evaluate and design motor-control applications further simplify the development process. The Freescale Kinetics MCU family, for example, has multiple motor control reference designs for a variety of applications. To help designers quickly navigate through the many possible choices, Freescale has created a web-based solution advisor to help narrow down the mix of features and capabilities needed for various target applications. The advisor walks designers through a series of questions about applications, functions, motor types, features, control algorithms and sensor types, before producing a report showing the devices, development boards and reference designs applicable to a specific design. After selections are captured, a report is generated showing the relevant reference examples and application notes for the designer's specific design requirements.

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TIME TO TAKE THE HEAT OUT OF LEDs

RALPH WEIR, CEO OF CAMBRIDGE NANOTHERM, HIGHLIGHTS THE NEED FOR A CHANGE IN LED THERMAL MANAGEMENT AND OUTLINES AN INNOVATIVE APPROACH

Driven by efficiency savings, legislation and the increasing viability of LEDs as a replacement for incandescent devices, the LED market is in the ascendant. According to market analyst house Statista, LED devices will make up 61% of the global lighting market by 2020, worth a staggering $64bn.

Yet there's a powerful headwind to growth. Whilst the total cost of ownership of an LED device is significantly lower than for an incandescent device, the high initial purchase price is makes mass-market adoption slower than it could be. Purchase prices have fallen considerably as technology has advanced and economies of scale kicked in, but compared to the cost of CFLs or halogens' price, parity is still a long way off.

The LED market, particularly for domestic bulbs, is fiercely competitive and price is a key factor when striving for market dominance. All too often price is driven down by using cheaper components, severely affecting light quality and drastically shortening LEDs' lifespan and reliability. Considering that these parameters are the main drivers for the adoption of LEDs, driving down costs through inferior components risks significant damage to the reputation of the LED industry – not a clever move just as the public is starting to embrace the viability of LED lighting.

It's All About Redesign

There is an alternative approach. If the LED industry takes a second look at the thermal management of its products, there's a huge opportunity to cut costs whilst maintaining quality and lifespan.

By better managing the heat generated by LEDs, manufacturers have the potential to reduce the number of LEDs used in each device – potentially eliminating half of them. By putting twice as much power through LEDs the same brightness can be achieved, and by dissipating the heat more effectively the same operating temperature can be met, preserving lifespan.

According to the US Department of Energy, the cost of LEDs and optics can be as much as 60% of the total cost of the bulb, so the savings that can made are significant.

But, how do manufacturers get rid of the additional heat in a fixed-size device? Standard Metal Clad Printed Circuit Boards (MCPCBs) are already pushed to their limits and simply cannot deal with the additional heat.

Exotic ceramics such as aluminium nitride can meet the thermal challenge, but their high price-point negates any savings from reducing the number of LEDs.

So it's back to MCPCBs. Traditionally these are aluminium boards coated with an epoxy resin to act as a dielectric layer. These resins are normally between 75-300 microns thick and are mixed with thermally-conductive materials, such as ceramic, to increase their thermal conductivity.

The problem is we've reached a point where the proportion of ceramic to epoxy is at its maximum – add any more ceramic and the epoxy loses adhesion and is liable to peel off the aluminium, causing a fatal short. This thermal bottleneck is holding back the development of devices that can be driven at the brightness needed to compensate for fewer LEDs.

Step Change

Radical new materials need to be considered to meet these thermal challenges. One solution is to use a clever combination of ceramic and aluminium. By converting the surface of the aluminium base material into dielectric nanocrystalline aluminium oxide (an alumina nanoceramic), manufacturers can enjoy the best of both worlds; the nanoceramic layer removes the need for additional epoxy resin dielectric.

The really clever part is the incredible thinness of the nanoceramic: the dielectric layer can be as thin as three microns, yet it offers breakdown voltages that easily meet industry requirements. This is a magnitude thinner than traditional MCPCBs can achieve, and means the heat has a fraction of the distance to go to reach the aluminium substrate.

The combination of the thinnest dielectric layer with the highest thermal conductivity yields the lowest thermal resistance of any aluminium substrate, and means LED manufacturers can finally

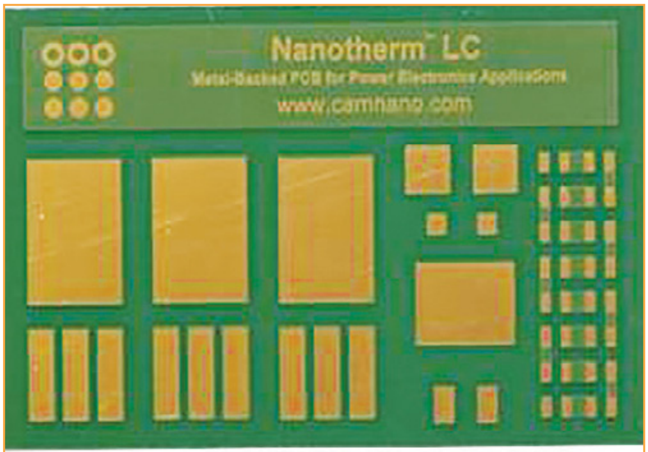

Figure 1: Nanotherm LC metal clad printed circuit board

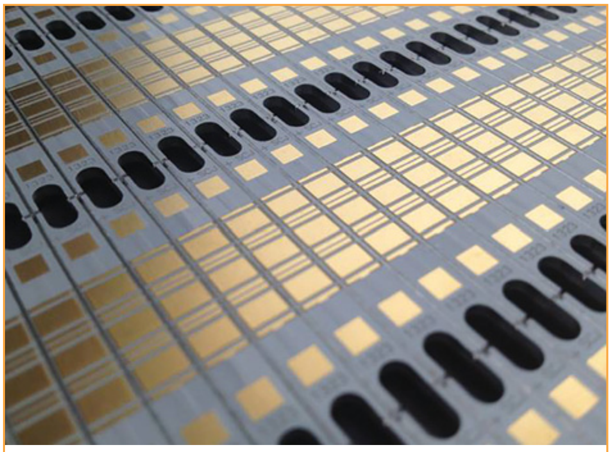

Figure 2: Another example of a Nanotherm LC MCPCB

run their LEDs bright enough to warrant reducing their numbers.

Nanoceramics cost a fraction of the price of high-end ceramics yet offer comparable thermal performance. Whilst more expensive than epoxy-coated MCPCBs, by investing a bit more in their substrate manufacturers can cut the number of LEDs they use, ultimately slashing the cost of a device. Add to this the ease of using nanoceramics – they can be treated in exactly the same way as a standard MCPCB and can be handled by conventional PCB shops – and there's a product that could revolutionise the LED industry. The proof? In tests high brightness LEDs mounted onto a nanoceramic substrate ran 34°C cooler than those on a standard MCPCB – a step change in thermal management. ●

ADVANCES IN OLED TV DISPLAYS

SAMSUNG AND LG ARE CURRENTLY COMPETING TO CAPTURE THE OLED TV SCREEN MARKET. **FAWZI IBRAHIM**, AUTHOR AND FORMER LECTURER, COMPARES THEIR TECHNOLOGIES

At its most fundamental level, there are two types of display technologies: emissive, where pixels emit RGB light directly from the screen, and non-emissive, such as liquid crystal displays (LCDs) which do not produce light and therefore do not give off a glow.

Examples of emissive panels include the traditional cathode ray tube and plasma displays, whereas the non-emissive LCDs use liquid crystals to regulate white light coming from a backlight of fluorescent tubes or LEDs behind the panel.

TV Screens

LCD television receivers employing LEDs for backlight are commonly – and erroneously! – described by manufacturers as LED TVs.

Organic light emitting diodes (OLEDs) are different; they are a new form of emissive display technology, and very thin solid-state displays that emit light directly.

While there have been quite a few experimental and prototype OLED displays in recent years, including an 11-inch, 960 x 540 pixel TV by Sony, OLEDs first appeared in actual consumer products as 4-inch to 8-inch displays in smartphones and tablets in early 2010.

OLEDs come into their own with large-screen television receivers. Mass production of small displays uses a fine metal mask (FMM) in fabricating RGB side-by-side subpixels onto a glass substrate. This involves the evaporation of small-molecule light-emitting materials through metal shadow masks. When one colour of material is being deposited, the other colour areas are blocked by mask.

Unfortunately, this technology cannot be used for large OLED TV screens because glass and mask sagging become critical issues. A new process technology called small mask scanning (SMS) has been developed by Samsung for large-screen TV manufacturing. In order to circumvent the sagging problem between the substrate and the mask, the glass substrate is moved during pixel deposition while both the small-area shadow masks and the evaporation sources are kept stationary.

A different approach was developed by LG, known as stack or tandem OLED that produces white light that's converted into RGB using filters.

Principles Of Operation

The OLED is an electroluminescent device with transparent organic material placed between two electrodes (an anode and a cathode), as shown in Figure 1. When a voltage is applied across the electrodes, current flows through the organic layer; electrons are injected into the lowest unoccupied molecular orbit (LUMO) of the organic emitting layer at the cathode end, and holes are injected in the highest occupied molecular orbit (HOMO) of the organic emitting layer at the anode end. Electrostatic forces bring the electrons and holes together and they recombine. Through these recombinations, a high-energy molecular state is formed called an exciton, which behaves like a single molecule with high energy.

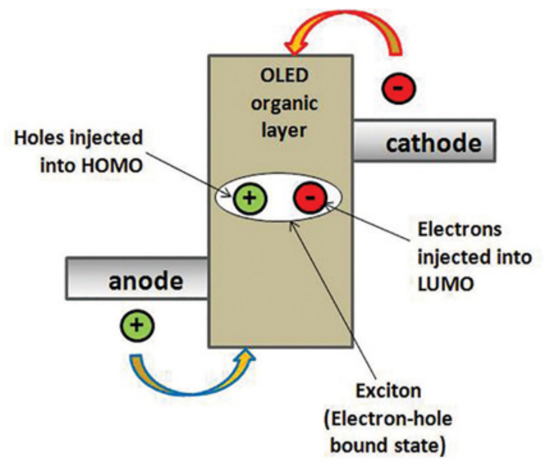

Figure 1: Electron-hole combination that forms an exciton

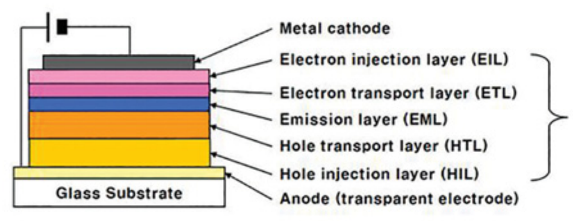

Figure 2: Structure of an OLED subpixel

Two types of excitons are formed: singlets and triplets. As these excitons decay, energy is released, which in the case of the singlet is accompanied by radiation in the visible region. The frequency of this radiation and hence colour of the emitted light depends on the difference in energy between the molecular orbits of the emitting material HOMO and LUMO, known as 'band gap'.

The decay of the triplet excitons produces heat energy only. For this reason, the internal quantum efficiency (IQE), defined as the number of photons generated inside the device for each hole-electron pair, is relatively low. At least this is the case with the low-cost, high-yield, small-molecule OLEDs (SM-OLEDs) that generate about 25% singlet states. In fact, even if all the electrons and holes form an excited state, the IQE level cannot exceed 50%.

The internal quantum efficiency may be improved with the use of conjugated polymer, P-OLED. However, the most dramatic improvement may be when heavy metals such as iridium, platinum and osmium are introduced into the emitter molecules in which the strong spin-orbit coupling mixes the two excited states, making triplets light-emissive as well with a theoretical 100% efficiency.

Typical OLED Structure

Typical OLED subpixels have a multilayer structure in which organic material is sandwiched between two electrodes, an anode and a cathode, as shown in Figure 2. The type of organic material determines the colour of the subpixel.

Immediately next to the anode is a hole injection layer (HIL) followed by a hole transporting layer (HTL), emitting layer (EML), electron transporting layer (ETL) and electron injection layer (EIL). The purpose of the first two layers, HIL and HTL, is to improve the hole injection efficiency. Similarly, on the other end, the EIL and the ETL are used to enhance the electron injection efficiency.

The electrodes (the anode and cathode) are used to reflect or transmit the generated light, depending on whether the structure is bottom or top emissive. In the bottom emission structure, light is transmitted through a transparent anode and reflected by the cathode, and vice versa for the top emission structure of OLED pixels. Thus, the optical properties (namely reflectivity, absorption and transmittance) and the structure of the electrodes are the dominant factors that determine the efficiency and optical properties of OLEDs.

Stack Or Tandem OLEDs

OLEDs age as current passes through the emissive materials of the pixel. Specifically, the emissive materials age in direct proportion to the current density passing through them.

> "Regardless of the early problems, OLED displays are getting more common and cheaper and are set to take over from conventional LCDs because of their superior performance and aesthetics and lower power consumption

One approach to dealing with the aging problem, while maintaining the resolution of the display, is to stack the red, blue and green elements on top of each other (see Figure 3) to produce white light. These OLEDs are known as WOLED.

The white emission may also be achieved by mixing two complementary colours (yellow and blue). To re-produce the three primary colours, RGB filters are added. WOLEDs with colour filters (WOLED+CF) panels have the advantage of reduced pixel gap and hence higher resolution, increased colour depth and improved lifetime, as well as reduced cost. One problem with the WOLED+CF approach is that light-output efficiency is reduced to 30% of

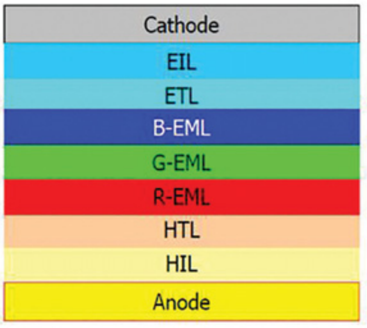

Figure 3: Stack OLED (WOLED) subpixel using three primary colours in tandem

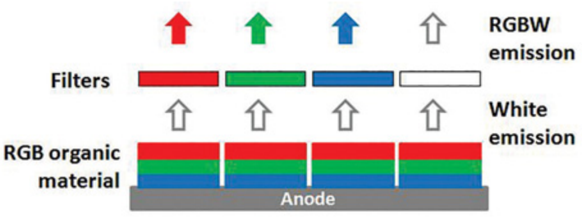

Figure 4: Stack WOLED+CF (RGBW) arrangement

the efficiency of the RGB side-by-side type because of light absorption by the colour filters. This problem can be minimized by adding a white subpixel to the filtered RGB subpixels, as shown in Figure 4. This arrangement is known as WOLED+CF (RGBW), currently used by LG for its large-screen television sets. For some, this brings back memories of the pre-digital two-component (luminance-chrominance) analogue television colour system of the sixties.

Pixel Matrix Design

Like LCD panels, OLED displays may be of passive matrix (PMOLED) or active matrix (AMOLED) type. AMOLED displays are similar to LCD panels in that they use thin film transistors (TFTs) as switches and drivers. However, they are different from LCDs in that OLEDs are current-driven and not voltage-driven.

Passive matrix panels are low-cost displays that suffer from low resolution compared with the active type, hence their use in small-size displays of up to five inches.

The AMOLED display has been widely used in most OLED display applications because of its superior properties, including fast response time, high and constant colour gamut, wide viewing angle, peak brightness, low power consumption and very slim design.

Usually, active-matrix OLED displays are fabricated using the well-tried and tested silicon TFT technology.

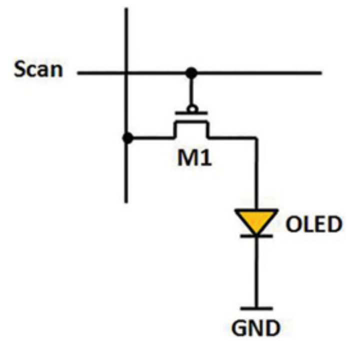

Figure 5: Simple pixel design using one TFT

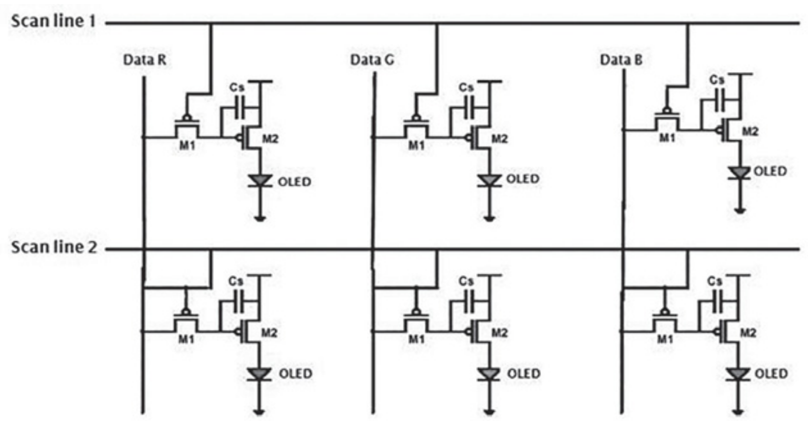

Figure 6: Part of an OLED matrix composed of two TFTs and one capacitor OLED subpixels

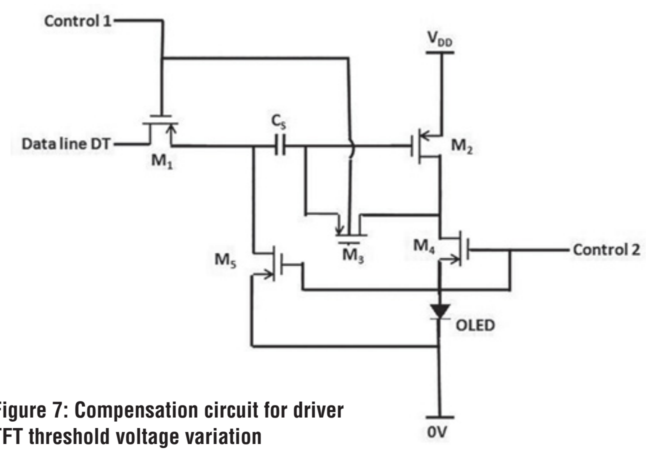

Figure 7: Compensation circuit for driver TFT threshold voltage variation

However, in order to fabricate large AMOLED display arrays, organic TFTs (OTFTs) – where the active layer consists of an organic material – are considered best because of their low-temperature fabrication and consequently lower costs.

OLED Pixel Design

The simplest pixel design consists of one TFT where the gate connects with the row or line scan and the drain connects to the column or data line, as shown in Figure 5. When the TFT is on, current is fed to the OLED and emission occurs.

This design is suitable for a low power-consumption application because it doesn't need a power supply. More advanced AMOLEDs use two or more TFTs and one or more storage capacitors; the purpose of the latter is to maintain pixel brightness steady through each frame.

Figure 6 shows two scan lines of a matrix display, each consisting of three subpixels: R, G and B employing 2TFTs, M_1 and M_2, and one storage capacitor, C_S. At the start of a frame, scan line 1 is selected by a negative-going pulse V_{SEL} turning on all the M_1 TFTs along that line, and all the M_2 TFTs off. All other lines are at ground level with their M_1 TFTs off.

Data in the form of a voltage representing the luminance level of each subpixel along that line is fed down the data lines to be stored in the relevant storage capacitor C_S. When V_{SEL} is removed from scan line 1, M_1 turns off. However, M_2 is turned on by the charge on storage capacitor C_S driving current through the appropriate OLED to emit a level of RGB luminance proportional to the original RGB data. The brightness of the subpixels is retained while the process is repeated for scan line 2, and so on until the end of the frame. The whole process is then repeated for the next frame, and so on.

Threshold Voltage Compensation

Oxide TFTs suffer from long-term instability of their threshold voltage V_{TH}. The brightness of the OLED depends on the current passing through it. This current is provided by the driving TFT whose V_{TH} variation produces instability, resulting in unstable light emission from the OLED, which causes a poor-quality image, hence the need for pixel-level TFT V_{TH} compensation circuits.

> The active matrix (AMOLED) display has been widely used in most OLED display applications because of its superior properties

An example of an OLED pixel driving circuit with threshold compensation is shown in Figure 7. The pixel consists of four switching TFTs (M_1, M_3, M_4 and M_5), one driving TFT (M_2), and one capacitor C_S. The arrangement has two control lines (Control 1 and 2) and a data line (DT). M_1 is the line selection switch, M_3 is used for the diode connection with M_2, and M_4 blocks current through the OLED during the data input period. The operation of the circuit is divided into two periods: data input and emission. During the pre-data input period (previous frame) Control 1 is high and Control 2 is low, see Figure 6.

Data Input Period

At the start of the frame, Control 1 is set low, turning M_1 and M_3 on. At the same time Control 2 is set high to turn M_4 and M_5 off.

OLED PROS AND CONS

OLED panels have the following advantages over LCDs:

- Lower power consumption
- Lower process temperature
- Lower manufacturing costs
- Slim structure
- Low weight
- No need for backlight
- Wider viewing angle
- Wide operating temperature
- Fast response time and reduced motion blur
- High and constant colour gamut

On the downside, OLEDs suffer from shorter life and sticking images as well high cost and low yield, all of which are being addressed by manufacturers.

With M_3 on, the gate of M_2 is connected directly to its drain. With M_1 on, the data input (DT) is connected to the left side of the storage capacitor C_S. The other side of C_S is connected to the gate of M_2 with a potential of $V_{DD} - V_{TH}$, where V_{TH} is the threshold voltage of driver transistor M_2. The charge across C_S is therefore:

$$(V_{DD} - V_{TH}) - V_{DATA}$$

where V_{DATA} is the voltage at data line DT. This charge is stored in the capacitor until the end of this period.

Emission Period

At the start of the emission period, Control 1 is set high turning M_1 off, and Control 2 is set low turning M_3 off and M_4 and M_5 on. With M_4 on, M_2's drain is connected to the OLED anode. With M_5 on, the left side of C_S is connected to ground taking its right side (M_2's gate) to $V_{DD} - V_{TH} - V_{DATA}$, providing a forward bias to M_2.

Current through the OLED is I_{OLED} = current driving TFT M_2, I_{M2}.

Given that I_{M2} is proportional to the square of $(V_{SG} - V_{TH})$ where V_{SG} is the potential difference between source and gate of M_2, then:

$$I_{OLED} \propto (V_{SG} - V_{TH})^2$$

But $V_{SG} = V_{DD} - (V_{DD} - V_{TH} - V_{DATA}) = V_{TH} + V_{DATA}$, therefore:

$$I_{OLED} \propto (V_{TH} + V_{DATA} - V_{TH})^2 \text{ making } I_{OLED} \propto (V_{DATA})^2$$

The current through the OLED is therefore independent of the M_2 threshold voltage, as well as independent of any variations in the power supply voltage.

Fabrication Advances

Currently, the two main patterning processes, SMS and WOLED+CF, employed by Samsung and LG respectively, are competing to capture the OLED TV market. They are being intensively developed to improve cost, yield and performance. The difficulties with Samsung's SMS fabrication may soon be overcome with some very promising developments.

Regardless of the early problems, OLED displays are getting more common and cheaper and are set to take over from conventional LCDs because of their superior performance and aesthetics, and reduced power consumption. ●

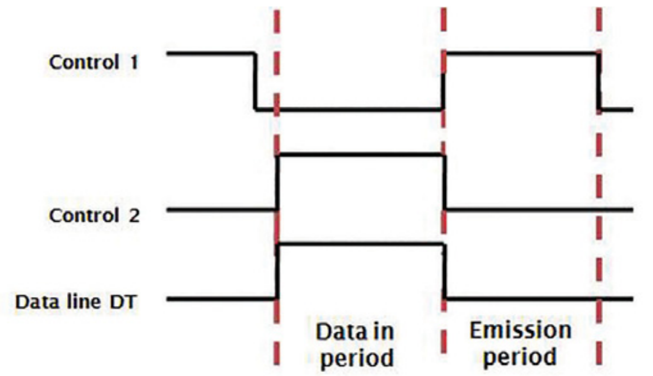

Figure 8: Data and control signals for the compensation circuit shown in Figure 7

TO BEND OR NOT TO BEND – THE CURVED OLED TV

Samsung and LG both chose to make a curved screen – a first in television receivers. The curvature is one of the two most striking features of OLED TVs. The other is the incredibly thin screen, at just 4.3mm or 0.17 inches. Both the curvature, with its radius of 5m (16.4 feet), and the slim panel add to its elegance and aesthetic appeal.

The curvature is achieved by using a flexible substrate such as plastic, in contrast to plasma and LCD panels which use glass substrates.

It has been argued that one reason for curving the screen is just because it is possible. In fact, the curvature, as small as it is, provides two advantages. First, it eliminates reflections from some ambient lighting on the sides. The second is improved viewing for people sitting away from the central sweet spot because the curved screen accommodates their viewing direction better and reduces the stretched keystone (trapezoidal) shaped image that is seen with flat screens viewed from an angle of the sides.

The flip side is that with normal front viewing, the top and bottom of the screen and picture don't look perfectly straight, suffering a subtle curve – but it's a hardly noticeable effect, only a 1.5% curve.

FAST TIME-TO-MARKET WITH INTELLIGENT DISPLAYS

BY **WOLFGANG AICHBERGER**, MARKETING AND SALES MANAGER AT DEMMEL PRODUCTS

The appearance of machines and controls in industrial and professional environments has changed fundamentally in the last few years. Appealing and ergonomic user guidance with the help of a touch display is today a distinguishing feature of machines and devices.

Integration of a plain display as a human-machine interface (HMI) leads to extensive efforts with hardware and software development of the associated driving electronics. State-of-art liquid crystal display (LCD) panels typically require a powerful 32-bit microcontroller, sufficient RAM and flash memory, as well as a display controller. For an attractive design, expensive graphic libraries have to be purchased that need adapting to existing hardware. Hardware specifications and data sheets often lack important details, and support from the manufacturers is hard to get. To meet all these challenges, developers with extensive know-how are needed and they possibly need additional training on specific items too.

Equipment manufacturers tend to focus on their core competencies and often employ ready-to-use solutions, even for larger production quantities. In contrast, the implementation of a plain display requires significant resources. High development costs and consequent selling prices can make a product unmarketable, especially for smaller production runs.

The integration of HMIs for process control is usually linked with high development costs. In industrial and professional applications, long-term availability of a display product is an important issue. Using conventional LCDs, any discontinued models would lead to extensive workload and costs for developers to adapt to the new display.

> "Font rendering performed by standard displays is usually based on black and white pixels without gray scale, causing a rather blurred and grainy representation of glyphs

Intelligent displays can help; they represent a completely different development approach, where all components necessary for display operation are integrated, including the driving electronics, software, memory and interfaces.

Figure 1: Integrated solution – management software and display panel

HMI

An HMI provides a visual status and allows for active intervention in a process. Today, user interaction increasingly takes place with machines, such as electric vehicle charging stations or parking ticket vending machines. In addition to the functional robustness, mechanical resistance and vandal- and weather-proof designs are needed for those applications.

Screens with projected capacitive (PCAP) touch technology meet these requirements. The capacitive touch sensor is placed behind protective glass and is thus considerably more robust than a resistive touch panel activated by physical pressure. Assembly behind cover glass and optical bonding, which ties together display, touch panel and cover glass with a special viscous adhesive, help to protect the electronics. This design results in better physical robustness and reduction of optical reflections, and consequent enhanced readability in bright environments.

Intelligent Displays

State-of-art intelligent displays, such as Demmel Products's iLCDs, include a fast controller, RAM and plenty of on-board flash memory. All applications, graphics, fonts, text templates and macro data are stored in the flash memory, with a typical 128Mbyte storage space, which can be extended by using an on-board MicroSD card.

Storage of user application updates and data such as application-specific log files may also be done with the help of the MicroSD card.

Intelligent displays can store any desired fonts. Text commands make it easy to display aligned (left/right justified, horizontally and/or vertically centered) and formatted strings. Text output can be word-wrapped automatically and may contain ANSI control sequences for fast and comfortable terminal implementation. Thanks to Unicode, non-Latin languages and fonts are also supported. Together with text template support, Unicode fonts greatly simplify the international deployment of devices.

All required text templates are stored in the display itself for access with very low communication overhead. This means foreign-language capability can be achieved without the need to adapt the application, even if a language is used that requires a different font. The language can be set through a single software command.

Font rendering performed by standard displays is usually based on black and white pixels without gray scale, causing a rather blurred and grainy representation of glyphs. Modern intelligent displays employ font anti-aliasing algorithms to ensure an overall smoother appearance and a more aesthetically-pleasing typography. Both the smoothing method and quality are adjustable. The default algorithm in newly purchased panels can be upgraded in existing deployments with software updates.

Powerful and intuitive screen design commands with a wide array of parameter options enable the developer to create elaborate screen designs that may even include 3D-like appearance. Graphical elements can be imported into the built-in panel memory in BMP, JPEG, PNG or (animated) GIF format. Regardless if they are imported or generated by commands, complex screen layouts require only a few bytes to be sent from the application to the intelligent display panel.

Screen memory commands support multiple frame buffers that can be used simultaneously. Drawing to a hidden screen and subsequently showing it with a single command facilitates an immediate screen update.

Management Software

These intelligent display functionalities can usually be managed via dedicated Windows IDE for setup, configuration and management. The best-in-class management software applying the latest Windows layout does not require programming skills. Many help functions support the

Figure 2: Globally unique font anti-aliasing feature integrated in intelligent displays

developer for comfortable and fast application development. On-the-fly Command Listing, Parameter Completion and Syntax Checking/Highlighting are very helpful for creating projects quickly. An auto-help function opens an additional help window with comprehensive command descriptions. These automatic functions are optional and can be turned off.

Contemporary display management software includes sample projects demonstrating the intelligent display's functionalities, enabling the user to learn the command set quickly and easily. They provide ideas and may be included in projects in part or as a whole. This software is typically available for download from the supplier website at no cost, and can even be evaluated without display hardware. Evaluation kits for trial, test and prototyping, along with helpful documentation and source code should be made available for download too.

Application Areas

Intelligent displays can be designed into practically any application needing a graphical display. They are used in a wide array of application areas such as medical electronics, industrial control systems, electric vehicle chargers and measurement equipment, among others.

In many cases, existing applications with simple monochrome character displays can be replaced easily by an intelligent display without having to change significant parts of the application. A slow RS232 port and a 5V power supply are often sufficient for creating a new device. Intelligent displays are chosen when the emphasis is on reliable interaction rather than computing.

Intelligent displays can be integrated as HMI in a simple way, in predictable time and cost frames. Control via standard interfaces and support by the supplier allow for a significantly faster time-to-market. Compared with other solutions, intelligent displays provide the best total cost of ownership in small-to-medium quantities, enabling SMEs to compete with state-of-the-art designs. ●

THE ALTERNATIVE: INTELLIGENT DISPLAYS

Intelligent displays represent a completely different development approach: all components necessary for display operation are integrated and on board, including the driving electronics, software, memory and interfaces.

Intelligent displays are no longer controlled by pixel-based addressing, so there is no need for pixel-based programming. Easy-to-learn parameterized high-level commands are used instead. This simplifies communication and allows the intelligent display to be driven by an inexpensive single-chip controller via a standard interface with small bandwidth.

Long-term availability of parts is an important issue for industry suppliers. Maintaining close ties to global LCD suppliers is helpful for keeping abreast of potential changes or end-of-life notifications of LCDs. Such an event is announced as early as possible and as a result, a re-design of the intelligent display is initiated immediately. This way, efforts are "hidden", and even the swap of the display with an equivalent replacement does not require the customer to change the existing hardware or software.

A potential operating system crash on the user interface may lead to a standstill of a machine costing several hundred thousand pounds, or may require urgent intervention in a control process. To safely avoid this, there is no operating system running on an intelligent LCD, but a rather stable firmware with zero boot time. This is the highest-priority requirement for some applications. Full functionality is ready after power-on. Intelligent displays are therefore the perfect alternative to panel PCs especially in critical applications. Because of their robustness, they meet extreme industry requirements coming from, for example, machine-building or medical device manufacturers. Indeed, panel PCs are much too expensive and an overkill for many applications.

An example of intellident displays are Demmel Products's iLCDs.

Figure 3: Robustness in harsh environments: iLCDs with capacitive multitouch

SPECIFYING THE RIGHT LCD DISPLAY FOR THE APPLICATION

A CLEAR, SHARP, UNAMBIGUOUS DISPLAY IS PIVOTAL TO ANY PRODUCT DESIGN, BUT WHAT OTHER FACTORS INFLUENCE THE DISPLAY CHOICE? THIS IS AN AGE-OLD QUESTION THAT STILL HAUNTS DESIGN ENGINEERS TODAY. **JIM HEMSLEY**, APPLICATIONS MANAGER AT VARITRONIX UK, EXPLAINS

Passive liquid crystal displays (LCDs) have served all market areas well for over 30 years. Although the growing availability and use of colour TFT (thin film transistor) technology have resulted in continued yet subtle developments within the passive technology, they have gone largely unnoticed.

The basic TN (twisted nematic) products give the visual appearance of black segments on a silver grey background, finding popularity first in watches and calculators. These early LCDs not only provided a clear readout, but more importantly, they offered low power consumption and a slim profile. As a result, LCD technology was quickly adopted in other applications that required versatile displays.

Customisation of LCDs is relatively easy since manufacturing is based on an etching process. Custom symbols, icons, special digit shapes and units of measure are all very easy to achieve.

Design engineers in the measurement sector were particularly quick to specify custom LCDs, since symbols such as V, A, mA, mV, Hz, kHz, Ω, °C, °F could be displayed in an instantly recognisable format (see Figure 1). This produced clear digital reading, based on a traditional seven-segment number layout, followed by the appropriate symbol and, if required, its multiplying factor. A wide range of products such as multimeters, tachometers, damp measuring meters and load/stress meters all benefited from this new technology and ease of customisation.

LCDs are not an emissive technology; they rely on a separate light source to create the image of an 'ON' segment, making them easily readable in direct sunlight. This feature makes them particularly suitable for use in marine, automotive and medical applications, and many other outdoor display applications where direct sunlight causes problems for emissive technologies such as LEDs. Petrol pump manufacturers were one of the early users of LCDs in both standard and custom formats.

These harsher environments require more reliable displays with wider operating temperature ranges. Companies with an LCD research and development background such as Varitronix quickly reacted to these new demands with improvements in LC fluids, polarisers, connection styles and manufacturing techniques. The demand grew for more information to be displayed and also for an improved appearance. As a result, subtly different digit styles emerged, giving a softer appearance to displayed numbers, allowing designers to make their end products more integrated and recognisable.

"Design engineers in the measurement sector were particularly quick to specify custom LCDs, since symbols such as V, A, mA, mV, Hz, kHz, Ω, °C, °F could be displayed in an instantly recognisable format

Layout Developments

The need to display more information also pushed forward the requirements of the drive electronics, which led to multiplexed display controllers. This unfortunately resulted in an unwanted degradation of view angles and contrast. Major LCD manufacturers like Varitronix responded with improvements to fluids and ITO coatings, and other enhancements.

Figure 1: The typical look of an LCD

Table 1: Overview of the most popular TFT technology options

Technology	FFS Fringe Field Switch	MVA Multi-domain Vertical Aligned	TN Twisted Nematic
Pros	v Best Colour v Sunlight Readability v No Colour Shift by Viewing Angles v Free Pooling & Ripple	v Wide Viewing Angle v High Contrast v Fast Response Time	v Less Technical Barriers v Low Driving Voltage
Cons	x Complicated process	x Need Compensation Film x Colour Shift	x Narrow viewing angle

Specification		FFS	MVA	TN
Brightness		Excellent	Normal	Excellent
CR		Excellent	Good	Excellent
Viewing Angle(>10:1)		Excellent	Excellent	Normal
Transmittance		Excellent	Normal	Excellent
Response Time		Good	Good	Excellent
Power Consumption		Excellent	Good	Excellent
Pooling/Ripple		Excellent	Normal	Normal
Colour Reproduction		Excellent	Good	Normal
Colour Shift	White	Excellent	Normal	Normal
	Red	Good	Normal	Normal
	Green	Good	Normal	Normal
	Blue	Excellent	Normal	Normal

Excellent Good Normal

The drive for increasilgly-complex information display continued, resulting in the need for alpha and numeric layouts to show basic messaging, prompts and menus. Starburst characters were a short-term fix for displaying alpha information, but this soon gave way to the now familiar dot matrix format and the standard range of character modules in formats such as 16-characters by 1-line (16 x 1), 16 x 2, 20 x 4, 40 x 2 etc. These display formats are still widely used today as a simple, easy-to-use option for messaging requirements found in products including fire alarm panels, vending machines and security access pads.

From there the next development was graphic layouts composed of a pixel matrix, such as 128-pixels wide x 64-pixels high, and higher resolutions such as 240 x 64, 240 x 128, and on up to 320 x 240 (QVGA). Within a short time these full graphics layouts were an accepted medium and the drive was on to offer resolutions of QVGA (quarter video graphics array) and upwards in full-colour versions. Driven in many ways by the mobile phone and data terminal industries, the full-LCD TFT display emerged.

It's fair to say that the intertwined development of mobile devices and LCD screens has driven both technologies

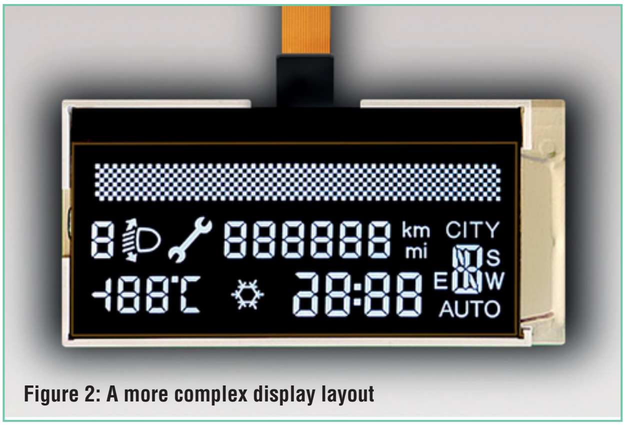

Figure 2: A more complex display layout

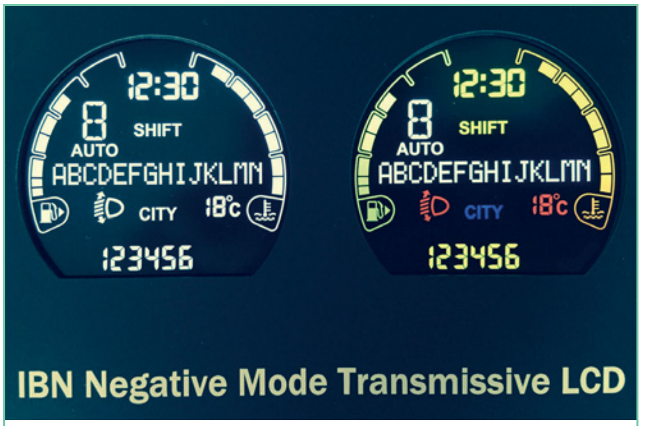

Figure 3: Adding colour by adding rear filters

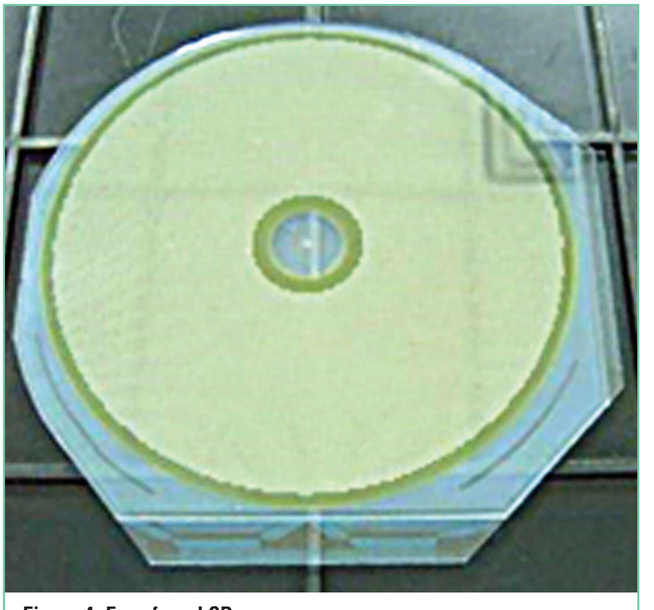

Figure 4: Free-form LCD

forward, resulting in LCD technology having a major influence on most products today.

Choosing The Right LCD

The first choice is between a mono or full-colour display. Until recently, most new designs used a colour solution, and passive mono technology seemed under threat. This is no longer the case as mono and colour LCDs sit side by side in the market, each in its niche.

Colour TFT panels cost more, of course, particularly when the additional real estate of increased memory and microproceeser capacity is added to the mix.

The most significant advantage of a colour panel is the ability to clearly show moving images or video information; mobile phones, data terminals, mapping devices and radar systems all clearly demonstrate this. These displays can be used in instrument clusters, centre console information systems and HVAC controllers in vehicles, as well as medical equipment, white goods and high-end consumer products.

Typical features required for colour TFT applications involve a wide range of resolutions (e.g. QVGA, WVGA, SVGA), super-high contrast, extreme brightness, high colour saturation, full viewing angles and fast response time.

Having decided which TFT technology is most suitable for the application (see Table 1), design engineers continue the selection of the panel by considering a combination of size, resolution and price. Other factors that influence the final decision are operating temperature, backlight brightness and lifetime (half brightness). Panel life-cycle is a very crictical requirement for the industrial and automotive arena where typical minimum product life cycles requirement is 3-5 years. How critical these parameters are depends on the application area.

Mono (Passive) LCD Panels

This older technology still has a large customer base, because it offers a stable longevity of supply, generally lower prices, simpler support electronics and easier customisation.

The main technology areas within this arena are:

- TN (twisted nematic)
- ETN (enhanced TN – adding of some dye)
- STN/FSTN (super twisted nematic)
- ESTN (enhanced STN – adding of some dye)
- DSTN (double cell STN)
- ISTN (using Dejima polymer LC film)
- IBN (improved black nematic) VA (vertically aligned)
- BCD (bistable cholesteric)

In general, the technical differences are related to improved contrast, viewing angle and reponse times, and need to be matched to the display requirements of the end product. Having decided which passive technology is most suitable for the application, the designer continues by considering a combination of temperature range, connection style, driving method, view modes (image positive +ve or negative -ve), backlighting etc. The result will depend on the application of the final product.

Passive LCDs have a much longer life and are more easily customised with significantly lower multiple order quantities

(MOQs) and initial non-recurring engineering charges than TFT panels. This is particularly attractive in industrial and automotive applications, where production lifecycles are a minimum of five years and very often more than 10 years of further support is required. For example, Varitronix is still supporting designs that have been in production for 20 years. This is particularly important where qualification testing of the end product is required. Medical and intriniscally-safe enviroments are prime examples where manufacturers are unable to change or modify the bill of materials of an instrument without applying for re-qualification, requiring expensive and lenghty re-testing.

Viewing modes are more flexible with passive mono technology – the displays can be reflective, transflective or transmissive. Backlights in some applications are not required or can be powered at a very low level in order to preserve battery charge or extend the lifetime of the LEDs within the backlight. Colour can be added by using a bi-colour or tri-colour backlight, or colour filters can be positioned at the rear of the LCD to highlight particular areas such as alarm symbols (see Figure 3).

When the display must fit into a pre-determined space in a product, a custom LCD will solve the problem by either being made to fit or by having a free-form shape such as cut corners (see Figure 4). The display can then maximise that available view window and the segment layout can ensure the information is portrayed in the most logical format.

Custom Fit Service

LCD technology will continue to serve a large portion of the display market with both colour TFT and passive products having their clear market areas. Where colour TFT is required design engineers can select from a range of standard available sizes, typically 2.4-12.1" for the industrial, medical and automotive market sectors, where customisation of the TFT panel is also possible at lower costs and MOQs than in the past.

Where size, cost and flexibility are the prime criteria, custom mono (passive) technology offers a better solution, and enhancements such as backlights, view angles and colour filters can all be included to give the end product a unique feel.

Leading-edge manufacturers like Varitronix can offer further design services by supplying the display as a module, sub-assembly, or a complete assembly, including customer circuitry, resulting in a single PCB solution. In some cases the final product can be supplied in the customer's end-product enclosure, packaged and ready for sale. ●

TRANSFORMING INDUSTRIAL USER INTERFACES WITH MULTI-TOUCH DISPLAYS

NICK HOW, MANAGING DIRECTOR OF ADVANTECH DISPLAY SYSTEMS, ANALYZES THE PROS AND CONS OF PROJECTED CAPACITIVE VS EDGE-TO-EDGE TOUCH TECHNOLOGY IN INDUSTRIAL APPLICATION USER INTERFACES

Modern user interfaces increasingly need more support from the underlying technologies – a demand particularly driven by sophisticated smartphones and tablets.

These products deliver a rich, intuitive and exciting way to control the user interface with gestures, flicks, zooms, rotatations and other screen and data manipulations. As these features become more prevalent in consumer electronics, so does the expectation for industrial products to follow suit.

Unfortunately, there are several barriers to industrial applications to replicating the screen controls seen in consumer electronics. We look at each of these challenges and consider the relative merits of traditional projected capacitive touchscreens (PCT) and edge-to-edge (e2e) resistive touch overlays as potential solutions. These challenges can be grouped as follows:

Electrical/EMI

Projected Capacitive Touch (PCT)

The hardest and most uncertain area of integration of new projected capacitive technology (PCT) is meeting the industrial standard for EMI susceptibility. Placing PCT overlays on the surface of a display effectively creates an aerial, inherently introducing an EMI weakness into the system. When EMI standards are low (as in consumer products), some tolerance can be allowed, in addition to perhaps false-touch or missed-touch events. However, in an industrial application such false or missing events can have serious consequences and should be eliminated from the system under all circumstances. Overcoming this barrier often leads to fundamental redesign of the touch overlay itself, and in changes in patterning, traces, cables, track lengths, etc, as well as bespoke work done at a firmware level to tune the algorithms measuring activity on these traces. For most customers, access to this kind of support can be challenging, to say the least.

Edge-To-Edge (e2e) Bezel-Free Resistive Touch

Resistive-touch technology was one of the first touch overlay systems to be developed in the 1960s. Decades of work have been carried out decoding and eliminating all the challenges from EMI disturbance.

Resistive technology consists of two continuous planes of conductive transparent material (ITO, or indium tin oxide), which provides for a simpler system and, when used properly, forms a strong protective barrier to EMI events. Success with this technology in industrial markets can be seen in its use in point-of-sale (POS), ATMs, the food industry, machine control and many other demanding applications with electrically-sensitive environments.

Mechanical And Environmental

One huge advantage afforded by PCT design has been the possibility to remove the bezel from products, revealing a true flat surface, easy to keep clean and aesthetically more appealing. Use of glass as a top layer also gives a hard durable surface that can be extended to the edge of a product.

When considering how this feature can be incorporated into an industrial product, it is important to think about the environment as a whole. Exposed edges look great but in an industrial application may not be sufficiently durable in all circumstances. Alternatives are polycarbonate or acrylic base layers that inherently perform better.

Drop ball tests exist to provide protection from direct impacts (such as metal tools, for example) but also differ between consumer and industrial applications. Glass is extremely hard but brittle. This brittleness can be reduced through chemical strengthening and lamination but may demand 3mm – or even 6mm – thickness to meet industrial expectations, which adds significant weight and cost.

Using polycarbonate and acrylic is possible in both PCT and e2e systems but is relatively easier in an e2e design.

Operating Temperature

PCT is drift-free from temperature differentials since the decoding works on a fixed physical grid. Despite this, control circuitry needs to be designed with wide temperature characteristics to meet the broad nature of an industrial temperature environment. As a relatively new technology this is not yet true of all such systems.

Resistive systems have a certain amount of drift caused by changes in temperature, which are compensated for with temperature sensing components in the decoding circuit. These operate over a wide range of temperatures, in some instances from -40°C to +85°C (as in automotive touchscreens). E2e dual-touch solutions currently operate in the -20°C to +70°C range with less than 1% drift in temperature.

Use With Gloves And Rejection Of Contamination

PCT works by measuring a change in parasitic capacitance between screen and environment. A user wearing gloves will severely affect this measurement, rendering a PCT system unusable. This has an impact on medical, industrial, laboratory and many other environments where gloves are mandatory.

Resistive e2e technology works on a mechanical principle, which requires force to close a circuit. As with any resistive system, the screen can be operated by hand, gloves, stylus and so on. Activation force can be adjusted to increase or decrease sensitivity and assist with things like palm rejection – the touch screen's ability to "reject" or ignore the presence of a palm during the process of drawing or signature capture. This protective feature extends to surface contaminants such as grease, food, water and so on, and is demonstrably superior in an e2e system.

No False Touches

The issue of false or missed touches is dealt with differently for each application. For non-critical interfaces, some level of false activation caused by EMI or contamination may be acceptable; in others it can be a total disaster. An e2e overlay can only give a false touch when a physical force is incorrectly applied to an area of the screen (in the same way that a traditional keypad can be activated accidentally). Protection from this can be achieved by increasing the operating force, but to the detriment of comfortable dual-touch operation.

Software

Regardless of the touch overlay, a detailed review of the design and style of the user interface should be made before trying to incorporate a tablet-style interface in any new product. Tablet and smartphone companies have million-dollar budgets to play with, and even then they sometimes fail to capture the consumer imagination.

Compare the two simplest on/off buttons here (Figure 1) – how much time did the two take to create? Now multiply that by every graphic you need to show and you can see how quickly these issues consume a huge amount of hidden time and cost.

Libraries are available but may not suit all. Irrespective of what needs to be created and what's off the shelf, a designer's input will be mandatory at an early stage. Gestures will increase this workload as will the smoothness of screen transitions, fades, pinch and zoom functions, etc.

Integrating the touch system into your own hardware is also an important area of consideration. Will you work in a Windows-type environment, where Win7 supports dual and multi touch out of the box in a variety of ways? Or will you embed the system directly into your micro via SPI/I2C? This route will demand some additional workload to create suitable system level drivers.

Both PCT and e2e support Windows and the embedded

Figure 1: The simplest style of on/off buttons

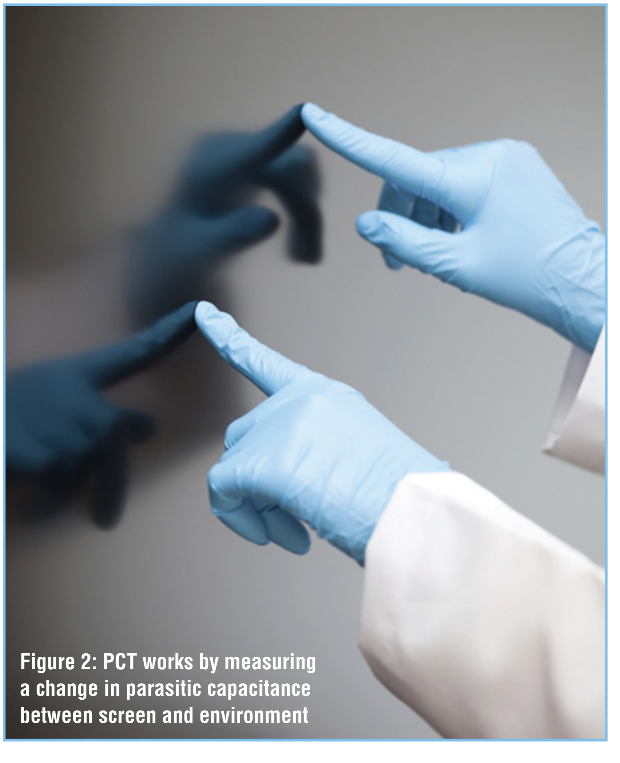

Figure 2: PCT works by measuring a change in parasitic capacitance between screen and environment

Figure 3: The issue of false or missed touches is dealt with differently for each application

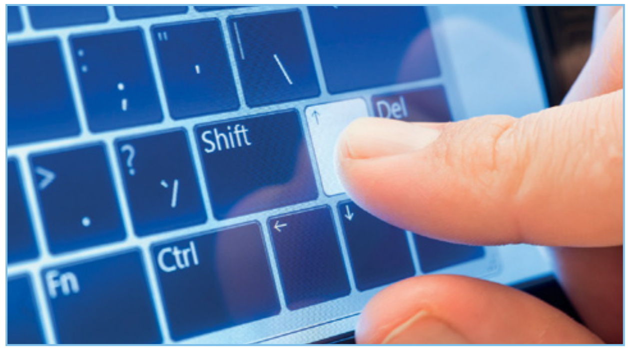

Figure 4: As with any resistive system, the screen can be operated by hand, gloves, stylus and other implements

routes. Linux is currently not served well by PCT systems, but a host of Linux applications and drivers are available for all kinds of resistive touch overlays, including e2e.

User Features

The advanced software interfaces on consumer devices take advantage of true multi-touch by applying data created to prevent issues with palm rejection and touch "shadows" caused by clothing. Some true multi-touch capability exists in up-to-date gaming but it still lags behind other leading-edge consumer products. Most applications are still driven and interfaced primarily through a single- or sometimes dual-touch when entering text. Gestures can be read and interpreted also with dual (two) touches enabling pinch, zoom and swipe style navigation.

PCT and e2e products offer single- and dual-touch out of the box, with PCT available at additional cost, for up to 32 touches. For the majority of industrial applications it is hard to imagine demands for true multi-touch at this time, but this may happen in the future.

Changing Perceptions

The rapid development of touch technologies has led industrial application designers to change their perceptions of how users interact with products, both in terms of quality of displayed images and the touch interface itself.

Both projected capacitive and e2e resistive technologies deliver a novel, intuitive multi-touch experience to the operator. There is no such thing as a perfect touch technology, but for now we believe that e2e offers an easy, safe and rapid way to bring the iPad experience into the industrial world, unless there are compelling reasons to create true multi-touch industrial applications.

DON'T MISS THE POINT, RIGOL'S NEW SIFI ARBITRARY WAVEFORM GENERATORS

Telonic Launch Rigol's new DG1000Z series of arbitrary waveform generators, the latest development in their family of fast, easy-to-use professional test instruments.

Rigol's DG1000Z series helps engineers to accomplish a wide range of testing applications by combining many functions in one easy-to-use instrument. Functions include arbitrary waveform generator, function generator, pulse generator, harmonic generator, and analogue/digital modulator.

The DG1000Z series also incorporates Rigol's Direct Digital Synthesizer (DDS) technology, ensuring that signals are delivered with stability, precision, purity and low distortion. These arbitrary waveform generators with innovative SiFi (Signal Fidelity) can generate arbitrary waveforms point-by-point and allow precisely adjustable sample rates and low jitter (200ps).

The arbitrary waveform memory is available with 8 Mpts (standard) and 16 Mpts (optional). Two full functional channels can be used as two independent generators offering ±1 ppm frequency stability and -125 dBc/Hz phase noise. The instruments have a built-in 8 orders harmonics generator and a built-in 7 digits/s full function frequency counter with 200MHz bandwidth.

Users can choose from up to 160 built-in waveforms with 14 bits vertical resolution and can benefit from a convenient arbitrary waveform editing interface. Versatile modulation types include AM, FM, PM, ASK, FSK, PSK and PWM. The instruments offer standard interfaces USB Host & Device and LAN (LXI Core Device 2011) and a 3.5“ TFT colour display. All models are supported by the Ultra Station PC software tool.

There are 2 models in the DG1000Z Series of Arbitrary Waveform Generators a 30 MHz and 60 MHz unit, with pricing starting at £369 on Telonic's dedicated Rigol website www.rigol-uk.co.uk.

RF Instruments

The DSA832 and DSA875 expand the DSA800 Spectrum Analyzer Series to 3.2 and 7.5 GHz respectively. With specifications that far exceed the DSA815-TG, these new instruments enable direct measurements of higher performance signals and systems. For design and development implementing Wi-Fi, Bluetooth, and other RF standards, the SSB phase noise down as low as -98 dBc/Hz at a 10 KHz offset empowers engineers to more accurately analyse modulations and noise surrounding their signals of interest. This becomes important for debugging and immunity testing of transceiver systems. The 7.5 GHz instrument enables engineers to investigate the 3rd harmonic of all of their critical 2.4 GHz applications. Additionally, resolution bandwidth settings down to 10 Hz means more precise visualization of low power RF signals.

With the EMI-DSA800 option you can enable the EMI RBW settings and the quasi-peak filter across the entire spectrum of interest for compliance and immunity testing. Whether you are still debugging your RF transceiver set, designing layout and configuration changes to maximize efficiency, or testing your system in noisy environments the DSA800 series spectrum analysers will help you to quickly and easily identify and analyse your areas of concern. Spectrum Analysers start at just £897 on Telonic's dedicated rigol website www.rigol-uk.co.uk

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www.telonic.co.uk

HIGH-BRIGHTNESS AND LOW-COST LED DRIVER – DC OR AC?

ASSOCIATE PROFESSOR SELIM BOREKCI FROM AKDENIZ UNIVERSITY IN ANTALYA, TURKEY, COMPARES AC AND DC LED DRIVER CIRCUITS

LEDs are now the most popular lighting device in many areas due to the advantages they offer, including high efficacy – a measure of how well a light source produces visible light, and longer life span. Unlike with florescent lamps, LEDs' relationship between operating current and voltage is not linear, so driving them is an important design aspect.

Figure 1 shows that LEDs are very sensitive to current change due to their nonlinear characteristics. For example, when LED voltage fluctuates between 3V and 3.5V, the LED current fluctuates around 1500mA, affecting the LED's luminous intensity, which is not a desired effect. (In photometry, luminous intensity is a measure of the wavelength-weighted power emitted by a light source in a particular direction per unit solid angle, based on the luminosity function, a standardized model of the sensitivity of the human eye.) The mathematical expression of a typical LED current and voltage is Equation 1:

$$I = I_s\,(e(v^{(Vd*q))/(n*k*T)} - 1) \qquad (1)$$

where I is the diode's forward current, I_s is the reverse bias saturation current, V_d is the diode's forward voltage, and n is the diode's ideality factor, a measure of how closely the diode follows the ideal diode equation. In addition, V_T is thermal voltage, k is the Boltzmann constant, T – temperature, and q – charge on an electron.

The relationship between an LED's luminous intensity and operating current is shown in Figure 2, where it can be seen that the luminous intensity is in direct proportion to the operating current. A standard 1W LED reaches its maximum luminous intensity at 350mA (as seen in the figure), above this value the LED can be damaged and have a shorter life.

The relationship between LED operating current and luminous intensity shown in Figure 2 is defined by Equation 2:

$$L = (I \times 0.2667) + 0.066655 \qquad (2)$$

where L is the lumen of the LED and I is the operating current. LEDs are meant to operate at constant current for flickerless and constant illumination levels; therefore, an LED driver circuit is designed to provide a constant output current.

LED Driver Topologies

The LED driver circuit is quite a popular research subject in power electronics. There are many LED driver topologies, which can operate the LEDs at either constant output current or constant output voltage. Constant-current LED driver circuits are used the most, since they are the most reliable.

LEDs can be driven with AC at high frequencies or with DC. Both approaches have their own advantages and disadvantages; however one important criterion is efficacy.

The purpose of this article is to compare the efficacy of AC and DC LED driver circuits. A current-fed, half-bridge parallel

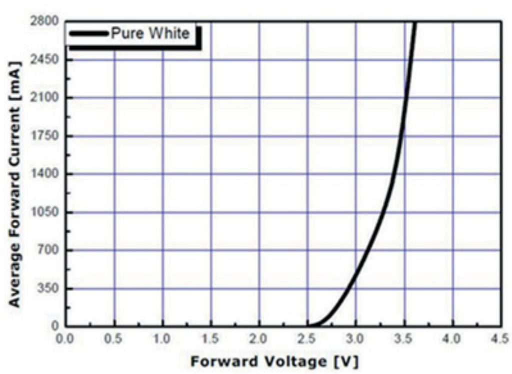


Figure 1: LED forward voltage and forward current characteristics

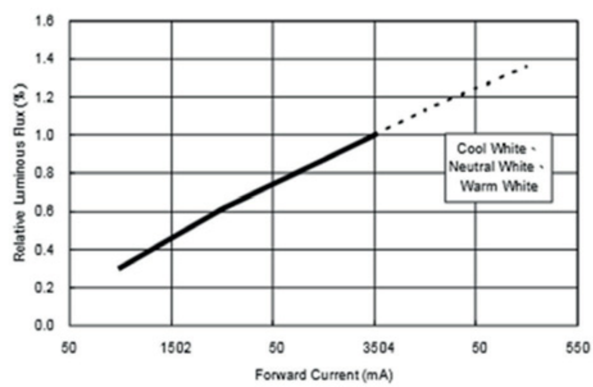


Figure 2: LED current versus LED luminous flux

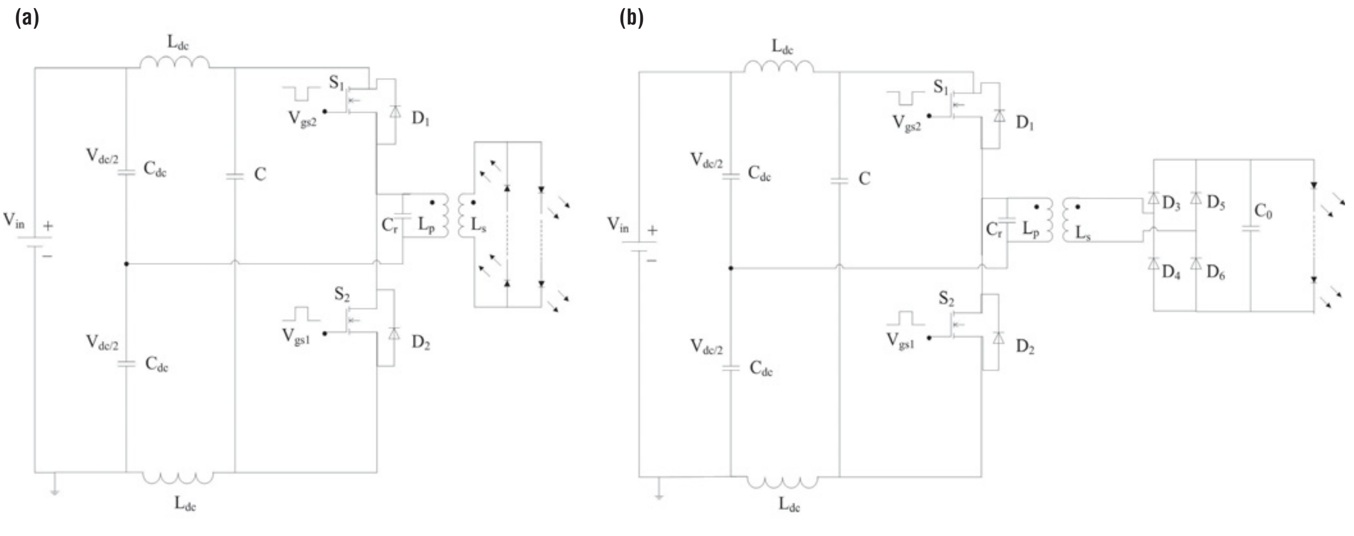


Figure 3: (a) AC LED driver circuit; (b) DC LED driver circuit

resonant DC/AC converter was designed and used as the LED driver for this research. Two configurations are built and compared; in the first, LEDs were driven with AC (Figure 3a), and in the second, for the same power, with DC (Figure 3b).

The first driver circuit is operated in AC mode at around 24kHz. In this case, there are two opposing LED arms, each having 43 1W LEDs connected in series. From Figure 4, which shows the driver circuit's measured operating current and voltage, it can be seen that the shape of the LED current is not pure sinusoidal but the LED voltage is. One arm is forward-biased in one half-cycle of the sinusoid signal and the other arm is off, so there is no need for a rectifier bridge circuit or an electrolytic capacitor. Because of the high frequencies, the human eye cannot see any changes in luminous intensity.

Maximum value of the LED current is designed to be 350mA, the allowed maximum operating current for a standard 1W power LED as mentioned earlier. Therefore, LED average current becomes lower.

P_{avg} (W)	Efficacy (L/W)	I_{avg} (mA)	I_{ma}x (mA)
10.31	98.74	77	352

Table 1: Calculated average power, luminous intensity and efficacy for an AC LED driver circuit

P_{avg} (W)	Efficacy (L/W)	I_{avg} (mA)	I_{max} (mA)
10.19	92.49	86	104

Table 2: Calculated average power, luminous intensity and efficacy for a DC driver circuit

To minimize switching losses, driver circuitry based on resonant topology results in zero-voltage switching. Figure 5 shows the MOSFET current and voltage waveforms.

The luminous intensity value can be calculated by using Equation 2; the average LED power and current in one period are shown in Table 1.

DC Operating Mode

As mentioned earlier, the second LED driver circuit operates in DC mode. Here, a full-bridge diode rectifier and electrolytic capacitors are connected to the output of the previous circuit to obtain a constant DC, with only one LED arm connected to the output. The output current across C_o is in DC form so there's no need for a reverse-connected LED arm.

In DC mode, the LED current is adjusted to be constant at 86mA to obtain the same power as in AC mode. Figure 6 shows the LED operating current and voltage waveforms in DC driving mode.

To make the best comparison between the DC and AC driver circuits' efficacies, both are designed to have the same power outputs. To this effect, the number of LEDs is reduced to 38. There's only one arm where 38 1W Edison LA1 LEDs are being connected in series, therefore the average output power is measured at 10W as with the AC driver circuit. Table 2 shows the LEDs' power, efficacy and average LED current for this circuit.

Better Results

A current-fed half-bridge resonant LED driver is designed to drive LEDs in AC or DC mode with the same output power. The efficacies of both drivers are close to each other, with

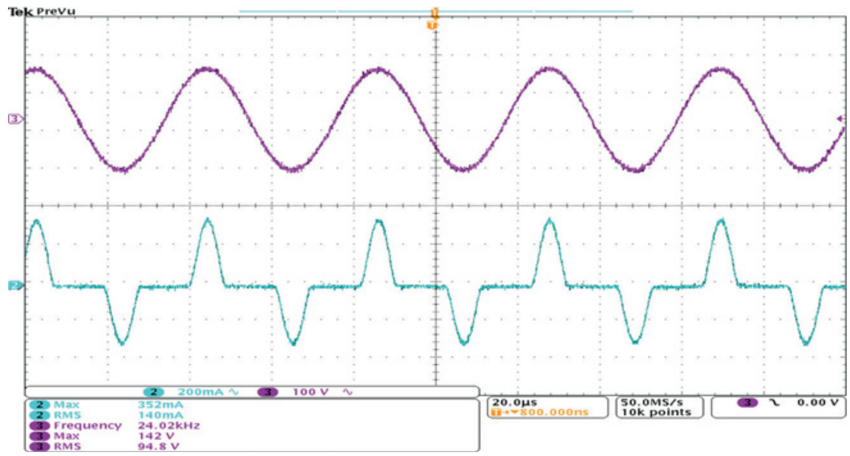


Figure 4: Measured LED voltage and current (addition of both arms) waveforms in AC operating mode

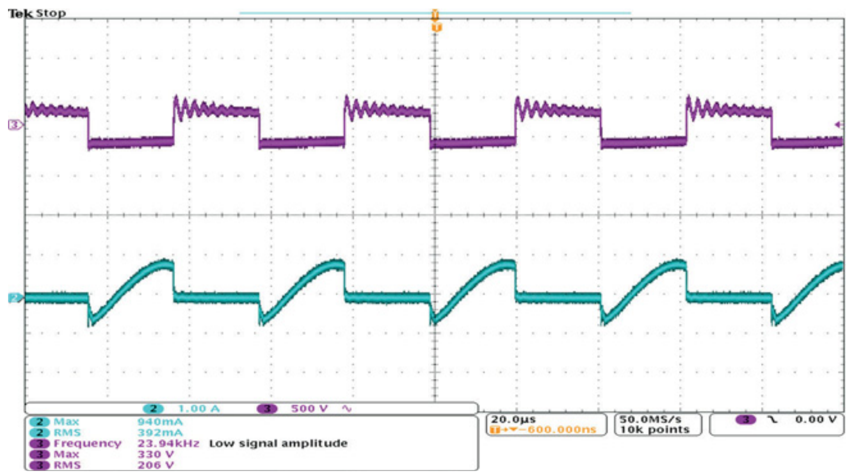


Figure 5: Waveforms of MOSFET's measured drain voltage and current

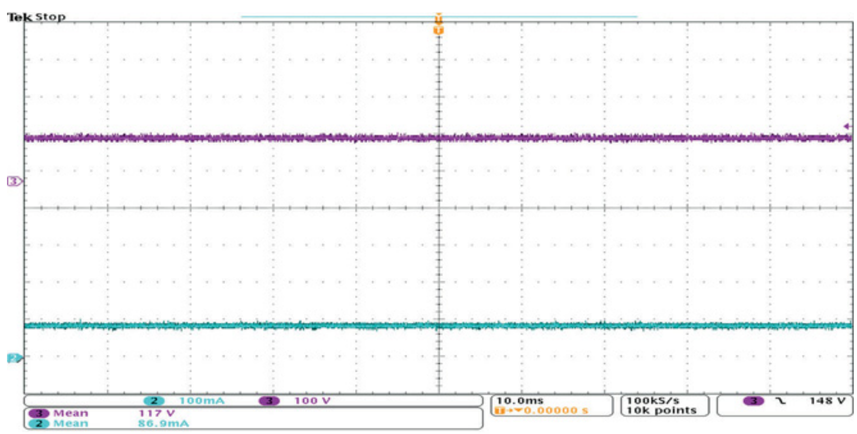


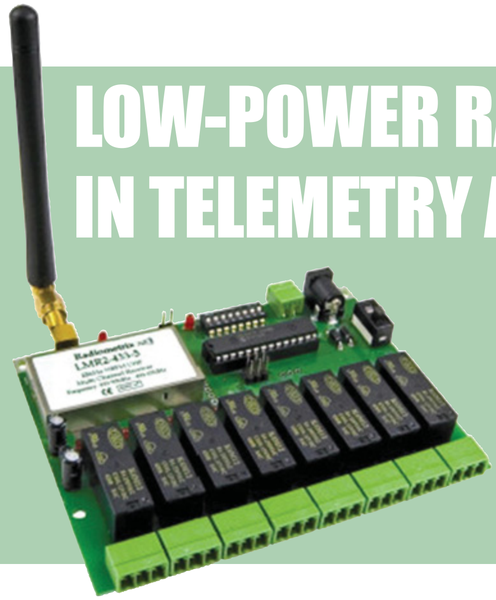
Figure 6: Measured LED voltage and current waveforms in DC mode

the AC driver showing a 6% higher efficacy than the DC driver. When the cost and design aspects are compared, the DC driver is cheaper, because of the lower number of LEDs.

For the same output power, 38 LEDs in DC and 86 LEDs in AC are used. Output current is constant with DC drive; and in an AC application, the LED current is in AC form.

Using electrolytic capacitors in the DC LED driver is a definite disadvantage of this circuit.

LOW-POWER RADIO TRANSCEIVER MODULES IN TELEMETRY APPLICATIONS



IN THIS SERIES, **PROFESSOR DOGAN IBRAHIM** OF THE NEAR EAST UNIVERSITY IN CYPRUS PRESENTS DIFFERENT TYPES OF RF SYSTEMS FOR EMBEDDED APPLICATIONS. HERE, HE DESCRIBES LOW-POWER RADIO TRANSCEIVER MODULES FOR TELEMETRY APPLICATIONS, WITH AN EXAMPLE OF A MICROCONTROLLER-BASED SYSTEM FOR MEASURING ULTRAVIOLET RADIATION

Radio telemetry systems are used to collect, analyze and transmit data from remote or inaccessible locations. Nowadays, wireless telemetry refers to distance data transfer using technologies such as radio, ultrasonic, infrared and in particular license-free low power radio (LPR), commonly used in many telemetry applications.

A radio telemetry system consists of one or several sensors that collect data, which is then transmitted to a receiving station for processing, recording, displaying and analysis.

Communication Methods

Although there are several data communications methods in radio telemetry applications, three methods are commonly used:

Periodic Transmission

Here, data is transmitted periodically, and the receiver checks for its availability. This is a simple method where the receiver executes in a loop, looking continuously for data; transmission is in one direction only.

The disadvantage of this method is that the processor is busy looking for data and thus cannot perform other tasks.

Interrupt Driven

The interrupt-driven method provides the fastest response time. The data is serviced as soon as it's available at the receive buffers. Here, the processor can perform other tasks when data is not available. Data transmission is in one direction only, as well. Interrupt driven data processing is more complex, requiring the interrupt service routine to be set up properly.

Data Polling

This method also provides a fast response and releases the processor to perform other tasks. Here, the receiver requests data from the transmitter whenever required. The transmitter in return sends the requested data, which is then processed by the receiver.

The disadvantage of this method is that transceivers are required at both ends for two-way communication.

In this article, we use the data polling method to receive and display ultraviolet radiation data on an LCD.

UV Radiation

Sunlight-produced UV radiation has harmful effects, including sunburn, skin cancer, cataracts, and so on. Equally, there are some positive effects of UV radiation, including the formation of vitamin D for strong bones.

UV radiation is usually divided into three spectra, depending on the wavelength (see Table 1).

UV-C is the most energetic and most harmful kind, but luckily it is completely stopped by the ozone layer. Accidental exposure to UV-C can damage the cornea of the eye and cause severe skin burns.

UV-B is required for synthesis of vitamin D; however, overexposure can cause cataracts, skin cancer and sunburn.

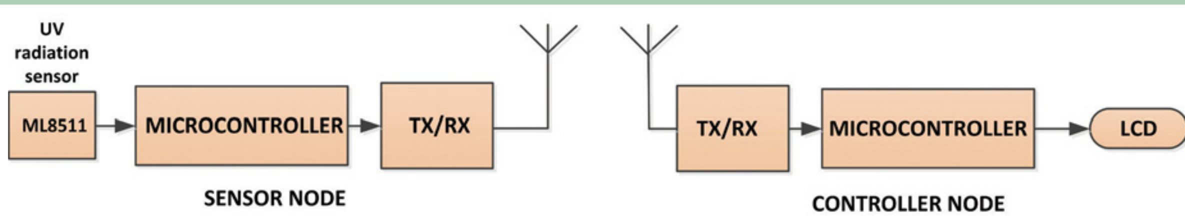


Figure 1: PX409 series barometric sensor

UV-B does not penetrate the skin as much as UV-A, the most common solar radiation reaching Earth. UV-A has tanning effects and also helps create vitamin D. This is the type of radiation made by tanning UV lamps.

Latest research shows that overexposure to UV-A or UV-B can cause sunburn, skin aging and skin cancer.

The Test System

Figure 1 shows the block diagram of a test system, where the sensor node consists of the ML8511 ultraviolet radiation sensor chip, StartUSB for PIC development kit (www.mikroe.com) and a TDL2A transceiver modem module.

The StartUSB for PIC kit is a PIC-microcontroller-based development board based on the PIC18F2550 microcontroller, operating with an 8MHz crystal. The microcontroller can be programmed via the mini-USB port on the board. The microcontroller is shipped pre-loaded with a bootloader program to be directly programmed from a PC. The development board provides access to the microcontroller I/O pins through board-edge connectors.

The controller node consists of a PIC18F45K22 microcontroller and a 16 x 2 character LCD.

The ML8511 Sensor

ML8511 is a UV sensor module (Figure 2) which converts photo-current to voltage, depending on the UV intensity. The sensor is equipped with an internal amplifier and is suitable for portable applications, as it consumes only 0.1µA in standby mode.

The sensor detects 280-390nm light most effectively, which corresponds to the UV-B (burning rays) spectrum and the UV-A (tanning rays) spectrum. Its basic features are:

- Sensitive to UV-A and UV-B radiation
- Analog voltage output
- 2.7-3.6V operating voltage
- Maximum sensitivity to 365nm wavelength
- Output voltage in mW/cm^2
- Available as a module.

The sensor module has four connections:

- EN: active HIGH enable pin
- OUT: analog output pin
- GND: ground pin
- 3.3: +3.3 power supply pin

Figure 3 shows its output voltage/UV intensity characteristics. The output voltage is directly proportional to the UV radiation in mW/cm^2, from 0 to $15mW/cm^2$, giving an output of 1-3V. This sensor's spectral response characteristic is shown in Figure 4.

The Modem Modules

Radiometrix (www.radiometrix.com) is a UK-based designer, developer and manufacturer of TX/RX wireless modem modules for radio telemetry applications, with a large choice of modem modules for this project. Users can select between VHF/UHF, single-channel/multi-channel, narrow-band/wide-band, low-

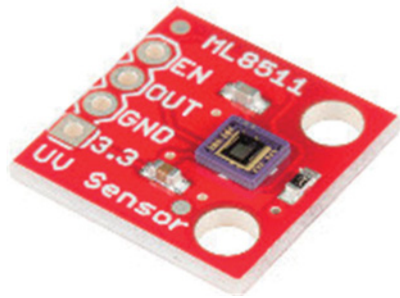


Figure 2: ML8511 UV sensor module

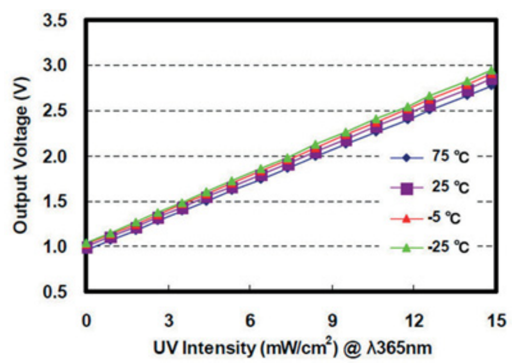


Figure 3: Output voltage/UV intensity characteristic of ML8511

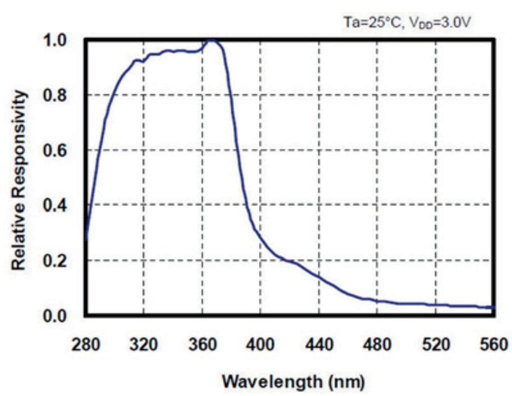


Figure 4: Spectral response characteristic of ML8511

Figure 5: The TDL2A transceiver module

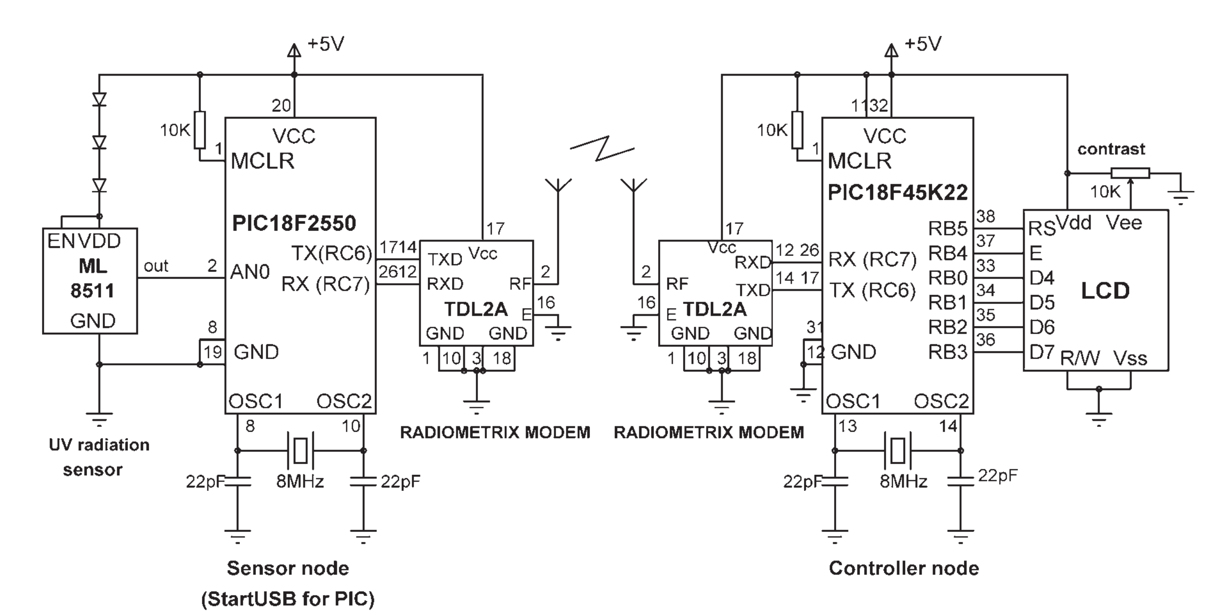


Figure 6: Circuit diagram of the project

Type	Abbreviation	Wavelength	Notes
Ultraviolet A	UV-A	400 – 315nm	Not absorbed by ozone layer
Ultraviolet B	UV-B	315 – 280nm	Mostly absorbed by ozone layer
Ultraviolet C	UV-C	280 – 100nm	Completely absorbed by ozone layer

Table 1: UV radiation spectrum

power/medium-power/high-power and transmit-only/receive-only modules.

For this project we used TDL2A transceiver module (Figure 5), a 9600-baud, half-duplex, multi-channel, radio modem with RF power output of 10mW (+10dBm), operating in the European 433.925MHz (channel 0) to 434.565MHz (channel 4) band, with usable range of several hundred metres. The receiver sensitivity is -107dBm.

The modules have five programmable channels with up to eight programmable unique addresses, and operate with +5V supply, consuming 28mA in transmit and 22mA in receive mode respectively.

Figure 6 shows the circuit diagram of the test system. On the sensing side, the UV sensor is connected to the analog input channel AN0 of the PIC18F2550 microcontroller. Three diodes are used to lower the +5V supply voltage for the ML8511.

TDL2A modem pins TXD and RXD are connected to the UART transmit and receive pins of the microcontroller respectively. The RF in/out pin of the TDL2A is connected to a suitable UHF antenna (e.g. 16.4cm wire).

On the controller node, the TDL2A modem pins TXD and RXD are connected to the UART pins of the PIC18F45K22 microcontroller. PORTB pins of the microcontroller are connected to a 16x2-character text-based LCD to display the UV radiation. The contrast of the LCD is controlled by a potentiometer.

The Software

The software of the test system is based on the mikroC Pro for PIC language.

Below is the sensor node operation program (Program 1), which executes in an endless loop. The program waits for a data request from the receiver, and then reads the sensor data and transmits it via the UART.

```
BEGIN
    Configure microcontroller I/O ports
    Configure UART
    DO FOREVER
        IF request for data received THEN
            Read UV data from channel AN0
            Transmit the UV data via UART
            ENDIF
    ENDDO
END
```

Program 1: Operation of the sensor node

Operation of the controller node program is shown in Program 2 on the next page. The program operates in an endless loop. The receiving side sends data request to the transmitting side and then

waits until data arrives. The data is then read and displayed on the LCD. This process continues after a delay of one minute.

Program 3 shows the complete sensor node program listing. Function Read_ML8511 reads the UV radiation data from the analog channel, converts it into mW/cm² and returns it in string variable UVTxt. This data is transmitted via the UART when requested.

The complete program listing of the controller node is shown in Program 4. At the beginning, the LCD interface is defined. Then PORTB and PORTC are configured as digital, and the LCD and UART modules initialised. The remainder of the program executes in an endless loop when data is requested from the transmitting side. The received data is displayed on the LCD. ●

```
BEGIN
        Configure microcontroller I/O ports
        Configure UART
        Initialize LCD
        DO FOREVER
                Send request for data
Wait until data is available
Read data from UART
Display data on LCD
Wait 1 minute
                ENDDO
        END
```

Program 2: Operation of the controller node

```
unsigned char UVTxt[15];
unsigned long Vin;

void Read_ML8511()          // Read UV radiation
{
 float UV, V;
 Vin = ADC_Read(0);         // Read from Channel 0
 V = ((float)Vin*5.0) / 1024.0;        // Convert to Volts
 UV = (V - 1.1) / 0.11;     // UV in mW/cm2
 if(UV < 0)UV = 0;
 FloatToStr(UV, UVTxt);     // Convert to string
}

 void main()
 {
 unsigned char c;
 ADCON1 = 0x0E;             // Configure AN0 as analog
 UART1_Init(9600);          // Initialize UART

 while(1)
 {
 if(UART1_Data_Ready() == 1)        // If data available
 {
 c = UART1_Read();          // Read the data
 if(c == 'R')               // If data requested
 {
 Read_ML8511();             // Read UV radiation
 UART1_Write_Text(UVTxt);   // Send UV radiation
 UART1_Write('X');          // Send terminator character
 }
 }
 }
```

Program 3: Sensor node program

```
// LCD connection definition
//
sbit LCD_RS at RB4_bit;
sbit LCD_EN at RB5_bit;
sbit LCD_D7 at RB3_bit;
sbit LCD_D6 at RB2_bit;
sbit LCD_D5 at RB1_bit;
sbit LCD_D4 at RB0_bit;

sbit LCD_RS_Direction at TRISB4_bit;
sbit LCD_EN_Direction at TRISB5_bit;
sbit LCD_D7_Direction at TRISB3_bit;
sbit LCD_D6_Direction at TRISB2_bit;
sbit LCD_D5_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB0_bit;
//
// End of LCD connection definition

void main()
{
 unsigned char buffer[15];
 ANSELB = 0;                // Conf PORTB as digital
 ANSELC = 0;                // Conf PORTC as digital
 Lcd_Init();                // Initialize LCD
 UART1_Init(9600);          // Initialize UART

 while(1)                   // Do forever
 {
 UART1_Write('R');          // Send data request
 UART1_Read_Text(buffer,"X",255);   // Read UV data
 Lcd_Cmd(_LCD_CLEAR);       // Clear LCD
 Lcd_Out(1,1, buffer);      // Display UV radiation
 Lcd_Out_Cp("mW/cm2");      // Display mW/cm2
 Delay_Ms(5000);            // Wait 5 seconds
 }
}
```

Program 4: Controller node program

ENABLING RICHER USER EXPERIENCES WITH HIGHER RESOLUTION HMIs

BY **LEE CHEE EE** FROM FTDI CHIP

Implementation of touch-based human machine interfaces (HMIs) initially took place quite some time ago. Early adoption was mainly in the consumer electronics and computing industries, where HMIs were able to provide a less cumbersome way to engage with electronic hardware, as well as often enhancing the design concept of the equipment into which they were integrated. Since then many different sectors have begun to benefit from them, including white goods, home automation systems, industrial control apparatus, point-of-sale units, vending machines, ATMs, information kiosks and security systems, to name just a few.

With the advent of technology that provides for the simultaneous detection of multiple touch points, the value of touch-enabled HMIs increased still further. Now commercial pressures are pushing for yet more technological advances – with HMIs based on larger-format higher-resolution displays being justified in an increasing number of applications.

Improved HMIs

A growing number of OEMs, serving a broad cross-section of sectors, are working on HMIs that support more detailed image content and greater colour depth. In addition, there are many places where HMIs with the ability to play video content may also prove desirable. In response to these demands, semiconductor platforms are being sought that deliver the necessary performance within the usual array of stringent design constraints – such as limited budgets, overworked engineering staff, space restrictions, tight time-to-market schedules, etc.

Manufacturers of refrigerators and dishwashers are keen to add features to their products that will make them more attractive to consumers and thus increase unit sales. Whereas previously they could get away with a fairly rudimentary

> “For photocopiers, these next generation HMIs will permit office workers to access brief instructional films on resolving paper jams

Figure 1: Washing machine HMI

Figure 2: Refrigerator HMI

HMI (perhaps a keypad and a 7-segment display), customer expectations have now been raised significantly, driven by the heightened usability of the electronic gadgets they already own.

There are opportunities for integration of larger format displays with a wide colour gamut, multi-touch operation and even audio-visual capabilities. In the case of washing machines, for example, animated content can help convey to the user the progress of the wash cycle. For photocopiers, these next generation HMIs will permit office workers to access brief instructional films on resolving paper jams. Likewise, video material can be used to show people how to operate self-service equipment like coffee machines.

In lifts, the prospective worth of more advanced HMIs is being recognised as well. Touch-enabled displays can not only be used to specify shoppers' destination floor within a department store or mall, but when they arrive the display can direct them to the place they want to visit, or advertise specific products that might be on offer. For hotel lifts this technology could be used to inform guests of the different facilities available there and their location.

Ground-Breaking Approach

An increasing proportion of OEMs' HMI designs are following a ground-breaking object-centric approach that has emerged over the last two years, requiring far smaller memory resources and less bandwidth for data transfer. Through this arrangement HMI system designs can be streamlined substantially by simply regarding visual and audio content as objects with pre-defined properties. Objects can include fonts, bitmap images, templates, chirps, beeps and overlays.

The large flash memory normally needed to store image data, as well as the frame buffer and wide parallel buses to support it, can be eliminated from the system. The component count for the resultant HMI is much lower, less board space is needed, power consumption is reduced and development times are shortened.

Another important aspect of this object-oriented methodology concerns animated content. With displayed images treated as objects rather than complex items made up of many pixels, animation is easily accomplished, simply by updating the coordinates of the object, as opposed to having to redraw the image again and again to accommodate any movements. Plus, a single object may be repeated in multiple locations without having to create additional content that impacts the system overhead.

EVE

The innovative object strategy just discussed has been pioneered by FTDI Chip and its Embedded Video Engine (EVE) platform. Through EVE, images can be rendered line-by-line (at 1/16th pixel resolution) rather than pixel-by-pixel, which is where the reduction in data storage and bandwidth requirements are achieved.

FTDI's FT81x series is typical of the latest EVE devices. Each IC in this series has higher resolution than the previous generation – supporting 800 x 600 pixels compared to 512 x 512 pixels. This means these ICs are able to offer greater image clarity and address larger display sizes (seven inches and above). The available memory has been expanded from 256kB to 1MB to cope with all the extra data involved.

Thanks to major algorithm enhancements, the devices in this new EVE series have much smoother video playback capabilities. This means that HMI designs can benefit from short animations that grab the user's attention or access to instructional film material. Another new feature is screen rotation, which expedites turning through 90°, making possible both landscape and portrait orientations (highly advantageous for portable/semi-portable designs).

> Commercial pressures are pushing for yet more technological advances – with HMIs based on larger-format higher-resolution displays being justified in an increasing number of applications

Multiple palettes are supported, covering 16-bit and 32-bit colours with transparency. Extra-large fonts have also been added, increasing the text options. Further performance improvements include the capacity to draw up to 16 pixels

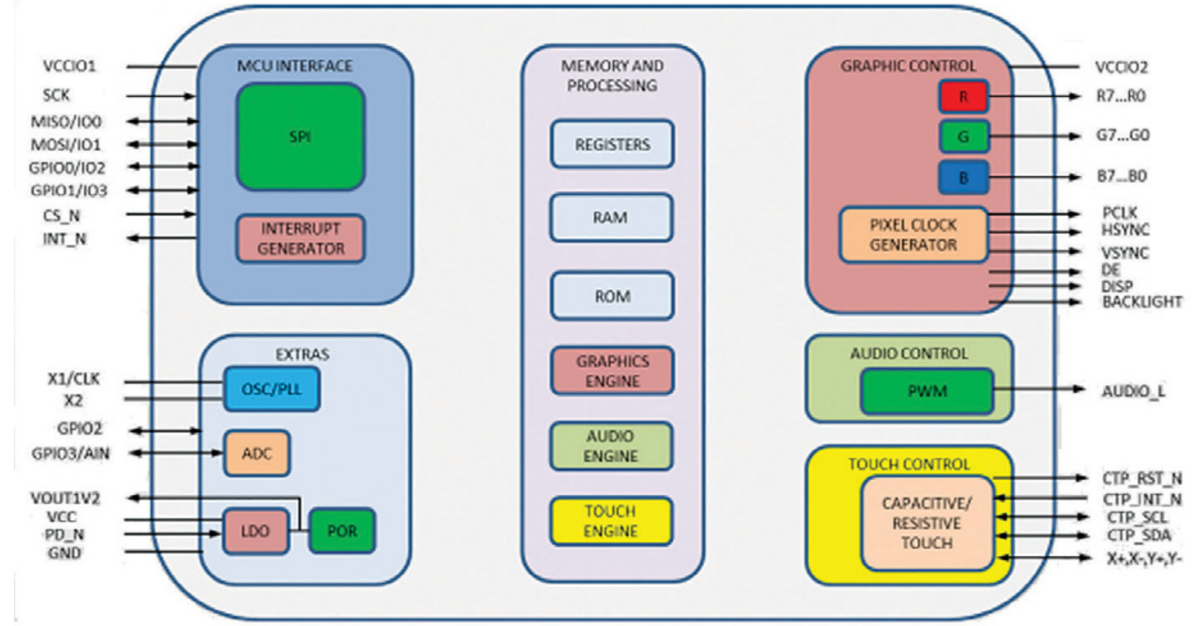


Figure 3: FT81X functional block diagram

during each clock cycle (quadrupling the performance of the preceding EVE generation) and JPEG loading 1000 times faster than previously practical.

By employing a more rationalised strategy to HMI development, such as the one described in this article, substantial reductions in both board real estate required and overall costs can be comfortably realised. In addition, these extra functional elements now being incorporated into the relevant ICs make possible other features to be explored in terms of the supply of absorbing and informative multimedia content. ●

AWS ELECTRONICS GROUP WINS AUTOMOTIVE BUSINESS FOR ITS SLOVAKIA FACILITY

AWS, one of Europe's leading specialist contract electronics manufacturers, has announced that a major Tier 1 automotive manufacturer will volume manufacture assemblies and systems at AWS's facility in Slovakia.

"We have won several significant automotive programs recently, which has led to very fast growth at our Namestovo facility in Slovakia. The latest deal is for LED lighting products that go into high-end vehicles, so the business is both high volume and high quality," said AWS CEO Paul Deehan.

AWS has continued to invest and grow its Namestovo plant to offer low-cost manufacturing opportunities for Tier 1 auto suppliers closer to their end users than from South-East Asia. The Slovakian facility uses exactly the same processes, equipment and management systems that AWS has developed for its UK plant, which also handles Fast Track and NPI business as well as through life MRO.

www.awselectronicsgroup.com

AWS ELECTRONICS GROUP

ASTUTE DELIVERS 'NEAR EYE' MINIATURE OLED DISPLAYS FROM MICROOLED

Astute Electronics has signed a worldwide franchise agreement with MICROOLED of Grenoble, France, a pioneer in the field of small, high-definition, low-power OLED displays that target Near-Eye Display (NED) applications such as video glasses, head-mounted sports devices, camera viewfinders, medical applications and many other professional devices. MICROOLED's low-voltage device architecture features a unique sub-pixel arrangement resulting in highest pixel density and lowest power.

The design of MICROOLED's displays provides ultra-high contrast, ensuring that 'black is black', which is essential for high image quality. Unlike other displays, no grid matrix is visible, further improving resolution, and the manufacturing technology enables a wide viewing angle with no loss in contrast or changes in colour. Power consumption is typically two or three times less than competing products, and response time is under one microsecond, ensuring blur-free images, even of fast-moving objects.

www.astute.co.uk

IET SEARCHES FOR THE WORLD'S BEST INNOVATORS IN ENGINEERING, SCIENCE AND TECHNOLOGY

The Institution of Engineering and Technology (IET) has launched a search to find the most exciting engineering, science and technology innovations from the engineering community as part of its Innovation Awards programme.

The IET Innovation Awards are designed to recognise breakthrough innovations that advance their respective field across 15 categories, from energy and sustainability to transport and healthcare.

The awards, which run annually, cover an international scope and are free to enter to anyone with a new and innovative product or service – providing budding or established engineering inventors with a unique platform to gain exposure for their ideas. All shortlisted and winning entries will be promoted to the IET's 160,000 members across the globe.

The scheme is open to organisations or individuals developing technologies that will introduce technological innovations that may contribute to improved way of doing things, new products, enhanced performance or better value.

"Innovation is essential for the growth of the global economy and raising the standard of living of all communities. Innovation is the differentiator that makes companies successful," said William Webb, IET President.

www.theiet.org/awards

NEW DSPIC33EP "GS" FAMILY OPTIMISED FOR DIGITAL POWER APPLICATIONS

Microchip launched the 14-member dsPIC33EP "GS" family of Digital Signal Controllers (DSCs), which delivers the performance needed for more sophisticated non-linear, predictive and adaptive control algorithms at higher switching frequencies. These advanced algorithms enable power supply designs that are more energy efficient and with better specifications. Higher switching frequencies enable the development of physically smaller power supplies that offer higher densities and lower costs. Compared with the previous generation, the new DSCs provide less than half the latency, when used in a three-pole three-zero compensator, and consume up to 80% less power in any application.

The new dsPIC33EP "GS" family includes advanced features such as Live Update Flash capability, especially helpful for high-availability or "always-on" systems. It can be used to change the firmware of an operating power supply, including the active compensator calculation code, while maintaining continuous regulation.

www.microchip.com

95%-EFFICIENCY DUAL SYNCHRONOUS STEP-DOWN SWITCHING REGULATOR

Linear Technology introduced the LT8616, a 42V input capable, high-efficiency dual synchronous monolithic step-down switching regulator. Its dual channel design delivers independent 2.5A and 1.5A continuous current to outputs as low as 0.8V. A dual channel synchronous rectification topology delivers up to 95% efficiency while Burst Mode operation keeps quiescent current under 6.5μA (both channels enabled) in no-load standby conditions, making it ideal for always-on systems. Switching frequency can be programmed from 200kHz to 3MHz and is synchronizable throughout this range.

The LT8616's 35ns minimum on-time enables $16V_{IN}$ to $1.8V_{OUT}$ step-down conversions, while switching at 2MHz helps designers avoid critical noise-sensitive frequency bands, such as AM radio, while having a very compact solution footprint. Its 3.4-42V input voltage range makes it ideal for automotive applications which must regulate through cold-crank and stop-start scenarios.

www.linear.com

MULTI-FUNCTION BOUNDARY-SCAN TESTER SUITS BENCHTOP AND FIXTURES

JTAG Technologies announced the latest in its highly versatile range of boundary-scan controller hardware for PCB assembly and system testing – the versatile JT 5705 series. This new design concept incorporates both JTAG/boundary-scan controller functions and mixed-signal I/O channels. Extensive input protection is provided to ensure high levels of in-service reliability and low maintenance. Connection to the tester is via a USB interface.

The first in the series – JT 5705/USB – is supplied as desktop instrument, primarily aimed at hardware validation applications in design, small-scale production test and, in some cases, field service and repair. The JT 5705/USB features two 15MHz TAPs and 64 I/Os available through 0.1" IDC connectors. Of the I/O channels 56 are always digital, 16 of which also feature a frequency function, with the remaining eight used as either digital I/O or analog I/O.

www.jtag.co.uk

INNOVATIVE 60V SYNCHRONOUS BUCK CONTROLLER SIMPLIFIES POWER SUPPLY DESIGN

Intersil's first 60V synchronous buck controller bypasses the intermediate step-down conversion stage traditionally employed in industrial applications. The ISL8117 synchronous step-down PWM controller's low duty cycle (40ns minimum on time) enables the direct step-down conversion from 48V to a 1V point-of-load. This technical achievement allows designers to reduce system complexity and solution cost in industrial, factory automation, medical and communications infrastructure applications.

In high-voltage applications where a lower output voltage is required, designers have traditionally relied on modules that increase system cost, or two stage DC/DC solutions that increase solution footprint and complexity. The ISL8117 uses valley current mode modulation with adaptive slope compensation to enable stable operation for a wide range of V_{in} and V_{out} combinations, with no external compensation required; its adjustable frequency up to 2MHz enables optimal costs, size and efficiency.

www.intersil.com

NEW MACHXO3LF DEVICES WITH ON-CHIP FLASH MEMORY

Lattice Semiconductor announced the newest member of its MachXO3 FPGA family – MachXO3LF – which provides essential bridging and I/O expansion functions to meet the increasing connectivity requirements of the communications, computing, consumer and industrial markets.

MachXO3LF devices come with on-chip Flash for configuration and usage. They utilize the same advanced package technology as the MachXO3L family, thus providing a small footprint and one of the highest I/O densities around. The pin-out compatibility allows customers to easily migrate between MachXO3L and MachXO3LF devices without changing printed circuit board design.

With the MachXO3LF devices, customers can get the benefit of FPGA design code changes during the engineering and development phase or during in-field design upgrades, and then easily migrate to lower cost MachXO3L devices when the design is finalized or an upgrade becomes unnecessary.

www.latticesemi.com

PANASONIC'S HIGH RIPPLE CURRENT CAPACITORS TARGET HIGH-RELIABILITY APPLICATIONS

Panasonic Automotive and Industrial Systems has introduced a new series of conductive polymer hybrid aluminium electrolytic capacitors with 45% higher ripple current, suitable for high-reliability applications that require low leakage, high capacitance and high stability.

The 125°C hybrid capacitors in 25V and 35V now feature a ripple current of up to $2900mA_{rms}$ – the best performance available for such small devices. The specification approaches the ripple current performance of solid polymer devices (10.2mm maximum height) but with the many advantages of the hybrid polymer capacitor technology, including low leakage current, high capacitance, low power consumption, stable operation and the ability to withstand test environmental conditions (85degC/85%/2000 hour RH).

Capacitance values are 10-330μF. The devices' high-withstand voltage is 25-63V. Endurance is 4000 hours at 125degC, the longest endurance in the industry by each case size (C, D, D8, F & G).

http://eu.industrial.panasonic.com/

SMALLEST IGBT GATE-DRIVER FOR 90-500KW INVERTERS

Power Integrations launched its 2SC0115T2A0-12 dual-channel gate-driver core for 90-500kW inverters and converters. Leveraging SCALE-2+ integrated circuit and isolated transformer technology for DC/DC power and switching signal transmission, the new driver core improves system reliability and performance by eliminating the need for an opto-coupler. The driver core's reinforced electrical isolation targets systems with a working voltage of 900V, which is typical for 1200V IGBT modules and complies with the PD2 and OV II requirements of IEC 60664-1 and IEC 61800-5-1. The 2SC0115TA0-12 gate-driver core supports modules up to 2400A and switching frequencies of up to 50kHz.

With a footprint of 53.2 x 31mm and a height of just 13mm, the 2SC0115TA0-12 gate-driver core is the most compact industrial unit of its type available. The highly integrated SCALE-2+ chipset uses about 85% fewer components than competing products.

www.power.com

PULSONIX AND UCAMCO COLLABORATE TO FULLY INTEGRATE GERBER X2 IN PULSONIX 8.5

WestDev, the EDA (Electronic Design Automation) company delivering technology-leading PCB design solutions, completed its Gerber X2 output, by working closely with Ucamco, the developer of the Gerber format. The output has been fully verified by Ucamco, conforming to the X2 specification.

Ucamco launched Gerber X2 to provide a robust, standardised method for automatically transferring layout data and valuable PCB design information from CAD to CAM. Extended Gerber has always done a great job of handling the first part; the image data. But now with Gerber X2, the PCB industry's de facto standard image format is even better, due to clearer design data, and automatic machine-readable data for greater transparency and information in the output stage of the design process.

www.pulsonix.com

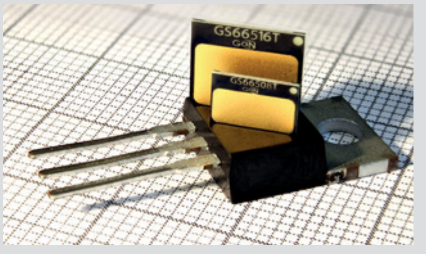
HIGHEST CURRENT GALLIUM NITRIDE POWER TRANSISTOR AT 60A

GaN Systems added another device to its range of E-mode GaN-on-Silicon high-power transistors based on its three core proprietary technologies. The new GaN high-power enhancement-mode device, designated the GS65516T, boasts the highest current capability on the market at 60A and further expands GaN Systems's range of power switching semiconductors.

The GS65516T 650V E-mode power switch features GaN Systems's new proprietary topside cooling configuration announced in March this year, which allows the device to be cooled using familiar and conventional heat sink or fan cooling techniques. It is packaged in low inductance and thermally-efficient GaNPX packaging and measures 9.0mm x 7.6mm x 0.45mm.

Additional features include reverse current capability, integral source sense and zero reverse recovery loss.

www.gansystems.com



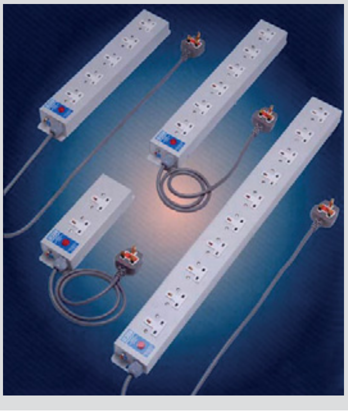
THE OLSON SLIM RANGE 13A BS1363 FOR DESK, WALL- OR FLOOR-MOUNTING

Olson slim range distribution panels are an integral component for all applications. They are differentiated from the rest by virtue of their metal casing. They offer better protection than plastic against radio frequency interference, and smoke and fire hazard.

The product range is highly versatile, available in different sizes, with a combination of cables and plugs. The units come as standard with 'mains-on' neon, but there are other options available with illuminated switch or surge protection.

Olson's products are easily tailored to suit customer's individual requirements.

www.olson.co.uk



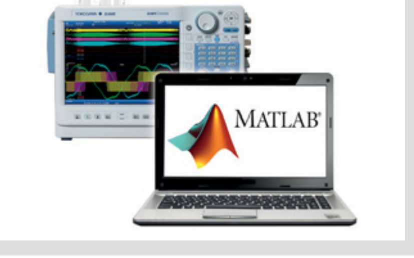
NEW SCOPECORDER FIRMWARE ADDS DIRECT MATLAB FILE SAVING

Yokogawa has released firmware Version 3.20 for the DL850 ScopeCorder series of instruments, which combine the features of a high-speed oscilloscope and those of a traditional data acquisition recorder in a single, portable instrument.

A key feature of the new firmware is direct file saving into the Mathworks MATLAB data analysis and visualisation environment, offering users quicker and easier import of measurement data. By supporting MATLAB's .MAT file format on the ScopeCorder, the measurement results can be conveniently imported into MATLAB more speedily and with smaller file size. The .MAT file format on the ScopeCorder is compatible with Level 5 MAT-files, the latest file format from MATLAB.

Other new features include support of an external USB printer for printing on long rolls of paper, and a "sure delete" function for erasing data from the ScopeCorder's hard disk drive.

tmi.yokogawa.com

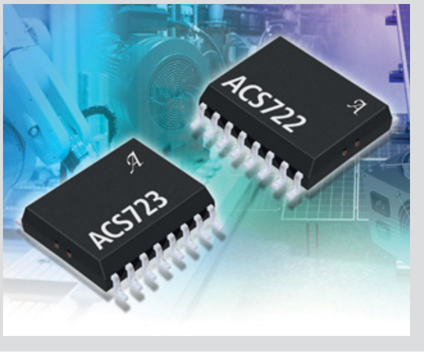


HALL-EFFECT CURRENT-SENSOR ICS IN HIGH-ISOLATION PACKAGE

The ACS722 and ACS723 Hall-effect current sensor ICs from Allegro MicroSystems Europe are now available in a high-isolation SOIC16 package. The low-profile surface-mount package is ideal for space-constrained applications while also saving costs due to reduced board area, yet provides a 4800V RMS isolation rating: the highest available from Allegro's family of surface-mount current sensor ICs.

The new high-accuracy devices provide economical and precise solutions for AC or DC current sensing in industrial and commercial applications. In addition to their small size and high accuracy, the ACS722 and ACS723 offer superior isolation performance, low power consumption, and a wide operating temperature range with near zero magnetic hysteresis.

www.allegromicro.com



HARTING EXPANDS DIN 41612 CONNECTOR FAMILY WITH M INVERSE STYLE

Harting has expanded its family of DIN 41612 connectors by adding devices in the M inverse style. This type is especially suited to implementing combined connections between circuit boards in which signal, coaxial, high-current (up to 40A) or optical fibre transmissions need to be combined in one connector for greater flexibility.

The new connector style is available in configurations with pole numbers of 78+2, 60+4, 42+6, 24+8 and 6+10, where the first number indicates the number of signal contacts and the second the number of special contacts. The 6+10 connector style in particular is completely new and enables up to ten special contacts to be integrated in one connector.

Users can combine connectors in a range of different configurations including both cable and circuit-board connections. The new devices allow the implementation of mezzanine and extender-card connections.

www.harting.co.uk

UMK 250 – ULTRA SMALL SPACE-SAVING FUSE AND FUSEHOLDER COMBINATION

Schurter is expanding its range of surface mount fuses with the UMK 250 series, providing primary and secondary overcurrent and short-circuit protection. The quick-acting characteristic of this fuse is in accordance with IEC 60127-4, providing the logical addition to the existing UMZ 250 time-lag series.

The UMK 250 is available in ten rated currents from 500mA to 4A. The fuse and clip combination is designed for easy fuse replacement. Rated for the protection of primary and secondary PCB circuits, the UMK 250 is suited to applications including power supplies, medical equipment, lighting and devices for home and industrial use.

This series is RoHS-compliant and compatible with lead-free soldering processes. The UMK 250 fuseholder is an ideal substitute for similar SMD fuses, where the fuse clips are not offered.

www.schurter.co.uk

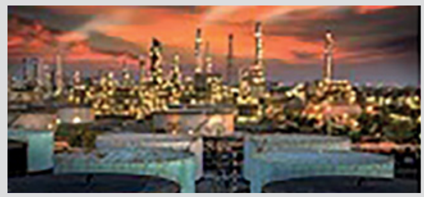
NETWORK CONNECTIVITY SOLUTIONS ENABLE OIL AND GAS TITANS TO IMPROVE EFFICIENCY

The Industrial Internet of Things (IIoT) and automation will continue to gather force in the oil and gas industry. Perle Systems, a global manufacturer of advanced Serial to Ethernet and secure device networking hardware, provides industrial networking products used in subsea, topside, onshore and hazardous locations.

Oil and gas industry leaders continue to look to digital technologies as a way to address some of the key challenges the industry faces today in this lower crude oil price cycle. Making the most of big data, IIoT and automation are indeed the next big opportunities for energy and oilfield services companies, and many are already starting work in these areas.

Perle device networking hardware is used for automation and IIoT Ethernet connectivity by oil and gas industry leaders like Chevron, Spectra Energy, Total, Schlumberger, Apache, Shell and Peabody Energy.

www.perle.com



1.0A STEP-DOWN SYNCHRONOUS DC/DC CONVERTERS WITH HISAT-COT

Torex Semiconductor has developed a new series of 1.0A output, step-down, synchronous DC/DC converters equipped with Torex's unique HiSATCOT fast transient response control.

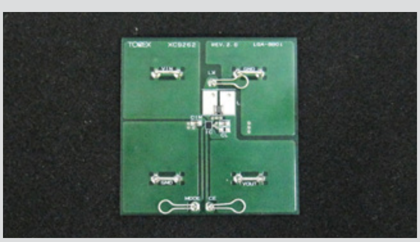
The XC9257/XC9258 series are step-down synchronous DC/DC converters with an output current of 1.0A and Torex's unique HiSAT-COT fast transient response control.

Compared to regular COT control, Torex's HiSAT-COT control enables greater suppression of frequency fluctuations caused by the load and input voltage, resulting in response speed eight times faster than previous products, and output voltage drop of 50%.

PWM control (XC9257) or PWM/PFM auto switching control (XC9258) can be selected for the operation mode, and a fast response, low ripple and high efficiency are obtained over the entire load range, from light loads to heavy loads.

The output voltage can be set internally to a value from 0.8V to 3.6V (±2.0%) in steps of 0.05V.

www.torex.co.jp



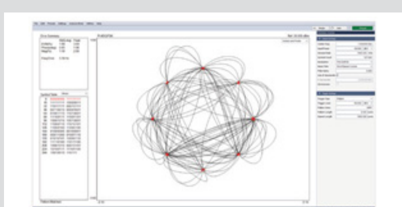
SIGNAL HOUND INTRODUCES FREE REAL-TIME DIGITAL MODULATION ANALYSIS TOOLS

Signal Hound has updated its free Spike Spectrum Analysis software by creating a variety of digital modulation analysis tools for its BB60C and BB60A USB-powered real-time spectrum analyzers. Spike software version 3.0.8 now provides constellation diagrams, symbol tables, error-vector magnitude (EVM) measurements and bit pattern matching analysis tools for a wide range of modulation types.

Coupled with a Signal Hound BB60C or BB60A spectrum analyzer, the updated Spike software includes real-time tools to analyze digitally modulated signals with bandwidths to 27MHz and frequencies from 9kHz to 6GHz.

Prior to version 3.0.8, Signal Hounds's Spike software was already capable of signal-to-noise and distortion ratio (SINAD), total harmonic distortion (THD), and percentage of modulation measurements. This update unleashes more sophisticated signal analysis of common digital modulations present in cellular various radio applications.

www.signalhound.com



INFINEON LAUNCHES NEW HIGH-POWER, LIGHT-TRIGGERED THYRISTOR

Infineon Technologies Bipolar GmbH has extended its family of bipolar semiconductors with an optically-triggered thyristor that improves reliability and lowers system cost of ultra-high-power applications.

Infineon's new 6-inch thyristor incorporates reliable optical triggering, eliminating the requirement for an external electrical trigger circuit. In addition, on-board safety features such as overvoltage protection, dv/dt protection and protection against forward voltage transients during recovery time further reduce component count and design complexity.

Thyristors are the technology of choice for controlling ultra-high currents and voltages because they deliver better performance than IGBT-based voltage source converters (VSCs) in terms of on-state losses and symmetric blocking capability. The introduction of a highly integrated light-triggered thyristor that, for the first time, integrates FRP (forward recovery protection) help minimize design overheads, improve reliability and drive down bill of material (BoM) costs.

www.infineon.com