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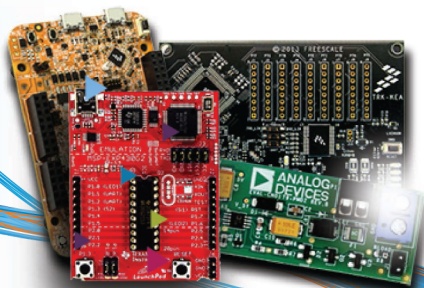
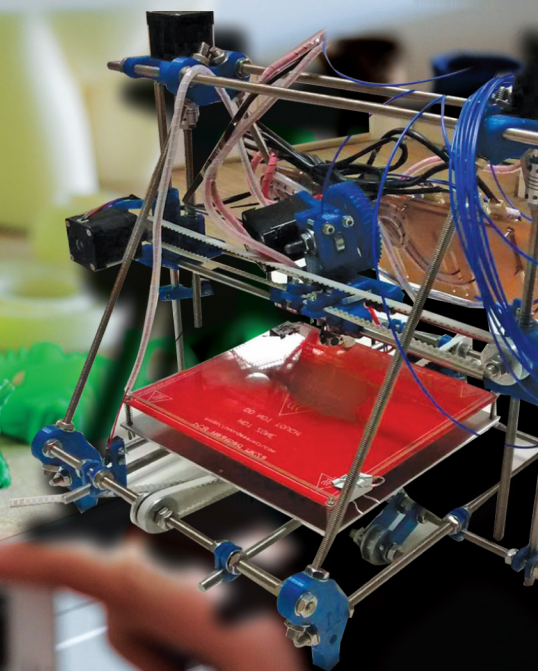
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EDITOR : Ramesh Chopra

EDITORIAL : Editorial Secretary

CORRESPONDENCE : Phone: 011-26810601; E-mail: editsec@efy.in
(Technical queries: eflyab@efy.in)

SUBSCRIPTIONS & MISSING ISSUES : Phone: 011-26810601 or 02 or 03
E-mail: support@efy.in

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BENGALURU : Ph: 080-25260394, 25260023
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HYDERABAD : Ph: 040-67172633
E-mail: eflyenq@efy.in

KOLKATA : Ph: 033-22294788
E-mail: eflyenq@efy.in

PUNE : Ph: 020-40147882
E-mail: eflypune@efy.in

GUJARAT : Ph: 079-61344948
E-mail: eflyahd@efy.in

CHINA : Power Pioneer Group Inc.
Ph: (86 755) 83729797, (86) 13923802595
E-mail: powerpioneer@efy.in

JAPAN : Tandem Inc., Ph: 81-3-3541-4166
E-mail: tandem@efy.in

SINGAPORE : Publicitas Singapore Pte Ltd
Ph: +65-6836 2272
E-mail: publicitas@efy.in

TAIWAN : J.K. Media, Ph: 886-2-87726780 ext. 10
E-mail: jkmedia@efy.in

UNITED STATES : E & Tech Media
Ph: +1 860 536 6677
E-mail: veronique.lamarque@gmail.com

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- Soldering/Desoldering Stations

Low-Cost Android Tablet from Lenovo

One of the slimmest and lightest models available

Lenovo has introduced its new Android tablet S5000 in India. As of now, the device is exclusively available on e-commerce website Amazon India in silver grey colour.

Lenovo claims it to be India's slimmest and lightest tablet. The 17.8cm (7-inch) tablet is 7.9mm thick and weighs 246 grams. It is powered by a 1.2GHz MediaTek MT8389 quad-core processor and has 3450mAh battery, 1GB RAM and 16GB internal storage capacity. The device does not support external microSD card but has USB on-the-go connectivity to connect microUSB port (or via adaptor) equipped devices. It also supports Wi-Fi, 3G and Bluetooth.

The tablet sports a 5MP rear camera AF, 1.6MP front camera and runs on Android 4.2 Jelly Bean, which is upgradable to Android 4.3 Jelly Bean.

Price: ₹ 10,999



Gaming Laptop from MSI

Perhaps the thinnest gaming notebook available

MSI has introduced its exclusive gaming laptop in India, the GS60 Ghost Pro, which it claims to be the thinnest gaming notebook ever. It is available in three different configurations, GS60 2PE Ghost Pro, GS60 2PC Ghost and GS60 2PL Ghost. The biggest difference between the three is the dedicated graphic card.

The Ghost Pro series runs on Windows 8.1 and sports 39.6cm (15.6-inch) full HD, anti-glare wide viewing angle screen (1080x1920

pixels). It is powered with a fourth-generation 2.5GHz quad-core Intel core i7-4710HQ processor (8 threads, 3.5GHz

turbo frequency, 6MB cache). It features 16GB of 1600MHz DDR3L RAM on the top-end in GS60 2PE Ghost Pro variant and 8GB of 1600 MHz DDR3L RAM in the other two.

The laptop features full HD webcam,

a full-colour backlit keyboard, 128GB SSD and comes with 1TB 7200RPM HDD with the top-end variant. It also supports 4x2W Dynaudio speakers with 7.1-channel, SPDIF output and Creative Sound Blaster Cinema 2.

For connectivity, the series includes 3xUSB

3.0 ports, 1xHDMI port, 2-in-1 card reader, microphone port, Bluetooth 4.0 options and Wi-Fi 802.11 ac.



Price: Starting approx. ₹ 120,000

Videocon Announces 4K UHD LED Television

The most feature-packed TV available

Videocon has launched 4K ultra high definition (UHD) smart television before the coming festival season. Mumbai, Thane and Pune markets are likely to get this televi-

sion first of all, followed by Delhi, Hyderabad and Chennai.

The television features amazing 3D, 8.3MP camera, 3D gaming, face detection and smartphone integration among many other things. It is being made available in five different screen sizes ranging from 102cm (40-inch) to 216cm (85-inch), priced at ₹ 91,990 to ₹ 999,990. Users can share media using Home Cloud technology with a phone via Wi-Fi, and use wireless display to stream videos from HDTV and mobile devices.



Price: ₹ 91,990 MRP for 102cm TV



GizMo ByTes

Apple iPhone 6, iPhone 6 Plus to hit Indian markets soon

Apple's iPhone 6 and iPhone 6 Plus smartphones will be available in India from 17th October. In the US iPhone 6 starts at \$649 and iPhone 6 Plus at \$749. iPhone sports 11.9cm (4.7-inch) screen and iPhone 6 Plus has a 14cm (5.5-inch) display. With iPhone 6 and iPhone 6 Plus Apple has made the thinnest devices ever. As iPhone 6 is powered by the new A8 processor, it is expected to be 50 per cent more energy-efficient. Both the models sport an 8MP iSight camera with face detection feature. iPhone 6 is also capable of capturing 43MP panorama photos. Users will be able to pay their bills on retail stores by simply tapping their smartphones on the payment terminals.

Nokia plans to bring cheaper 4G, 3G phones in India

Nokia wants to recapture the market position which it lost in 2012 to Samsung, it seems. While commenting upon its plans, Chris Weber, corporate vice president of Microsoft's mobile device sales told PTI, "We want to continue to push price points lower and lower than anything we have today. That's the statement for both 3G and LTE (4G) because that is the thing which gives us scale of the ecosystem." Sources reveal that Nokia has plans to launch latest 4G-enabled phone Lumia 830, priced at around ₹ 26,000, latest by October. One of the main reasons for the telecom operators not bringing out 4G network services in the country is the limited availability of affordable devices to access the 4G network.

Microsoft starts text search for audio and video content

A new range of media services has been started by Microsoft's Azure. One of these services makes it possible to conduct text searches of audio and video content. Microsoft has designed the tool such that you can search through video archives. It will also come handy for finding specific moments in media files. The tool is allied with a movie library, and it is expected that you will be able to search for a quote in a film. It can be transported to the moment in question.

Sony's Smartphone Xperia C3 Dual Launched

With the selfie-lovers in mind

Sony has announced the launch of Xperia C3 Dual smartphone in India for the selfie-loving generation. The phone runs on Android 4.4 and includes several software customisations from Sony like Xperia Themes support.

Sporting a 14cm (5.5-inch) 720p HD display, the smartphone is powered by 1.2GHz quad-core Qualcomm Snapdragon 400 processor, 8MP rear camera, 2500mAh battery, 3G support, dual-SIM support, 1GB RAM, 8GB internal storage and microSD card slot. Its unique feature is the 5MP front camera that is coupled with an LED flash. It also has a 25mm wide-angle lens with 80-degree field of view and 720p video recording support.



Price: ₹ 23,990

Wireless Shower Speaker from ENRG

For music lovers, even in the shower

ENRG has introduced its first wireless shower speaker M8 that gives you the freedom to play music, skip songs, increase/decrease volume and answer phone calls, even while you are in a shower. ENRG incorporates Bluetooth inside the shower head, in dual channel, so that one can connect to the music easily.



Price: ₹ 1590

One of the speaker is that it is capable of receiving signals within 10 metres, thus providing a never-before musical bathing experience to its users. It can also be attached with the shower head and can be used otherwise as well. It has battery back-up of around 11.5 hours with the maximum output voltage of 5.5V.

One of the most striking features

age of 5.5V.

Wi-Fi Cameras: Focus, Shoot and Share

Smartphone cameras are capable of shooting and sharing photographs and videos instantly on Instagram and Facebook, but what about their image quality? If you do not want to compromise on quality, a Wi-Fi enabled camera may fulfil your need. It allows shooting and instant sharing of high-resolution images with highly powerful optical zooms, even in low-light situations

SANCHARI BANERJEE

For the socially-connected people, who like clicking and sharing their moments, the Wi-Fi enabled camera is the device to have. Being social and being connected is the need of the hour.

Taking cognisance of the changing times, camera makers came up with Wi-Fi enabled cameras that have built-in wireless connectivity and can shoot and share pictures and videos simultaneously. So, all you need is a Wi-Fi enabled camera and Wi-Fi environment to get going.

Why a Wi-Fi camera and not a smartphone?

A few years ago, you had to use a film roll that you had to drop off at a processing lab. It was only after a few days that you could get your hands on developed negatives and prints. Then, the one-hour photo-labs evolved, leading to the digital ones. But now we can-

not wait that long. We see no need to download photographs from a memory card before uploading them on the web. Well, you must be thinking, why not use a smartphone instead of buying a Wi-Fi enabled camera? You carry the smartphone with you at all times, and it lets you shoot photographs whenever you want. Now give this a thought: Are you happy with the quality of the images your phone captures?

If you are a serious photographer, who does not want to compromise on the quality of the photographs, and also does not want to wait a single moment in sharing those photographs through applications such as Flickr, Facebook, Instagram, or Twitter, the Wi-Fi camera bridges this gap for you. At a minimum level, these cameras allow you to transfer photographs to your iOS devices, Android phones or tablets. And, if there is a Wi-Fi hotspot nearby, you can upload your shots directly to a web service from the camera itself.

Turn any camera into a Wi-Fi camera

Wi-Fi enabled point-and-shoot cameras retail at a higher price but if you want to save a few bucks, Wi-Fi enabled SD cards, called Eye-Fi, may be useful to you. These SD cards have in-built Wi-Fi antennae that can transform any camera into a Wi-Fi enabled camera. Since it is just 'work-around' technology, do not expect the high-end features of a Wi-Fi camera coming in. These cameras may also lack the on-screen interface. You can set up the Eye-Fi SD card on your computer and then place it in the camera, where the photographs are uploaded automatically to your computer or a web space, if connected to a Wi-Fi network.

Setting up your Wi-Fi camera

Once you have a Wi-Fi enabled camera in your possession, you just need to set up its basic features that allow photographs to be uploaded directly to a computer or a web service. There are some cameras which already have built-in photo-sharing

BEST WI-FI CAMERAS IN INDIA TO CHOOSE FROM

	Canon IXUS 265 HS	Canon PowerShot SX510 HS	Canon PowerShot SX700 HS	Samsung WB30F	Samsung DV150F	Samsung WB350F
						
Price	₹ 8,995	₹ 15,995	₹ 22,995	₹ 9,900	₹ 8,990	₹ 19,999
Key attractions	<ul style="list-style-type: none"> ➤ Enhanced creative shot ➤ Wi-Fi connectivity ➤ NFC compatibility ➤ 16.0 megapixels high-sensitivity CMOS sensor ➤ 46 filter effects ➤ Google Drive support ➤ Tube-like curved surface ➤ 12x optical zoom lens (25-300mm) 	<ul style="list-style-type: none"> ➤ Super zoom camera ➤ 30x optical zoom wide-angle lens (24-720mm) ➤ Versatile shooting ➤ Intelligent Image Stabiliser (Intelligent IS) ➤ 12.1 megapixels CMOS ➤ Wi-Fi connectivity ➤ Zoom Framing Assist Seek feature 	<ul style="list-style-type: none"> ➤ Sleek 34.8mm body ➤ Easy to use ➤ DIGIC 6 ➤ 30x optical (25-750mm) with 60x ZoomPlus ➤ Wi-Fi and NFC ➤ Zoom Framing Assist function ➤ Full HD video recording ➤ MP4 compression format ➤ Mobile Device Connection button ➤ Google Drive support ➤ Remote shooting 	<ul style="list-style-type: none"> ➤ Powerful zoom ➤ One-touch Wi-Fi connectivity ➤ Auto-share and auto back-up ➤ Motion Photo ➤ Smart filter lens and colour effects ➤ Live Panorama ➤ Remote control via smartphone ➤ 10x optical zoom and HD video recording 	<ul style="list-style-type: none"> ➤ LCD display and GIF animation creation ➤ Wi-Fi ➤ F2.5, 25mm, 5x zoom lens/16.2 megapixels ➤ Five colours and aluminium body ➤ Smart filter, live panorama, split shot, smart auto 	<ul style="list-style-type: none"> ➤ 21x optical zoom, 23mm wide angle ➤ Wi-Fi and NFC ➤ Elegant retro design ➤ 75mm hVGA Hybrid Touch screen ➤ Excellent low-light settings ➤ Full HD movie recording

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facilities. You need to check the switch to enable the wireless local area network (WLAN) that allows you to send the pictures automatically to the destination. A Wi-Fi camera will require you to sign-in to use the local Wi-Fi network hotspot and also accept the terms of agreement. It includes a USB cable and connection to let you connect to a computer, if required. A Wi-Fi enabled camera may come with a CD featuring programs for photo editing.

The advantages and challenges

Before buying a Wi-Fi camera, you must know all the benefits that it offers you. The main benefit, as we already know, is that you can upload your files wirelessly at the touch of a button to your destination. There are some other benefits too, such as:

1. Storage in your camera gets quicker access.
2. Just one step is required to share your albums or photos, rather than a lengthy procedure that you may have to follow otherwise.
3. If you set up the camera in a way that the photos get deleted as soon as these are uploaded, you will never choke the SD card.

However, there is a flip side to it as well. Most Wi-Fi cameras today offer a lower battery life while they are connected to the Internet. Also, before investing in one of these gadgets, you should be sure of a reliable Wi-Fi connection everywhere you want to click. Since it is a Wi-Fi enabled device, you also need to take care of the encryption and privacy issues.

Features to look for

Even though we are talking about Wi-Fi cameras here, we cannot deny that other features are also important for consideration. Dimensions of the Wi-Fi cameras vary from 5.6 × 9.6 × 2.3 centimetres to 9.4 × 13.0 × 6.4 centimetres.

The lens types also have variants like super zoom, wide angle, compact, interchangeable and DSLR. Depending on the lens type, the performance of the camera also differs.

An optical zoom lens can vary from 10x to 21x. Greater optical zoom ensures

better photo quality for distant objects.

So you need to choose your camera depending on your requirement and the purpose to be served; and optical zoom is one of the most important criterion for the same.

Some other features of a Wi-Fi camera that need your due attention are: processor, operating system, sensor, low-light capacity, display size, and resolution and quality of video recording. The battery life also needs to be looked into because that is where most cameras fail when they need to perform. The internal storage (which can range from 2GB to 8GB) is another major requirement so that your SD card does not get full before you upload the photos to a web service.

Most of the cameras have connectivity options like 3G, Bluetooth, GPS, et al, along with Wi-Fi, of course. Some cameras also feature autofocus, connectivity to Google Play Store and cloud services (SkyDrive or Google Drive) for auto back-up of photographs and special filter effects.

Price

Most of the Wi-Fi cameras available in India are priced between ₹ 10,000 and ₹ 25,000. If you are looking for a camera that offers 14-16 megapixels, it will cost you between ₹ 13,000 and ₹ 15,000. A camera with 16-20 megapixels will be available for ₹ 20,000 to ₹ 25,000.

Apart from Samsung and Canon, there is also Sony Cyber-shot DSC-WX200 (₹ 12,490), which offers Exmor R CMOS image sensor, full HD recording, 10x optical zoom and 18.2-megapixel camera.

Conclusion

A Wi-Fi camera is an amazing gadget and its performance will certainly make you happy, especially when you are on a trip or some outdoor project. The excellent picture and video quality, highly powerful technologies, hassle-free transfer of pictures and videos, auto-sharing and auto back-up will make your camera experience feel like a dream. We hope to see further action from more brands in this Wi-Fi camera segment in the future. ●

The author is a correspondent at EFY

NASA making tiny robots to explore other planets

An army of autonomous self-driving robots is being developed by NASA which would be equipped with webcams, Wi-Fi antennae and GPS to explore other planets in the future. The army of robots is codenamed as swarmie. The swarmies function just like an ant colony. When an ant finds out a food source, it notifies rest of the colony through a special signal. Then the other ants jump in and take that food to their nest.

NASA's Kennedy Space Center in Florida has developed the software which controls these swarmies. These robots move out in different directions and start searching for a specific material, such as ice-water on Mars. If any of the rover finds something similar, it uses radio communication to call other robots to help in collecting more samples.

Kurt Leucht, one of the engineers who are associated with the project, said, "For a while people were interested in putting as much smarts and capability as they could on their one robot. Now people are realising you can have much smaller, much simpler robots that can work together and achieve a task. One of them can roll over and die and it's not the end of the mission because the others can still accomplish the task."

The testing phase for these swarmies is just in its primary stage and presently the robots have been programmed just to look for bar-coded slips of paper. In next few months the tests will also include RASSOR, which is a mining robot, designed to dig into alien surfaces and look for valuable materials. These tests will determine how much this software can control the robots when they are functional.

Intel launches world's smallest 3G modem

Intel has launched the world's smallest 3G standalone modem for the Internet



The self-driving swarmie robots could be used to search alien surfaces one day (NASA/Dmitri Gerondidakis)

of Things (IoT). It is likely to find application in home automation, industrial automation and wearable technology.

Intel XMM 6255 is just 300 square millimetre in size, which is as small as one-cent US coin. Intel has packed Intel Power Transceiver Technology in this 3G modem chip. Intel Power Transceiver comprises receiver, amplifier, transmission and power management units in a chip. The company has focused on low power consumption and overheating issues while developing this chip.

Intel claims that XMM 6255 can work even in low signal areas without the need of a stronger antenna. The chip can be used in smartwatches to provide on-board Internet connectivity. For instance, this chip could be used in Gear S smartwatch which comes with 3G SIM card slot. Many other devices can also use this chip for Internet connectivity, just as carbon monoxide monitor and Nest Protect smoke alarm uses Wi-Fi to send warnings to a smartphone. The Wi-Fi can be replaced with the IoT by using the XMM6255 chips.

After smart watches and eye-wears, here comes a smart shoe

An Indian hi-tech start-up has developed a real-life GPS-enabled smart sports shoe which vibrates to give directions to the wearer. The sneakers can also count the number of steps taken, distance travelled and calories burnt. The smart shoes, called LeChal, are ready to go on sale very soon.

A detachable Bluetooth transceiver is integrated into the shoes, which links to a smartphone app. This app directs the wearer using Google maps and sends a vibrating signal to indicate a left or right turn. Krispian Lawrence, 30, and Anirudh Sharma, 28, who developed the smart shoes founded their start-up Ducere in 2011.

Lawrence says, "We got this idea and realised that it would really help visually challenged people as it would work without any audio or physical distractions. The footwear works instinctively. Imagine, if someone taps your right shoulder,

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your body naturally reacts to turn right, and that's how LeChal works."

Smart shoes are generally aimed at demographic markets like dementia patients and children whose parents want to track their movements. But this smart shoe will target mass-market consumers, and its main focus is on creating stylish footwear along with hi-tech functions. Already 25,000 orders have been received for the shoes in advance which cost \$100 to \$150. The shoes are being manufactured in China.

There are certain limitations in these shoes which can become drawbacks however, such as battery failure, loss of Bluetooth connectivity and so on. But these problems can be resolved through live feed of a user's position to a friend or a relative. The best part of these shoes is, as per Lawrence, you will no longer lose your phone. If you go away too far from your phone, the shoes buzz as a warning.

Here comes the smallest audio mixer in the world

Music is a must for every party, be it a large one or small. If your budget is low then you can't hire a DJ, obviously. Keeping this budget thing in mind, two New York based folks have built an affordable audio mixer called Openmix.

Openmix, claimed to be the smallest audio mixer in the world, is a cross fader which allows smooth transition from one song to another. Its wide compatibility is its key factor, and as it connects two devices through a headphone jack, Openmix can be used with PCs, smart-phones, tablets and MP3 players, too.



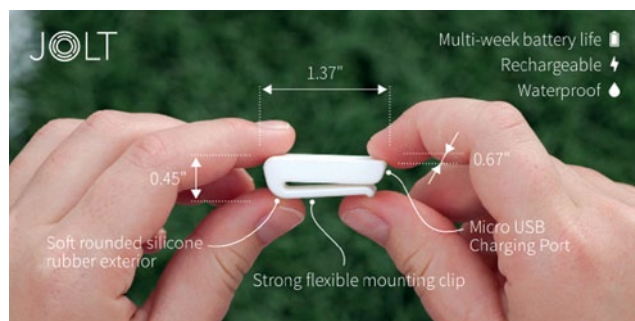
Smallest audio mixer (Courtesy: www.kickstarter.com)

Openmix does not run on batteries. Just one audio source needs to be plugged in the right male headphone jack and the other one in the left. Then connect your speakers with the female headphone jack on the other end. Now you can move from one device to another by turning the knob. You also have the option to become a DJ by plugging in another iOS or Android device with a third-party DJ app, and you can add sound effects to your music.

Openmix retails for \$39. The makers of the product have promised to deliver it by January 2015, but the success of such a product is quite uncertain in this competitive market of smartphones and tablets and all their apps.

A jolt sensor can easily detect concussion now

Concussion, a traumatic brain injury, is quite common for people who are into sports like boxing, wrestling, football, soccer and basketball. Concussion is caused by a bump or jolt to the head. Due to concussion, the brain moves quickly back and forth after receiving a serious blow to the head.



Jolt sensor (Courtesy: www.mhealthspot.com)

Concussion becomes worse if minor knocks and injuries are neglected. Now MIT graduates Benjamin Harvatine and Seth Berg have developed a device, Jolt Sensor, to detect these head injuries in real time.

Jolt Sensor is a small soft clip which is enclosed by a silicon rubber exterior. This sensor can be clipped to a headgear, helmet or any wearable on our head. It vibrates to alert whenever a chance is there for concussion. Jolt Sensor is totally waterproof and it can resist dust, sweat and rain. The device battery lasts for weeks and can be recharged through a standard micro USB port.

The sensor has another important feature: it can be connected to parents' and coaches' Android or iOS smartphones, wirelessly. They can keep track on the sports persons' ongoing events by using Bluetooth as its connectivity range is nearly a hundred metres.

It has a built-in cognitive test and concussion symptom checklist which helps the physio to evaluate the impact on the brain. If the injury is serious enough, the affected athlete is sent to a doctor who can take reference from the data collected by the app and sensor, which is stored in the cloud, to make the detection of concussion.

Telepathic mail communication may soon be a reality

Yes, it's true that telepathy happens and that now it can help in sending emails.

Messages can get transmitted without any motor or peripheral sensory systems, as has been proved by researchers from the University of Barcelona in Spain, Axilum Robotics in France, Harvard Medical School and Starlab Barcelona in Spain. They tried to devise a technology which allows transmission of an email just with the power of mind. In the screening test the conscious transmission was also performed by a volunteer in Thiruvananthapuram (India) as he sent greetings to a person in France.

Electrical impulses were recorded by electroencephalography (EEG) headsets. These impulses, created by chemical reaction between neurons of the brain, are fed into a computer interface. Then this electrical stimulation is used to implant translated message in the receiver's mind. Researchers made use of brain-computer interface (BCI), which is a crucial interface for creating brain-to-brain communication

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systems and computer-brain interface (CBI), a precise brain stimulation technique. These technologies are combined to perform computer-mediated brain-to-brain (B2B) communication.

The information gets transmitted between two minds in the form of binary streams of encoded words. Researchers say that this new 'hyper-interaction' technology will impact the cognitive research in the field of neuroscience and scientific study of consciousness.

Soft robots that can change shape

A new kind of untethered, soft robot is being developed by a team of researchers from Harvard and Cornell University. This robot is able to walk using four legs, and when it commutes its shape also changes. This autonomous robot has some awesome features including its ability to operate through puddles of water or a snowstorm and can even bear limited exposure to heat. If it is run over by an automobile, even then the robot 'feels' fine.



The soft robot

A paper titled 'A Resilient, Untethered Soft Robot' has been published by Wyss Institute for Biologically Inspired Engineering, Department of Chemistry and Chemical Biology, at Harvard University and the School of Mechanical and Aerospace Engineering at Cornell University, which details their research work. Innovative composite materials are being used by researchers in fabricating this soft robot, like silicone elastomer, polyaramid fabric and hollow glass micro-spheres.

The robot is able to carry miniature air compressors, battery pack, valves and controller, and is able to facilitate its autonomous operation. Some new fabrication techniques have been de-

veloped, too, to create its soft body with modified Pneu-Net actuators. The robot's body is so designed that it stays resilient to adverse environmental conditions, as mentioned earlier.

Laser optical tweezers to study how Malaria infects

Malaria, the disease that spreads through mosquitoes, affects millions of people every year and also causes many deaths all over the world. Malaria is caused by Plasmodium Falciparum parasite which invades red blood cells one by one. The parasite blocks one by one all the capillaries that transmit blood to the brain and other organs. This invasion and infection process is very swift.

Researchers hardly get to study the infection stage. It is important to study the infection and invasion process in development of effective drugs and vaccines. The researchers from Cambridge University have developed laser optical tweezers to study this interaction process between parasite and red blood cells. They have been studying invasion process but it is important to study pathogenesis process too. Pathogenesis is the development of Malaria. The parasite that causes disease infects red blood cells but it invades in less than a minute after its release.

Laser optical tweezers can record and control the movement of cells. Extremely focused laser beam is used to apply very small force to control cells more precisely. The optical tweezers can be used to select parasites that have just invaded from red blood cells. This method of invasion process is useful for scrutiny as it helps scientists to study the parasite before it loses its potential to infect other cells. Researchers also focused on measuring the adherence between parasites and red blood cells, which turned out to be very weak. This adherence can be blocked using drugs and antibodies.

Laser pulse that can turn glass into metal

Vienna University of Technology's group of researchers have made the

impossible possible by turning glass into metal through ultra-short laser. Hence, a huge change is happening in the science of material properties and that too at a very fast pace.

Scientists from the Vienna University, Georg Wachter, Christoph Lemell and Professor Joachim Burgdorfer, collaborated with the research team of Tsukuba University in Japan to conduct the experiment jointly. In the experiment, electric current was measured in quartz glass while being illuminated by a laser pulse. Once the laser was turned off the material returned to its original state. In this case the laser pulse worked as a strong electrical field. The field was so powerful that it could completely change the structure of electron states of a material.

The project involved several quantum processes which keep happening together. Supercomputers have been of great help in this project to make the interaction between the laser and electron and also among all the electrons. Within modern-day transistors a large number of charge carriers move during each switching operation. Now, with this new experiment, we have come to know that laser pulses are able to switch electric currents thousand times faster than the transistors.

16-year-old invents device to turn breath into speech

A 16-year-old boy from Panipat (Haryana) has created an innovative contraption which is capable of turning breath into speech using Morse code. The young talent, named Arsh Shah Dilbagi, is the only finalist from Asia who has been selected for Google Science Fair, 2014. Arsh has named his innovation, Talk.

Arsh says the device is aimed at helping speech-impaired and paralysed people in their communication process. According to him, this is the fastest and cheapest gadget of the kind.

The device uses signals from a person's breath, using Morse code. The signals are picked up by a sensor and converted into speech. Talk, the device, is categorised under augmentative and alternative communication (AAC) devices and costs about 5000 rupees.

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Self-Driving Cars: The Next Revolution

The revolution, when it comes, will be engendered by the advent of autonomous or self-driving vehicles. And the timing may be sooner than you think, according to a KPMG report

DEEPAK HALAN

The time is 7.30pm and you have just managed to end your business meeting. However, you still have more tasks to complete. Your travel time back to your home is about an hour and you would like to get moving at the earliest. You take some deep breaths to relax from the grilling meeting, fish out your mobile phone on which rests an app that will have the nearest cab sent to you. Within seconds of sending the request you receive a text confirmation and in the next few minutes—the cab.

“Home,” you say, as you start initiating a video call with a prospect in New York. The car first checks road conditions and then glides into the self-drive lane, checking and flashing a message that you are likely to reach home in the next 45 minutes. During this time, you will have closed a business deal with the New York prospect, apprised a subordinate, answered a few calls from your office and yes, also set your pick-up time for tomorrow morning. You reach home relaxed and ready to spend some quality time with your family. As you get off the car, it glides away to pick up its next guest. No one wishes you good night—as there is no driver in the car!

This technology is enabled by equipping cars with a host of sensors, cameras and radar systems. Artificial intelligence (AI) then guides the cars as to where to drive. It is important that the automobiles collect a vast quantity of data about nearby obstacles, compute risks and make micro-second decisions.

How it all began

Modern solid-state control systems



Fig. 1: Dashboard view of Google self-driving car (Source: www.slashgear.com)

made their way into automobiles only in the early seventies with the proliferation of transistor technology and affordable solid-state products. The transistor served a very good purpose to incorporate aspects like the ignition's mechanical points into electronic ignition modules. This was maintenance-free, more reliable and cost-effective. The growing need of being able to control automobiles with higher accuracy in order to meet the tightening emissions and fuel economy standards catalysed the automotive computer systems' evolution.

Modern automotive computer systems came into the picture only by early 1980s when almost every car manufactured in the US had a check-engine light and a primitive computer. The onboard computer was indeed a bit ancient, given its huge tin box with edge-board connectors which had a propensity to oxidise and result in drivability issues. Stricter emission

laws saw the advent of microprocessors in car engines, since sophisticated control processes were needed to regulate the air and fuel mixture so that the catalytic converter could eliminate most of the pollution from the exhaust.

In the last few years, the automotive sector has seen a lot of innovation and advancements in technology. Today, computers are being used for a number of aspects in cars. This has resulted in cars that are fuel-efficient, more secure and environment friendly. With time, cars are getting more and more sophisticated.

How different are car computers

Car computers are quite different from the typical computers that we are familiar with, that is, those having a CPU, a monitor and keyboard. A car computer generally looks like a small box. It is known as electronic control module (ECM) and is usually placed

behind the glove box or in the engine compartment.

An ECM manages the key engine operations, such as spark timing, fuel delivery, emissions and, in some cases, the automatic transmission too. The computer gets electrical signals from sensors and input devices associated with the engine on a regular basis. It analyses this information and sends control signals to valves, controllers and other output devices, to balance the requirements of power, fuel economy and emission control.

The ECM uses closed-loop control, a control method that monitors outputs of a system to control the inputs to a system, managing the emissions and fuel economy of the engine (as well as a number of other variables). Collecting data from a number of different sensors, the ECM keeps track of everything from the coolant temperature to the quantity of oxygen in the exhaust. Using this data, it performs millions of calculations per second, which include looking up values in tables, calculating the results of long equations to decide on the optimal spark timing and determining how long the fuel injector is open. The ECM works with the objective of achieving the lowest emission levels and highest mileage.

A contemporary ECM could even have a 64-bit, 100MHz processor. While this processing power may seem insignificant (considering the levels to which today's computers have reached), actually your car computer is more efficient than your PC. The programming memory needed by a typical ECM is approximately 1MB to 2MB. Whereas, generally, we need about 2GB of programming space on our PC. The microprocessor is packaged with several other components on a multi-layer circuit board. Besides, there are several other components in the ECM that support the processor. Some of these are mentioned below.

Analogue-to-digital converters. These read the outputs of certain sensors in the car. The output of a sensor is an analogue voltage. Since the processor understands only digital numbers,

the analogue-to-digital converter transforms this voltage into a 10-bit digital number.

Digital-to-analogue converters. Sometimes the ECM has to give an analogue voltage output to certain engine components. As the processor on the ECM is a digital device, it requires an element that can convert the digital number into an analogue voltage.

High-level digital outputs. In some of the recently launched cars, the ECM fires the spark plugs, opens and closes the fuel injectors and switches the cooling fan on and off. Such computerised tasks need digital outputs. For example, an output for controlling the cooling fan might supply 12V and 0.5A to the fan relay when it is on, and 0V when it is off. The minute amount of power that the processor supplies energises the transistor in the digital output, allowing it to supply a considerably higher amount of power to the cooling fan relay, which in turn provides an even higher amount of power to the cooling fan.

Communication chips. These chips carry out various communication standards that are used on cars. There are several standards used, but the most popular one is called controller-area networking (CAN).

Car computer doctor

Data streams, that is, the signals generated by on-board computers, constantly flow through operating system of the car, adjusting and re-adjusting the engine. Diagnostic computers that

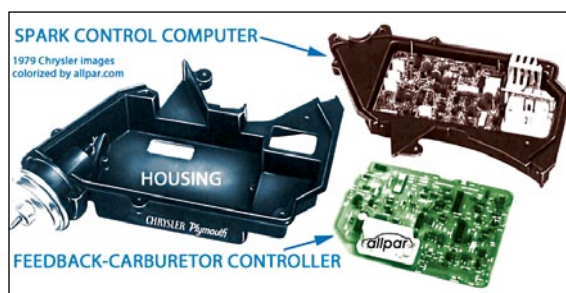


Fig. 2: Early automotive computer systems used in 1979 Chrysler cars (Source: www.allpar.com)



Fig. 3: ECM from a 1996 Chevrolet Beretta (Source: http://en.wikipedia.org/wiki/Engine_control_unit)



Fig. 4: A master diagnostic technician using a laptop computer to diagnose and repair the brake system (Source: <http://www.cbsnews.com>)

are interfaced with the car's computer read the data streams flowing through the system. If there is a problem with engine oil or car temperature, the information is communicated by the car computer. The problem could be related to faulty electrical or mechanical component, damaged wiring, etc.

The car computer system is programmed to send a problem signal whenever required. This signal gets stored in the car computer's memory

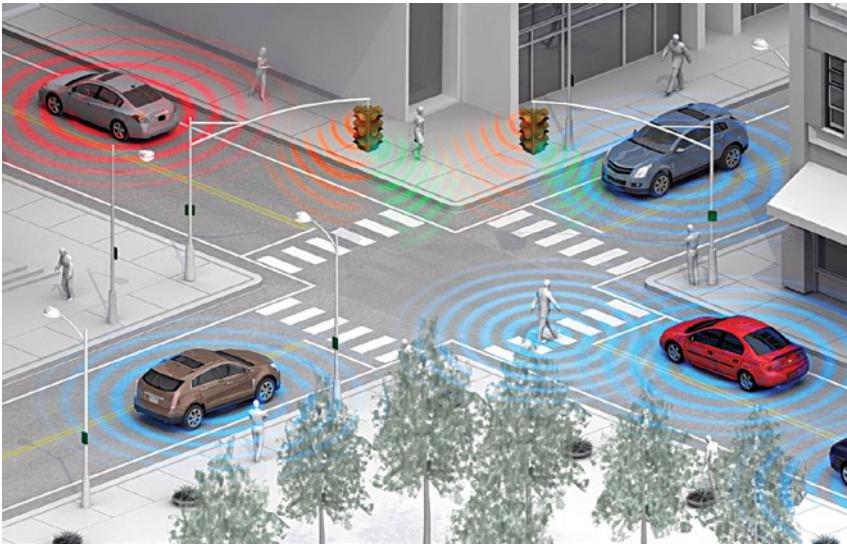


Fig. 5: Vehicle-to-vehicle communication rendering (Source: wot.motortrend.com)

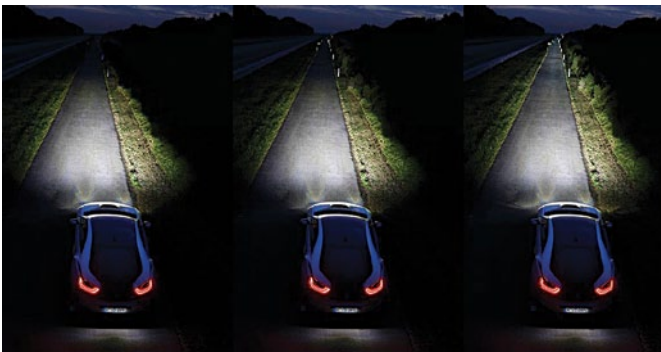


Fig. 6: BMW i8's new headlights, from LED low beams (left), shining 100m ahead (middle) to LED high beams (right) (Source: <http://ecomento.com>)

so that it is available whenever a diagnosis is done later. The car repairs shop must have access to information either in hard copy form or online to translate what the codes mean and how to go about diagnosing the particular problem.

Technological advancements have made more auto repairs possible. Generally, car computers remind you to check the tyres pressure, coolant level and see if the brake oil and engine levels are adequate. Some computers even remind you when a service or insurance premium is due.

In time to come, your car will even be able to tell you if the BMW in front is facing some problem. This will help you decide whether you should stay clear of it to prevent an accident or you should extend some help to the driver.

Soon you should be able to up-

load your car computer diagnostics data to a website and analyse it for some recommendations on how to get your car back on the road. And if you are not the do-it-yourself type, you will be able to send the data to a repairs shop wirelessly. The shop could then send you an estimate with a list of all the required jobs that need to be done on your car. You could simply accept or reject the offer, without having to go physically all the way to them.

Perhaps our great grand children will not have to worry about maintenance of their cars at all. Just as cars would drive themselves, these would also be able to link up with the on-board diagnostics to see if there are issues and, if so, self-drive to the repairs shop.

The road ahead

As the degree of computerisation in cars increases these will be able to exchange info about traffic, weather, road conditions and several other aspects. However, one of the most important aspects is that, cars will be able to com-

municate their velocity and direction and caution each other about accidents that could happen. This technology is called vehicle-to-vehicle communication, or V2V, and we can look forward to it soon.

On-car devices equipped with V2V emit a short-range safety signal ten times per second and detect signals from other vehicles to determine whether a potential accident is about to happen. Cars equipped with the devices will sound beeps when they detect possible hazards, such as another vehicle entering an intersection, an approaching pedestrian, a patch of slippery ice ahead, or even their driver speeding too fast around a curve.

Then we have researchers, app developers and car companies developing technologies to scrutinise human drivers in a manner that ensures there are no accidents. Advanced sensors in the passenger cabin will keep an eye on a driver's key parameters, such as heart rate, eye movements and brain activity, to sense any abnormal condition—be it sleepiness or a heart attack.

In-car systems are increasingly being geared up to operate in synergy with smartphones and tablets. Chevrolet, Honda and other car brands have joined Apple to equip cars with an eyes-free mode for Siri—the voice assistant on an iPhone. The system enables drivers tell Siri to send messages, create calendar events or activate turn-by-turn navigation, without the need to take their mobile phone in their hands.

Next, we have car manufacturers innovating a new generation of smart headlights that can automatically regulate their brightness or direction based on on-road conditions. Laser high beams will be used to light up roads for nearly half a kilometre—which is twice the range of LED high-beam headlights and using even lesser energy.

We are not quite sure what the future holds for the auto industry in the long run. We might see robots sitting behind the steering wheels and driving our fully automated cars! ●

The author is associate professor at School of Management Sciences

Designing Modular Smartphones: How Possible is it?

Making smartphones modular is a promising idea, but designing such hardware brings many challenges with it. This article focuses on design considerations and associated challenges in designing a modular smartphone



PANKAJ V.

Smartphone, one of the most empowering innovations in the modern world, has become an intimate object in our lives. However, the pace with which technology is advancing is shortening its life span. What if we could have a long-lasting modular mobile device that was always at par with the latest technology?

Modularity in a smartphone would mean interchangeable parts, which would provide us the benefits of customising our smartphone exactly the way we want, but upgrading any specific part without changing the whole device. For example, one could choose the desired processor or have multiple camera lens options for the phone. Even if some component failed with use, the user could simply replace the component without having to change the whole device.

The idea seems promising enough to some big players who have already started working on their prototypes.

This concept can be easily related to the fact that smartphones are the personal computers (PCs) of future, and the concept of building a modular PC is well established with almost every part replaceable and changeable in any PC. However, the design challenges of building a modular PC the size of a small fridge is different from that of building a modular device which is small, thin, light and depends on a very small power source.

How can we build such a thing?

There are a lot of design challenges and considerations that have to be considered before developing a functional modular smartphone that can withstand the test of time. Let us look at some of the most important elements here.

Open hardware platform. A modular smartphone is an alluring idea but an open platform is a must for a successful design. A modular design with proprietary interfaces and limited

availability of modules won't do any good for the success of the idea over the long term, since the ecosystem surrounding the hardware would fail to grow without an open hardware platform to foster it. An open hardware platform would allow anybody to create own modules, ensuring the creation of a vibrant third-party developer ecosystem, lowering the entry barriers and increasing the pace of innovation by substantially compressing the development time-lines for these modular smartphones.

Standardised base module. No doubt the smartphones are incredibly compact devices, and different components are fitted into a compact body, but the modular concept of replaceable parts forces us to think differently. The design calls for a standardised base module on which self-contained units of different modules can be connected/disconnected.

A standardised base module would ensure some control over the platform and also make sure there is enough cohesion in the developer community. The whole customisation will revolve around this base module.

A standardised base module will make sure everything fits together and works. This base module should constitute different slots to connect or disconnect the replaceable modular components. It could also have a small reserve battery, which is necessary to swap the other modules, especially the external battery module.

According to some experts, it would be a good choice to have very little functionality other than just transferring data packets within different modules on the base module. This would keep the basic cost down and ensure enough space for enhancing modular functionality.

The open hardware platform comes with a side effect as well. The device could crash or stop functioning on connecting a sub-standard module designed by some other manufacturer. So, an important consideration while designing the base module would be to include enough safeguards for thermal and power management built on to it. This would secure the device from any functional hazard, if any bad or sub-standard module is connected, thus ensuring normal functioning of the device after the removal of such module.

Interfacing

Connectors between the main base unit and the other modules are also a big performance challenge. If we see integrated designs, these are set up for high performance. Connectivity between different units is highly optimised, but breaking this up and building external connectors that operate at similar performance levels would be a huge challenge.

Any external connector connecting different modules would give the device a 'Lego' kind of look, while at the same time making it bulkier. Moreover, such a modular system would consume more power, since hot swappable and standard connectors would now replace the more fine-tuned custom connections.

Will connectors be the knell of doom?

Well we have alternatives; the device doesn't have to be connector based in the first place. Today, we have architectures which do not require any connectors, by having their electrical interfaces defined in the mechanicals of the device itself. This way the PCB of any module can be connected with

What about the drivers?

Swapping of modules in smartphones will include software update challenges as well. The option of self-discovery seems to work fine in the PC world where it automatically figures out that there is a new thing connected and the processor starts downloading the drivers or seeking for the drivers, but there will be some considerations while implementing modularity in smartphones:

1. Updating the driver software, if you are implementing 'hot swapping' of modules where a module can be replaced without switching off the device.
2. Reading the modular drivers at the time of power-up could accompany a side effect in the form of delay in boot-up time.
3. What about the CPU? Moving from one CPU to another will also require updated drivers for all the modules attached. Where can we get those?

“I think efforts around the base architecture are more important than any specific concept. People should be more focused on trying to standardise the base module and the high-speed interface to connect these other modules. That will go a long way in making modular phone concept a reality” — Satish Mugulavalli, co-founder & chief architect, Verismo Networks

the PCB of the other modules without the standard connectors. Or the casings of modules could have embedded electrical interconnects to connect the modules.

Nate Srinath, founder-director, Inxee, explains, “If we look at the phones today, we are moving towards thinner and thinner architectures, so most connectors available are big for these. We have to look for very fine customised, thin connectors which are very durable and can make multiple modules connect. Some architecture doesn't have any connectors but the electrical interfaces are defined in the mechanicals itself. If we can dream, there are so many ways to do it, but the bottom line is somebody has to standardise it and then make everybody adhere to it.”

Let's talk solutions

A plausible solution could be electro-permanent magnets. Electro-permanent magnets are passive in both on and off states and can be used to transfer data as well as power. These require a voltage for transition between two states and their off-state magnitude is lower. But when turned on, their magnitude increases many

folds, which is good enough to hold different modules. Also, eliminating any external connector, these connections would allow the device to be slim and maintain its aesthetic looks.

Another contact-less power and communication interface technology which might help is capacitive media converter. The technology is still in development phase where coupling occurs by capacitance at higher frequencies and inductance at lower frequencies. Experts believe that if connectors are avoided, it could also help in reducing the additional industrial design overheads related to increased volume and weight.

But one needs to carefully consider contact and contact-less options while going for the connections between modules. Ashwin Ramachandra, VP and head, ErND Practice, Sasken Communication Technologies, explains, “The moment you look at contact-less options, a new problem immediately comes up. Integrating issues with respect to signal, power and bandwidth will definitely be there. But for the areas like when you are connecting the processor with memory you can't afford to overlook these issues, you need a fairly strong connector or a

Google's Project Ara vs ZTE Eco Mobius

Modular smartphones do not seem very far in future. Companies like Google and ZTE have already begun addressing the challenges, and both of them have unveiled their prototypes with intermediate solutions for the issues.

Both the prototypes focus on parts up-gradation and replacement without discarding rest of the phone. While ZTE's Eco Mobius seems to be a quasi-modular architecture with four swappable modules, namely, screen, battery, camera and a combination of processor and memory, Google's Project Ara plans to have more modularity in terms of number and types of modules.

Eco-Mobius architecture doesn't allow adding new kinds of components but Ara's architecture would let you add new type of components, taking the smartphone functionality to a whole new level. Google's proposed device will not only have the basic smartphone modules but also be able to plug modules, like a prototype infra-red imaging lens module for night photography, and even the type of modules which would let you read your blood oxygen levels with a swipe of your finger.

ZTE hasn't revealed much on their design but Google has revealed its complete roadmap. Project Ara is 'open' for all who want to have their say in designing next-generation smartphones for the whole world. Google has created a module development kit, and the module development is open to potentially unlimited number of interested parties. This certainly would help in innovation, accelerating the development and adoption of newer technologies.

What we should look for is an interfacing which could connect modules without snaps or hinges and help make modules with as less added complexity, cost and weight as possible

critical line connecting processor to the memory."

Swapping those modules

A modular phone presents the idea of swapping different modules and configuring the phone features by ourselves. But how can we really swap a camera module with a battery module, or a memory module with a Wi-Fi module?

Actually, the solution is pretty straightforward but it does have some considerations. For such a system, you would have to define a standard interconnect architecture and make the modules intelligent so that they know who they are talking to. Making each module 'smart' or intelligent will not be much of a challenge as we have many low-power and optimally-powerful processors available to do the job.

This way the base module or the main master or the controlling module can easily make decisions on what kind of module is attached to it; it can be a camera or a battery or any other

module. Now everything will only depend on how much area we want to use and what kind of functionality we want to have in the phone.

Some people suggest that we can also have architecture of common control bus and have the modules complying to the control architecture, with a separate data bus which takes care of data. Ashwin Ramachandra, Sasken Communication Technologies, explains, "Looking it from signalling perspective, you need to start looking at signal flows and then identify control signals. If you are able to create a backplane where all your signals flow on one particular set of lines, you are beginning to establish something like that."

We can actually borrow some mechanisms from existing technologies as well. Ashwin adds, "If you go to the automotive segment, there is something called a CAN bus. Let's say, if you start loading your operating system and a signal goes on to your CAN bus, the CAN bus has a mechanism of arbitrating and then trying to figure

out how to start communicating with the signal."

However, such solutions will also carry with them complexity issues.

Power concerns

As already discussed, by making the phones modular one thing we are doing is, having an architecture where we are adding connectors (or interfaces), and in the process of adding these we are adding a lot of communication chipsets. This is going to make a significant impact on the power requirements of the device.

Also, if we are making the modules intelligent enough to be swappable, every module will have a computing element on it, and instead of one computing element now we will have multiple controllers, which means additional power requirement.

Increasing the amount of intelligence on the device will only add to power requirements and power needs will increase in proportion to the number of modules we have on the device.

If we just have a single physical PCB, the shortest route is much smaller. But if you are drawing wires across components, obviously we are taking a longer route. Pure physics tells us that we need extra assistance if we are taking up such a design, which directly affects the performance as a power consumption issue.

RF behaviour

RF behaviour is one of the most significant aspects of regulatory approval for any device. While the industry is still waiting for a functional prototype to test RF behavior on a modular device, many experts predict that the modular architecture would show better RF response.

Nate Srinath, founder-director, In-see, says, "RF behaviour should have no impact here, or in-fact in modular architecture it will be even better. In our experience we have seen that the more we isolate RF interfaces, the performance gets better. It happens so because when we have the integrated

PCB, lot of noise issues from other components like the battery, LCD or the touch sensors have an impact on the RF signalling. But as we will move towards modular, we will actually isolate all of the RF components from the other parts of the system, so modular will actually make the performance better."

Other challenges

The whole project of modular smartphone is a big challenge. Most mobile phone manufacturers are focused on reducing sizes of the phones for better user experience and looks. The current integrated design allows designers to innovate in areas such as curved displays or higher-resolution cameras.

But when we talk about a mobile phone, a major concern is the form factor. Making the device more modular will definitely impact on size of the device. We can easily predict that,

with a modular architecture size of the phone is only going to increase. So, keeping the form factor same for the modular device will be a challenge for the designers and engineers.

The other issues that should be taken care of while designing a modular device would be liability and overall ruggedness of the modules. What will happen if the device is dropped? If it starts coming apart then we have an issue. Additionally, the modules and interconnects must be rugged enough to handle frequent plugging and unplugging.

Besides, today's non-modular devices are made to resist mechanical shocks in terms of functionality as well. Ensuring the same thing with the modular device will be a bigger challenge. We need to engineer for the fact that mechanical shocks have least impact on the performance of the individual modules as well as the overall body.

A feasible technology standpoint

Modular architecture in smartphones is challenging but it opens up a new area of research which is probably going to be very exciting for the engineers. It is definitely a feasible technology standpoint but the associated considerations must not be sidelined.

When a device becomes mobile or mobility oriented, we take care of many issues. But if we are going modular, we are actually increasing those engineering challenges that are not going to be very easy to solve.

The key focus in the modular designs would be to ensure there are common communication and interface mechanisms at both hardware and software levels. As long as the modules adhere to these specifications, these issues would be addressed. ●

The author wrote this as a technical journalist at EFY. He recently opted and shifted to the hands-on training division of EFY


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3D Printing, Community Meets and Budget-Friendly Tools Drive Open Electronics

Open hardware is leading us to the next industrial revolution where digital fabrication (read 3D printers) is allowing everyone with an idea to bring it to fruition. Community meets, demo sessions and low-cost electronics are also fuelling open source electronics. There have been some new initiatives and innovations to give the open community a boost

ABHISHEK A. MUTHA

Open source electronics is enabling people to realise their designs quickly. Designers and hobbyists are turning their ideas into reality through digital manufacturing. The power of product development today is not only with the major corporations but is trickling down to individual designers and entrepreneurs. As a matter of fact, semiconductor multinationals are gradually investing significant time and energy on this do-it-yourself (DIY) community. The availability of low-cost manufacturing tools and low-cost distribution on the Internet sites are levelling the playing field. So let's explore the driving factors for people ranging from hobbyists, DIYers, specialists/experts, professionals and even academicians to create and build open source systems.

It is all about making and sharing

"Open source electronics is electronics designed with the spirit similar to open source software. When more eyes look at open source electronics,

any possible defect will be identified quickly and, more important, new ideas to utilise the same hardware for different applications will emerge," says Dhaval Vasa, solution architect, eInfochips.

With open source electronics, everything is to be released publicly. "I have been working on

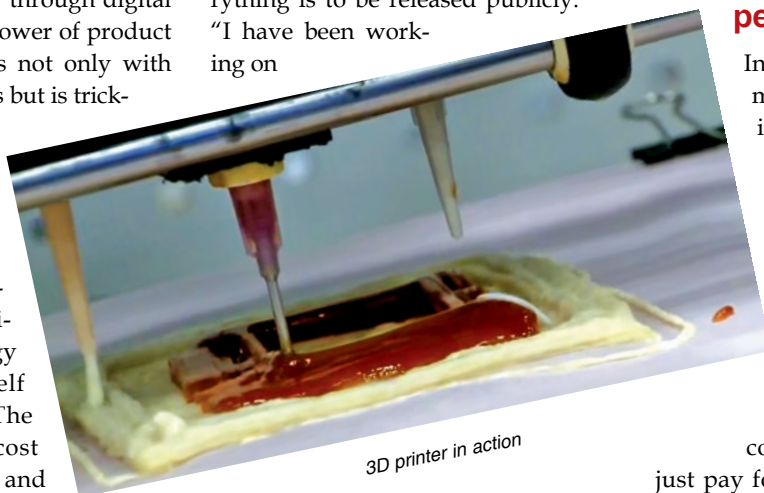
you built it so that any new person can have an accelerated learning instead of starting from scratch." When hardware is open, it enables you to modify it, better it and pull out something really great.

More and more people going open

In India, the kind of development happening in the field is at an elementary stage, but there is a constant rise in the number of people exploring open source hardware. Kuber shares, "In 2009-10, when I started exploring open source hardware, there were not many people who had heard of such a

concept. The norm was you just pay for a course, learn 8051 and get back to make a summer project." Today, everyone is buying and building their own robotics project. People are widely adopting open source hardware. She adds, "In every technical session or robotics competition, there is at least one thing made using an Arduino hardware."

There are many people, especially those with software background, stepping up and creating open source products. Sivaram says, "But one thing I have noticed is, sometimes people try to achieve too many things in one project."



3D printer in action

open source electronics for past many years and for me it is something non-proprietary — all documentation is made available, be it schematics or PCB layout," says Varun Sivaram, CEO and founder, Technigriti Systems Pvt Ltd. He adds, "Arduino, for instance, releases everything including the Eagle CAD file. Anyone can modify it and build stuff."

Open source electronics is all about sharing knowledge, believes Priya Kuber, director, Arduino India. She says, "It is not about just getting behind closed doors but teaching others how

What's driving open source

An open source project is released publicly, with design files available online for download with a defined sharing licence which allows designers to replicate, hack, improve, modify and contribute to the project. Of course, there are some factors driving hobbyists, electronic enthusiasts and even professional designers to replicate, improve and build stuff. Let's find out what's motivating them to do so.

Cost-effective tools enabling open system designs. With respect to India, although open source electronics is still at a nascent stage, Kavita Arora, founder, Bangalore MakeSpace and Open Source Creativity, says, "Electronic components and embedded computing modules are getting more affordable today, which is definitely one of the most interesting changes in this arena." This cost-effectiveness is motivating hobbyists to design and build systems in a budget-friendly manner. Popular boards like Arduino are also copied and built into non-branded (such as Freeduino) boards that sell at a lower cost at sites like kitsnspares.com

Sharing his personal experience, Sivaram notes, "When I used to buy boards, an Arduino, for instance, cost me around 1100 rupees. Keeping aside the Chinese clones of Arduino, Indian boards are available today for 600 to 700 rupees. The hobbyists I meet today are buying these pocket-friendly, India made boards which enable them to build many projects." This is really driving the costs down and, in turn, helping a lot of people build stuff using open source hardware.

Communities collaborate and innovate. More than the availability of cheap hardware what motivates people is actually the people around them, believes Kuber. So, more of competition, clubs and communities are driving people to build stuff using open source electronics. She says, "We have an open house every Friday at the Arduino office which is open to everyone. We teach enthusiasts on various

Highlights of Electronics Rocks 2014 (Open Design track)

October 10-11, 2014 at NIMHANS Convention Center, Bengaluru

1. PixHawk Fire: Open source autopilot for drones on Linux. Starting with a test run to check out some manoeuvres, go over to its development process, applications and openness.

2. Open source for automation and robotics in industrial sector. This session will highlight basics of the open architecture for industrial/consumer robotics and automation, and some demonstrations explaining the working nature of the protocols and RTOS for robotics. Will include real-time implementation concepts on automation and knowledge about drivers, along with the proof of concepts/practical demos.

3. Using e-scrap and Android AppInventor for rapid prototyping. For those who, although unfamiliar with core electronics and programming, wish to design industry-level products. Will cover parts of e-scrap you can use, such as non-working cell phones, cell-phone chargers and motherboards. Application design tools will also be explained.

4. Coolest applications on the coolest boards. Comparison of popular development boards like Arduino, Raspberry Pi, RIoT, Galileo, Gooseberry and UDOO, and for which kind of applications each one is suitable.

5. Workshop: Let's Get Started With 3D Printing. A workshop on getting started with 3D printers, the software needed, creating mechanical designs and more hands-on elements for newbies to printing.

6. 3D printing will change how the world learns

- Rapid prototyping and its benefits
- Operating 3D scanners, 3D printers and 3D printing web portals
- Developing innovative 3D printed products
- Supporting defence sector with advanced technology
- Increasing employment, killing unemployment
- Reducing cost of goods

7. Low-cost rapid prototyping for Indian situations. Aakash, the founder of Aha 3D, will share his experiences while working on sophisticated 3D printing technology. Useful for those who want to build viable business out of low-cost/DIY 3D printing.

8. From paper to life: Additive and subtractive rapid prototyping. Besides introducing the basic concepts of rapid prototyping, it will introduce you to the applications of 3D printers and CNCs as a part of rapid prototyping.

Other factors driving the open source hardware community

1. Platforms like Arduino, Raspberry Pi, Plugcomputer, BeagleBoard and LaunchPad have become de-facto standards. All other semiconductor companies are coming up with add-on/daughter cards that are compatible to either of these platforms.

2. There are disruptive changes happening, especially in design space, due to open source electronics. Prototyping hardware cost has been reduced by nearly 50% due to use of open source electronics versus evaluation/development kits (such as Anjan Contractor built 3D Food Printer using RepRap.org).

3. Accessibility to different kinds of 'silicon' from a variety of semiconductor companies has been a major benefit. Open source software community has become more active than ever in order to provide latest kernels, drivers, builds, libraries and applications that enable good support for such open source electronics. Major beneficiaries are universities and students who are able to use these devices to make very interesting projects.

4. TI has taken additional measures by providing a reference design library. TI Designs provides all design files for reference designs, including bill of material, enabling designers take benefit of this and go to market quickly.

Source: Dhaval Vasa, Solution Architect, elinfochips

methods to interface one technology to an Arduino. One week we have session on Bluetooth, another week we have on GSM and the next we focus on touch interface, and so on." Kuber adds, "If people come together and learn, it boosts the engagement and the learning process."

There is a lot of buzz among people to play with open source hardware and create something. A lot of them are attending sessions actively

organised by various communities, enabling them to engage and learn efficiently. Sivaram adds, "Last time the IoTBLR group was having a demo session, there were around 150 people put up in a hall. I also administer a Facebook group called Open Source Hardware Bangalore (OSHWB). It has 700-800 members. So there is definitely a lot of interest."

Talking about Electronics Rocks (eRocks) held in Bengaluru, Varun

notes, "Last year, eRocks was pretty good as a lot of open source companies had come. May be, this year it would be awesome." As a matter of fact, some really interesting presentations are expected this year (see box). Distributors are trying to support the community through open source development tools and boards being made available at an almost zero margin. "Kits'n'Spares would be selling the latest Raspberry Pi 'B+' boards at the lowest ever price in India," says the company's spokesperson Shyam Pandey. Codes to get discounts are being provided to design communities, for instance, through EFY's Electronics Design Community page at facebook.com/designelectronics

Semiconductor majors showing interest in open source. Semiconductor companies like Marvell, ATMEL, Broadcom, TI and even Intel are promoting open source to reach out to more designers who influence product management or decision making. In an article titled 'Intel CEO on Why He is Betting Big on the Maker Movement,' Brian Krzanich talks about open source communities and believes that there may be a 'next big thing' coming out of such communities. He says, "Those are the people who are inventing. Those are the creators. Those are the guys that are going to take something they see or do there and take it to Kickstarter."

Plugcomputer (plugcomputer.org), Arduino, Raspberry Pi and Beagle series are some real examples of how semiconductor companies want to reach out to a larger designer base that can consider using their silicon as part of their designs. Moreover, the Internet of Things (IoT) has made it an even better avenue for such companies to come up with the designs along with add-on cards that enable connectivity and storage options.

Big industry stalwarts are 'opening' their products to ensure that, not just a group or team of engineers but an infinite audience can work on it and improve it. Earlier it was not

Interesting innovations from around the world

1. 3D printer that makes pizza for astronauts on long missions. Last year, Anjan Contractor, a mechanical engineer, was in the news for a US\$ 125,000 grant from NASA to build a prototype 3D printer. Now he has successfully built a prototype



Picture of the cooked pizza

of a 3D food printer that can make pizza. The software for the printer is open source, while the hardware is based on the open source RepRap Mendel 3D printer. It could give astronauts a nutritious, comforting alternative to the canned and freeze-dried, pre-packaged foods they currently use. In the video, the 3D printer takes food 'building blocks' to create the crust, cheese and so-called 'protein layer' for the dish, all cooked while being printed out. The cartridges the printer uses, as claimed by the maker, will last 30 years.



3D printer in action

2. Novena. Open source laptop. A new open hardware computing platform, flexible and powerful, designed for use as a desktop, laptop, or stand-alone board. Novena is a 1.2GHz, Freescale quad-core ARM architecture computer closely coupled with a Xilinx FPGA.



Internals and casing

It is designed for users who care about free software and open source, and/or want to modify and extend their hardware. All the documentation for the PCBs is open and free to download, the entire OS is buildable from source, and it comes with a variety of features that facilitate rapid prototyping.

For crafty people who want to build their case and define their own style, the main PCBA, stuffed with 4GB of RAM, 4GB microSD card and an Ath9k-based PCIe Wi-Fi card is available separately that boots to a Debian desktop over HDMI. Its fun features include:

- 100Mbit dual Ethernet capability allows laptop to be used as an in-line packet filter or router
- USB OTG enables laptop to spoof/fuzz Ethernet, serial, etc over USB via gadget interface to other USB hosts
- Utility serial EEPROM for storing crash logs and other bits of handy data
- Spartan-6 CSG324-packaged FPGA that has several interfaces to the CPU, including a 2Gbit/s (peak) RAM-like bus, for your bitcoin mining needs. Or whatever else you might want to toss in an FPGA.
- High-speed I/O expansion header useful for implementing a wide variety of functions, from simple GPIO breakouts to high-performance analogue data sampling front-ends

3. Spark Core: Arduino compatible Wi-Fi

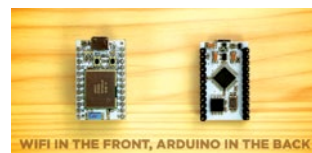
development board. Spark Core is an Arduino-compatible, Wi-Fi enabled, cloud-powered development platform that makes creating Internet-connected hardware a breeze. This little board packs a punch with a 72MHz ARM Cortex M3, the best Wi-Fi module on the market, wireless programming, and lots of pin outs and peripherals. There's nothing you can't build with the Core.



The board



Fully built laptop



Spark Core

What's new from vendors

1. Daughter cards/add-on boards compatible to known platforms.
2. Better support of software to enable focus on application development or problem solving – providing compatible / well-known IDE, debugger support and compatible add-on boards for rapid prototyping.
3. Industries are providing access to the design source details to bridge gap between time to market and R&D. However, the access is still limited, with terms and conditions.
4. Announcement by Parallax to open source its Propeller 1 P8X32A. This is a sign of things to come, and hopefully more vendors will follow. The Propeller 1 (P8X32A) is now a 100% open multi-core microcontroller, including all of the hardware and tools: Verilog code, Spin interpreter, PropellerIDE and SimpleIDE programming tools, and compilers. The Propeller 1 may be the most open chip in its class.

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director, Arduino
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Varun Sivaram
CEO and founder,
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Systems Pvt Ltd

so, informs Boris Landoni, technical director and co-founder, www.open-electronics.org. He says, "One had to hack a product to figure it out, but now they help us, give us ready pieces of code, enabling us to build better." For instance, he adds, "After Microsoft's Kinect was hacked, Microsoft had seen a surge in sales and has come up with a software development kit to use it. People have started working on creating projects of which Microsoft certainly had not thought of."

New innovations

With the advent of 3D printing, laser cutting and computer numerical control (CNC) machining (and open source machines for these techniques), people with bright ideas are finding it easy to build things. "I foresee a lot of other manufacturing related innovations which will make it even more easier for anyone to create open hardware. Small, open source pick-and-place machines, open source laptops and open source semiconductors (Parallax, Momentum) are a few examples," shares Anool Mahidharia, director, Lumetronics.

The world of open source hardware runs fast, but this year there has been an explosion of 3D printers. All are strictly open source but with some additional features than those presented before. "This is also the year of Linux," believes Landoni. He adds, "After Raspberry Pi has been on the market, new embedded boards integrate increasingly powerful processors and the features are more interesting."

Interesting initiatives

Almost every large-scale industrial production process is now available in small format. This allows makers to develop smart, innovative, open hardware for prototyping. With a prototype in hand, makers can then pitch for funding via crowd sourcing websites. This completely bypasses the traditional Manufacturer - Distributor - Reseller - Retail model.

The distribution chain is also shortening. Who sells also produces, and often with very low margins. Like Raspberry Pi and Arduino, there is not much space for the retailer, to the benefit of the consumer.

Many applications will run on the Web; the open source codes can be edited and compiled directly on line for better development time and reality. "This is not a futuristic vision, already there are these realities, but will grow like wildfire and will be more user friendly," notes Landoni.

The road ahead

With all these initiatives and developments, the aim to create an ecosystem of open source hardware in India looks brighter. With smaller sensors, smaller actuators, high energy-density batteries, low-power microcontrollers and connected devices emerging, the 'Internet of Things' revolution is also around the corner. Cost of boards and tools will become more affordable, and there will be a lot more participation from people. This will enable everyone to translate their thoughts and ideas into prototypes efficiently and effectively. ●

The author is a senior technical correspondent at EFY

Best Buddies: The Web and Open Source Electronics

Here are a few interesting online locations that help you learn about, use, build and share open source electronics



Tabby, an open source universal chassis that can be assembled in less than an hour (Courtesy: OSVehicle)

JANANI GOPALAKRISHNAN VIKRAM

Although the World Wide Web (WWW) itself is considered by many as the biggest success of open source (OS), the dependence of OS on the WWW is actually even greater. Imagine how difficult it would be to create, share and collaborate with people across the world without the Web as a backbone? An issue focusing on OS electronics would therefore be quite incomplete if we do not talk about online resources that aid in the development and use of such electronics. Here, we look at some such interesting sites that satiate your cu-

riosity and enthusiasm to build open hardware. However, note that we are not repeating the oft-mentioned and already well-known resources such as Arduino or Raspberry Pi's official blogs, Make Magazine, and such.

1. How can I get my PCB designs fabbed?

There are several OS tools available on the Web to design printed circuit boards (PCB). However, many often think it is futile to fiddle with designs if they cannot get them fabricated. Now, the Web also makes such facilities available at your doorstep.

During his I-Day speech, our Prime Minister insisted on manufacturing in India. He invited people to make in

India, sell anywhere in the world. So, when it comes to your PCBs too, made in India ought to be the first choice to explore. PCB Power (www.pcbpower.com) is an Indian firm specialising in design and manufacture of PCBs. While they supply to customers in hi-fi verticals like aviation, defence, railways, industrial electronics, etc, what sets them apart from others is that they also print small orders for learners and enthusiasts! Ordering is quite easy and unambiguous too. First, enter basic specifications like size, layers, delivery period and quantity, and get a quick online quote. If you are okay with the rates, you can place an order by uploading the Gerber files and fabrication parameters.

Another choice is German manufacturer Fritzing Fab (<http://fab.fritzing.org/fritzing-fab>), which manufactures in Berlin and supplies to any place in the world. Fritzing Fab consolidates orders and fabricates them together once a week, which makes it possible to process even single-PCB orders at a reasonably low cost. Apart from fabrication services, Fritzing also offers loads of learning materials, and a freely downloadable OS software that helps you create, document and share OS electronics.

OSH Park (<https://oshpark.com/>) is another option, where PCB orders from the community are consolidated, manufactured in the USA, and shipped for free to anywhere in the world. Again, this is an affordable option, and OSH Park ships promptly within 12 to 15 days of ordering. To get an idea, they charge US\$ 5 per square inch for three copies of two-layer boards, and

US\$ 10 per square inch for three copies of four-layer boards.

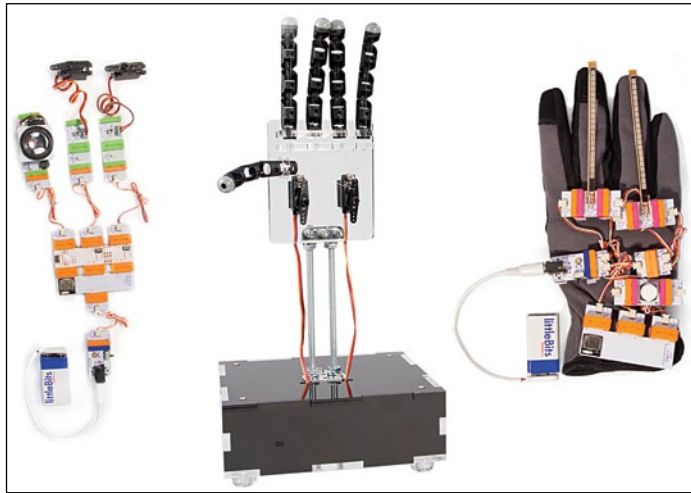
2. How do I make my own vehicle?

You might not intend to really compete with the Tatas and Toyotas of this world, but have you ever wished that you could build your own vehicle, for kicks or due to any special needs? Well, OSVehicle (<http://www.osvehicle.com>) or OSV is an upcoming open source vehicle platform that offers a way out. Their first prototype, Tabby, was showcased at last year's Maker Faire. Tabby is a versatile, universal chassis on which you can build a variety of vehicles ranging from two, three or four seaters to even cargo carriers, capable of travelling up to 80 kilometres per hour. With their starter kit, you can supposedly assemble Tabby in less than an hour! Tabby is certified as road-safe and also complies with environmental norms. OSV technology is compatible with all types of engines—electric, hybrid and internal combustion. All the plans and blueprints can be downloaded from their website and modified at will. The forum is quite active and can be a medium to share your ideas, solve your problems and collaborate on new projects. OSVehicle, like most successful OS businesses, offers two modes to build your vehicle—do it yourself, or do it together. The former means downloading all the designs and doing it all yourself, while the latter includes paid services and support.

You can also check out OScar (<http://www.theoscarproject.org/>), another project aiming to reinvent mobility using OS.

3. How do I get my kids interested in OS?

Many like to see their kids do what they like to do themselves! While that can be quite imposing many a times, it could turn out positively in the case of OS electronics, because it is a great means of science, technology, engineering and mathematics (STEM) learning in the early years



littleBits offers open source electronic building blocks that can be used to learn or prototype electronics (Courtesy: littleBits)

and deeper exploration later. Luckily, OS electronics has some nice goodies for kids too.

Although it might not seem directly like an electronics project, Scratch (<http://scratch.mit.edu/>), a project of the Lifelong Kindergarten Group of MIT Media Labs, is a great way to get your kids started with programming—a life skill to survive in the electronics community! Scratch lets them visually program and create interactive stories, games and animations, which can be shared with the thriving online community. Scratch is sure to teach kids—or even adults—to think and reason multi-dimensionally and work collaboratively, another must-have OS skill.

Kids might find littleBits (<http://littlebits.cc/>) very interesting too.



Scratch is a fun way for kids to learn essential open source skills like visual programming, collaboration, etc

It offers an easy way to understand, develop and prototype electronics while making it all seem like child's play, literally, with their colourful building blocks! littleBits is an OS library of electronic modules that

snap together with tiny magnets. No wiring, soldering or programming. Snap them together and they start working. Take them apart, and make something new. They work just like building blocks that kids play with. cloudBit, another snap-on module, enables kids to join the Internet of Things (IoT) bandwagon too. Now, making a smart towel holder or SMS-controlled calling bell is child's play! Several interesting kits and bundles of littleBits modules are on sale online.

If you are an electronics-pro, you would probably just want to pick up some projects or parts, roll up your sleeves and get started with your little helper! However, before you indulge in any OS project with your kids, keep in mind the fun aspect. As Dave Neary, an OS expert at Red Hat explains in one of his blog posts, "As long as their hands are in gunk and they are taking things apart, or there's the possibility of blowing something up, kids will stay interested. As soon as the activity starts to seem like work, they switch off."

4. How do I get parts for my projects?

Open source means lot of trial and error, experimentation and freedom to try things out. However, all of us know OS or free software is not necessarily fi-

nancially 'free,' as in free beer! This is especially true of OS electronics, where there is a physical, tangible aspect. You get lots of designs online, as well as free and OS software for everything from design to simulation. But when it comes to actually making the product, you need to buy some components.

While some like to go backpacking to their local electronics bazaar, it is also possible to buy most of what you need online. There are sites like Adafruit Industries (<http://www.adafruit.com/>), Make Magazines's Maker Shed (<http://www.makershed.com/>) and SparkFun Electronics (<https://www.sparkfun.com/>), Simple Labs (www.simplelabs.co.in) and Explore Labs (www.exporelabs.com), which have a thriving online community that answers doubts, shares tutorials, projects and ideas, while also selling electronic components, parts, kits, etc. Or, you can check out retailers like Kits'n'Spares (www.kitsnspares.com), Futurlec (www.futurlec.com),

AliExpress (www.aliexpress.com) or Robotkits (www.robokits.org).

Most of these sites sell all kinds of electronics, not just OS ones, so look for what you want. Before you buy, compare the pricing and deals on a few websites and then order, because it is possible to get free shipping and other offers.

5. How do I find projects, get doubts cleared?

This is perhaps the easiest question to answer—because that is the main advantage of OS electronics. Nobody wants to keep their knowledge to themselves in the OS community. If they have found a better way of doing something, they want to share it. If they find an enthusiast wanting to learn something, they are eager to teach.

There are umpteen OS electronics websites with thriving forums and communities. OpenElectronics (<http://www.open-electronics.org/>),

OpenCores (<http://opencores.org/>) and OpenCircuits (<http://www.opencircuits.com>) are some of the sites that cover only OS electronics. That apart, most of the do-it-yourself websites like MAKE: (<http://makezine.com/>), Electronics For You (www.electronicshobby.com), Instructables (<http://www.instructables.com/>), Popular Mechanics DIY (<http://www.popularmechanics.com/technology/how-to/>) and DIY (<https://diy.org/>) also have lots of OS content and projects.

The websites of OS boards, such as Arduino (<http://arduino.cc/>), Raspberry Pi (<http://www.raspberrypi.org/>) and Beagleboard (<http://beagleboard.org/>), are perfect places to go to if you are working with these specific boards because you find innumerable ideas, solutions to problems, and enthusiastic knowledge-sharing on these communities. ●

The author is a technically-qualified freelance writer, editor and hands-on mom based in Chennai

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How to Select Your Next Development Board

Selection becomes tough when one has to choose from a list of boards with almost similar capabilities. From designers to young hobbyists, everyone finds it difficult to identify the right board for them. We hope this article will serve as an aid for selecting your next development board

SNEHA AMBASTHA

Built around a microcontroller (MCU) or a microprocessor (MPU), a development board allows a learner to get the correct design, along with the required speed and convenience to create an easy, interesting and foolproof project. The idea behind the creation of a development board was to make the task of a product designer easy. However, over time, this trend has changed. Now development boards are being widely used by hobbyists, young engineers and other learners.

For an amateur or a young engineer who has just started building projects, assembling a bunch of small components on a single hardware in a particular design so as to create a working project is a very tough job. A single mistake in designing the basic board for a project can lead to failure. This is where a development board proves useful. A designer does not have to keep modifying the basic circuit of the project while using a development board. The development board acts as the basic building block, leaving an engineer with time and effort to work on other parts of the project.

Basic uses of a development board

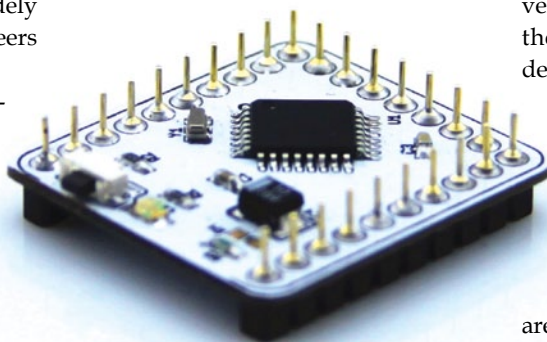
All development boards are used for certain type of work, be it an open source development board or another type that allows modifications in its existing design. Listed below are some uses:

1. To develop the software, bench-

mark and evaluate the MCU/MPU used. The software is developed to enable the MCU/MPU to work with the different on-board components in order to make the board suitable for the basic operations of any application.

2. To develop the software drivers, prototype and validate them for the new system-on-chip (SoC) intellectual property (IP) blocks, like a video engine or a modem.

3. To test the customised logic blocks, or the system IPs in a field-



programmable gate array (FPGA), connected to the core of the MCU/MPU and running at the speed of an application-specific integrated circuit (ASIC).

4. To shorten the development time by providing a ready-to-use platform for firmware development and data collection.

Of course, there are other uses but these depend upon the application a development board is used for.

Open source development board

The development boards licensed

under the open source licences allow engineers to add some value to their designs by incorporating them in the existing design, giving some credibility to the creator of the original board. These boards have circuits that can be modified or improvised and rebuilt. They facilitate the involvement of various open source communities with the associated engineers in order to provide their views on every aspect starting from selecting the board to creating a working model.

Working with an open source development board becomes easier with the availability of free drivers and development tools that can be easily downloaded from Internet.

Some popular boards in this category are the i.MX53, Beagle-Bone Black, Raspberry Pi, Arduino UNO, Gooseberry, Origen, Snowball and Intel Galileo. The list of boards is quite long and additions are made to it every year. These open source development boards provide an open design, size, processing speed and a great price to start with. Other features include the open source software tools that inspire application developers to build third party applications around the projects based on these boards.

Seetharaman Devendran, general manager, MCU, LPRF, sales & marketing, Texas Instruments, says, "The open source development boards like MSP430 are like cupcakes for the student community as these provide the debugging facility at the initial steps. The other development boards that do not have the open source design do not allow any debugging, and this makes it tough to work with those designs."

We can get a better understanding of these boards by going through their detailed specifications given in Table I.

Recently launched in India by ST-Microelectronics, the Nucleo development board features the STM32 MCU family line and allows one to choose the right MCU from amongst the various combinations of power consumption, performance and features. It supports the Arduino connectivity ST Morpho headers that make it easy to expand the functionality of the development platform for Nucleo to choose any specialised shielding. It has an integrated programmer or debugger, and therefore does not need any separate probe for the same. It comes with the STM32 comprehensive HAL library of software and other software examples, along with some online resources.

Tiny development boards

The requirement of compact devices with maximum efficiency and power led to the development of several tiny, Lilliputian-sized development boards. Despite their size, the boards have wireless communication facilities built-in, encouraging the connection of embedded devices and revolutionising the term Internet of Things (IoT). Some of these are described below.

Femtoarduino (price: \$22). Considered to be the clone of Arduino, Femtoarduino is ultra-small (20.7x15.2 mm) and uses Arduino libraries and compiler. It has a computing power similar to Arduino UNO and uses ATMEGA 328p, 0.13-centimetre connectors, 0402 components and weighs only about two grams. It has 0.25-centimetre-sized pins, and thus can be used on a standard breadboard or perfboard.

Intel Edison. Compatible with open source software tools, Edison features Intel's Atom, a 22nm Silvermont micro-architecture based SoC. It has a dual-core CPU and a single-core MCU with integrated Wi-Fi, Bluetooth low energy (BLE) memory and storage. Edison supports more than 30 industry-standard I/O interfaces via a 70-pin connector. It also supports projects like Arduino, Python, Node.js, Yocto Linux

Basic components of a development board

1. Microcontroller or microprocessor for suitable type of applications
2. Power circuit for supplying power to the MCU and other on-board components
3. Basic inputs, such as buttons, sensors, etc
4. Basic outputs, such as LEDs, LCDs, motors, etc
5. Programming interface to facilitate programming of the MCU
6. Communication and user interface, such as the USB port, wireless network ports, etc

and Worlfram.

Digispark (price: \$8.95). A USB development board with Attiny85 microcontroller, it is also similar to the Arduino board, yet is smaller and cheaper. It supports Arduino IDE 1.0 and is compatible with Linux, Windows and MAC operating systems. It has six I/O pins, of which two are reserved for USB only – this is in case the program communicates over USB. It automatically selects the required power from the external source connected via USB.

mbed LPC11U24 (price: \$44.95). A low-cost development board with the NXP LPC11U24 MCU, it has been mainly designed for rapid prototyping of low-cost USB devices. But it can also be used for battery-powered applications and 32-bit ARM Cortex-M0-based designs. It has a built-in drag-and-drop Flash programmer with 32kB Flash. It uses a proprietary online compiler that is given access to when the board is purchased. Although this prohibits the need to download and install anything, it encourages the requirement of an active Internet connection to push the codes to the board.

FLORA (price: \$24.95). Designed to empower wearable projects, FLORA is round in shape and has a diameter of 4.45 centimetres. It has a flexible and easy-to-use power supply with a 2A power FET, which is usually not included in wearable options. FLORA is fully Arduino compatible, and so, all the Arduino tutorials and libraries are supposed to work on it.

Teensy 3.1 (price: \$19.80). An ARM Cortex M4-based development board at such low price is a steal. 18mm × 30.5mm in size, Teensy 3.1 is a complete USB-based MCU board. It allows single push-button programming and works with MAC, Linux and Windows operating systems. It supports a Wi-

nAVR C compiler and Teensyduino—an add-on for Arduino IDE. It has about 34 I/O pins suitable for a solder-less breadboard.

USB Bit Whacker (price: \$24.95). The USB Bit Whacker is a PIC-processor-based development board featuring the PIC18F2553 MCU. It is 25mm × 40mm in size and has 16 I/O ports. It produces HEX files with almost any compiler. With the transmission and reception ports, it can be used as a USB to UART converter board.

Mini-32 (price: \$29). Another PIC-based development board, it features the PIC32MX534F064H MCU and operates on 3.3V power supply. It supports CAN communication and can be used as a DIP40 PIC32 substitute for PIC18 and PIC16 MCUs. It has a USB HID boot-loader, which simply means that no additional software is needed to access the board. The compiled files can be simply dragged and dropped.

Other development boards

There are some development boards that do not allow any modification in the existing design and the codes, and they are sometimes compatible with only a few specific software. These boards have very specific development tools that are available either at a very high price or only through specific manufacturers and distributors. These development resources also have very limited support systems.

Most of these boards are available as packaged evaluation kits that contain the development boards along with the required tools and software. Some of these are:

Tiva C series. It features the Tiva TM4C129x-series ARM Cortex-M4-based MCU. It supports the evaluation version of Keil RealView MCU development kit along with IAR Embedded

Table I: Some Popular Open Source Development Boards

Table I: Some Popular Open Source Development Boards																			
Specifications	Banana Pi	BeagleBone Black	Cosmic+ Board	Cubieboard 3	Cubox-i4Pro	Game-Slick	Humming-Board i20x	Intel Galileo	Intel NUC 3815YBE	MarsBoard RK366	Mirabox	Novena	ODROID-U3	Radxa Rock Lite	Raspberry Pi B+	RioBoard	RouterBOARD RB953GS-5HnT	UD00 Quad	VIA Spinboard VAB-600
SoC	Alwinner A20	Ti Sitara AM335x	Freescale iMX6 Quad	Allwinner A20	Freescale iMX6 Quad	Amlogic 8726-A1X	Freescale iMX6 Dual	Intel Quark SoC X1000	Intel Atom E3815	Rockchip RK3066	Marvell Armada 370	Freescale iMX6 Quad	Samsung Exynos 4 Quad	Rockchip RK3188	Broadcom BCM2835	Freescale iMX6 Solo	Qualcomm QCA9558	Freescale iMX6 Quad/Atom	WonderMedia WM8950
	ARM Cortex-A7	ARM Cortex-A8	ARM Cortex-A9	ARM Cortex-A7	ARM Cortex-A9	ARM Cortex-A9	ARM Cortex-A9	x86-64 Bay Trail-H	x86-64 Bay Trail-H	ARM Cortex-A9	ARM7	ARM Cortex-A9	ARM Cortex-A9	ARM Cortex-A9	ARM11	MIPS 74Kc	ARM Cortex-A9	ARM Cortex-A9	ARM Cortex-A9
CPU	1 GHz	1 GHz	1 GHz	1 GHz	1 GHz	1 GHz	1 GHz	400 MHz	1.46 GHz	1.6 GHz	1.2 GHz	1.2 GHz	1.7 GHz	1.6 GHz	700 MHz	1 GHz	720 MHz	1 GHz (?)	800 MHz
	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz	500 MHz/167 MHz
GPU	Mali-400MP2	PowVR SGX530	Vivante GC2000 + GC335 + GC320	Mali-400MP2	Vivante GC2000 + GC335 + GC320	Mali-400	Vivante GC2000 + GC335 + GC320	Intel HD Graphics	Intel HD Graphics	Mali-400MP4	N/A	Vivante GC2000	Mali-400MP4 @440 MHz	Mali-400MP4	Broadcom VideoCore IV	Vivante GC880 + GC320	N/A	Vivante GC2000 + GC335 + GC320	Mali-400
	1 GB	512 MB	256 MB	2 GB	2 GB	1 GB	1 GB	256 MB	1 SO-DIMM socket	1-2 GB	1 GB	4 GB SO-DIMM	2 GB	1 GB	512 MB	1 GB	128 MB	1 GB	1 GB
RAM	?	?	?	?	?	?	?	?	up to 1066	?	?	?	?	?	?	?	?	?	?
	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
PCIe USB	DDR3	DDR3L	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3L 1 mini 2 + 3 header	DDR3	DDR3L 1 mini	DDR3 1 mini	LPDDR2	DDR3	?	DDR3	DDR2	DDR3	DDR3
	No	No	No	No	No	No	No	Client	No	OTG	No	OTG	No	No	No	No	No	No	No
Storage	OTG On Board	Device 4 GB Flash	OTG 512 MB Flash	OTG 8 GB Flash	No	8 GB Flash	No	Client 8 MB Flash + 8 KB EEPROM	4 GB eMMC	4 GB Flash	1 GB Flash	No	eMMC module	OTG 4 GB Flash	?	OTG 4 GB Flash	128 MB Flash	OTG	No
	SD	microSD	microSD	microSD	microSD	microSD	microSD	SD	No	microSD	microSD	SD	microSD	microSD (SDXC) ?	microSD	microSD and SD	No	microSD	microSD
Networking	SATA Ethernet	10/100	No	SATA 2.0 Gigabyte	eSATA 2.0 Gigabyte	No	mSATA Gigabyte	No	SATA 2.0 Gigabyte Ethernet (RTL8111)	No	2x GbE	SATA 2.0 1 GbE + 1 100Mbit	?	b/g/n (RTL8188)	No	3x GbE (AR8327)	3x GbE (AR8327)	SATA GbE	10/100 (V76113)
	Wi-Fi	No	No	ab/g/n (BCM4329)	b/g/n (BCM4329)	b/g/n (BCM4329)	b/g/n (BCM4329)	No	No	No	b/g/n (88W8787)	b/g/n	No	b/g/n (RTL8188)	No	No	a/n (QA9538)	n (RT13370)	b/g/n opt. (AR9271)
Communication	I2C	No	No	Yes	2.1 + EDR	4.0 LE	No	No	No	No	No	Opt.	No	No	No	No	No	No	No
	SPI	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Generic I/O	GPIO	12-bit ADC	12-bit ADC, 12-bit DAC, PWM	?	No	?	No	12-bit ADC, 6 PWM	PWM	No	No	8x 12-bit ADC, 8x PWM, via FPGA	No	ADC, PWM	No	PWM	No	10-bit ADC, PWM	No
	Analog	No	No	?	No	No	No	No	No	No	No	Header	No	ADC, PWM	No	PWM	No	10-bit ADC, PWM	No
Other Interfaces	CSI, UART	CAN, UART	CAN, JTAG, OpenSDA, RS-232	UDA, UART	CIR rx/tx	CIR rx, CSI-2, FlexCAN, UART	CIR rx, CSI-2, FlexCAN, UART	Arduino 1.0 headers, JTAG, 6x UART	SMBus	CIF, UART	JTAG	High-speed I/O expansion header (provides GPIO breakout)	UART	UART	UART	CSI, UART	RS-232, 2x SPI	Arduino 1.0 headers	CIR
	Micro In	No	No	Header 3.5 mm, HDMI, S/PDIF	No	No	Yes 3.5mm jack, SPDIF	I/A	3.5 mm	Yes	N/A	Yes	3.5 mm	?	No	Yes	N/A	Yes	3.5 mm
Audiovisual Interfaces	Audio Out	HDMI	No	Optical SPDIF	Optical SPDIF	HDMI	3.5mm jack, SPDIF	I/A	3.5 mm	Yes	N/A	Yes	3.5 mm	3.5 mm, HDMI, S/PDIF	Yes	3.5 mm, HDMI	N/A	Yes	3.5 mm
	HDMI	Yes	Yes	Micro HDMI	No	Yes	Yes	I/A	HDMI 1.4a	Yes	N/A	Yes	Yes	Yes	Yes/DVI compatible	Yes	N/A	Yes	Mini HDMI 1.4
Power	LVDS	No	No	No	LCD header	No	LCD header	I/A	LCD header	RGB	N/A	Part of "aDP Adapter Board"	No	Yes	?	Yes	N/A	LCD header	DVO connector
	Other Video Out	Composite	No	VGA	No	No	No	I/A	VGA header	No	N/A	No	No	AV output	Composite video	?	N/A	No	No
Operating System	Linux	Linux	Linux	Android	Linux	Android	Linux	Linux	Linux	Linux	Linux	Linux	Linux	Ubuntu/ Linux	Linux	Linux	RouterOS	Linux	Linux
	Android	Android	Android	Android	Android	Android	Android	Windows	Android BSD	Linux	Linux	Linux	Android	Android	Linux	Linux	Android	Android	Android
Size (mm)	92 × 60	86.4 × 53.3	100 × 72	110 × 80	55 × 55 × 42	?	85.6 × 54	123.8 × 72	101.6 × 101.6	105x78	133 × 83 × 20	?	83 × 48	100 × 80 × 30	85.6 × 54.0 × 19.5	120 × 75	183 × 105 × 24	110 × 85	100 × 72 (Pro-ITX)
	48 g	40 g	64.2 g	220 g (kit)	?	?	?	?	?	90 g	?	?	48 g	?	45 g	?	?	?	?
Weight	5 V	5 V	5 V	5 V	5 V	5 V	5 V	7-15 V	12 V	5 V	5 V	16 V DC	5 V	5 V	5 V	5 V	8-30 V	6-15 V	12-24 V
	10 W supply, 1.15 W idle in Linux	1.05-2.3 W	5 W supply, 1.83 W typ.	?	15 W supply	?	10 W supply	?	36 W supply	10 W supply	15 W	1.6 W	?	?	3 W	5 W supply	25 W max	?	?
Power Consumption	micro USB	miniUSB or DC jack or LiPo	miniUSB or DC jack	miniUSB or DC jack or LiPo	Micro USB	Micro USB	Micro USB	DC jack or PoE	DC jack	DC jack	DC jack	DC jack or any 3 cell RC, LiPo, battery via optional charger module	?	DC jack or USB OTG input	Micro USB or GPIO header	DC jack	DC jack	DC jack	DC jack
	micro USB	miniUSB or DC jack or LiPo	miniUSB or DC jack	miniUSB or DC jack or LiPo	Micro USB	Micro USB	Micro USB	DC jack or PoE	DC jack	DC jack	DC jack	DC jack or any 3 cell RC, LiPo, battery via optional charger module	?	DC jack or USB OTG input	Micro USB or GPIO header	DC jack	DC jack	DC jack	DC jack



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MAJOR CONTRIBUTORS TO THE STORY

- **Bhupender Singh**, consultant-Embedded System, Multisoft Systems
- **Sani Theo**, team leader, EFY Labs
- **Seetharaman Devendran**, general manager, MCU, LPRF, sales & marketing, Texas Instruments

Workbench development tools and Sourcery CodeBench development tools (for a limited time). It is compatible with Texas Instruments' Code Composer Studio IDE. Although it has an in-built debugger, it allows one to connect an external debugger through the ARM 20-pin connector, J1.

Kinetis K22 Tower System Module. It features the latest Kinetis K22 32-bit ARM Cortex-M4 MCUs from Freescale and allows USB connectivity with a crystal-less operation. It operates on a stand-alone debugging tool and has an independent battery-operated power supply for real-time clock (RTC). It uses the Kinetic Design Studio IDE along with Freescale MQX real-time operating system for MCU software development along with a Kinetis software development kit.

LPCXpresso. This development board features the LPC11U68 Cortex-M0+ MCU from NXP. When used with Eclipse-based IDE and the low-cost target board with an attached JTAG debugger, it can be used to evaluate all the LPC11E6x devices. This board supports the GNU C/C++ tool chains available both in free and pro versions. Its compatibility with Arduino UNO and peripheral module (PMOD) standards opens up options for its existing peripheral board.

How to select

It can be a daunting task for anyone selecting the right development board from a plethora of options, having so many features and specifications, available in the market. Luckily, there are some pointers that can help narrow down the choices. Here is how you should proceed with your selection:

1. First select the project to be built and the components required for it.
2. Identify the right MCU with the required number of pins, I/O ports, interface and other features, such as live input power, speed, memory, etc.
3. Create a list of the development

boards that match the project requirement.

4. Identify the availability of the integrated development environment (IDE) and the development tools required for the listed boards.

5. Check the associated simulators and compilers—some boards do not allow GCC compilation.

6. Identify the right board as per the budget of the project.

Although the steps listed above are not the only parameters needed to make a decision, engineers often find these to be useful while selecting a development board for their projects. The idea behind listing these steps is to narrow down the research and select the right development board at an affordable price.

However, Sani Theo, a team leader at EFY Labs says, "Working every now and then with various types of development boards, I feel that the main criteria to select them is to first understand the requirement of the project and to understand what type of MCU will be essential. Then, the other important factor that comes into picture is our familiarity with the MCU. I consider two MCUs—one from Atmel and the other one from some other manufacturer. If I am familiar with Atmel, my approach will be to select the development board based on Atmel MCU."

Bhupender Singh, consultant-Embedded System, Multisoft Systems says, "Identifying the main features on the drivers and the availability of free drivers play an important role when it comes to the selection of a development board." He adds that, currently every manufacturer is tying up with an open source community to come up with an open source development board so that it becomes easy for an engineer to get the associated free software along with free support. ●

The author is a technical journalist at EFY

Today's Analysers are Modular, Flexible and Highly Capable

The latest analysers make speedy measurements, occupy lesser space, have multiple measurement capabilities and software-defined functionalities powered by FPGAs. These modular instruments are meeting performance and other capabilities of bench-top instruments



ABHISHEK A. MUTHA

Analysers now aim at meeting all the test needs of an engineer from design stage to testing stage. Available in low-cost to high-performance range, the analysers are used for a variety of applications, such as 5G, smart antennae (like multiple-input and multiple-output) and smartphones.

Traditional analysers are box type instruments with the capability of analysis in-built into them. With the newer modular PCI eXtensions for Instrumentation (PXI) based analysers, channels can be added as per requirement. For instance, by adding a card to an 8-channel logic analyser, it can have 16 channels, and by adding another card it can have 32 channels, and so on.

Functionality of traditional analysers is fixed, that is, logic analysers

would do digital pattern analysis, while protocol analysers would do protocol-level analysis on specific, limited set of protocols. But the newer analysers are completely programmable in different environments, whether LabVIEW or any other text based programming language.

A programmable analyser can have 'fixed' personality wherever required. Whether it is radio frequency (RF), digital

logic analysis or spectrum analysis, it is possible to use it as a traditional analyser, just like the box type instrument. If you are building a new protocol and want to do an analysis of that protocol, you have the flexibility to incorporate the capability into it. "Today, people talk about monitoring the spectrum instead of just performing a simple spectrum analysis, or probably even look at it as an intelligent demodulator. These are the software-defined personalities that you can bring to analysers," says Satish Mohanram, technical marketing manager, National Instruments.

"Testing instruments are supporting high bit rate testing. This enables faster data rate development of future telecom technologies," notes Madhukar Tripathi, regional manager, Anritsu India Pvt Ltd. Earlier, programming used to happen mostly on a computing platform, where you put the logic into

a processor, try and implement it. But today, there are high-speed protocols, which run into gigabits and terabytes, where it is important to perform analysis at high speed to be able to cater to these high-speed digital buses and high-speed RF signal data. "Analysers come with a field-programmable gate array (FPGA) on board which can be programmed by the users. You can do real-time analysis, for immediate processing of incoming data, to exactly understand the kind of signal coming through, unlike in a traditional case where you just take the data and do off-line analysis of the protocol," says Mohanram.

What's shaping the analysers

One is FPGAs. High-speed analysers have in-built FPGAs. For instance, if need arises for a protocol analysis, the FPGA aboard takes the signal and processes it in-line. If there is communication that has to go back, it is sent and, at the same time, analysed information is available for the user to look at. "The FPGAs are also capable of breaking down the signal for analysis to learn the kind of communication happening, if at all this necessity arises," informs Mohanram. He adds, "Hardware in-loop is a very common way of testing new-generation protocols because, if you have to test a protocol, you have to be able to emulate the receiver. It becomes easy with the FPGA based in-line processing capabilities and complete programmability that you get off these instruments."

The FPGAs can be chosen based on signal being handled and the amount of in-line processing to be done. If the end user has a very high-end protocol

that has to be implemented, and it needs a lot of logic and digital signal processing (DSP) blocks, a high-end FPGA could be used. Even the size of the FPGA is pretty much configurable based on the customer's need.

Traditional analysers have been box type but now analysers are coming with just a single-slot card. Their size is shrinking tremendously, thanks to semi-conductors and multi-core technologies. "FPGA and shrinking size are the key elements bringing down the cost and increasing the capabilities of these instruments," believes Mohanram.

Besides, a single instrument now includes, for instance, spectrum analyser, logic analyser, oscilloscope, digital multimeter and multiple-slot PXI chassis capabilities, which reduces investment on instruments. It also minimises the effort on measurement, automation and learning how to use the instruments, besides occupying much lesser space in labs. Adesh Kumar Jain, applications engineer, Keysight Technologies India Pvt Ltd, says, "Software tools control different instruments from a single software on a single screen. Even mobile versions of software tools are launched by companies to control/monitor measurements from smartphones. These are supplemented with tools to make automation easier."

Also, many power applications have fast-changing asynchronous current pulses which are not suited to fixed data length FFT analysis. Hence, gapped analysis causes events to be missed, resulting in inaccurate measurements. "The Newtons4th Ltd (N4L) power analysers use real-time discrete Fourier transform (DFT) technique with variable-window no-gap analysis to ensure the optimum speed and accuracy at all times," says Motiwale.

Why FPGA based analysers

Apart from the flexibility, FPGA based analysers are better for hardware in-loop testing and test coverage in time. Today, systems are all interconnected. There is lot of security and logic built into every communication protocol to ensure that no signal or information

Other factors shaping analysers

Broadband. LTE, Bluetooth, Wi-Fi, digital TV all require broadband real-time spectrum analysers when signal demodulation is needed.

Extensibility. It should be possible to accommodate continuously-changing broadcast requirements with the same hardware platform using task-specific software written to address the new needs. What could be more cost-effective than having an application programming interface (API) to write new functions?

Easily upgradable. It should be possible to upgrade the analyser easily when the need arises, just as a PC can be upgraded when more memory or storage is required.

—Bruce Devine, CEO, Test Equipment Plus, Inc.

is lost when it goes from one end to another.

Consider people who are building multiple-input and multiple-output (MIMO) systems to define the next generation of mobile communication called 5G. One of the biggest challenges that engineers face is having to define and implement the base station or customer premises equipment (CPE) even before the standard is defined. "In this case, you need logic analysers, spectrum or RF signal analysers, which can really behave as though it's a physical phone, and at the same time analyse the complete protocol that goes between the base station and the CPE. So the protocol is being defined and at the same time you are trying to emulate a particular device. This is not possible with traditional spectrum, logic and RF analysers," informs Mohanram. With FPGA technology, it becomes possible.

Testing is becoming a lot more thorough. According to Mohanram, "Earlier perhaps people used to test four different points, which is a small example, on a protocol to say it is fine. But today, instead of testing limited number of points, they could test pretty much all different points on the curve. So very thorough testing is possible because of FPGA." FPGA is basically a concurrent logic; everything happens in parallel and, because of that, the set time also drastically comes down.

Selecting the right analyser

Flexibility is one factor that is often missed out while selecting analysers. Scientists and engineers are comfortable using traditional instruments and have stuck on to those. It is a mindset people have stuck on to, but now it is

What is CPE?

In 3G and 4G, a base station is the cellular tower and CPE, in this case, is your phone. But moving towards 4G or 5G, instead of a phone it could be a router or a much more sophisticated device which could handle voice, audio, video and may be even some control signals. Mobile phone is one type of CPE that could be a much more complex CPE in upcoming next-generation technologies. Therefore, instead of calling it a mobile phone, it has a more generic name: CPE.

slowly changing. People realise, if they have the capability to define exactly what the analyser can do, they really are able to make optimal use and get the best throughput out of the system or the instrument they are building.

Mohanram says, "What we generally ask them is, 'Tell us what you exactly want to do with an analyser?' and we make them do it right in front of us by guiding them on how they could go about bending the instrument according to their requirements rather than adjusting with what the vendor typically provides," He adds, "Because of the buzz surrounding defining functionality of these instruments, that mindset is slowly changing, and I think that's one point I would like to emphasize which people should keep in mind while selecting these products."

Another factor that people generally ask while selecting analysers is, "Can this analyser analyse this particular protocol?" If it is followed by a yes, they immediately go for it, informs Mohanram. But the real question should be, "Can it be done in real time?" This is not considered while picking analysers. Real-time analysis helps users to do a two-way communication analysis, be it logic or communication from a RF stand point. People forget to ask about

What's driving growth of analysers?

Common factors	<ul style="list-style-type: none"> ➤ Active electronically steered RADAR with multiple capabilities using complex signals ➤ New wireless standards 3G to 4G now moving towards 5G ➤ Smart antenna technologies like MIMO, Beam forming ➤ Complex smart phones with multiple technologies working simultaneously ➤ Study of electrical and magnetic properties of material
Power analyser	<ul style="list-style-type: none"> ➤ Measurement of product efficiency for inverters, LEDs and electronic ballasts, UPS systems and transformers
Logic analyser	<ul style="list-style-type: none"> ➤ Design, analysis and troubleshooting of complex digital or logic circuits ➤ Analysis of embedded designs with features such as advance trigger functions and serial bus decoding features like I²C, SPI, CAN, UART, RS232
Spectrum analyser	<ul style="list-style-type: none"> ➤ Receivers/transmitters -frequency response, bandwidth, modulation, harmonics ➤ Amplifier characteristics, filter characteristics ➤ EMI pre-compliance measurements ➤ Analysing RF spectrum ➤ Testing of active and passive equipment ➤ Finding of VSWR of DUT ➤ Spectrum monitoring and management ➤ Interference hunting ➤ EMC pre-compliance testing ➤ Capturing intermittent events

MAIN CONTRIBUTORS TO THIS ARTICLE



Adesh Kumar Jain
applications engineer,
Keysight Technologies
India Pvt Ltd



Bruce Devine
CEO, Test Equipment
Plus, Inc.



Madhukar Tripathi
regional manager,
Anritsu India Pvt Ltd



Manisha Motiwale
technical manager,
Scientific Mes-Technik
Pvt Ltd



Satish Mohanram
technical marketing
manager, National
Instruments

real-time capabilities and get into trouble after getting the instrument.

Talking particularly about power analysers, Manisha Motiwale, technical manager, Scientific Mes-Technik Pvt Ltd, informs, "Manufacturers normally specify basic accuracy, but user should consider the accuracy specification for the complete range in which measurement is done. Also, one should check the standard and optional features, and accessories as per requirement."

Why real-time processing

In most cases, what usually happens is that the test engineers are told, "You have to test this particular protocol coming from your system. Get an analyser for that," informs Mohanram. He says, "That's the mandate an engineer gets. Sure there are a lot of analysers which can analyse that particular protocol, but what they don't share is the information on how they do that

analysis." These analysers capture all the information and a software on the instrument takes that data and processes it off-line to give the analysed information.

In the above case, if a particular protocol needs handshaking, it becomes completely impossible for people to use those off-line analysers. Handshaking means, based on an incoming signal, the analyser has to generate some other signal to establish communication and, once that happens, it starts pumping out data. In such cases, it is not feasible to use off-line analysers. To avoid this, engineers should look for online analysers.

Off-line analysis ideally has a transmitter and receiver, which can only split packets and see what is happening. Mohanram notes, "That is not a complete test that you are doing, because if you are trying to analyse a packet or trying to analyse commu-

nication protocol, you would want to do it as a different layer like physical or application layer, for instance. But if you just do splitting then you are not able to completely test the capabilities at every different layer. That drawback can be overcome by taking an analyser that can do in-line processing."

Pricing

For almost the same cost that people used to pay for box type analysers, the high-end FPGA-enabled analysers come in really handy. "I would say, at the same cost there is more and more functionality getting packed into these analysers and they are shrinking in size," says Mohanram.

Using a PC to do the processing work for all manner of test and measurement equipment may not be feasible for the larger manufacturers, but it does serve the user very well. "PC-based processing for test equipment is here to stay," says Bruce Devine, CEO, Test Equipment Plus, Inc. It puts pricing pressure on the traditional companies that build test equipment with the processor inside their equipment. He adds, "It is now difficult for many companies to justify the expense of buying anything but PC-based test equipment because of the cost savings, upgradability and extensibility of PC-based systems."

Today's analysers are a boon for engineers

Design engineers are supposed to spend time on designing their products rather than learning new instruments and spending time debugging instrument related issues. Today's instruments cater to all the different issues generally faced by these engineers. They are reliable, can be easily automated and can be reused for different platforms. Various software tools support instruments covering different technologies. Thanks to these capabilities, they enable engineers to invest least possible time on measurement, be confident about the measurements and spend more time on designing efficient products. ●

The author is a senior correspondent at EPY

From Sensors to Interfaces – Wireless Communication Has a Lot to Offer

The world of wireless communication has exploded in the last few years, making its way to the common man but becoming a genuine challenge for the designers. Let us discuss some new components and technologies that are now available for designing safe and secure communication devices

SNEHA AMBASTHA

Wireless communication is growing rapidly to touch every aspect of our lives. Besides communication, it now allows technologies like Machine to Machine (M2M) and the Internet of Things (IoT) to evolve, for instance.

While there are modules that transmit the data from our body to the cloud, there are also modules that send that data to our mobile phones or laptops for us to analyse. Then there are modules that can be embedded in our shoes so we can know, for instance, how much we have walked or run, for how long, and how many calories we have burnt in the process. For all this, we need to use power-efficient wireless systems with small form factor, high reliability, small size and low cost. The systems should also have less interference. Obviously, the responsibility of design engineers is increasing.

Communication interfaces

The integral part of a device that enables communication is an interface. No communication is possible without it. But the important thing to understand is that, the interface should allow minimum power consumption during data transfer and be efficient at the same time. With wired communication, the efficiency has not been much of a concern, though power has always been. Now, with the advent of wireless communication, the wired interfaces are getting replaced with wireless interfaces like interface modules and smart sensors. Even microcontrollers (MCUs)

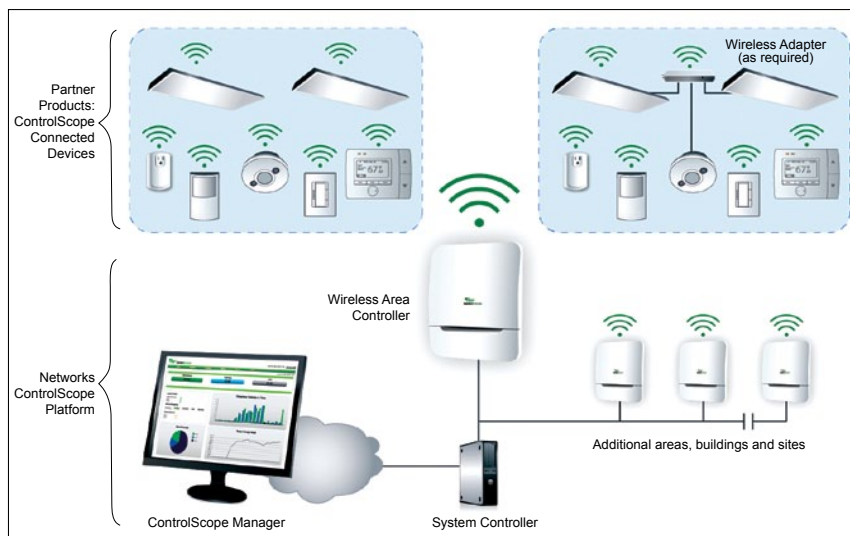


Fig. 1: Wireless communication

are getting integrated with the transmitters to provide better interfaces. Such interfaces can help reduce wires and overcome the obstacles that make hard wiring impossible or impractical.

Complex communication interface.

It is an interface, generally for an 8-bit MCU, that allows integration of a transceiver (sub-GHz) with an ultra-low-power 8051 core to allow a data transmit rate of up to 256kbps and a maximum output power of about 20 decibel-milliwatts (dBm). It is called complex interface because the MCU is integrated with the transceiver on the same module. It is suitable for applications related to IoT, wireless connectivity and low-power processing.

Interface with frequency hopping spread spectrum technology. It is an interface that allows rapid signal transmission over multiple frequency channels. It operates in a frequency band of

900MHz to communicate between the operator interface and individual, or groups of smart sensors. The 900MHz band is Federal Communication Commission (FCC) licence-free, has lower signal loss than other available frequency bands, offers greater signal transmissions through obstructions and avails greater transmission distances. A designer can use this interface to replace the RS-485 wiring that is used between the smart sensor and the personal computer or human-machine interface (HMI). One can also use it to design devices that can work on multiple frequency channels.

Interface for medical equipment.

Some medical equipment like electroencephalograph (EEG)/polysomnography (PSG) holer monitor or a blood glucose monitor (BGM) need wireless interfaces to allow the patients mobility and provide continuous data

for tracking. These interfaces have multiple MCUs replaced with a single MCU on a module, so as to reduce the component count and to provide a continuous reading even if the transceiver fails. It also applies to such wearable devices as a wristband to warn against possibility of a heart attack.

Wireless interface module. This module, based on Bluetooth wireless technology, supports display serial interface (DSI) protocol. This decreases the requirement of an external power source, thus further decreasing the number of components on the module. Such modules receive power from software drives, allowing the engineers to design a compact hardware without any requirement to search for an appropriate external power source.

Wireless transceiver with serial data interface. It supports 2×3 multiple input and multiple output (MIMO) configurations for a better array gain and a significant increase in data throughput. This allows the designing of a module without additional frequency requirement and increased transmit power.

Avinash Babu, senior project manager, Mistral Solutions, says, "There has been considerable traction on low-power wireless interfaces like Bluetooth low energy (BTLE or BLE), ZigBee and low-power radio frequency (RF) in the last couple of years. Many of today's low-power wireless solutions are aimed at enabling the Internet of Things."

Wireless microcontrollers

According to Babu, "There are several standard off-the-shelf wireless MCUs available currently, which the designer can use to quickly implement wireless solutions." The recently introduced wireless MCUs based on BLE technology are suitable for systems that have ultra-low-power consumption requirements. These MCUs support different data transfer rates like 250kbps, 500kbps, 1Mbps and 2Mbps, and have good blocking performance and a receiver sensitivity of about -94dBm at 1Mbps. Such MCUs enable long-range applications without any external frontend. These have hardware debug sup-

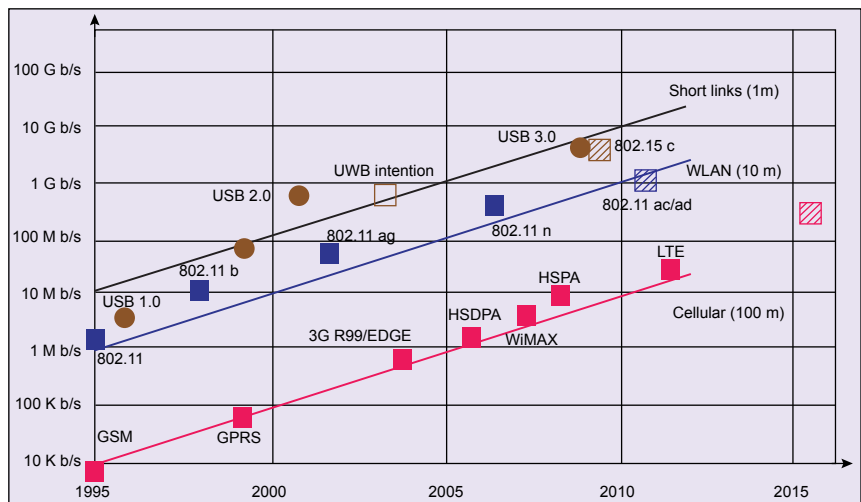


Fig. 2: Trend in wireless communication (Source: Google Search)

port and provide retention to all the relevant registers in all the power modes.

Then there are wireless MCUs suitable for applications related to IoT. This family of MCUs has built-in support for security protocols. Mrinmoy Purkayastha, vice president-Marketing, Calsoft Labs, says, "Security is a very important element in IoT and M2M communications. Devices with embedded hardware accelerators that support different security standards are valuable to build products that are reliable and power-efficient." This family of MCUs is well suited for such applications as heating, ventilation and air-conditioning (HVAC), power-line communication, refrigerators and smart e-meters.

Praveen Ganapathy, director-Processor & Connectivity Applications, TI (India) says, "Design engineers can now design using a single-chip MCU with built-in Wi-Fi connectivity. TI has created a wireless MCU for the Internet of Things, that integrates a high-performance ARM Cortex-M4 MCU, allowing customers to develop an entire application with a single IC. With on-chip Wi-Fi, Internet and robust security protocols, no prior Wi-Fi experience is required. The Wi-Fi network subsystem includes an 802.11 b/g/n radio, baseband and MAC with a powerful crypto engine for fast, secure Internet connections and 256-bit encryption. The Wi-Fi Internet-on-a-chip includes

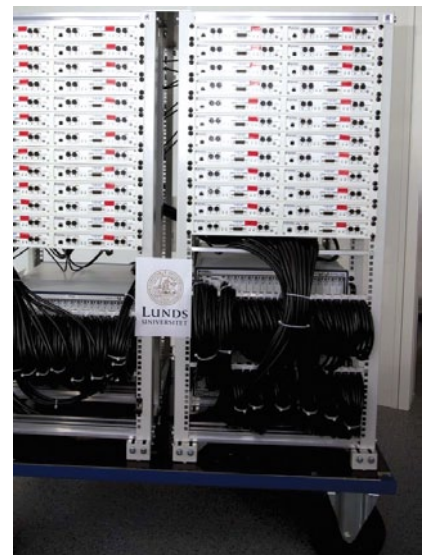


Fig. 3: The massive MIMO testbed at Lund University in Sweden is based on USRP RIO (Source: National Instruments)

embedded transmission control protocol (TCP)/Internet protocol (IP) and transport layer security (TLS)/secure sockets layer (SSL) stacks, hypertext transfer protocol (HTTP) server and multiple Internet protocols."

Smart sensors

The smart and intelligent sensors help reduce the installation and system costs. These increase system flexibility, simplify system deployment and address a new set of applications that was previously impossible with a wired approach. The sensors allow the engineers to design a system with ben-

TABLE I
Components and Chips

Manufacturer	Device Family	Part Number of family	Benefits Summary	Applications	Technologies	Key Parameters
Silicon Labs	Wireless Microcontroller	Si106x/Si108x	Combines high-performance wireless connectivity and ultra-low power microcontroller processing into a small 5mm x 6mm form factor	Home automation Home health care Building HVAC control Telemetry	Compliant with the 802.15.4g smart metering standard	-On-chip debug -Ultra-low power 8051MCU core -2 μ s wake-up time
NXP	Wireless Microcontroller	JN5148	Offers fully compliant 2.4GHz IEEE802.15.4 transceiver, 128kB of ROM and 128kB of RAM to support both the networking protocol stacks	JenNet, JenNet-IP and ZigBee PRO applications	Based on the IEEE802.15.4 standard	-Operating current consumption of 18mA when receiving, and 15mA when transmitting @ +3dBm -Ultra low power consumption -Highly efficient memory architecture -32-bit RISC CPU – 32MIPs
Texas Instruments	Wireless Microcontroller	CC2541-Q1	Enables the building of robust network nodes with low total bill-of-material costs	Both low-energy and proprietary 2.4GHz applications	Bluetooth Low Energy	-2.4GHz low energy compliant -Supports data rates of 250kbps, 500kbps, 1Mbps, and 2Mbps -Excellent link budget, Enabling long-range
Atmel	Wireless AVR Microcontroller	Atmeg-a256RFR2	Combines AVR microcontroller and best-in-class 2.4GHz RF transceiver and offers highest RF performance for single-chip devices.	-ZigBee/IEEE 802.15.4 – full and reduced function device -General purpose 2.4GHz ISM band transceiver with microcontroller -RF4CE, SP100, wirelessHART, ISM applications and IPv6 / 6LoWPAN	ZigBee/IEEE 802.15.4	-Ultra low power consumption (1.8 to 3.6V) for AVR & Rx/Tx: 10.1mA/18.6mA -38 programmable I/O lines -Speed grade: 0 – 16 MHz @ 1.8 – 3.6V range with integrated voltage regulators
Hope RF	Wireless Transceiver Module	RFM12B-S2	Module is implemented with a unique PLL (phase locked loop) and operates in the 915MHz band	Applications compliant with FCC and ETSI regulations		-Wakeup timer -Differential antenna input -Programmable TX frequency deviation (from 15 to 240kHz) -Programmable receiver bandwidth (from 67 to 400kHz)
Silicon Labs	Wireless Transceiver	Si4438 RF	High-performance, low-current, ISM band transceiver covering the 425 to 525MHz frequency band	-Smart metering and automated meter reading -Robust in home communications to home appliances -Long-range backhaul communications to the collector		-Frequency range: 425–525MHz band -Receive sensitivity: –124dBm -Power supply: 1.8V to 3.6V -> 84dB blocking for > 8MHz offset
Texas Instruments	System on Chip	TMS320T-C16636	Multicore SoC architecture designed for high-performance wireless infrastructure applications		CDMA/HSPA/HSPA+, TD-SCDMA, GSM, TDD-LTE, FDD-LTE, LTE-A and WiMAX	-Eight TMS320C66x DSP core subsystems per core @ 1.2GHz -ARM Cortex A15 quad core cluster @ 1.2GHz per core with 4MB L2 cache coherent memory
Allen-Bradley	Wireless Interface Module	Bulletin 22-WIM	Provides a wireless communications interface between computers equipped with Bluetooth wireless technology	All products that support the DSI protocol	Bluetooth wireless technology	-Full-duplex point-to-point protocol -Compatible with all powerflex compact-class drives and peripherals

Changing standards and technologies

Today, if we talk about the standards and the technologies associated with wireless communication, we will notice that there are fewer standards than technologies. Of course, there is a continuous research and innovation in baseband technologies to make them transmit/receive data faster and securely in noisy environments. Of all the standards in wireless communication, IEEE has become the most popular over the years (apart from 3GPP) due to its broad coverage of wireless technologies for different applications. IEEE standards like Wi-Fi and WiMAX provide high data transfer rates (11Mbps to 150Mbps), depending on the availability of the network. At the other end of the spectrum, a whole range of technologies under the 802.15 umbrella cover specialised applications such as wireless personal area networks, body area networks and industrial wireless communications.

Purkayastha says, "There is a considerable amount of research going on in RF side to develop software-defined radios with tunable RF support for better long-range wireless communication (4G/5G), personal area network and sensor area networks (802.15 umbrella). Then there is research going on to increase the interference cancellation techniques associated with the technologies." Most of the wireless communication technologies developed in the past are meant for use in applications that required clients to download data from the network most of the time. However, new applications like SmartGrid and SmartCities require sensors to upload data back to the grid all the time. Therefore wireless interfaces need to be designed to be more uplink efficient.

Wireless Gigabit (WiGig). WiGig is based on the more advanced 802.11ad standard and was named so by Wi-Fi Alliance. It allows a super-fast video streaming with a data transfer speed of up to 7Gbps. WiGig is based on the triband frequencies (2.4GHz, 5GHz and 60GHz) and has a network operating range of more or less nine metres only, so the triband chipsets can be considered to be advantageous as one can seamlessly switch between the 802.11n, 802.11ac and 802.11ad (WiGig) wireless standards.

Bluetooth Smart. Although it is the same old Bluetooth technology without much change, Bluetooth Smart uses less power as it does not send out signal all the time. This technology is better known as BLE and is widely used in almost every application, from home automation to medical devices and from mobile payments to retail geo-fencing. Companies like Apple and PayPal are working to build applications based on this technology to push phone upgrade messages and to implement a voice recognition technology.

5G. Although there are improvements going on in the existing technologies, companies like National Instruments (NI) are working on new ITU standards like 5G. 5G is in its early development stage and is anticipated to offer a significant measure of profit over the other existing technologies. It not only requires a software support but also requires a good hardware support for faster communication. New ways have been found to research, develop and test radios designed using 5G. The LabView Communication System Design Suite by NI makes this task possible in three steps: algorithm development by researchers; radio mapping using non-design tools by the designers for generating design standards; and radio implementation through code generation by the team.

"In order to support all these new technologies, the industry is working closely with product designers to help them write software to exploit new features, and working together on issues like power management to increase the efficiency of wireless communication devices without any compromise in the functionality," says Mrinmoy Purkayastha.

efits without any compromise in the system's reliability and measurement quality. Wireless sensors make the end product excitingly useful for the users.

The low-power ZigBee standards are basically optimised to the needs of the wireless sensor networks and thus offer self-healing mesh networking option along with robust self organising, low cost and complexity, the large extent of scalability and an excellent battery life. The smart sensors are also supporting wireless communication in smart meter and advanced meter infrastructures

(AMI), opening up a wide scope of designing options for the engineers.

Integrated transceivers

There are certain transceivers that not only offer a complete but also a high-performance mixed-signal system and RF on a single chip. In this category, there are some input/output RF based transceivers compatible with ZigBee standards that incorporate different layers of elements into another layer, facilitating a fast deployment feature.

This family of transceivers is

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equipped with the smart wake-up feature that enables it to wake only at defined intervals and scan the channels to receive a valid packet. It allows the designers to incorporate timing-critical elements so as to facilitate shorter deployment cycles. Such transceivers are designed for high-performance cost-effective wireless systems operating at very low-power and low-voltage conditions. These have integrated filters and so do not require any of the costly external filters.

Operational amplifiers (op-amps)

Op-amp is another important component that helps in wireless communication. It captures the sensor information, amplifies it and then passes it on.

The latest range of op-amps offer very low input offset voltage and almost zero drift. Thus, being high-precision op-amps, these allow the engineers to design a product that would process the data without much wait. This family of op-amps is virtually unaffected by any temperature change and can tolerate extreme temperatures in the range of -40°C to +125°C.

New-generation system on chip (SoC)

From BLE to the other standards, such as IEEE 802.15.4, RF4CE and ZigBee, the SoCs are compatible with many applications based on these standards. There are highly integrated SoC solutions with tightly coupled physical layer of the OSI model (PHY) and media access control (MAC) to minimise latency and to avoid complex software portioning across multiple devices. The best thing is the availability of better software suites to support the design of these SoCs.

Safe and secure communication parameters

The increasing use of wireless communication brings security into question. Then there are issues like noise, interference, energy efficiency, network coverage, reliability and latency. Purkayastha says, "Several integrated circuits with interference management

TABLE II Design and Development Tools		
Name	Type	Manufacturer
Code Composer Studio (CCS) Integrated Development Environment (IDE) for Multicore Processors	SW Development Tools, IDEs, Compilers	Texas Instruments
WLAN Measurement Suite	Test and Measurement tool Support for IEEE 802.11a/b/g/n/j/p/ac standards and up to 4x4 MIMO measurements	National Instruments
DriveExecutive software	Provides a simplified interface for programming, maintenance and troubleshooting of your PowerFlex AC and DC drives	Allen Bradley
Visual System Simulator	Enables engineers to design the right system architecture and formulate suitable specifications for each of the underlying components.	National Instruments
Advanced Design System	EDA software for RF, microwave, and high speed wireless communication with WiMAX, LTE, multi-gigabit per second data links, radar and satellite applications	Keysight Technologies
SimpleLink Bluetooth CC2564 Module Evaluation Board	Evaluation Modules and Boards	Texas Instruments

MAJOR CONTRIBUTORS TO THIS ARTICLE

- Avinash Babu, senior project manager, Mistral Solutions
- Mrinmoy Purkayastha, vice president-Marketing, Calsoft Labs (an Alten Group company)
- Praveen Ganapathy, director-Processor & Connectivity Applications, TI (India)
- Satish Mohanram, technical marketing manager, National Instruments

and noise filtering capabilities are used in communication devices. Interference is a major issue in crowded areas, such as shopping malls, airports, busy industrial areas, etc, where MIMO with multiple antennae for transmission and reception are used for interference cancellation." Satish Mohanram, technical marketing manager, National Instruments, says, "High-end wireless technologies like 5G require high amount of bandwidth to transfer large amount of data without any latency. MIMO provides those devices a space diversity for a deterministic transfer for data over wireless medium."

Companies like National Instruments are working on the prototyping tools for Massive MIMO to help design high-end wireless technology based devices from the scratch. Massive MIMO enables MIMO diversity and transmission without any loss in signal, enables the use of low-cost and low-power components, simplifies the media access control (MAC) layer and also provides robustness to intentional jamming and interference.

Test initiatives and solutions

Cost-effective ways have come up recently to test wireless communication devices at a high speed using shorter and flexible measurement steps. The tools not only test the existing but also the new formats of radio, including WiMAX, Bluetooth, HSPA+ and LTE. Then there are test sets to reduce the capital investment required in order to optimise the architecture for the non-signalling test. These sets help plan the test and troubleshooting graphically, which simplifies the testing process and reduces long-term costs related to the advancements in test modes.

From latency to high-power usage, the new range of embedded components is helping the designers to overcome all the issues that would decrease the popularity of the wireless devices designed by them. It also opens up a lot of opportunities before the designers to choose the best components at a very low price, and the changing technologies are helping further. ●

The author is a technical journalist at EFY

Part 2 of 2

Network Protocols and Smart Sensors: An Introduction to Wireless Sensor Networks

Wireless sensor networks (WSNs) have seen explosive growth in recent years because of their independent sensing capabilities. The first part of this article gave basics of the technologies used in WSNs. This concluding part covers network protocols and types of sensors generally used

DR J.D. JAIN

A wireless sensor network is a communication system which senses and gathers information from a certain area and sends it to where it is required. In such networks the communication system requires networking protocols which are efficient, reliable, scalable and secure.

Fundamental differences in sensor networks which affect protocols are:

Data sink(s). That is, the nature of data sink(s). For example, whether the end user is embedded in sensor network or access points

Sensor mobility. This aspect may influence protocols at the networking level as well as at localisation service

Sensor resources. Such as computing ability

Traffic pattern. For example, whether data is generated continuously during environmental monitoring

The factors to be considered while designing WSN protocols are:

1. Routing decisions to be undertaken considering the importance of energy resources in the network.

2. Communication channels often exist between events and sinks. Since sink nodes are typically used for overall description of the environment rather than explicit readings from the individual sensor devices, the communication in sensor networks is normally referred to as data-centric rather than address-centric, and the data may be aggregated locally rather than collecting all the raw data sent to the sink(s).

3. Sensors have the knowledge of

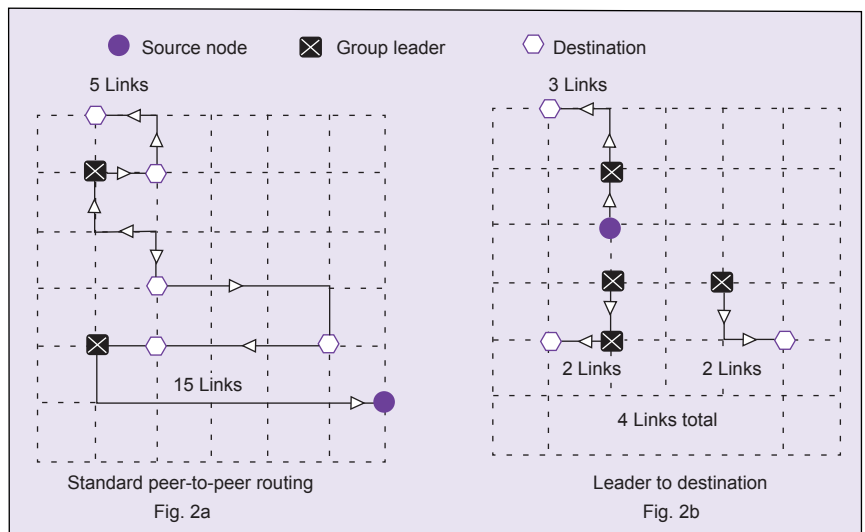


Fig. 2: Multicast routing reduces message path length and improves efficiency

their own location to usefully assess their data. The location information can be utilised for routing purposes.

4. If a sensor network is well connected, the topology control service should be used in conjunction with the normal routing protocols.

Multiple access protocols

When multiple nodes desire to transmit, protocols are needed to avoid collisions and loss of data. In frequency division multiple access (FDMA), different nodes have different carrier frequencies. FDMA also requires additional hardware and intelligence at each node. In code division multiple access (CDMA), a unique code is used by each node to encode its messages. However, this increases complexity of the transmitter and receiver.

In time division multiple access

(TDMA), the RF link is divided on time axis with each node given a predetermined time slot it can use for communication. This decreases the sweep rate, but a major advantage is that it can be implemented in software. All nodes require accurate, synchronised clocks for TDMA.

Medium access control protocols

Medium access control (MAC) protocols focus on reducing the idle power consumption by setting the sensing transmitters to sleeping mode as often as possible. MAC protocols have been designed for ad-hoc networks which primarily focus on optimising fairness and throughput efficiency with less emphasis on energy conservation. Some protocols like IEEE 802.11 eliminate the waste caused by

colliding packets in WSNs. Some others avoid unnecessary reception of packets by nodes that are unintended destinations. It has been assessed that idle power consumption can be of the same order as that consumed by the transmitter and receiver. Some of the MAC protocols are described below.

S-MAC. This protocol creates a sleep schedule that determines when to activate the receivers and when to put them in sleep mode.

Timeout-MAC (T-MAC). It eliminates idle energy further; instead of allowing the messages to be sent continuously, messages are transmitted in bursts in the beginning of the frame.

DMAC. Since many WSNs have data-gathering trees routed to a single data sink in the direction of packets arriving at a node, DMAC takes advantage of this by staggering the wakeup times for nodes based on their distance from the data sink.

Traffic-adaptive medium access (TRAMA). Aforementioned protocols help in minimising the power consumption by reducing the time that the transmitters remain in idle state, TRAMA attempts to reduce wasted energy consumption caused by packet collisions. Nodes determine their transmitting state using adaptive election algorithm (AEA). In AEA, each node calculates a priority for itself and all two-hop neighbours for the current slot. If a node has the highest priority for that slot and has data to send, it wins that slot and sends the data. If one of its neighbours has the highest priority, it sets itself to the receiving mode. In short, AEP assigns priorities for the unused slots to the nodes needing extra slots.

Sparse topology and energy management (STEM). When data packets are generated, the sensor generating the traffic uses a paging channel (separate from the data channel) to awaken the downstream neighbours.

Storage technology for portable devices

Flash memory has been the most reliable storage technology. However, visible limitations for future Flash cell

scaling include power consumption, charge storage requirements of the dielectrics, reliability issues and capacitive coupling between adjacent cells. Efforts are being made to reduce these limitations through system management techniques and fabrication technology (such as high k-dielectrics, nano crystal storage media and Fin-FET). However, there is no doubt that Flash will remain the dominant non-volatile memory technology at least down to 45nm node. Nevertheless, there are new memory technologies available, such as ferro-electric RAM (FeRAM), magnetic RAM (MRAM), ferro-electric polymer RAM (FePRAM), phase change memory (PCM), resistive RAM (RRAM), probe storage, carbon nano-tube memory (CNT) and molecular memory. The most promising are probe storage memories and PCM.

IEEE 802.16

IEEE 802.16 working group has come up with a standard called broadband wireless access (BWA), commonly known as WiMAX (worldwide interoperability for microwave access). IEEE 802.16 has specified two aspects of the interface for WiMAX, the physical layer (PHY) and the media access control layer (MAC).

The physical layer defines electrical and physical specifications for a device's establishment and termination of connection to communication medium, communication flow control, modulation coding, etc. It was designed to accommodate the need for a low cost yet allowing for high levels of integration. The use of direct sequence allows the analogue circuitry to be very simple and very tolerant towards inexpensive implementations.

The MAC layer was designed to allow multiple topologies without complexity. The power management operation does not require multiple modes of operation. The MAC allows reduced functionality device (RFD) that need not have Flash or large amounts of ROM or RAM.

MAC is divided into three sub-layers: convergence, common part and

security (or privacy). The convergence sub-layer describes how wireline technologies, such as asynchronous transfer mode (ATM), Ethernet 802.1 (LAN/MAN) and Internet protocol (IP) are encapsulated on the air interface and how data is classified.

The common part sub-layer is responsible for idle-mode processes like cell selection, paging structures and location-area updates. This layer is also responsible for sleep-mode processes, handover procedures, multicast and broadcast services, quality-of-services class and automatic repeat request (ARQ) processes. It also does header suppression, packing and fragmentation for efficient use of spectrum.

The security sub-layer provides the subscribers with privacy, authentication or confidentiality across the broadband wireless network. It uses encapsulation protocol and privacy key management (PKM) protocol. One of the features of MAC layer of 802.16 is that it is designed to differentiate service among traffic categories with different multimedia.

WiMAX is a wireless metropolitan area network technology which fits between wireless local area networks and wireless wide area networks. This standard introduces many advantages including variable and high data rate (up to 75Mbps), last-mile wireless access (up to 50km), point-to-multipoint communication, large frequency range and quality of service.

WiMAX supports two network architectures, namely, point-to-multipoint (PMP) mode and mesh mode. PMP network has one base station (BS) and multiple subscriber stations (SSs). The BS is the central control point and regulates all the traffic on the network. The multiple access schemes in WiMAX include both frequency division duplexing (FDD) and time division duplexing (TDD). TDD is more flexible than FDD.

The performance of IEEE 802.16 is assessed by throughput and delay. Throughput of scheduler is defined as the maximum bandwidth allocated by the scheduler with respect to the requested data rate by the subscriber stations, and the delay is defined as the

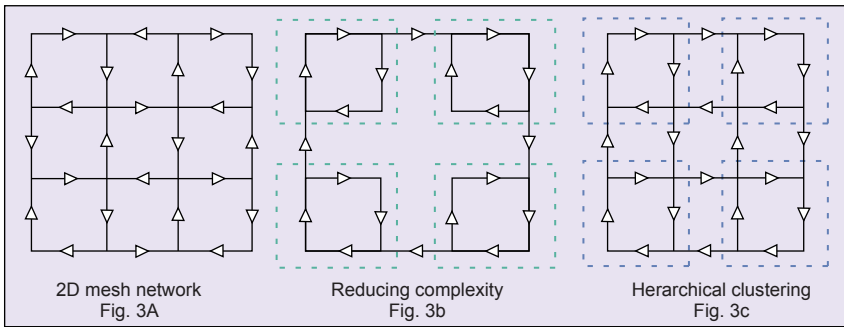


Fig. 3: Mesh network and modifications

time taken by the scheduler to allocate bandwidth for the packet in queue.

IEEE 802.15.4 defines a total of three frequency bands of operation: 2.4GHz, 915MHz and 868MHz. The 2.4GHz band offers a total of 16 channels (channel 11-26), 915MHz offers 10 channels (channel 1-10), and 868MHz offers just one channel (channel 0). The bit rate of the protocol depends on the selection of frequency of operation.

Frequency	Bit rate	Channels - Range
2.4GHz	250kbps	16 (11-26)
915MHz	40kbps	10 (1-10)
868MHz	20kbps	1 (0)

The maximum length of an IEEE 802.15.4 MAC packet is 127 bytes. Each packet consists of header bytes and 16-bit cyclic redundancy check (CRC) value. The 16-bit CRC value verifies the frame integrity. In addition, it optionally uses an acknowledged data transfer mechanism. With this method, all frames with a special ACK flag set are acknowledged by its receiver.

IEEE 802.15.4 based WSNs can support a maximum of 250kbps for 2.4GHz bandwidth. Therefore WSNs are employed in areas requiring intrusion detection or fire alarm, and where the packets are generated at very low data rates.

Network topology

The basic issue in communication networks is the transmission of message to achieve a prescribed message throughput quality of service (QoS) and quantity of service. Depending on QoS, installation in the environment, economic considerations and the application, one or a combination of the

following topologies may be adopted: fully connected, mesh, star, ring, tree or bus. Of these, mesh type with some modifications has been found to be more useful (see Fig. 3(a)).

Mesh networks are regularly distributed networks that generally allow transmission only to a node's nearest neighbours. The nodes in these networks are generally identical, so the mesh networks are also referred to as peer-to-peer (see Fig. 2(a)). Mesh networks are good for large WSNs that are distributed over a geographic region, such as personnel or vehicle security surveillance systems. Another advantage of mesh networks is that, although all nodes are identical and have the same computing and transmission capabilities, certain nodes can be designed as 'group leaders' that take on additional functions (see Fig. 2(b)).

Multicast systems in mesh networks use a hierarchical leader based scheme for message transmission. Each group of nodes has a designated leader that is responsible for receiving messages from and transmitting to nodes outside the group. The group leader for communication should be the entry node of each group, while the group leader for DSP should be the exit node. Multicast routing improves efficiency and reduces message path length (see Fig. 2).

Routing tables for distributed networks increase exponentially as nodes are added, and hence the number of links increases exponentially. To simplify the network structure, one can use hierarchical clustering techniques (see Fig. 3(c)). The hierarchical structure must have the same structure at each level.

Hierarchical network structure simplifies routing and is also amenable to distributed signal processing and decision making, since some processing can be done at each hierarchical layer. Failure recovery is also straightforward. If a link fails, one may simply switch in one of the disabled links to take over. Hierarchical structure must be consistent, that is, it must have the same structure at each level.

Edge binding. The phenomenon of edge binding means that much of the routing power of peripheral stations is wasted because peripheral links are unused. Thus message tends to reflect the boundary into the interior or move parallel to periphery. To avoid this, the Manhattan geometry connects the nodes at one edge of the network to nodes at the opposite edge, thereby reducing the complexity (see Fig. 3(c)).

Power management. With the advent of ad hoc networks of geographically distributed sensors in remote site locations, there is a focus on increasing life time of sensor nodes through power generation and power conservation. Researchers are designing micro-electro-mechanical systems (MEMS), which can generate power using solar, vibration and thermal energies.

Miniature RF components for transceivers. RF identification (RFID) devices can also be used for power management purposes. The transponder micro-circuit has an L-C tank circuit which stores power from received interrogation signals, and uses that power to transmit a response. RFID operates in a low frequency range of 100kHz to 1.5MHz, or a high frequency range of 900MHz to 2.4GHz, and has an operating range up to 30 metres. TDMA is especially useful for power conservation, since a node can remain inoperative between its assigned time slots and wake up in time to receive and transmit messages.

The required transmission power increases as the square of the distance between source and destination. Therefore multiple short message transmission hops require less power than one long hop. A current topic of

research in power controls is that each node cooperates with all other nodes in selecting the individual transmission power level.

Smart sensors

The IEEE 1451 standard makes it easier for different manufacturers to develop smart sensors and to interface these devices to networks. A smart sensor is a sensor that provides extra functions beyond those necessary for generating a correct representation of the sensed quantity. These include signal conditioning, signal processing and decision making/alarm functions.

Main objectives of smart sensors are: (a) move the intelligence closer to the place of measurement, making it cost-effective to integrate and maintain distributed sensor systems, (b) clustering of transducers, (c) control, compute and communicate for a common cause and (d) seamlessly interface many sensors of different types. The concept of virtual sensor is also fulfilled.

A virtual sensor, a component of smart sensor, is a sensor/transducer plus the associated signal conditioning and DSP. MEMS sensors are now well developed and are available for most sensing applications in WSNs.

Transduction mechanisms of sensors

Transducers convert energy from one domain to another and their outputs are generally voltages or currents. The sensory transduction may be carried out by using any one or more of the following effects of physical principles: piezo-resistive, piezo-electric, capacitive, inductive, magnetic or electro-magnetic, magneto-resistive, magnetic field, thermal (thermo-mechanical, thermo-resistive, thermocouples, resonant temperature sensors, thermopiles or bolo meters).

Optical transducers. These make use of photo-electric effect, photo-conductive effect, or optical-fibre based technology (for instance, devices like accelerometers often use time-of flight information, IR detectors or UV detectors).

Electro-chemical, chemical and biological. Used for solids, liquids and gases, these include metal-oxide gas sensors, interdigitated-gate electrode FETs (IGFETs) and their arrays, ion-sensitive FETs (ISFETs) like ionophone, quartz crystal micro-balance (QCM) and micro-cantilevers. Types of gases that can be monitored using metal-oxide gas sensors are CO_2 , CO, H_2S and NH_3 . Other applications are in medical diagnosis of smallpox, anthrax chemical warfare, food monitoring, security and surveillance (using implantable bio-sensors).

Acoustic wave sensors. Such sensors as surface acoustic wave (SAW), thickness shear mode (TSM) and flexural plate wave (FPW) make property changes, such as mass into detectable electrical signals.

Commercially available nodes come with five sensors installed for temperature, light, acoustic, acceleration/seismic and magnetic effects. Especially suitable for surveillance purposes, these work with operating frequency of 916MHz or 433MHz, with a data rate of 40k bits/sec, having a range of 10 to 30 metres. Installation of these devices requires a great deal of programming.

Ultra wide band (UWB) is of great interest in distributed networks, since UWB is a short-range technology that can penetrate walls. It is suitable for multi-node transmissions and has built-in time-of-flight properties that make it very easy to measure ranges down to 1cm with a range of 40m.

Moreover, UWB transceivers can be made very small and are amenable for MEMS technology. Since in pulse position modulation no carrier is needed, it means the antennae are not inductive. But signals coming from MEMS may be very noisy, of low amplitude, biased and dependent on secondary parameters, such as temperature, which is an undesired characteristic. That is why the signal conditioning circuits are very essential. ●

Concluded

The author is director (R&D) at Global Institute of technology, Jaipur

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An Introduction to Plesiochronous Digital Hierarchy

Plesiochronous digital hierarchy is a digital multiplexing technique that offers bit rates starting with the basic multiplex rate of 2Mbps with further stages of 8, 34 and 140Mbps. It is used in telecom transmission networks to transport large quantities of data from one place to other place

DR RAJIV KUMAR SINGH

Delivery of services like telephony, voice-over-IP, video streaming, telemedicine, broadcasting of TV programmes, high-speed file sharing, online banking, online video gaming, online education and shopping, needs a transmission network capable of very high data-rate transport capabilities. Innovation in the telecom industry has led to a new kind of multiplexing and de-multiplexing technique called plesiochronous digital hierarchy (PDH).

The term plesiochronous is derived from Greek *plēsios*, meaning near, and *chronos*, time. This ensures that PDH network elements run in *nearly* time synchronised manner. Multiplexing of several low data-rate channels is done to utilise the high data-rate transmission capacity of transmission media. The bit rates start with the basic multiplex rate of 2Mbit/s with further stages of 8, 34 and 140Mbit/s. Such a hierarchy is shown in Fig. 1. PDH networks provide circuits to switched public networks and may also be used to build synchronisation networks.

Evolution of PDH

With the introduction of pulse code modulation (PCM) technology in the 1960s, communication networks were gradually converted to digital technology over the next few years. PCM allows multiple use of a single line by means of digital time-domain multiplexing (TDM). The PCM involves

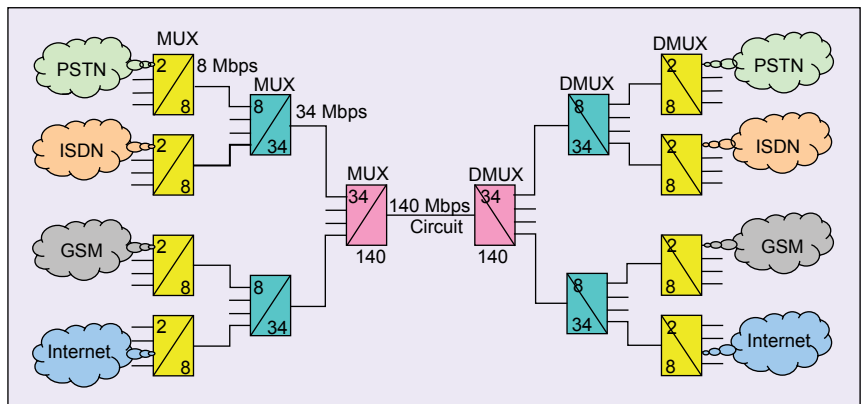


Fig. 1: Plesiochronous digital hierarchy used as a circuit provider

sampling, quantisation and encoding. As a standard voice telephone signal has a bandwidth of 4kHz, it is sampled at twice the 4kHz frequency, that is, at 8kHz (Nyquist rate). Each sample is then converted to an 8-bit binary number. This occurs 8000 times per second.

Thus, if we multiply 8k samples/s $\times$ 8 bits/sample, we get the standard bit rate ($= 64\text{kbps}$) for a single voice channel. A transmission rate of 2048kbit/s ($= 64\text{kbps} \times (30+2)$) results when 30 such coded channels are collected together into a frame along with the necessary signalling information (equivalent to two time slots). This so-called primary rate, 2048kbit/s , is used in most parts of the world.

The growing demand for more bandwidth meant that more stages of multiplexing were needed throughout the world. In order to meet the demand for higher bit-rates, the digital multiplex hierarchy PDH evolved in various parts of the world, differing

with one another. PDH hierarchies developed and adopted by Europe, North America and Japan used different tributaries for multiplexing and de-multiplexing (Fig. 2).

In Europe, PDH adopts bit rates starting with the basic multiplex rate of $2048\text{kbit/s} \approx 2\text{ Mbit/s}$ with further stages of 8, 34 and 140 Mbit/s. In this system, 30 channels are multiplexed together that results in 2.048Mbps basic rate, which is designated as E1. If four such lines are multiplexed together, and taking some framing bits, we get 4×30 channels = 120 channels = 8.448Mbps = E2 designation.

Multiplexing four E2 lines together we get 4×120 channels = 480 channels = 34.368 Mbps = E3 designation. Again, multiplexing four such E3 lines results in 4×480 channels = 1920 channels = 139.264Mbps = E4 designation. Further multiplexing such four E4 lines results in bit rate = 4×1920 channels = 7680 channels = 564.992Mbps = E5 designation.

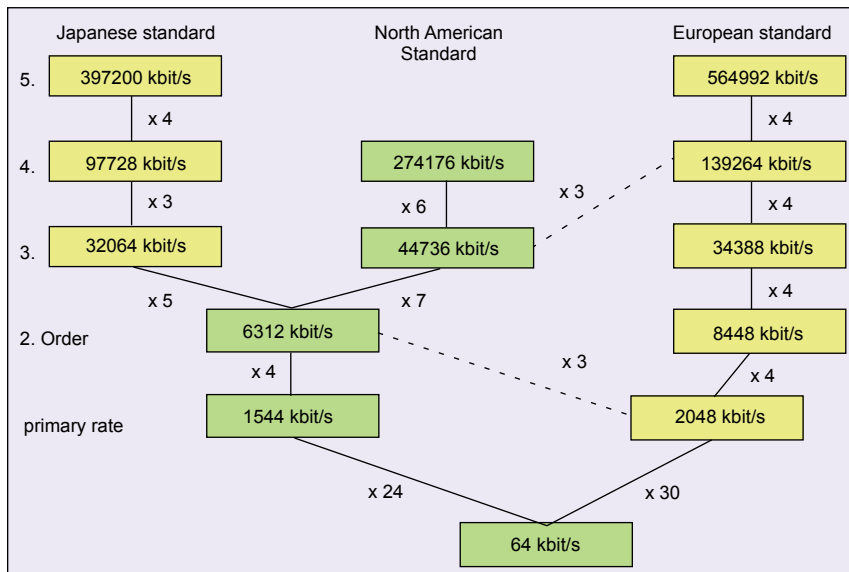


Fig. 2: PDH multiplexing hierarchies used in the different geographical areas

The basic digital multiplexing standard established in the United States, called the Bell System Level 1 PCM Standard, or the Bell T1 Standard, multiplexes 24 separate voice channels together, resulting in a primary rate of 1544 kbit/s. This basic rate is also being followed by Canada and Japan. In the USA's (North American) DS1 System each voice channel is 64 kbps and is designated as digital signalling Level 0, or DS-0. Each frame in the 24-channel multiplexer consists of 8 bits/channel $\times$ 24 channels + 1 framing bit = 193 bits. The total data rate when transmitting 24 channels is determined by 193 bits/frame $\times$ 8000 frames/s = 1.544 Mbps = T1, or DS-1 designation.

If four T1 lines are multiplexed together, we get 4×24 channels = 96 channels = 6.312 Mbps = T2, or DS-2 designation. Multiplexing seven T2 lines together we get 7×96 channels = 672 channels = 44.736 Mbps = T3, or DS-3 designation. If six T3 lines are multiplexed together, we get 6×672 = 4032 channels = 274.176 Mbps = T4, or DS-4 designation.

Similar hierarchy has also been adopted by Japan, but with slight deviations at higher order multiplexing/de-multiplexing levels. Japanese PDH system multiplexes 24 channels together, which results in basic rate of

1544 kbps. At the second order, four such lines are multiplexed together. Taking some framing bits, we get 4×24 channels = 96 channels = 6.312 Mbps. At the third order level, five second order lines are multiplexed together resulting in 5×96 channels = 480 channels = 32.064 Mbps. Again, multiplexing three such third order lines results in 3×480 channels = 1440 channels = 97.728 Mbps. Multiplexing such four fourth order lines results in bit rate = 4×1440 channels = 5760 channels = 397.2 Mbps.

General structure of PDH signals

The PDH signal is a serial signal stream with a frame structure formed by bit-interleaving the various signals carried within its structure. A general frame structure for a 2.048 Mbps bit stream is shown in Fig. 3. Each frame consists of 30 channels in channel-associated signalling (CAS) scheme or 31 channels in common-channel signalling (CCS) scheme. Sampling rate of each channel is 8000 samples/s (frame duration 125 microseconds) and there are 8 bits/sample. Thus, the basic speed of each channel is 8000 samples/s $\times$ 8 bits/sample = 64 kbps. In total, there are 32 time slots in each frame (designated as TS0, TS1, ..., TS31)

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		FAS/NFAS Bits								Ch1		Ch15	Ch16								Ch17		Ch31								
									Ch1		Ch15	MFAS Bits								Ch16		Ch30									
Frame Numbers	0	C1	0	0	1	1	0	1	1			0	0	0	0	S	A	S	S												
	1	0	1	A	S	S	S	S	S			a1	b1	c1	d1	a16	b16	c16	d16												
	2	C2	0	0	1	1	0	1	1			a2	b2	c2	d2	a17	b17	c17	d17												
	3	0	1	A	S	S	S	S	S			a3	b3	c3	d3	a18	b18	c18	d18												
	4	C3	0	0	1	1	0	1	1			a4	b4	c4	d4	a19	b19	c19	d19												
	5	1	1	A	S	S	S	S	S			a5	b5	c5	d5	a20	b20	c20	d20												
	6	C4	0	0	1	1	0	1	1			a6	b6	c6	d6	a21	b21	c21	d21												
	7	0	1	A	S	S	S	S	S			a7	b7	c7	d7	a22	b22	c22	d22												
	8	C1	0	0	1	1	0	1	1			a8	b8	c8	d8	a23	b23	c23	d23												
	9	1	1	A	S	S	S	S	S			a9	b9	c9	d9	a24	b24	c24	d24												
	10	C2	0	0	1	1	0	1	1			a10	b10	c10	d10	a25	b25	c25	d25												
	11	1	1	A	S	S	S	S	S			a11	b11	c11	d11	a26	b26	c26	d26												
	12	C3	0	0	1	1	0	1	1			a12	b12	c12	d12	a27	b27	c27	d27												
	13	E	1	A	S	S	S	S	S			a13	b13	c13	d13	a28	b28	c28	d28												
	14	C4	0	0	1	1	0	1	1			a14	b14	c14	d14	a29	b29	c29	d29												
15	E	1	A	S	S	S	S	S			a15	b15	c15	d15	a30	b30	c30	d30													
		Timeslot TS0								TS1		TS15																			
Legend	Ci	Cyclic redundancy checksum bits													Frame alignment bits																
	E	CRC-4 Error signaling bits												0	Frame alignment supervision bit																
		CRC-4 Multiframe alignment												1	CAS multiframe alignment																

Fig. 3: The 2.048Mbps basic frame structure

resulting in $32 \times 64\text{kbps} = 2.048\text{Mbps}$ speed.

In CCS scheme, TS0 and TS16 time slots are used for synchronisation, bit-error detection, alarm indication, frame alignment, etc. Cyclic redundancy check (CRC-4) bits allow the detection of errors. In TS0 time slot, frame alignment supervision (FAS) bits allow targeting of synchronisation to find the beginning of the frame. FAS bits are only transmitted on odd frames. Non-frame alignment supervision (NFAS) is used to manage alarms and errors, such as loss of signal (LOS) indication in the event of link failure or frame loss. NFAS uses a bit equal to '1' to avoid coincidences. In TS16, bit A is used for remote alarm indication for such instances as a power fault, loss of incoming signal, or loss of multi frame alignment. Bit S is used for maintenance or performance monitoring. Multi frame alignment signal (MFAS) is used to synchronise the channel-associated signalling.

Difficulties with PDH

Traditionally, PDH system is pleiochronous, which means the network elements work more or less in

time-synchronised manner, not in exact sync. Slight differences in timing signals mean that justification or stuffing is necessary when forming the multiplexed signals. Inserting or dropping an individual 64kbit/s channel to or from a higher digital hierarchy requires a considerable amount of complex multiplexer/de-multiplexer equipment.

One of the major hurdles with PDH system is adoption of different standards around the world. Various geographies of the world use different hierarchies, which lead to problems of international interworking. For example, between those countries using 1.544Mbit/s systems (USA and Japan) and those using the 2.048Mbit/s system (Europe), specialised interface equipment is required to interwork the two hierarchies.

To recover a 64kbit/s channel from a 140Mbit/s PDH signal, it is necessary to de-multiplex the signal all the way down to the 2Mbit/s level before the location of the 64kbit/s channel can be identified. PDH requires 'steps' (140-34, 34-8, 8-2 de-multiplex; 2-8, 8-34, 34-140 multiplex) to drop out or add an individual speech or data channel (Fig. 1).

Channel cross-connection is also an issue with PDH. In this system, identification of individual channels in a higher-order bit stream is not possible. Most PDH network equipment is proprietary. Vendors use their own line coding, optical interfaces, etc. Moreover, PDH systems lack in network management and monitoring capabilities too. In most parts of the world, there is no standardised definition of PDH bit rates greater than 140Mbit/s. Besides, each multiplexing section has to add overhead bits for justification, which is again not an efficient use of the available transmission bandwidth. PDH net-

work architecture does not allow ring structure and works in point-to-point topology.

Conclusion

A PDH transport system provides the technical means to transfer large quantities of data between two network nodes. But it is very difficult to interoperate different PDH networks as it is a specific vendor proprietary based technology that lacks in global standardisation. Different parts of the world use different hierarchies for multiplexing and de-multiplexing. Moreover, PDH does not allow direct multiplexing, which means individual tributary signals cannot be inserted or removed into the PDH multiplexed signal without intermediate multiplexing and de-multiplexing steps. Supervision and maintenance functions are limited. This makes PDH an inefficient signal transport technology. ●

The author, working with BSNL, holds a PhD degree from IIT (BHU), Varanasi. He holds senior research fellowship of UGC at Centre of Advanced Study, Department of Electronics Engineering, IT-BHU in Varanasi. His current research interests include wired and wireless technologies for high-speed Internet access

Part 2 of 3

Fire Control Systems: The Electronics Behind Big Guns

The first part of this article explained what big guns actually do and how, and more importantly the crew protection systems. This part describes various fire control systems

B. KAMALANATH

To shoot a target, the gun of a tank or self-propelled gun (SPG) has to be oriented at a particular angle with respect to horizontal and vertical planes. These two angles are called 'firing solutions' which are highly dependent on various factors and need to be calculated mathematically. Fire control system (FCS) further alleviates this complication.

Before knowing how FCS alleviates the complication, it is necessary to first understand the complications present in shooting. Primary target for a tank is an enemy tank. A shell fired from a tank's gun will not travel in a straight line but will lose altitude due to gravity as it travels. So a gunner must know the distance of the target, and accordingly shoot higher to compensate for the fall. But if the target is on an elevated or depressed ground with respect to the tank, the compensations differs.

Apart from such factors, crosswinds blow the shells away from the target. So before shooting, the wind speed should also be known. Based on wind speed, the shell has to be fired off the target (towards the direction of the blowing wind), so that the wind can take it to the target. These many factors have to be considered for just shooting a stationary target!

To further complicate matters, a moving target presents a problem in a different league. The shell should be fired such that the target will come into the shell's path and take the hit, in what is called 'lead shooting'—

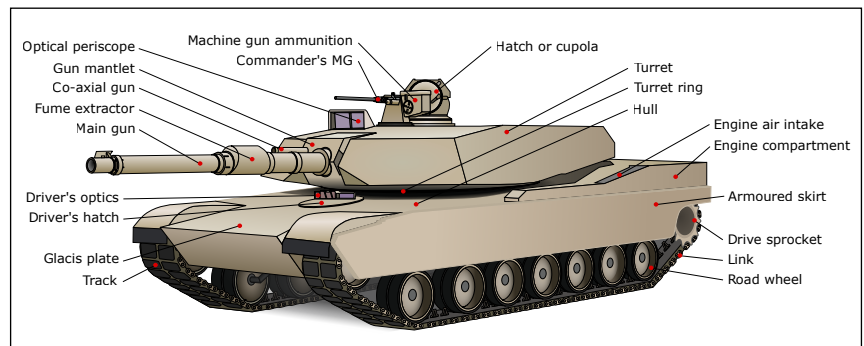


Fig. 12: Components of FCS and tank (Courtesy: <http://en.wikipedia.org>)

synonymous to a fielder running to catch the ball in cricket. To lead shoot, the gunner must know the speed of the target and its bearing. If the target is moving perpendicular to the gun then shooting it will be relatively easier. But if the target is making a different angle then shooting it will not be easy.

When shooting a moving target complicates the matter, shooting a stationary target while the tank itself is on the move is equally complicated. For this, the speed and angle the tank is making with respect to the stationary target should be known, and accordingly the shell has to be fired. Shooting a moving tank from a moving tank was a fascination and was taken for granted as impossible during World War II.

Because, for targeting, the earlier tanks had only telescopic sights engraved with stadiometric scales and crosshairs, the tank commander had a commander's sight—a traversing periscope. It had to be rotated manually through a wheel to get a 360° view. The tank commander

would search for targets rotating this sight. He would select a target and command the gunner to shoot it. The gunners were trained to use the stadiometric scales for estimating the range of the target and shoot it. To shoot a target, the tanks had to halt and thus became a sitting duck for other enemy tanks.

But today, with the introduction of electronic fire control system (FCS), which calculates the firing solution, the contemporary tanks can shoot moving targets accurately even while on the move. What is inside an FCS? The FCS has a ballistic computer, electronic sights and an array of sensors.

Ballistic computer. FCS is based on a ballistic computer which chiefly derives inputs from various sensors fitted in the tank. But it derives primary data from the electronic sights.

Electronic sights. Electronic sights have replaced the telescopic sights of the earlier tanks. Electronic sights are technically nothing but cameras hooked to interactive LCD screens. These sights are capable of

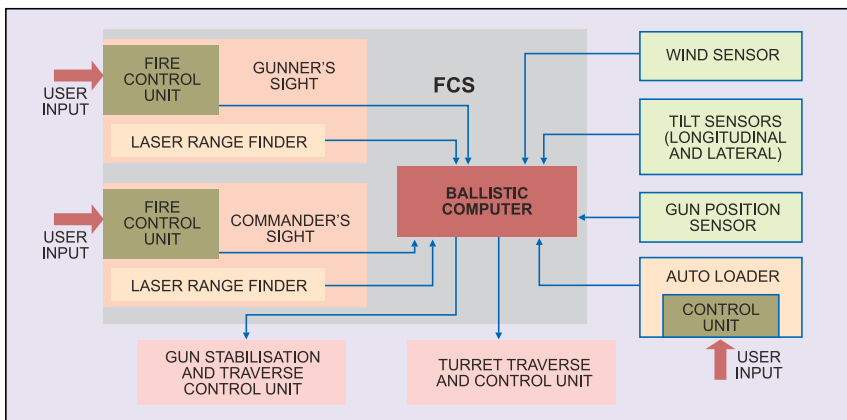


Fig. 13: Block diagram of a tank's FCS

showing images even during night time due to their low-light image capturing capability through thermal imaging. The sights are technically called forward looking infra red (FLIR) imagers. These are generally capable of detecting IR wavelengths in the 8 to 14 micron band and have their lineage from the targeting sights of combat aircraft. These imagers actually see (sense) the heat signature of a target rather than its visual image; even a target well-camouflaged inside foliage cannot escape from it. Because of these sights, contemporary tanks are as active in the nights as they are during day time. But tanks of the past were night-blind.

Crosshairs are generated electronically and are not engraved crosshairs; the ballistic computer keeps track of the alignment of the crosshairs. The gun gets heated heavily due to high pressure build up inside the barrel during firing process. The gun barrels tend to slightly bend due to this heating. This miniscule bending can lead to pronounced deviation at longer range. Often the gunner, using a system called muzzle reference system, can adjust the crosshair's position in his sight based on the barrel's degree of bending.

The commander's and gunner's sights are almost equally capable and independent. The tank commander's cumbersome opto-mechanical sights of the past have been replaced by a stabilised panoramic sight for day and night observation. Commanded

through a joystick, these panoramic sights can rotate 360°. The gunner's sight is also night-imaging capable but not panoramic. The gunner's sight can be enslaved to the commander's sight by the commander to see what the gunner sees. These sights find the range, speed and the bearing of a target!

With an embedded laser range finder (LRF) present in the sights, the ballistic computer gets the range of the target. The LRF flashes a narrow pulse-coded IR laser beam for a microsecond on the target area covered by the crosshairs. With laser sensors associated with the LRF, the reflected laser beam from the target is sensed. The time duration between the flashing and sensing gives the round-trip time between the tank and target. From this the ballistic computer calculates the range. The typical maximum range of laser rangefinders is 10 kilometres with an error of 10 to 20 metres at the extremities of the range.

Similarly, for a moving target, the gunner has to keep the crosshairs on the target for a second or two. During this time period, the computer flashes the LRF on the target repeatedly and extrapolates the target's course. Now the ballistic computer has the data regarding the target's range, speed and angle.

Sensors. Using wind sensors situated on the top of the turrets, the ballistic computer measures the crosswind speed. Using pendulum static canti-

lever sensors located at the centre of the turret roof, the ballistic computer calculates how much the tank is tilted due to uneven ground.

Similarly, the ballistic computer takes the speed of the tank and its course from a system called inertial navigation system (INS). (This INS is a navigation system that helps ships, aircraft and missiles to find their position in the open water and airspace, respectively. But a tank getting them is one of the strangest aspects of battle dynamics.) From the gunner's console, the gunner has to manually input the data regarding the ammunition type and some miscellaneous data.

Additional functions of FCS

The FCS has some additional functions. For instance, FCS lays and stabilises the gun and produces symbology for the gunner/commander.

Laying the gun. From the data derived from the sensors and sights, the firing solution is derived in no time. Accordingly, the ballistic computer actuates amplidyne that move the turret in the required position. Similarly, the gun is also actuated through the amplidyne. A constant feedback is maintained to ensure that the turret and gun are moved according to the desired angles.

If the tank is moving fast and the gun is kept at the required angle rigidly, even a slight bump on the road can take the gun off the correct angle. If at that particular instant a shot is fired, even a slight bump will reduce the accuracy. So the ballistic computer holds the gun loosely on the target through stabilisation. To sense the tank's movements, accelerometers are used as sensors that give an electrical output whenever the tank jerks. Immediately the FCS correspondingly controls the amplidyne and maintains the gun in the required orientation—all in just a fraction of second.

Symbology. Apart from these sensing and controlling operations, the ballistic computer generates symbologies on the display regarding various

parameters, like range of the target. By displaying a ready symbology on the sight, it also indicates to the gunner that he can shoot.

Autoloader and shell loading. The firing solution has been derived, the gun is laid, what about the ammunition? Generally, it will be loaded even before deriving the firing solution. Who does it? Western tanks require a soldier known as loader who, under the command of the gunner, picks up the appropriate shell from ammunition rack and loads it in the gun. A slight mistiming can result in amputation for him.

The Soviet Union/Russian-origin tanks use an important system called autoloader. The autoloader is a separate system but loosely interacts with the FCS. The autoloader selects the shell according to the gunner's command and loads it in the gun. During combat, different types of shells are required to tackle various situations. For this, the gunner inputs the re-

quired shell type in his console and the autoloader loads accordingly. The FCS checks whether the autoloader has loaded the shell into the gun or not.

Engagement sequence

In a typical combat, the tank commander (with his panoramic sight) searches for a suitable target, detects it and presses a switch called align switch. The FCS slews the turret to face the target. The gunner then takes over the engagement of the target. The gunner aligns the reticle on the target and then the FCS takes over the engagement from him. The FCS starts performing the sequence of events from ranging and tachometric process (detecting the speed of the target), lays the gun and when all are set, the gunner can fire the gun.

The commander, after having assigned a target to the gunner, uses his panoramic sight to locate the next target. If he has located a target

even before the current firing, it is stored in the memory of the FCS. After firing and damage assessment of the target is over, the gunner can take up this new target from the FCS memory. The commander can keep on looking for new targets through his sight and, if required, he can take over the engagement from the gunner and himself shoot on sudden threats. In the past such an engagement sequence would have been a dream! The modern tanks are said to be capable of typically engaging around six different targets within 35 seconds while on the move.

Apart from these commander's and gunner's sights, the tank driver also has a day/night-capable sight. With that he can drive the tank as efficiently during nights as he does during day; the driver needs not to even switch on the headlights to drive. In some very latest tanks, rear facing cameras feed imagery to the driver who can easily reverse the tank, or manoeuvre into the



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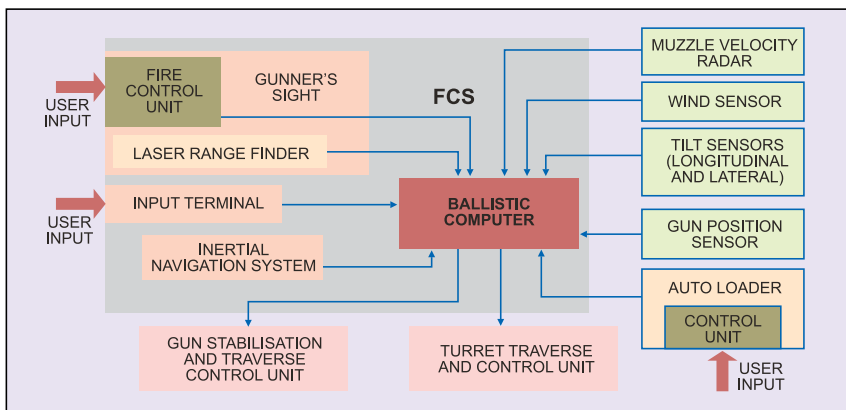


Fig. 14: Block diagram of SPG's FCS

confined spaces of a transport aircraft easily.

Fire control system of SPG

The FCS of a self-propelled gun also performs more or less like a tank's FCS. It executes the gun laying and stabilisation job but does not have the complexity of engaging a moving target or firing the gun on the move. For an SPG, the targets are stationary and the gun is also stationary. But what is important is the number of shells rained accurately on a target situated at long ranges. Because once artillery shells start coming, the enemy will track their trajectory through their weapon locating radars and find out locations of the guns. Then the enemy will not sit idle. They will try to neutralise the SPGs with their own guns in what is called as 'counter battery fire' in artillery parlance. So, to evade counter battery fire, the SPGs are required to bombard heavily and then move away rapidly in what is called as 'shoot and scoot' tactics.

But laying the gun accurately has not been easy. A fraction of a radian deviation will cause the shell to deviate and land way away from the target. (A *trigonometric milliradian (mrad)* is the angle formed when the length of a circular arc equals 1/1000 of the radius of the circle.) The place where the SPG stands, its elevation/depression, tilt, etc affect the gun's alignment. During firing, the gun

also moves backwards due to recoil and needs to be readjusted for every shot fired. All these complexities are met by the modern electronic fire control systems.

The first requirement to fire at an unseen target is that the FCS must know its geographical position. So it derives its own position with respect to 'true north' through a navigation system based on an inertial navigation system. Often this navigation system's output is added with a GPS 'topping' for accurate derivation of coordinates. When the target's geographical coordinates, altitude and other environmental parameters are entered into the FCS, it finds out how the target is aligned with it and in which direction. It also takes other inputs like altitude of the current position, tilt angles if any, wind speed, etc. With that, it transforms the positional information into firing solution, which tells how the gun has to be aligned. Accordingly, it actuates the electrical drives and lays the gun. In World War II era photographs we often see the gunners working with a bare chest, beaten by sun and dirt. To an extent, we can comfortably say that modern-day guns can be fired without losing the crease of gunners' uniforms. Not only that, the enemy is at the MRSI of these guns. We know mercy, but what is this MRSI?

MRSI stands for multiple round simultaneous impacts. As these SPGs fire at a long-range target, the shell reaches the target in a parabolic tra-

jectory. If a shell is fired by slightly depressing the gun, the shell's trajectory will have a shallow angle and it will reach the target quicker than the previous shell. Using this technique, it is possible for the SPG to rapidly fire some five shells by progressively depressing the gun for each firing. Thus the shells will land on the target at almost the same time and can pepper the target. This is what MRSI is for.

Though easily said, this technique is impossible to execute without modern FCS and automatic loaders. The FCS calculates the time interval between successive firings and lays the gun at the required firing angle. The time duration between the successive firings may be at a maximum of 2-3 seconds. So, within 20-30 seconds, the entire firing can be completed and the SPG can move even before the enemy recovers from the shell shock. Typically, if four SPGs fire on a single target in this fashion, it is possible that a total of twenty shells land on the target at the same time to annihilate it in no time.

Apart from this indirect fire, the SPG also retains some direct fire capability. For this it has an electronic sight, as in the case of a tank, but with limited functions. When the direct fire mode is selected, the gunner puts the target on the crosshairs and the FCS accordingly lays the gun. This direct fire mode is very rarely used. For direct firing the gun will be almost parallel to the ground. Engaging a moving tank in this position will be out the limits of the FCS of SPGs.

Having understood what big guns actually do and how, and crew protection systems in the first part, this part described various fire control systems. The concluding part next month will cover various types of smart shells and anti-tank missiles.

To be concluded next month

The author is a techno-strategy analyst pursuing doctorate in military electronics. Several of his articles on this subject have been published in this magazine since 2006

Telecom Offers Mostly Developer and Installation Roles for Fresh Graduates

Network infrastructure, integration and IT are the three main roles available for fresh engineers in India's telecom sector today. Let us explore the other aspects related to a career in this sector and find out if telecom could be the best bet to kick-start your career

ABHISHEK A. MUTHA

According to a recent report, telecommunication services are likely to grow to 15% of the GDP by 2015. The escalation in the domestic market is expected to grow with the arrival of new players and launch of new services. This growth potential in the sector makes it a highly sought after sector by professionals. Let us dive straight into the kind of roles available for an engineer in this sector, followed by the diverse responsibilities of telecom engineers and their remuneration.

There are various roles available for engineers, such as radio frequency (RF) survey engineer, base transceiver station (BTS) engineer, microwave engineer and spectrum analysis engineer. But all these are limited in terms of numbers and allocation to fresh engineering graduates. For freshers, jobs are available mostly as network and integration engineers or as software/application developers.

A network engineer performs design, audit and optimisation of a network to meet a customer's requirements. This role is applicable for design and optimisation of radio access network, transmission, core and services networks. The network engineer can also be engaged in the whole process from pre-sales of services and networks to service delivery and acceptance. Basically, the role is more focused on executing, audit, design and optimisation services, where the network engineer is responsible for a part of the solution and a part of the service process. As a result, the engineer is responsible to keep timing,



You could be an integration engineer...

Responsibilities and tasks:

- Support pre-sales activities, including pre-studies
- Plan implementation of the product configuration/integration work
- Execute product configuration
- Execute integration work
- Prepare acceptance test and handover to customer
- Identify and drive improvements
- Perform post-project activities

Preferred requirements:

- Problem solving and troubleshooting skills

performance and quality according to requirements and the contracts.

An integration engineer can be expected to analyse, prepare, implement and verify the configuration and integration of a node, network or a system. A software engineer focuses on projects where C/C++ programming language is widely used. For managing the products, Java is the preferred language.

Tasks and responsibilities

The responsibilities in this sector depend

You could be a telecom engineer...

As a telecom engineer, you will be responsible for preparation and reviewing the project document including detailed designing of security systems like closed circuit TV, personal access system and intrusion detection. Candidates with oil and gas or building management system experience will be preferred.

Requirements:

Your engineering degree in instrumentation/electrical/electronics with 1 to 3 years of relevant industrial work experience would be an ideal fit.

on the position one holds. Depending on the area, be it installation, software, infrastructure or network, the tasks differ from company to company. See the boxes for some of the latest job profiles at reputed organisations hiring engineers to work in the telecom domain.

How remunerative is the job

For software engineers, George Abraham, associate vice president-Recruitment, Sasken Communication Technologies Ltd, informs, "The CTC (cost to

company) would be 315,000 rupees per annum with medical, superannuation benefits provided additionally. Entry-level freshers will undergo foundational competency training (three months) and domain hands-on training (six months). Then they will have opportunities to work in software development and testing in the telecom embedded system domain."

As per figures provided by TimesJobs.com, 48% of the engineers working in telecom sector, who are basically freshers, get anywhere between 80,000 and 300,000 rupees per annum. Middle-level 25% engineers draw anywhere between 400,000 and 700,000 rupees per annum and senior 15% engineers are paid one million rupees and above.

According to PayScale.com, a telecom engineer earns an average salary of 403,545 rupees per annum. Experience does have a moderate effect on pay in this sector. A skill in network management or administration is associated with higher pay for the job. But a telecom network engineer earns an average salary of 359,426 rupees per annum. The skills that increase pay for this job the most are an understanding of GSM and telecom. Most people with this job profile move on to other positions after about ten years in this sector.

Minimum qualification required

Ideally, telecom companies look for graduates (B.E./B.Tech in ECE/CS/Telecom) with good academic record of anywhere between 60% and 70% aggregate in all papers in engineering and having cleared in first attempt. Some companies also recruit EEE and IT graduates and provide necessary training.

Demand areas

Going by the statistics provided by TimesJobs.com, Bengaluru tops the list of top five cities hiring engineers for telecom sector, with a share of 28%. Second in the list comes Delhi with 16% of the jobs. Mumbai falls next with 13% while Chennai and Pune share 11% of the jobs each.

Understandably, a big chunk of

You could be a network optimisation engineer (NPO)...

Responsibilities and tasks:

As a network optimisation engineer your role would be to provide network performance services covering a variety of tasks, such as network performance audits, quality and capacity optimisation, parameter planning, network feature planning, network statistics analysis, troubleshooting and performance management. You must be willing to work in late shifts if the project demands. Customer focused mindset and process orientation are important for providing the services with high quality. You should have relevant work experience in mobile telecommunication area and solid background with GSM systems. Any 3G/WCDMA working knowledge would be a definite plus. This role requires practical knowledge of radio network planning and optimisation tasks throughout the network planning process. Working knowledge of NSN system and tools would be an added advantage.

Position requirements:

- Positive attitude, teamwork, focus on the customer's demand, consulting approach, quality orientation, ability to work in matrix organisations and effective communication skills, planning, organisation and executing skills
- Good communication and documentation skills
- Ability to handle customer meetings and discussions

Professional Courses for Telecom Domain

Certified course for a telecom infrastructure engineer

1. Communication Basics of Telecom
2. GSM Channels & Implementation
3. CDMA Introduction in Telecom
3. Telecom Site Introduction
4. Telecom Equipments & Materials
5. Complete 3G Solution
6. Introduction to Operation & Maintenance (O&M)
7. Telecom Network Solution (NOC)
8. Complete RF Section
9. Telecom Management Solution
10. Paper Formalities and Report Generation

Extra:

1. Group Discussion and Aptitude Test Preparation
2. Practical Site Exposure

Certified telecom course for a network engineer

1. Communication Basics of Telecom
2. Basics of Telecom Networks
3. Telecom Network Switching
4. CCNA (Cisco Certified Network Associate) Basics, Advanced and Lab Training
5. Unix Basic and Advanced Level

Extra:

1. Personality Development Programme

the jobs for engineers is in software domain; 22% of the jobs being for software engineers and application programmers each. Roughly 8% of the jobs are in areas of RF engineering and hardware installation or maintenance. About 7% of the jobs are for network administration.

Professional courses could be an option

Although some companies have their own in-house training facilities to train new entrants, the others look for candidates with some kind of experience or formal training in the subjects. There are a handful of organisations that provide professional certification courses in India. Typically, these training programmes are designed to give candidates an overview of communication, GSM and CDMA systems. These

Notable hiring companies

- Nokia Solutions and Network
- Wipro
- Ericsson
- Tata Communications
- Alcatel-Lucent
- Avion
- HCL

provide a more practical approach towards the telecom industry.

There are several professional courses for telecom domain with duration of one to six months. Depending on your field of interest, you could go for that particular course. In the programme structure, the topics that are touched upon during these courses are highlighted in the box below. These could, again, vary from one institute to another, some of whom also provide placement and guidance. ●

The author is a senior technical correspondent at EFY

What's In This Month's DVD?

This month's DVD brings to you a variety of software, starting with Sigasi design tools to the open source Chipmunk simulation and schematic tools. Also check the debugging tools like Thunderbench and H-Jtag along with a Spice circuit optimiser

SNEHA AMBASTHA

Sigasi

Sigasi is a design creation tool that replaces your VHDL editor and helps you deal with the complexity of VHDL design. Based on Eclipse platform, Sigasi offers instant syntax error reporting and instant code style checks.

EDWinXP

EDWinXP is a fully-integrated EDA software package for automated design of electronic products. It integrates Schematic Editor, EDSpice Simulator and Mixed Mode Simulator for simulation, PCB Layout Editor to create PCB layouts and Fabrication Manager to generate manufacturing output files for Photoplotter, NC Drill, etc.

Chipmunk

Chipmunk is a collection of software tools for Unix systems and OS/2 (a series of computer operating systems, initially created by Microsoft and IBM) that performs a wide variety of tasks, such as electronic circuit simulation and schematic capture, graphics editing and curve plotting, to name a few.

ThunderBench

ThunderBench is a comprehensive integration of a debugger, a C/C++ compiler and an IDE within the Eclipse platform for ARM Cortex devices. The Eclipse standardisation in ThunderBench removes the pain of changing IDEs.

H-Jtag

H-Jtag is a debug agent that includes three tools: H-Jtag Server, H-Flasher and H-Converter. H-Jtag Flasher is a Flash programmer whereas H-Jtag

Popular resources

7Zip. Compress and decompress your files using the 9.20 version of 7zip.

JRE. Upgrade to the latest update for JRE version 7 for Windows 32-bit system in order to improve the security of your system. The older versions do not include the latest security updates.

VLC Media Player. Update your VLC Media Player to version 2.1.5 for DVDs, VDVs, streaming protocols and various audio and video formats (MPEG-1, MPEG-2, MPEG-4, DivX, MP3, Ogg, 3GP, etc).

Opera. Install the latest version of Opera web browser version 24.0.1558.53_S on your Windows computer to search, navigate and browse with style.

Free Download Manager. Download files and whole websites from any remote server via HTTP, HTTPS and FTP on your Windows computer using the Free Download Manager 3.9.4 Build 1472 / 5.0 Build 3126 Alpha.

Thunderbird. 31.1.0 version of Thunderbird is the latest version of a free email application that allows an easy set-up and customisation with great features.

Mozilla Firefox. Mozilla Firefox version 32.0 is the latest version of a light and tidy open source web browser with simple and effective UI, fast speed and strong security capabilities.

Apache Open Office. The latest version of Apache OpenOffice (version 4.1.1) is here to allow word processing, spreadsheets, presentations, graphics, databases and more.

Comodo Internet Security. Comodo Internet Security is a free, multi-layered security offering 360° protection.

Server is a debug agent. The H-Converter is a converter tool that supports different file formats like HEX, BIN and ELF.

ASCO

A Spice Circuit Optimizer (ASCO) simplifies the design process by automatically verifying, fine-tuning and optimising the circuit functionality. It helps in redesigning a circuit already described in the Spice net-list and allows an easy migration of the designs to an advanced semiconductor technology.

ExpressPCB setup

ExpressPCB setup program includes ExpressSCH for drawing schematics and ExpressPCB for circuit board layout. Designing of 2- or 4-layer boards can be done just by inserting the component footprints and then dragging them into positions.

IndigoSCADA

IndigoSCADA is a tool for small custom projects. It supports multiple HMI windows and multiple users with dif-

ferent access rights. It has a real-time event and alarm notification.

TANGO

TANGO is a device-oriented control system for Linux and Windows operating systems. In order to implement the distributed control objects, TANGO provides a framework in C++, Python and Java.

CodeLite

CodeLite is an open source, cross-platform IDE for the C/C++ programming languages. Built and tested on Windows 7, Ubuntu 12.04/12.10/13.04/13.10, Vista and XP, it has a built-in support for GCC/clang/VC++ that acts as a generic support for compilers.

PWCT

Programming Without Coding Technology (PWCT) is not a wizard for creating any application in 1 2 3 steps; it is a general-purpose Visual programming tool designed for novice and expert programmers. ●

The author is a technical journalist at EFY

EDWinXP: An Integrated Electronics Design Suite

This Windows based software package integrates different tools to automate all stages of electronics product design cycle right from circuit schematic designing to PCB fabrication

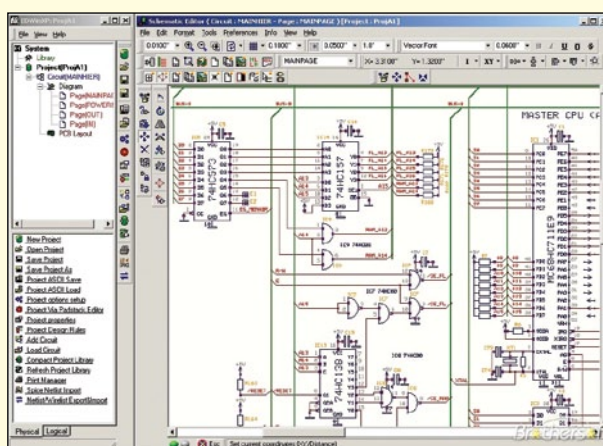
ANAGHA P.

EDWinXP is an integration of tools that cover all stages of electronic design process, which include schematic capture, circuit simulation, PCB design and layout, generation of PCB manufacturing and testing documentation. It also provides the users with several verification and validation tools to check the integrity and correctness of the schematic and PCB layout design. One can use this suite to produce PCBs of several kinds including flexible PCBs, RF boards and multi-layer PCBs.

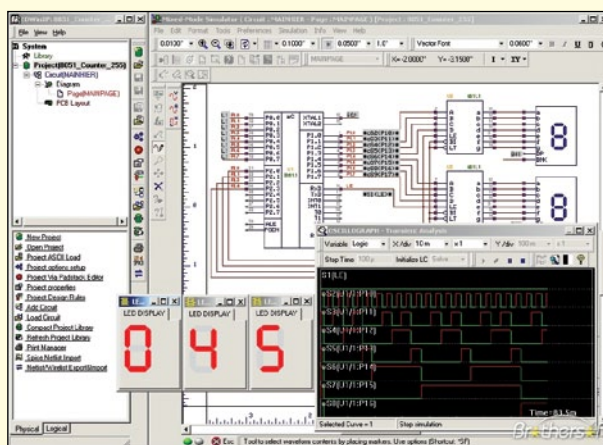
One of the most notable benefits of using this tool is that you can perform reverse engineering of designs. This means, project database can be completely reconstructed using full set of artworks in Gerber ASCII format or complicated PCB Outline. This is achieved through two stages. First stage involves import of graphic elements in artworks and distribution into relevant categories. As an example, the traces are distributed to Trace Master and pads to Padstock category. Next stage of reconstruction has several steps executed in a predefined sequence.

The inclusion of IPC-355 format for PCB assembly output and IPC-356A format for bare board testing allows PCB manufacturers to verify Gerber data against the design net list. This would assist in identifying several design flaws which might have resulted in unusable PCBs.

Fast, round the clock support by the company is another major benefit



EdWinXP1



EdWinXP2

Developer	Visionics, a subsidiary of Norlinvest Ltd
Licence type	Shareware
Disk space	350MB
Version	1.9

of using this software. This company is based in India and works very closely with its customers. The users can even

give suggestions and influence the development of this tool by participating in the active discussion forums at company's website.

Integrated tools

The seamless integration of tools in EDWinXP makes it a bit complicated to start with but, once mastered, this package is easy to work with. Its graphical user interface (GUI) is simple to follow and allows easy shifting from one tool to the other in the package. The suite has following components integrated into the main software tool.

Schematic Editor. It is the front end of any PCB design for creating circuit diagrams using standard symbols and connections. Each component in the schematic has a label that

displays parameters of that particular component. You can also modify or add other parameters or texts and notes to it. This captured schematic is automatically front annotated to layout mode by the tool. Schematic DXF Export option lets you export EDWinXP schematic graphics into AutoCAD DXF format.

Library Editor. EDWinXP library

System requirements

Processor	1. Pentium III: Minimum 900MHz CPU, or equivalent 2. Pentium IV: Its equivalent or higher
Operating system	Both 32-bit and 64-bit versions of the following: 1. Windows 8 2. Windows 7 3. Windows Vista 4. Windows XP 5. Windows 2000
Memory/OS	1. Windows 8: 2GB minimum; 4GB or higher recommended 2. Windows 7: 1GB minimum; 2GB or higher recommended 3. Windows Vista: 1GB minimum; 2GB or higher recommended 4. Windows XP: 512MB minimum; 1GB or higher recommended 5. Windows 2000: 256MB minimum; 512MB or higher recommended
Others	1. 800 x 600 px and 256-colour display minimum; 1024 x 768 px 32-bit colour display recommended 2. Two-button mouse minimum; three-button mouse or wheel mouse recommended 3. Minimum 500MB free disk space 4. Optional graphics accelerator card 5. Internet Explorer version 5, its equivalent or higher

comes with a large collection of pre-defined graphical representations of standard components in both schematic and PCB layout view. The user can update, customise or enhance the components of the library using the Library Editor tool. The components also contain details like packaging information, thermal parameters and link to simulation modules.

Mixed Mode and EDSpice simulators. Simulators let you test the performance of a circuit for various DC operating points for a range-applied signal over output levels, supply voltages and temperatures. EDWinXP provides a Mixed Mode Simulator (the system's native circuit level analyser) and an EDSpice Simulator (full implementation of SPICE standards).

Layout Editor. This lets you create and edit PCB layout for the designed schematic. It also allows you to begin layout with a pre-existing schematic, edit existing layouts or capture the

design directly in PCB layout mode. Operations like placing components, renumbering of components, routing and error check are automated. 3D Board Viewer and 3D Trace Viewer are the other features.

Fabrication Output Manager. This program is used to generate manufacturing output files for Photoplotter, NC Drill, etc. NC Drill data can be generated in Excellon format with or without tool movement optimisation. Users also have the option to create drill templates that can be printed or saved in Gerber format for photoplotting. It is possible to insert dimensions of various mechanical drawings. PCB assembly output is generated in IPC-355 format and bare board testing output is obtained in IPC-356A format. You can also export the entire database in GenCAM format. Users can generate disk files containing bill of material and generic data for pick-and-place machines. The tool supports RS-274D and extended RS-274X Gerber ASCII formats. Integrated Gerber ASCII file viewer enables the user to verify artworks before sending them for plotting and manufacturing.

Features

EDWinXP is rich in features and the added features in each revised version are incorporated from the customers' feedback and suggestions. The key features are:

Front and back annotate. Designs can be captured in Schematic Capture or Layout Editor. The design created using Layout Editor is back annotated to the Schematic Editor and the one created using Schematic Editor is front annotated to the Layout Editor.

Microcontroller kit. It comes with a microcontroller kit that mimics the functionality of 8051, AVR, PIC and Motorola microcontrollers. Moreover, editing and compilation of programs in C and Assembly languages and debugging the code in real time is possible. The kit also contains series of models like memory, 7-segment displays, series/parallel pattern generators and interrupt generators for generating parallel and serial data patterns and

asynchronous hardware interrupts.

Filter designer. EDWinXP offers automated filter designing where you can choose the filter type, enter the output frequency and quality range, and the program calculates the parameters and generates schematic. This can be imported to PCB layout format.

Autoplacing and autorouting. Autoplacing of components in the schematic layout is possible with Schematic Editor. The autoplacing parameters and design rules can be set by the customer. Autorouter can be executed in PCB layout with default parameters or user-defined parameters using Arizona Autorouter in EDWinXP.

Analysers. Another feature is the different types of analysers that help a user check the integrity and correctness of layout design. The electromagnetic analysers—field analyser and signal integrity analyser—are used to inspect electromagnetic effect on the board, and thermal analyser lets you examine the thermal hotspots on the board.

And much more! EDWinXP has option to get a 3D view of the component packages. VHDL Editor lets you automate project creation from VHDL source. With the project version control you can keep track of the changes made to the projects. The entire design details are stored in an integrated database that can be accessed simultaneously by the Schematic Editor, Layout Editor, Simulators and Fabrication Manager. This program offers backward compatibility to older DOS-based design files. VHDL/Truth Table to

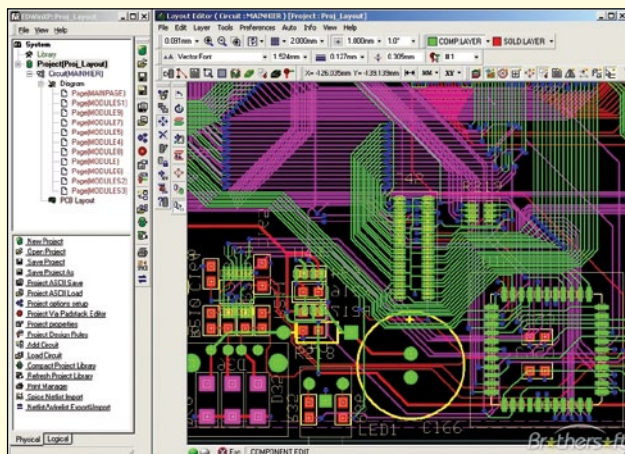
Installation guide

1. Unzip file EDWinXP190.ZIP to a temporary folder.

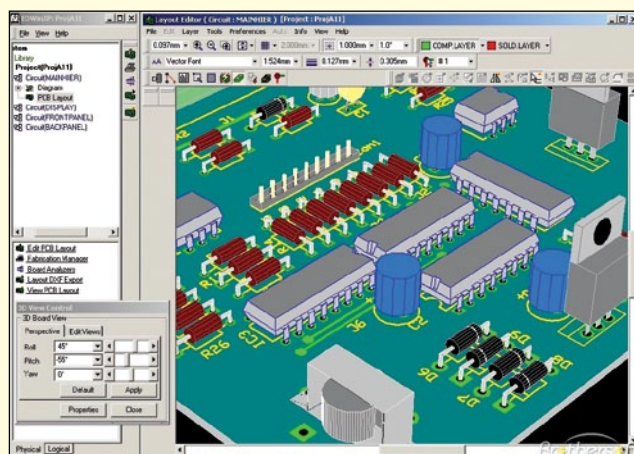
Note: Temporary folder name should not have spaces in between or number of characters more than 8. This will lead to error messages 'Install.lst missing or invalid' or 'Command Line Invalid.'

2. The unzipped folder EDWinXP190 has executable file Setup.exe. Double-click this file (or right click on it and select 'Run as administrator' from the drop-down menu) to launch the installation wizard.

3. In the installation window that appears, select 'Install EDWinXP Evaluation' and continue with the installation procedure.



EdWinXP3



EdWinXP4

diagram converter, 3D IDF file viewer, Filter Designer, ODB++ export and import are some of the other modules available on EDWinXP.

Different types of licensing

The evaluation version of EDWinXP provided in the DVD comes with all the features of EDWinXP with 14-day licence, after which it can be activated directly from Visionics website www.visionics.a.se.

visionics.a.se or through their distributors. Upgrades can be made to Non Commercial, Commercial and Small Biz versions of EDWinXP Schematic, Standard, Deluxe or Professional packages.

Online technical support for the product and for creating libraries is available at support@visionics.a.se or edwin@visionicssupport.com. Besides, Visionics offers live chat for custom-

ers with the support desk, thereby ensuring quick response and solution to design issues. Service pack updates containing additional features and bug fixes are posted on the website. The site also provides discussion forums on the product, newsletters and elaborate tutorials, training projects and demos in document and/or video formats. ●

The author is a technical correspondent at EFY

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Linux Porting and App Development is a Breeze with JTAG Debuggers

Considering the complexity of today's embedded systems, using a Linux-aware JTAG debugger vis-à-vis traditional agent based debugging can be more efficient and effective in reducing the time-to-market for Linux-based systems

T.S. JAGADISH

When it comes to embedded systems running Linux, developers are primarily concerned about two things: porting or making Linux run on the target without errors, and developing applications that can run on Linux to carry out the job the embedded system is designed for.

JTAG debuggers with Linux awareness are rising to the occasion, helping developers to debug embedded systems running Linux. This article looks at why it is difficult to use traditional methods for Linux debugging, before delving into how JTAG debuggers help sort out bugs in the different stages of Linux booting and Linux application development.

Unique challenges posed by Linux

There are several steps involved in the Linux booting process. The boot-loader first copies itself to RAM from Flash and then loads the Linux kernel. Next, the Linux kernel boots up and performs the transition from physical addresses to kernel virtual addresses.

The memory space allocation for particular processes in the physical memory may be fragmented across multiple memory regions, but these appear to be in a continuous memory address space for the process using it.

Understanding a Linux based embedded system

A Linux based embedded system can be split into three main components:

1. The Linux kernel. The Linux kernel is the core of the Linux operating system (OS), having ultimate authority. It is the first component to start after the system has been initialised by the boot-loader.

2. Kernel modules. Linux kernel modules are dynamically loaded and unloaded as and when needed; once a Linux kernel module is loaded it has the same level of authority as the Linux kernel. Kernel modules are mainly used for device drivers.

3. Application software. Application software cannot access the Linux kernel memory or hardware directly as they run in user mode on a Linux system, with reduced privileges. So, if some application software needs to access the peripherals or memory, it needs to request the Linux kernel to provide system-level access to it.

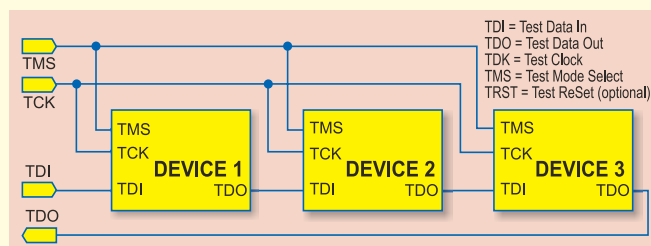


Fig. 1: Interconnection of JTAG-compliant devices in a PCB

This is done using the virtual addressing, which is maintained by memory management unit (MMU) of the Linux system.

In Linux, there is a constant switching between the kernel space and user space, and also between different processes. This makes tracking of virtual memory impossible and complicates the debugging of these processes or the Linux kernel. These issues cannot be addressed using common methods like adding 'print' statements, or agent-based debugging solutions, such as the Kernel GNU debugger (KGDB) or the

GNU debugger (GDB).

Using KGDB, a developer cannot examine the current state of the system by halting the CPU, especially in a multi-core or

multi-processing environment. The breakpoints that we set in KGDB cannot halt the execution of all the processes at once as the Kernel GNU debugger (KGDB) requires a communication port, such as Ethernet (also a process), to be working continuously for the KGDB agent present in the target to communicate with the host system. This also means that to start agent based Linux kernel-debugging, we require a communication channel to be established with a working IP stack and working device driver, which may not be possible when the

Hi, JTAG!

Joint Test Action Group (JTAG) is the common name for the IEEE 1149.1 Standard Test Access Port and Boundary-Scan Architecture. JTAG was originally introduced around 1990 for testing printed circuit boards (PCBs) using boundary scan, and is still widely used for this application.

Later, JTAG was used as an integrated circuit (IC) debug port in embedded processors to enable debuggers to connect and communicate with chips to perform operations like single stepping, placing hardware and software breakpoints and source-level debugging of code. JTAG can also be used for flashing of boot firmware.

The connection between the host PC and the JTAG debugger is generally established via USB, serial port or Ethernet depending on the model. If it is an Ethernet supported debugger, we can debug the target remotely from anywhere in the network.

JTAG debugging is also referred to as on-chip debugging (OCD). Its working speed is from 10MHz to 100MHz depending on the chips. Some JTAG debuggers have Eclipse plug-ins to access JTAG via an integrated development environment (IDE), while some JTAG interfaces use any GNU debugger (GDB)-aware frontend as software interface.

while booting up the Linux kernel or later while running Linux processes. The boot-loader passes on arguments while calling the Linux kernel for execution and any mistakes in the arguments may prevent Linux from booting up.

Agent based debuggers cannot be used to debug these issues because the Linux OS is not up during this stage. To debug these issues we need to have access to the processor registers, for reading the present values, and over-writing them with correct values in case they are wrong. This can be done only using JTAG debugging tools.

Readying your debuggers

Most JTAG debuggers need to be provided a configuration file that has information like processor architecture, JTAG clock, core start-up mode, memory initialisation, etc. There is no standard format for these configuration files, so every JTAG debugger uses its own format. However, developers do not have to worry much about these configuration files because the vendors who provide the JTAG debuggers will also share these files for all supported processors and most of the commonly-available evaluation boards in the market. For custom boards, the users can edit an existing configuration file that more or less matches the board features and use.

The configuration file is very important because it helps the debugger to know the processor we are trying to debug, the components present on this target board, and how all these components are interconnected. If these values are correctly set, the JTAG debugger can load the Linux OS even without a boot-loader. This helps when the boot-loader and the OS are being developed simultaneously.

Source-level debugging using JTAG

For source-level debugging, the Linux kernel needs to be built with debug info. Select the option 'Kernel Hacking -> Compile the kernel with debug info' in the configuration file for building

usage of virtual memory management in Linux. Keeping track of memory mapping and memory allocation during this process is critical. When using the traditional agent based solution, we need to use both GDB and KGDB to trace system calls into the Linux kernel and kernel modules. The use of multiple agent based debug tools may complicate the debug process.

These are just some of the problems one could face when trying to solve problems in embedded Linux based systems using traditional non-JTAG methods. Now, let us

look at how things become simpler with Linux-aware JTAG debuggers.

Busting boot-loader issues

A boot-loader loads and starts the Linux kernel every time the system is powered on or reset. Boot-loaders, such as the open source U-Boot, support a wide range of embedded processor architectures and boards.

In order to set up a boot-loader, we need to configure hundreds of registers. Even if a single register initialisation value is wrong, it may cause issues

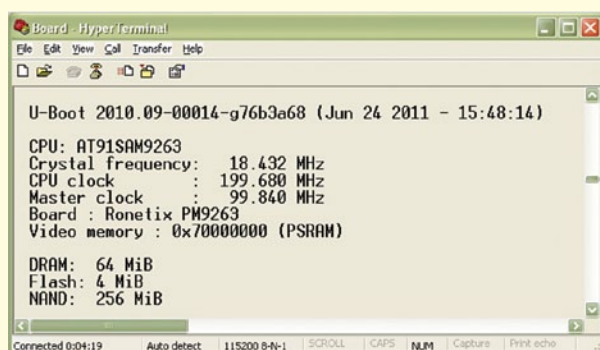


Fig. 2: U-Boot display

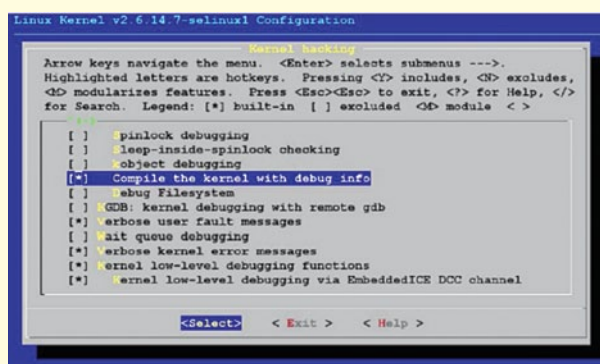


Fig. 3: Linux kernel configuration

kernel is not stabilised, or when these communication devices themselves need to be debugged.

In some scenarios, the Ethernet or UART port may not be available for agent-based debugging. For example, cell phones simply do not have serial Ethernet interfaces!

Developers debugging in user mode will require stepping into system calls from user mode to Linux kernel mode and back into user mode. Keeping track of memory addresses when stepping into and out of these two modes is challenging because of the

Example 1

A portion of the JTAG debugger PEEDI's i.MX6 configuration file where processor-related parameters and board components are initialised.

```
[DEBUGGER]
PROTOCOL = gdb_remote ; gdb remote
REMOTE_PORT = 2000 ; TCP/IP port

[TARGET]
PLATFORM = CortexA8 ; platform is CortexA8

[PLATFORM_CortexA8]
JTAG_CHAIN = 4, 5, 4 ; list of TAP controllers in the JTAG chain
JTAG_CLOCK = 10000 ; JTAG Clock in [kHz]
TRST_TYPE = PUSH_PULL ; type of TRST output: OPENDRAIN or PUSH_PULL
RESET_TIME = 100 ; length of RESET pulse in ms
WAKEUP_TIME = 1000 ; Time to delay the JTAG operations after RESET
CORE0 = IMX6A_SMP_2, 0xBA00477 ; TAP is Cortex-A CPU
CORE0_STARTUP_MODE = RESET ; stop the core immediately after reset
CORE0_ENDIAN = LITTLE ; core is little endian
CORE0_BREAKMODE = SOFT ; breakpoint mode
.
.
.
[INIT_DDR]; initializing a DDR memory
mem write 0x020c4018 0x00260324;
mem write 0x020e05c0 0x00002000;
mem write 0x020e05b4 0x00000000;
mem write 0x020e0338 0x000000030;
mem write 0x020e0300 0x000000030;
mem write 0x020e031c 0x000000030;
mem write 0x020e0320 0x000000030;
mem write 0x020e032c 0x00000000;
mem write 0x020e05ac 0x000000030;
mem write 0x020e05c8 0x000000030
```

the kernel.

Once we have built the Linux kernel with the debug symbol, we need to have the file system also present to do source-level debugging. Once these are ready, we need to connect the target to the host system through the JTAG debugger as shown in Fig. 4.

Below are the GDB commands used in Insight console of PEEDI JTAG debugger to connect to the target, load vmlinux and start debugging.

```
(gdb) target remote <PEEDI's IP>
(gdb) cd <path of the vmlinux>
(gdb) symbol-file vmlinux
(gdb) hbreak start_kernel
(gdb) c
```

This will allow the board to boot and hit the breakpoint at start_kernel function, and from there we can start debugging. Users can set their very first breakpoint in any function of their choice, and not necessarily at start_kernel.

When debugging applications that are running in user mode, the

developer needs to start and stop all the threads related to that application at once to view the variables and the stack. It is also necessary to watch peripheral registers across different processes and the CPU. Traditional agent based debugging like GDB operates at the thread-level and can only stop a single thread. GDB cannot stop the entire system or multiple threads simultaneously.

Using JTAG we can connect to the system without changing the state of the processor registers and synchronise contexts for the Linux kernel and applications even when it is running. This helps the developer to connect JTAG when there is an error and examine the Linux kernel objects, application contexts, system calls and parameters used for system calls.

Using JTAG debuggers, we can flash the boot-loader, the Linux kernel and the Linux file system in Flash, and also debug the code present on the Flash memory by placing hard-

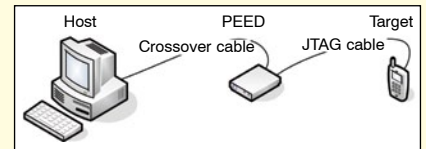


Fig. 4: Hardware set up of a JTAG Debugger

ware breakpoints and single-stepping through the code.

JTAG is here to make debugging more effective

As embedded systems become feature-dense, debugging them is also becoming increasingly difficult. Traditional agent based Linux debugging is less effective and not efficient in today's complex environment. However, using JTAG debuggers we can easily overcome these issues. We can even simplify things further by integrating a JTAG debugger with IDEs like Eclipse so we can edit, compile and debug easily in a graphic mode. IDEs help to debug the code in source level or in disassembly.

With time-to-market becoming increasingly important, companies are able to shorten the development time drastically using JTAG debuggers.

There are many players in the JTAG debuggers market, including:

1. Ronetix (<http://ronetix.at>)
2. Wind River Systems (<http://www.windriver.com>), and
3. Lauterbach (<http://lauterbach.com>)

JTAG debuggers from all these vendors vary a lot in price, differ in the number of processors supported and the IDE used for debugging. Before purchasing a hardware-debugging tool, it is good to check with the vendor about the processors supported and its Linux awareness.

The PEEDI JTAG Debugger from Ronetix is a cost-effective debugger that has almost all the features compared to the other tools present in the market. It supports a wide range of processors and works with IDEs like Eclipse, Insight, MULTI, IAR IDE, eCosPro, etc. ●

The author is technical head at Uchi Embedded Solutions, Bengaluru

A SPICE Circuit Optimiser (ASCO)

An open source optimiser for the existing SPICE simulators, ASCO has its codes available under the GNU GPL licence. Designed to address the problems related to electric circuits, ASCO is the result of interaction with experienced designers. Try out ASCO included in this month's DVD, available with EFY Plus

SNEHA AMBASTHA

ASPICE circuit optimiser, popularly known as ASCO, has found its way through an academic research project that intended to design low-voltage, low-power and high-performance analogue circuits for mobile communications. SPICE (simulation program with integrated circuit emphasis) is a general-purpose, open source analogue electronic circuit simulator.

The main task of ASCO is neither to suggest nor to create new circuit arrangements but to simplify the design process. It automatically verifies, fine-tunes and optimises the functionality of the circuit for temperature and voltage throughout the process.

Features

ASCO has a set of in-built features due to which it is considered a great help for the designers in quest of designing a better circuit. Perhaps the most interesting is that, ASCO is simulator-independent. This means, it functions independent of the simulator it is working with. It thus provides out-of-the-box support for multiple simulators like ngspice, Qucs, LTspice, HSPICER, Spectre R and Eldo. That is not all, the future releases of ASCO are expected to include more simulators. Key features of the tool are described below.

(*Note.* If a simulator can be launched from the command line, can read the inputs from the text files, output the result in the ASCII format, it can be added to the list of the supported SPICE simulators. It flexibly works with tools like FastHenry.)

Number of variables. ASCO is hard-coded in 'C' and theoretically

Key functions of ASCO

- Fully redesigns a new circuit described in a SPICE netlist
- Initiates the circuit optimisation capabilities in existing SPICE simulators, using high-performance parallel differential evolution optimisation algorithm
- Reuses and optimises an existing circuit
- Simplifies the design process

Benefits of using ASCO

Works as an automation tool. ASCO does all the tedious tasks and gives time to a designer to concentrate on the solutions for the existing problems and the challenges related to architectures.

Easy migration. Designers can migrate a working and an existing design to an advanced semiconductor technology without much effort.

Explore new design space. It allows the designers to easily explore a new design space for an already existing topology so as to reduce the power consumption and area. ASCO allows the designers to find feasible topology even before deriving the equations to describe the circuit operation.

Increase in robustness and yield. ASCO increases the robustness and yield of a previously designed circuit just by guaranteeing that it complies with all the constraints in (all/some of) the process corners and all the design goals.

does not have a limit to the number of circuit variables that can be optimised. The only constraints that can be imposed are due to availability of the computer memory or the time required to generate a functional circuit.

Process-voltage-temperature (PVT) corners. Using the simulator functionality, ASCO can help determine the PVT corners for a designed circuit. The tests related to various design corners

and Monte Carlo analysis are limited only by capabilities of the simulator and to the time it takes to complete the optimisation process.

Efficiency. Using the differential evolution (DE) process, the optimisation algorithm features a global optimisation. Till date, it has been used in various applications producing great results in acceptable amount of time. As suggested in an open literature, this optimiser can also be looped in with a local optimiser to gain the convergence speed.

Parallel or distributed computation. There is simultaneous evaluation of the proposed values over multiple computers in one network so as to save time. ASCO does not have any limitation to the number of computers used or the number of values evaluated at a time.

No recompilation needed. Optimisation of arbitrary netlist in different conditions does not require recompilation of the code within the supported SPICE simulators.

File format. All the output data and the log information related to optimisation are stored in the plain text format so as to guarantee their readability in future. This format also allows the data and the files to be used by other existing tools after the optimisation process.

ASCO is a free software tool and its codes are available under the GNU GPL licence.

Optimisation algorithms

ASCO has both global and local optimisation algorithms, which makes this tool easily acceptable with many simulation tools. But what are those algorithms? We already know that ASCO uses DE for global optimisation, but is ASCO also capable of local optimisation?

The answer is yes. ASCO has one global optimiser (DE) and two local optimisers (Hooke&Jeeves and Nelder-Mead). The configuration file contains parameters to tune the DE whereas the source code allows the tuning of local optimisers. Thus the two local optimisers can be selected only at the time of compilation by editing the file 'asco.c'

DE generates new parameter vectors by adding the weighted difference vector between two population members to a third member. In situations where the resulting vector yields a lower objective function value than a predetermined population member, the newly generated vector replaces the vector it is compared to.

Distributed computation methods

Currently, ASCO supports the following three methods for parallel computation:

Send. Each process receives one vector at a time and returns the single cost back to the Master process before receiving any new vector.

Scatter. All the vectors are scattered among all the existing processes in the same generation, and all evaluations are performed before returning all the cost values back to the Master process, which is repeated in the next generation.

Scatter with load balancing. In situations where the power of the computer is evenly available to each process, the optimisation time decreases. This is either due to different machines or due to machines with different loads balancing the number of simulations according to the computational resources. However, in perfectly balanced situations, all the processes start and finish the optimisation at the same time.

Competition

ASCO is one of its kind but has plenty of competition when it comes to circuit optimisation. Although all those mentioned below are not optimisers, they do have in-built algorithms to support optimisation as a feature.

TINA. Though TINA is a design suite for circuit simulation and PCB design, it has in-built circuit optimisation capability apart from analysis, designing and real-

How to install and use ASCO

Typing the following commands at command prompt will help create the executables for installation:

```
tar -zxvf ASCO-<version>.tar.gz
cd ASCO-<version>
make
```

This will create two executables 'asco' and 'asco-test' that need to be copied to a common directory so that these can be used later.

However, for portability building and for installing ASCO across different environments, GNU Autotools are recommended. If you are using Autotools, you only need to type the following command at the command line:

```
tar -zxvf Autotools.tar.gz
```

All the necessary files like configure.ac and Makefile.am are packed in Autotools.tar.gz and are distributed along with ASCO. In order to configure and compile further, the following commands are required:

```
aclocal
automake -f -c -a
sh autogen.sh
./configure
make
```

To use ASCO, copy the executable ASCO to examples/<YOUR SIMULATOR>/inv. If you are using Eldo, execute the following commands:

```
cp asco examples/Eldo/inv
cd examples/Eldo/inv
./asco -eldo inv
```

If you are using any other simulator, replace Eldo and eldo with appropriate text.

Following is the link to the binary version of ASCO for win32:

http://asco.sourceforge.net/downloads_win32.html

ASCO can also be compiled in win32 using 'cygwin' and 'MinGW32.' However, in case of any issues 'Makefile.win32' can be used.

time testing of digital, analogue, HDL, MCU and mixed electronics circuits. It has Berkely Spice and XSpice based SPICE simulator engines. It refines the result of a design procedure and tunes the already working circuits.

DELIGHT.SPICE. It is a computer-aided design (CAD) system and a SPICE circuit analysis program with interactive optimisation. It contains the recent and powerful optimisation algorithms along with a methodology for the designers for their intuition and man-machine interaction.

Utmost IV. It is used to generate accurate and compact models, macro models and Verilog-A models for RF

and analogue applications. It simulates as well as optimises any combination of data, including the data values that have been extracted. It supports SPICE simulators HSPICE, SmartSpice, Spectre and Eldo. Utmost IV combines direct extraction and parameter optimisation techniques.

EvoSpice. It is a numerical optimiser for LTSpice IV. It maximises or minimises the circuit behaviour aspects (power dissipation, output amplitude, etc) by automatically selecting the component values. It uses rapid evolution instead of differential evolution and is hundred times faster as compared to the other systems.

A member of electro-tech-online says, "ASCO requires you to compile C code and therefore is a bit difficult to use whereas EvoSpice is available only as a limited free trial. Anyway, both can be used to automatically adjust component values in a simulation, to minimise or maximise some aspect of a circuit's performance."

Scope and audience

ASCO requires an experienced circuit designer to select the circuit topology and to find reasonable operating conditions. The fact is that it's an experienced designer who can define the test benches and measurements to achieve the desired design objectives, define realistic design goals and evaluate the circuit of the proposed sizes to select the most suitable one.

One of the key requirements of using this tool is that, the experienced designer should be well versed with the operation of a SPICE simulator. The designer is expected to at least understand the consequences of each of the assumptions made during optimisation to carry out the optimisation process efficiently.

Surprisingly, despite being an optimiser for the popular simulation tools from SPICE, ASCO has not been much in use! There are some questions regarding the usage of this tool but no reviews to find out how useful this tool has been. ●

The author is a technical journalist at EFY. The article is based on the documents available at <http://asco.sourceforge.net/>

High-Speed SerDes: The Heart of IoT Products

This transceiver from Terminus Circuits is first of its kind, designed and implemented in India. It provides the high-performance data processing required for many of the Internet of Things applications

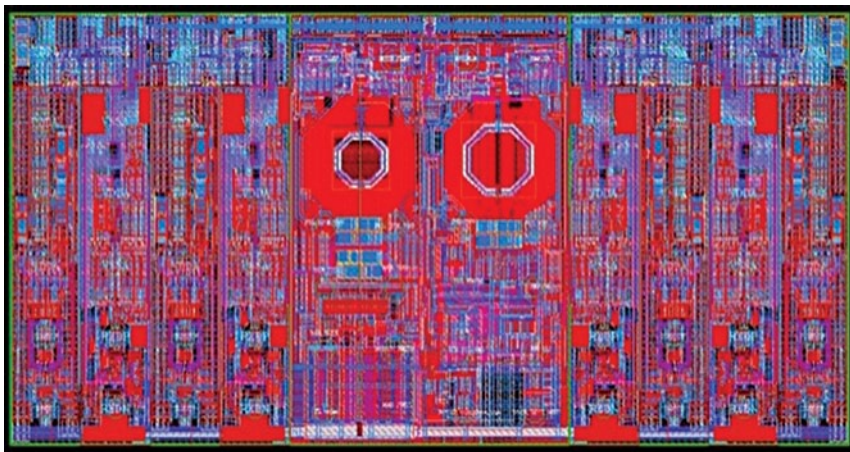
ANAGHA P.

PHY is an abbreviation for physical layer of the conceptual open systems interconnection (OSI) model. With ever increasing demand for faster data transfers, over the recent times, the demand for hi-tech electronic products has considerably increased in India. Especially with introduction of the concept of the Internet of Things (IoT), where every device is connected to each other and to the Internet, there is growing need for enabling high-speed, high-throughput and high-performance systems.

The multi-standard 10Gbps SerDes offered by Terminus Circuits is an off-the-shelf intellectual property (IP) offering that forms part of a main system-on-a-chip (SoC) or high-end equipment manufactured and sold by original equipment manufacturers (OEMs). It was designed and developed by K.S. Sankara Reddy, founder of Terminus Circuits, and his team in 65nm general-purpose (GP+) technology.

It is a PHY product that can support channels up to 32dB of attenuation, covering most of the cables supplied by the cable vendors. This multi-standard SerDes supports standards like serial ATA (SATA), serial attached SCSI (SAS), XFI, 10GBASE-KR, Peripheral Component Interconnect Express (PCIe) and universal serial bus (USB). This product forms the heart of high-speed and high-throughput servers.

The device is suitable for complex applications like weather forecast, brain simulations, high-performance computing (HPC), cloud computing and network operations centre (NOC). It can



Terminus Circuits Quad Lanes PCIe 3.0 PHY_10Gbps Multistandard SerDes Hard IP solution

Specifications

Product:	10-gigabit SerDes (PHY)
Usage:	High-speed, high-throughput serial link
Features:	<ol style="list-style-type: none"> 1. Low supply voltage, typically 1.0V 2. Designed and developed in GF 28nm SLP technology node 3. Supports multiple standards and data rates ranging from 2.5Gbps to 10Gbps: <ol style="list-style-type: none"> (i) USB 3.0 (4.8Gbps) (ii) PCIe Gen2 (5.0Gbps) and Gen3 (8.0Gbps) (iii) SATA III (6Gbps) (iv) SAS (12Gbps) (v) 10GBASE-KR or 802.3ap or Backplane Ethernet (1Gbps and 10Gbps) (vi) Optical fibre XFI standard (10.55Gbps) (vii) Common electrical I/O (6.25Gbps) 4. Throughput of 40Gbps built-in 8GHz, 10GHz PLLs 5. Built-in 8GHz, 10GHz PLLs
Developed by:	K.S. Sankara Reddy and team
Company:	Terminus Circuits

also act as enabler for SoCs targeting the latest standards like SuperSpeed and SuperSpeed+ USB (USB 3.1), PCIe 4 and applications like solid-state drives with native PCIe, terabyte routers, etc.

Design elements

The analogue part of the transceiver is the physical medium attachment (PMA) that comprises custom-made transistors with a QUAD configuration for attaining high throughput (up to 40Gbps).

The clocking solution consists of three individual phase-locked loops (PLLs) that support data rates and standards ranging from 2.5Gbps to 10Gbps.

The digital side of the product, like Physical Coding Sublayer (PCS) and MAC (Media Access Controller) layer, consists of 500,000 standard cells connected for controlling and enabling the device connectivity between digital and analogue worlds, thus making the complete system that meets the standards

What is a SerDes?

A serialiser/deserialiser, or SerDes, is a transceiver that converts parallel data to serial data, processes at high data rates and connects again to parallel interface. It enables transmission of large amount of data from one point to another over a single/differential line, thereby reducing the number of data paths, and hence the number of pins, complexity, cost, power and board space of the circuit.

mandated by various committees like USB.org, PCI-SIG, SATA, IEEE and SerDes.

The innovative design of this SerDes would help the OEMs in reducing the number additional off-the-chip components, such as high-precision resistors, clocking solutions and current-bias circuits. The complete solution is built on monolithic silicon as a single block. Thus the reduced number of external connectors and packaging complexities simplifies the test solution and reduces overall size, cost and power consumption of the system.

This SerDes is a specification-driven product that needs to meet stringent requirements of high-speed interface technologies. Its innovative transistor-level circuit design is key factor for the optimal solution that provides low power, high performance, cost saving for applications that meet customers' expectations. It comes with built-in PLLs designed for 10GHz frequencies for clocking solutions. A non-chip, high-precision bias current generator in the design helps to reduce the necessity for multi-chip modules or single-module solution with clocking, data transfer and multiple bias generators.

Design challenges

It took almost three years to claim the finished SerDes IP design. Currently, there are only a handful of companies across the globe that provide such high-speed SerDes IPs. The product is first of its kind developed completely in India and meets the requirements prescribed by the standards bodies like IEEE, USB.org and PCI-SIG.

The complexity of the design being very high, its development required manpower that had years of experience in designing SerDes IPs and their sub-blocks. Scarcity of highly knowledgeable, skilled and experienced workforce in this field was a challenge.

The product has received the 'Most Innovative Product of the Year 2013' award from India Electronic and Semiconductor Association (IESA) in recognition of innovative ideas that were implemented in the design of SerDes, which helped the customers to mitigate their SoC and package complexities.

This is a finished product that can be readily adopted by fabless design houses or OEMs. These products are offered through flexible licensing, royalty or buyout options. It can be sourced to customers worldwide through the web portal Design & Reuse (D&R). The IPs can also be picked up by OEMs who intend to do fab-out of their designs through foundries like Taiwan Semiconductor Manufacturing Company (TSMC), GlobalFoundries and Integrated Device Manufacturer (IDM). ●

The author is a technical correspondent at EFY



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- Providing magnetic solutions and customized magnets as per the requirements of our clients.
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All our core geometries are available in both
Manganese Zinc and Nickel Zinc material grades



- RM Cores
- Pot Cores
- PM Cores
- Rods, U & I Cores
- Planar Cores
- Blocks
- Bars
- Discs
- Toroids (2mm to 101 mm) with "UL approved Epoxy Coating" & Bead Cores etc.



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RFID Based Access Control Using Arduino



AKHIL KAUSHIK

Radio frequency identification (RFID) is used in many applications. Here, we present an access control system based on EM-18 RFID reader module and Arduino UNO board.

RFID is a non-contact, automatic

identification technology that uses radio signals to identify, track, sort and detect a variety of objects including people, vehicles, goods and assets without the need for direct contact or line-of-sight contact (as found necessary in bar code technology). RFID technology can track movement of objects through a network of radio-en-

ergises the tag. The tag responds to the reader's query and announces its presence via radio waves, transmitting its unique identification data. This data is decoded by the reader and passed to the local application system via middleware. The middleware acts as an interface between the reader and the RFID application system. The system

then searches and matches the identity code with information stored in the host database or backend system. In this way, accessibility or authorisation for further processing can be granted or refused, depending on results received by the reader and processed by the database.

Circuit and working

Fig. 1 shows the circuit of RFID based access control using Arduino board.

The circuit is built

around Arduino UNO board (Board1), RFID reader module (RFID1), solenoid lock and a few other components.

Arduino UNO board. Arduino is an open source electronics prototyping platform based on flexible, easy-to-use hardware and software (called sketch). It is intended for artists, designers, hobbyists and anyone interested in creating interactive objects or environments.

Arduino UNO is a board based on ATmega328 microcontroller. It consists of 14 digital input/output pins, six analogue inputs, a USB connection

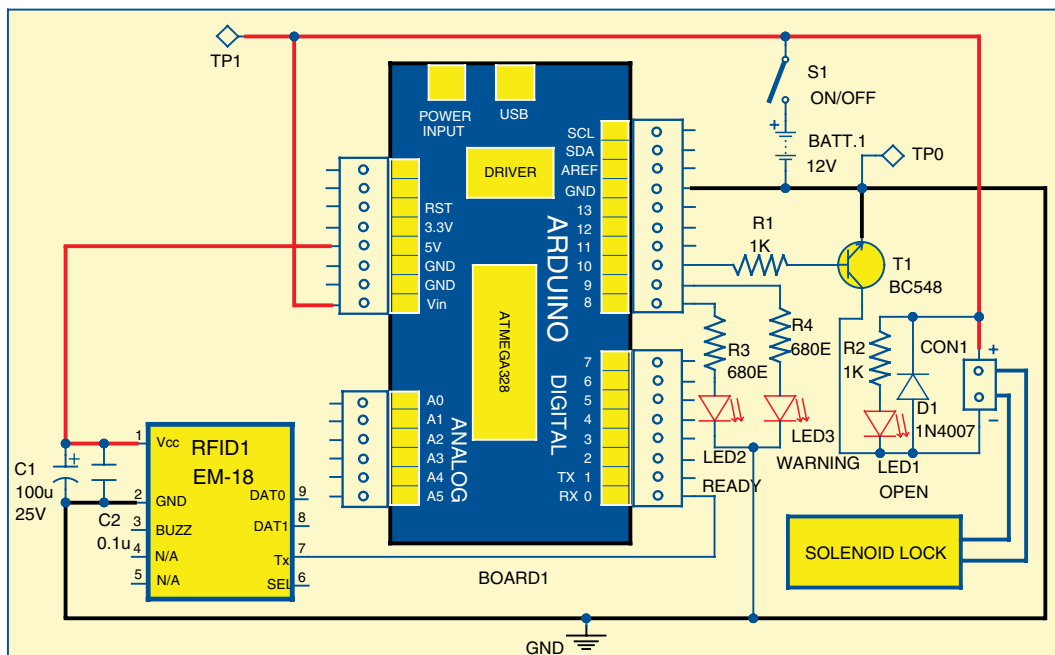


Fig. 1: Circuit diagram of the access control system

PARTS LIST

Semiconductors:

BOARD1	- Arduino UNO board
RFID1	- EM-18 RFID reader
T1	- BC548 npn transistor
D1	- 1N4007 rectifier diode
LED1-LED3	- 5mm LED

Resistors (all 1/4-watt, $\pm 5\%$ carbon):

R1, R2	- 1-kilo-ohm
R3, R4	- 680-ohm

Capacitors:

C1	- 100 μ F, 25V electrolytic
C2	- 0.1 μ F ceramic disk

Miscellaneous:

CON1, CON2	- 2-pin terminal connector
S1	- On/off switch
BATT.1	- 12V battery
	- 12V electric strike (solenoid lock)

abled scanning devices over a distance of several metres. A device called RFID tag, or simply a tag, is a key component of the technology.

An RFID system typically consists of three key elements:

1. An RFID tag, or transponder, that carries object-identifying data (unique ID code)
2. An RFID tag reader, or transceiver, that reads and writes tag data
3. A back-end database that stores records associated with tag contents

An RFID reader emits a low-level radio frequency magnetic field that

TABLE I
EM-18 RFID Module
Specifications

Heading	Specifications
Reading distance	6-10cm
Dimensions	40mm×20mm×8mm (L×H×W)
Frequency	125kHz
Compatible card codes	Manchester 64-bit, modulus 64 encoding
Current rating	35mA (max.)
Operating voltage	4.6V-5.4V DC

TABLE II
Test Points

Test point	Details
TP0	0V
TP1	12V

for programming the on-board microcontroller, power jack, an ICSP header and a reset button. It is operated with a 16MHz crystal oscillator and contains everything needed to support the microcontroller. It is very easy to use as the user simply needs to connect it to a computer with a USB cable or power it with an AC-to-DC adaptor or battery to get started. The microcontroller on the board is programmed using Arduino programming language and Arduino development environment.

Pin 0 (RX) of Board1 is connected to pin 7 (TX) of RFID1. Pin 10 of the board is connected to solenoid driver transistor T1 through base resistor R1. When pin 10 goes high, T1 conducts and solenoid is activated, which means lock is opened.

RFID reader module. In this project we used EM-18 RFID reader module (Fig. 2) operating at 125kHz. The mod-



Fig. 2: RFID reader module



Fig. 3: RFID tags

ule comes with an on-chip antenna and can be powered with a 5V power supply. The transmit pin (TX) of the module should be connected to receive pin (RX) of Arduino UNO board. Some specifications of the module are listed in Table I.

RFID tag. An RFID tag is a smooth card of credit-card size (Fig. 3), which is read by an RFID reader. It works at 125kHz and comes with a unique 32-bit ID. Normally, each tag has a unique ID number which cannot be changed. You can find out its unique ID through software.

Software

The software for this project is written in Arduino programming language. The Arduino UNO is programmed using Arduino IDE software. Atmega328

on Arduino UNO comes with a boot loader that allows you to upload new code to it without the use of external hardware programmer. It communicates using STK500 protocol. You can also bypass the boot loader and program the microcontroller through in-circuit serial programming (ICSP) header, but with boot loader the programming is quick and easy.

There are two sketch software codes for this application: ReadTag.ino for reading the tag's unique ID and AccessControl.ino for the main application.

Reading tag ID. To read the tag's unique ID, first you need to upload ReadTag.ino sketch into Arduino board by following the steps given below:

1. Connect TX pin of RFID1 to RX pin of Board1 as shown in the Fig. 1
2. Launch Arduino IDE. Connect Board1 to your PC and select the correct serial COM port and Board from Tools menu. Open ReadTag.ino sketch and compile it using Arduino IDE.
3. Burn ReadTag.ino sketch into the microcontroller in Arduino board
4. Open Serial Monitor from Tools menu in Arduino IDE
5. Hold RFID tag close to RFID1
6. Note down the tag ID shown on the Serial Monitor window. This ID will be used in the sketch later in the main application

Programming the main application. The main application of this project is access control system. So we need to upload AccessControl.ino sketch into the microcontroller in Board1. Note that before uploading the sketch into the microcontroller, you should remove the RFID reader mod-

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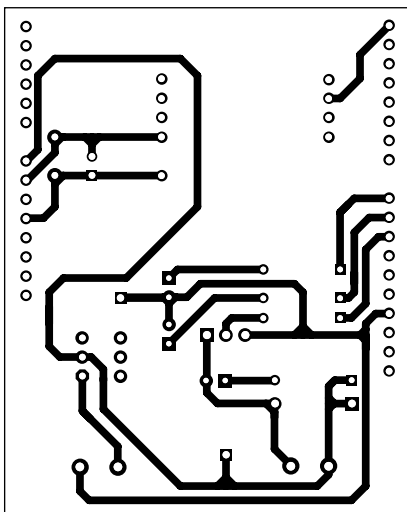


Fig. 4: An actual-size PCB layout for the circuit

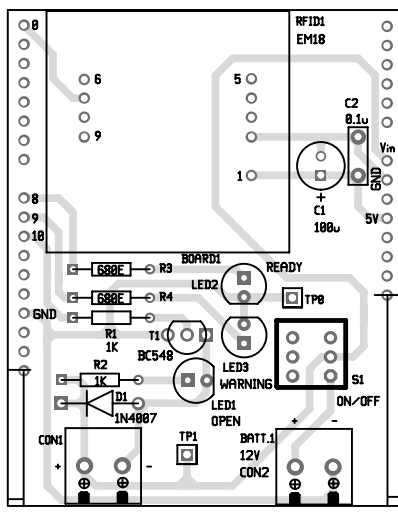


Fig. 5: Component layout for the PCB

ule from the circuit. For programming:

1. Open the AccessControl.ino sketch from the Arduino IDE
2. Change the tag ID in AccessControl.ino sketch with the ID you have noted down earlier
3. Connect the Arduino board (Board1) with the PC

4. Upload the sketch into the board
If uploading is successful, you will see the glowing of LED2. It means the system is ready to read the tag. Now, bring the tag near RFID1 reader. If tag ID matches with the ID in the code, solenoid lock will open for five seconds. It closes automatically after five

EFY Note

The source code of this project is included in this month's EFY DVD and is also available for free download at source.efymag.com

seconds. Glowing of LED1 indicates that the lock is open. Glowing of warning LED3 means that you are using the wrong tag.

Construction and testing

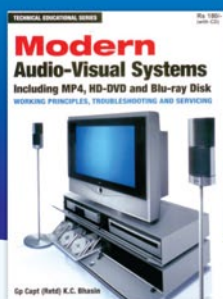
An actual-size, single-side PCB (Arduino shield type) for access control is shown in Fig. 4 and its component layout in Fig. 5. Assemble the circuit on recommended PCB to save time and minimise assembly errors. Double-check for any overlooked error.

To test the circuit for proper functioning, verify correct 12V supply for the circuit at TP1 with respect to TP0. ●

The author is a third-year B.Tech student (computer science engineering) at Institute of Engineering and Technology, Alwar (Rajasthan)

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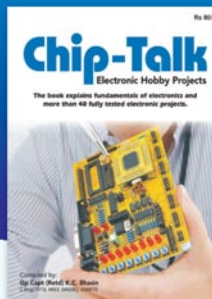
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Weather-Forecast Monitoring System

M. KATHIRESAN, A. ROBSON BENJAMIN
AND C. VIJAYAN

Weather forecasts play an important role in our day-to-day life. A good weather monitoring system helps in better planning and any preparations that may be required in case of adverse weather.

This project deals with the construction of a weather display system using low-cost components so that any electronics hobbyist can build it. Instead of using sensors to gather the weather data, the project gets the information from professional weather stations located around the world through an international weather data provider. The author's prototype is shown in Fig. 1.

World weather online

During the past few years several weather data providers have prolifer-

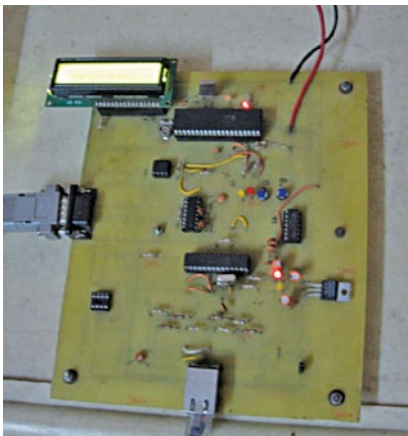


Fig. 1: Author's prototype

ated on the Internet. One such provider is worldweatheronline.com. It offers a free application programming interface (API) that can be used by the developers to get the weather data. A client device is needed to access the worldweatheronline.com API to get weather data by sending a uniform resource locator (URL), simply known as the Internet address.

In order to get access to the API one has to register with the weather website. Upon successful registration, a unique access key code is assigned and sent to your email ID. This unique code must be included with the request URL that is sent to the server. One can send approximately 500 requests per hour to the server. The server accepts the client device request and sends the necessary data to the client.

The server provides three types of message formats for weather data: XML, JSON and CSV. The first two formats are a bit difficult to use because one must use format headers and keep track of special string of characters to identify data. The CSV format is simple because it uses readable characters where the data is separated by a comma (,) character.

To request weather data, the URL message shown below is sent to the server.

```
"GET/free/v1/weather.ashx?q=madurai&format=csv&num_of_days=2&show_comments=no&no&key=yayjgrdysb6hpftc2jwek5c9";
```

The response to the URL message



is a stream of readable characters that include HTTP protocol information followed by weather data. The HTTP protocol information contained in the weather data is removed by a routine in the client software. The data values that follow are separated by commas. The current data and the forecast are separated by line feed and carriage return. The data layout information is available as comments in the CVS format. The following is an example of response from the server that contains weather data header in CSV format:

```
HTTP/1.1 200 OK
Cache-Control: public, no-cache="Set-Cookie", max-age=120
Content-Type: text/plain; charset=utf-8
Expires: Tue, 14 Jan 2014 06:20:17 GMT
Server: Microsoft-IIS/7.5
Set-Cookie: wwoanon=BameQIJHzwE
kAAAANDc0NGEwZmEtOTY5ZC00Mz-FILThhNzItNWZmNWQzMWZl
NmQ27xVhqIEhtREITXXX7wBw-3Pa5XkM1; expires=Mon, 24-Mar-2014
16:58:17 GMT; path=/;
HttpOnly
X-AspNet-Version: 4.0.30319
hit-for-pass: 1
Date: Tue, 14 Jan 2014 06:18:19 GMT
Age: 0
Connection: close
X-Powered-By: UKFastWebcclerator
X-Cache: MISS
```

The following is the CSV data format:

```
date,tempMaxC,tempMaxF,tempMinC,tempMinF,windspeedMiles,windspeedKmph,winddirDegree,winddir16Point,weatherCode,weatherIconUrl,weatherDesc,precipMM
```

TABLE I
The URL Message Details

Commands	Description
GET	Command used to get data from the server using HTTP protocol
Q	Name of the city for which weather data is needed (here, Q = Madurai)
Format	Format of data (here, CSV format)
num_of_days	Number of days for which the data is required (here, num_of_days = 2)
show_comments	To display comments (here, comments are not needed = no)
Key	Access code received on registration

PARTS LIST

Semiconductors:

IC1	- PIC18F4685 microcontroller
IC2	- ENC28J60 Ethernet controller
IC3	- 25LC256 EEPROM
IC4	- 74HCT125 quadruple 3-state buffer
IC5	- MAX232 dual driver/receiver
IC6	- 7805, 5V regulator
IC7	- LM3940, 5V to 3.3V converter
LCD1	- 16x2 LCD display
LED1-LED4	- 5mm LED

Resistors (all 1/4-watt, $\pm 5\%$ carbon):

R1	- 330-ohm
R2	- 4.7-kilo-ohm
R3	- 470-ohm
R4	- 10-kilo-ohm
R5-R7, R9-R10	- 220-ohm
R8	- 2.7-kilo-ohm
R11-R14	- 49.9-ohm
R15	- 100-ohm
VR1	- 10-kilo-ohm preset

Capacitors:

C1	- 0.33 μ F ceramic
C2, C5, C12-C16	- 0.1 μ F ceramic
C3	- 0.47 μ F ceramic
C4	- 33 μ F, 10V electrolytic
C6-C7	- 33pF ceramic
C8-C9	- 18pF ceramic
C10	- 10 μ F, 10V electrolytic
C11	- 0.01 μ F ceramic

Miscellaneous:

X _{TAL} 1	- 10MHz crystal oscillator
X _{TAL} 2	- 25MHz crystal oscillator
CON1	- 2-pin terminal block
CON2	- DB9 female COM port connector
CON3	- RJ45 Ethernet connector
CON4-CON5	- 2-pin connector

06:18 AM,29,116,http://cdn.worldweatheronline.net/images

wsymbols01_png_64/wsymbol_0002_sunny_intervals.png,PartlyCloudy,10,16,37,NE,0.0,60,10,1015,40 2014-01-14,30,86,21,70,11,17,37,NE,116,http://cdn.worldweatheronline.net/images/wsymbols

01_png_64/wsymbol_0002_sunny_intervals.png,Partly Cloudy,0.1

2014-01-15,31,88,21,70,9,14,30,NN E,116,http://cdn.worldweatheronline.net/images/

wsymbols01_png_64/wsymbol_0002_sunny_intervals.png,Partly Cloudy,0.1

The client software

The TCPIP client board, which houses Microchip TCPIP Stack 5.42, is configured to work as client. More detail on the stack can be obtained from www.microchip.com website.

The general TCP Client.c file available in stack is suitably modified to carry out the following tasks:



Fig. 2: Block diagram of the weather forecast monitoring system

TABLE II
Test Points

Test point	Details
TP0	0V
TP1	9V
TP2	5V
TP3	3.3V
TP4	Train of pulses
TP5	Train of pulses

1. Send required URL to the server
2. Remove the HTML header from the incoming weather data from the server
3. Store weather data in the EEPROM
4. Send the stored data from the EEPROM to the host PC via COM port

Circuit and working

The block diagram of weather forecast monitoring system is shown in Fig. 2 and circuit diagram of the client board is shown in Fig. 3. The circuit contains Microchip PIC18F4685 (IC1), Ethernet controller ENC28J60 (IC2), EEPROM 25LC256 (IC3), quadruple 3-state buffer 74HCT125 (IC4), dual driver/receiver MAX232 (IC5), 16x2 LCD display and magnetic jack RJ45 Ethernet connector.

Ethernet controller ENC28J60 operates with 3.3V supply, so level-shifter IC 74HCT125 is used to maintain proper TTL levels between PIC and ENC via SPI bus. LCD is wired in a 4-bit mode with data lines connected to port pins RD0 through RD3 of the microcontroller IC1. The control lines RS, R/ $\bar{W}$ and EN are connected to RD4, RD5 and RA5. Status LED2 connected to RA2 is used to indicate working of the stack by blinking.

Pins RC3, RC4 and RC5 are used for SPI communication. Pins RC6 and RC7 are used as TX and RX lines for serial communication. Dual driver/receiver MAX232 provides necessary voltage levels for serial communication

between the PC and the client board. RB3 and RB4 pins act as $\bar{CS}$ lines for the

ENC and EEPROM, respectively. Pin RB5 acts as reset line for ENC28J60. EEPROM 25LC256 is used for storing incoming weather data.

The client board should be connected to the Internet through Ethernet port of the modem or router.

Power supply. The client board circuit is powered by 5V and 3.3V supplies (refer Fig. 4). A 9V DC supply is fed to the 5V regulator 7805 (IC6). This 5V supply drives LM3940 (IC7) and the other circuit including PIC18F4685 microcontroller, LCD display and level shifter 74HCT125. LM3940 is a 5V to 3.3V converter. ENC28J60 is powered by the 3.3V supply. LED1 is used to indicate the presence of power in the circuit.

Host software

The host software is developed using Delphi language, which is simple to use and does not require DLL files like VB for running its application exe. The Delphi exe file can run on any windows platform. Delphi front panel view of the weather monitor is shown in Fig. 5.

The Setting button at the screen's bottom is used to configure the COM port parameters such as port number and baud rate. The Open button opens the relevant COM port, sends City Name in the edit box window and character 'S' to the client board which initiates the start of the client program. The Show button is enabled only after all the processing is over; it enables the user to view the data in the Report List. If a query is sent for a city whose weather data is not available, the server sends 'Unavailable' message to the client. That information is passed on to the user by displaying the message through a pop-up window.

Free third-party COM port library, SDL component Report List library and Scroll Message library are used,

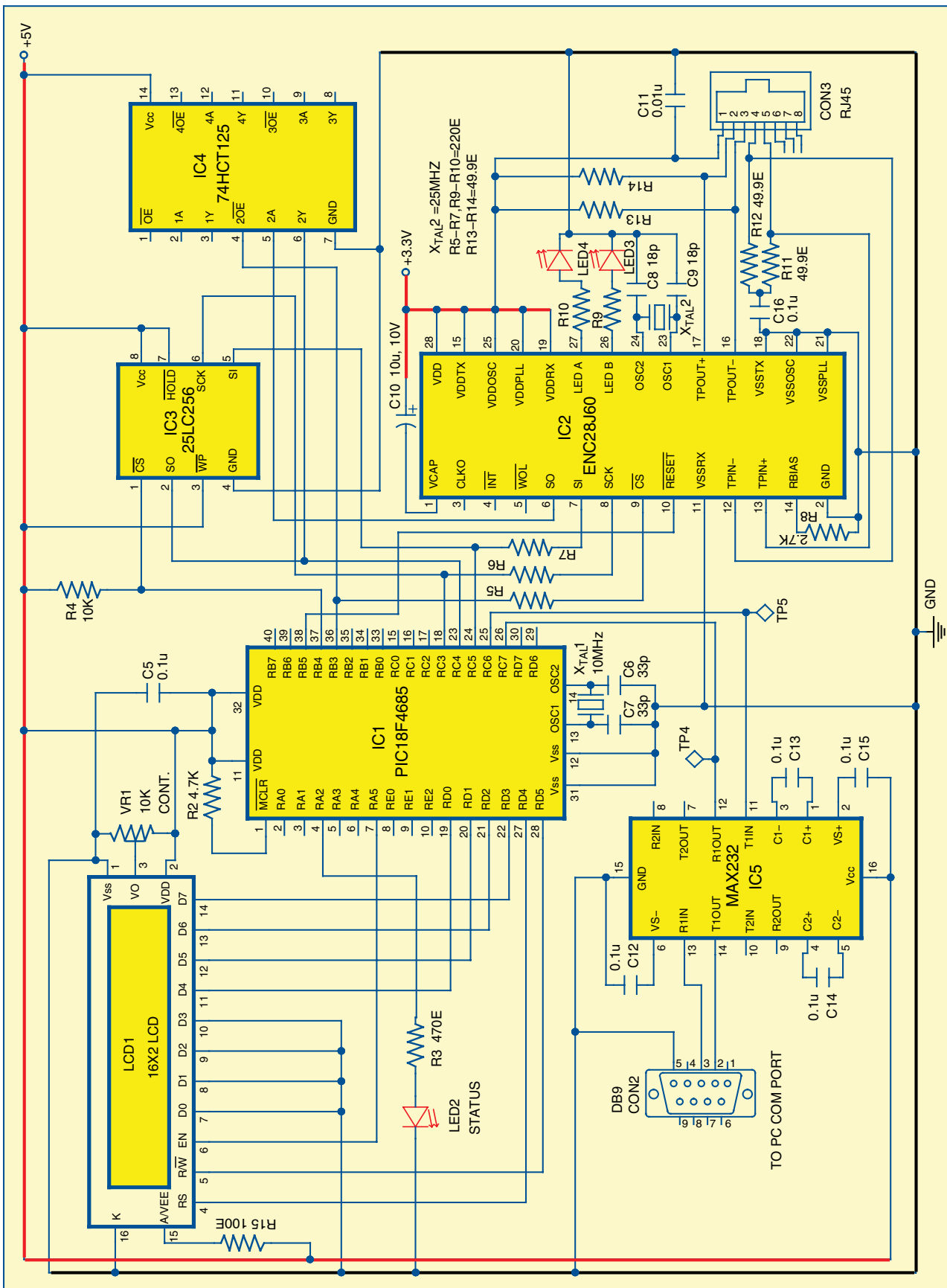


Fig. 3: Circuit diagram of the client board

which are freely available on the Internet for download. The incoming CSV data format from EEPROM via COM port is stored in a string array. Simple software routines are included in the Delphi program to extract individual

weather data from the CSV format and displayed in Report List.

Reset button is used to reset the Delphi form. The user has to change the COM port number available in his PC and baud rate is fixed to 19200.

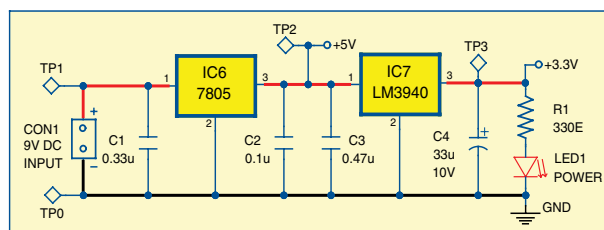


Fig. 4: Power supply

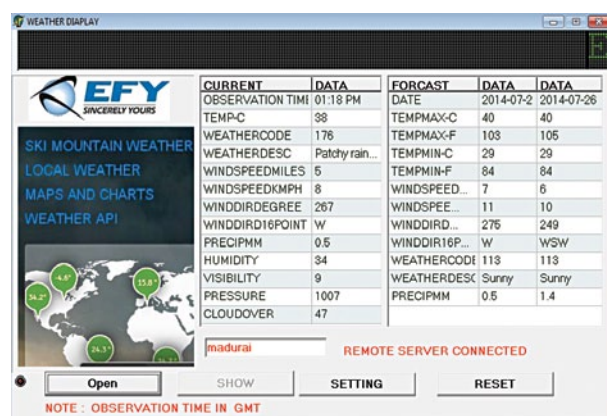


Fig. 5: Delphi front panel display

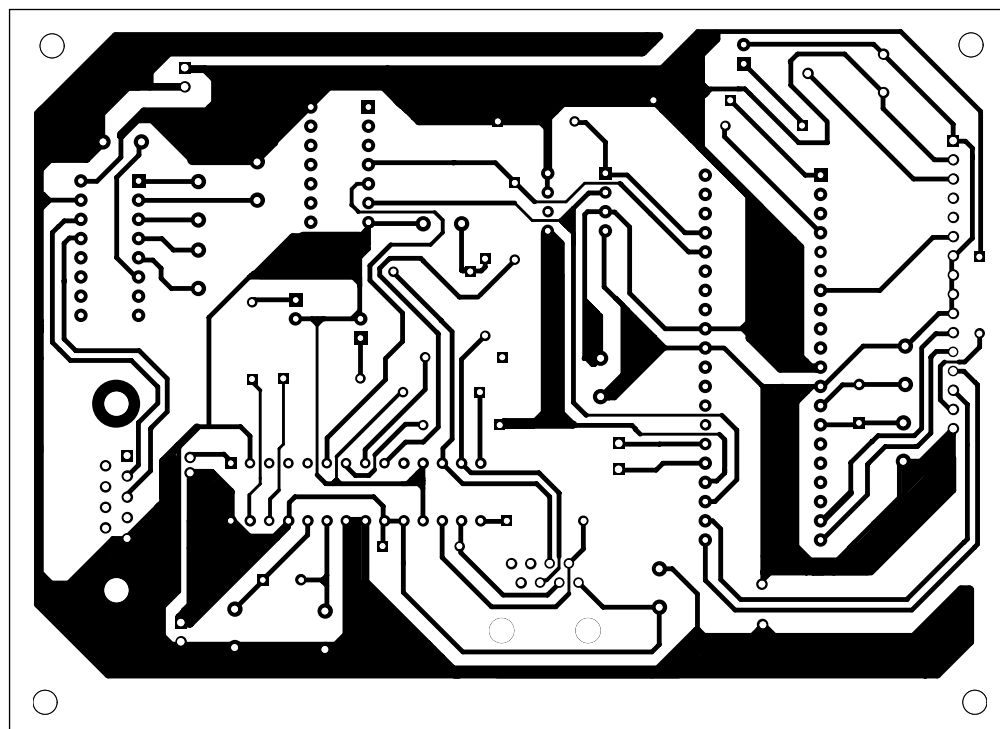


Fig. 6: An actual-size, double-side, solder-side PCB layout of the client board

Construction and testing

An actual-size, double-side, solder-side PCB layout of the client-board is shown in Fig. 6, component-side track layout in Fig. 7 and the component layout in Fig. 8. An actual-size, single-side PCB layout for the power supply is shown in Fig. 9 and its component layout in Fig. 10.

Mount the components on the PCBs to save time and minimise assembly errors. Check proper connections before connecting the 5V and 3.3V

supplies to the PCB at CON4 and CON5, respectively.

If your PC does not have a serial COM port, you can connect it to USB port by using a USB-to-serial converter. In that case, first you need to install appropriate driver in your PC. After connecting the client board to your PC, launch the weatherdisplay.exe Delphi program. A window screen will open up similar to the one shown in Fig. 5 with blank data columns.

In the display panel of this window click on the Setting button and choose the COM port. Note that your PC COM port baud rate should be 19200. Enter the city name in the edit box, for instance, Madurai. Now switch on the client board. The 'TCP-Client' message should appear on the LCD. Vary VR1 to adjust the contrast of the LCD to get clear visibility of the message.

Next connect one end of the Ethernet cable to the RJ45 connector in the client board and the other end to the Ethernet port of your broadband modem/router which has Internet connection. You need to configure your Internet connection in your PC from the control panel. You should disable wireless Internet connection. If Internet connection is successful, you will see the blinking of LED3 and LED4.

Now, click on Open button at the bottom of the screen. The IP address (192.168.0.102 in our case) should appear on the LCD. The Show button will be inactive first but after a few seconds it will get enabled and 'Remote server connected' message will appear at bottom of the screen. Upon clicking on the Show button weather data will get displayed in the report sheet as shown in Fig. 5.

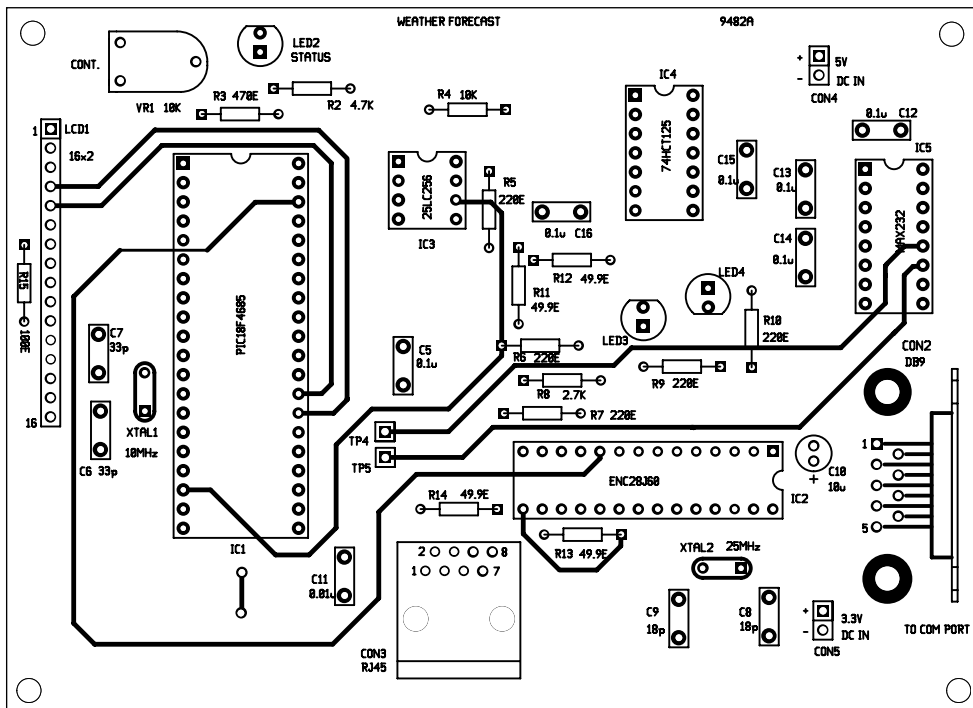


Fig. 7: Component-side track layout of the PCB

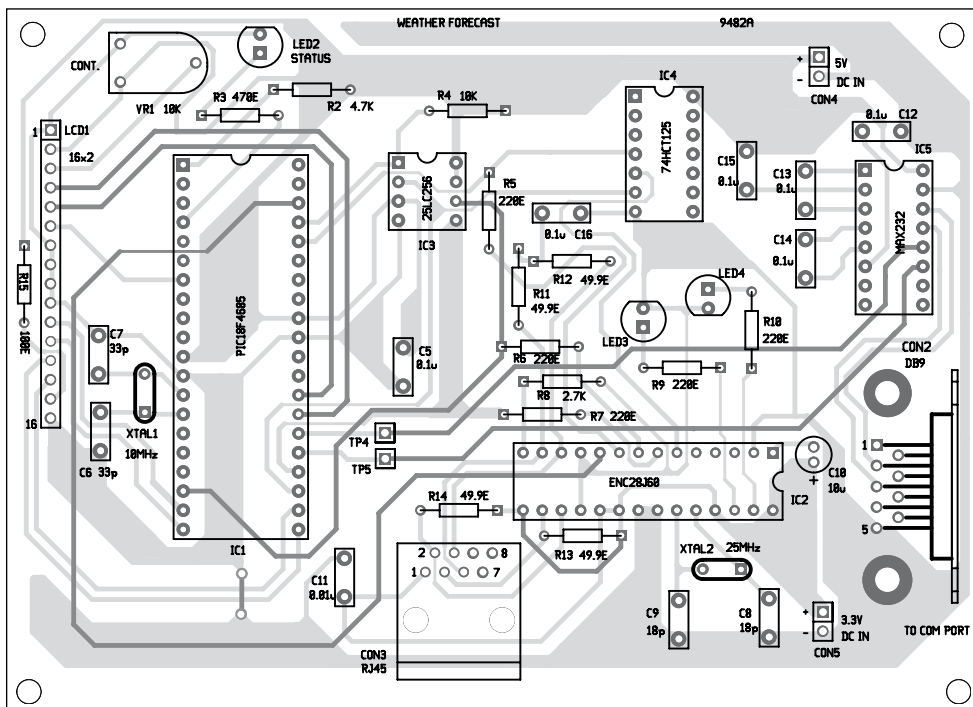


Fig. 8: Component layout of the client board circuit

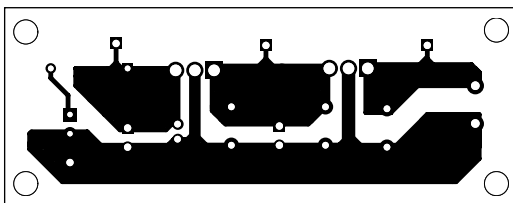


Fig. 9: An actual-size PCB layout of the power supply

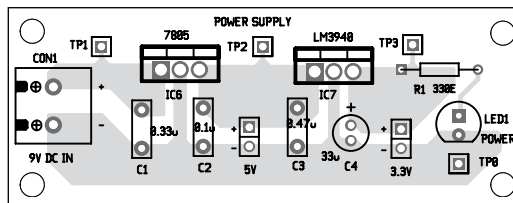


Fig. 10: Component layout of the power supply PCB

EFY Note

The source codes of this project are included in this month's EFY DVD and are also available for free download at source.efymag.com

At any time, if you face any problem in the circuit, refer Table II for trouble-shooting.

Further applications

Some other applications of this system could be:

1. Apart from the weather data one can get different types of weather analysis by sending relevant URL request to the server by referring to the full document available on the website.

2. It can be made into a portable system by interfacing it to a 10.2cm (4-inch) TFT colour LCD display and making it wireless using MR24WBOMA instead of ENC28J60

3. This design may be better than a backyard weather station because you receive accurate professional weather forecasts.

4. One can modify the design to connect with other data providers to display important data such as news headlines and stock market information. ●

The author, M. Kathiresan, is a retired sub-divisional engineer, mobile services, BSNL, Madurai. A. Robson Benjamin is an associate professor of physics at The American College, Madurai and C. Vijayan is an associate professor of physics at S. Vellaichamy Nadar College, Madurai. The authors thank worldweatheronline.com website moderators for providing free weather API for the project

T.K. HAREENDRAN

A vast range of audio-associated integrated circuits (ICs) are readily available for use by experimenters, professional design engineers and hobbyists. Most of the ICs are modestly priced with universally recognised part numbers. Described here is an interesting circuit of a 3W USB stereo amplifier based on PAM8403 IC from Power Analog Microelectronics. Designed for portable applications, PAM8403 is a 3W (class-D) stereo amplifier suitable for high-quality sound reproduction. Its filter-less architecture allows the chip to drive inductive loads directly, without any low-pass output filters, which saves the system cost and size.

Circuit and working

Fig. 1 shows circuit diagram of the 3W USB stereo audio amplifier. It is built around PAM8403 module (Board1), 5V voltage regulator LM1117-5 (IC1) and a

few other components.

PAM8403 IC is available in DIP-16 (regular) and SOP-16 (SMD) packages. With a little skill and patience, even a novice can rig up the stereo amplifier system on a small prototyping board. DIP-16 package may not be available from a local component vendor as the package is not very popular in this age of microelectronics. Fortunately, PAM8403 based stereo audio amplifier modules in pre-wired form are readily available from online component vendors at affordable price. Anyone can build one's own stereo audio system using this module just by adding some external components.

The circuit shown here may be assembled on a separate prototyping board. Use of suitable pin headers is recommended for mounting the PAM8403 module on prototyping board. It is seen from the circuit diagram that two separate power inputs, USB B-type (CON5) and external 7-12V DC (Jack2), have been incorporated for

total convenience and flexibility. However, if you are interested only in USB power, the onboard regulator (and related components) is not needed. Anyway, before giving power to the circuit, the entire assembly must be checked carefully for correct connections.

Note that the absolute maximum working voltage of PAM8403 module is 5.5V. Therefore do not use four AA dry cells ($1.5V \times 4 = 6V$) to power the system. It is recommended to use four rechargeable (Ni-Cd/Ni-Mh) cells ($1.2V \times 4 = 4.8V$), or three dry/alkaline cells ($1.5V \times 3 = 4.5V$). Further, do not make the audio input signals too high as that will deteriorate the sound quality, and probably destroy the chip

Test Points

Test point	Details
TP0	0V
TP1	5V when USB is used
TP2	5V when Jack2 is used

PARTS LIST

Semiconductors:

Board1	- PAM8403 module
IC1	- 5V regulator LM1117-5
D1, D2	- 1N5819 diode

Resistors (all 1/4-watt, $\pm 5\%$ carbon):
VR1, VR2 - 50k potentiometer

Capacitors:
C1, C2 - 10 μ F, 25V electrolytic

Miscellaneous:

- S1 - On/off switch
- Jack1 - 3.5mm stereo input jack
- Jack2 - DC power jack
- CON1 - 3-pin connector
- CON2-CON4 - 2-pin connector
- CON5 - USB B-type connector
- LS1, LS2 - 4-ohm, 3W speaker

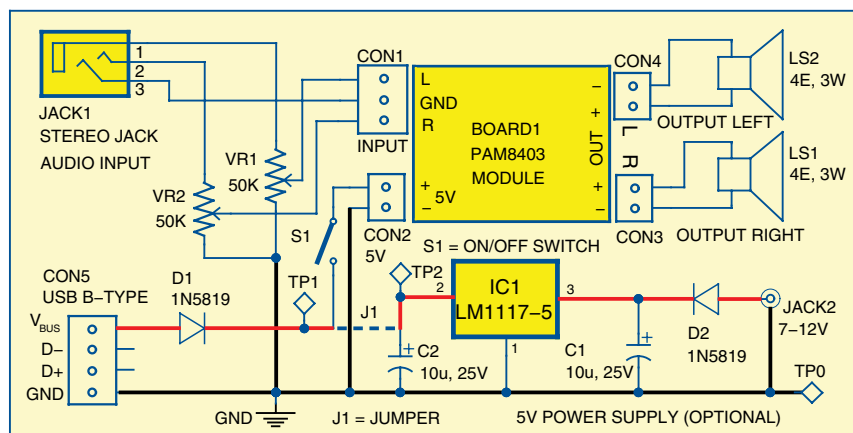


Fig. 1: Circuit diagram of 3W USB stereo audio amplifier



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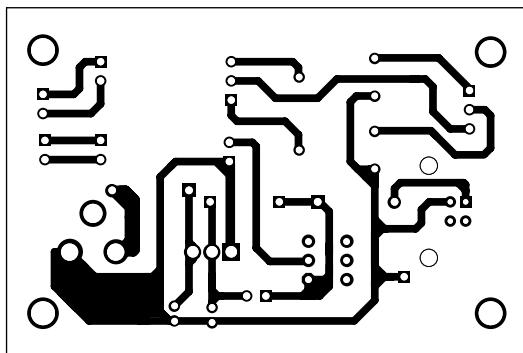


Fig. 2: An actual-size PCB layout for the circuit

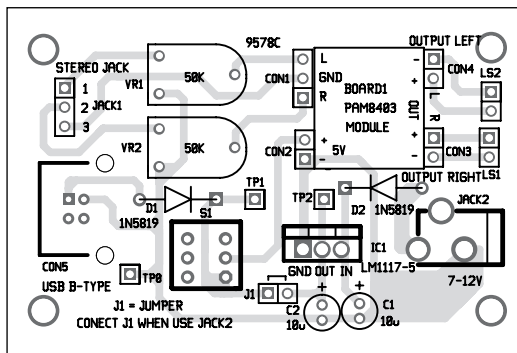


Fig. 3: Component layout for the PCB

within seconds.

Stereo audio output from an external source available at 3.5mm stereo input Jack1 is routed to PAM8403 module through two independent volume-control potentiometers VR1 and VR2. Similarly, 5V DC supply from USB port of the device available at USB input CON5 is extended to PAM8403 module through a protection diode (D1) and on/off switch (S1). The external DC input at Jack2 can be used to power the system from any 7V to 12V DC power source.

The LM1117-5 is a fixed 5V low-dropout-voltage regulator which offers current limiting and thermal shutdown. This IC is commonly available in TO-220 (regular) and SOT-223 (SMD) packages. Note that, a minimum of 10μF tantalum capacitor is required at the input and the output of LM1117-5 to improve transient response and stability.

Construction and testing

An actual-size, single-side PCB for the USB stereo audio amplifier is shown in

Fig. 2 and its component layout in Fig. 3. After assembling the circuit on PCB, enclose it in a suitable plastic box.

Connect CON1 through CON4 on Board1. Fix Jack1 on PCB for stereo audio input.

Fix USB B-type connector CON5 and

Jack2 on the PCB for the two power supplies. Fix switch S1 on front panel of the box for power supply and pots VR1 and VR2 for volume control. Connect jumper J1 in the PCB (see Fig. 3) if you are using the 7-12V supply via Jack2.

For connecting the speakers, two connectors are available on the PCB. Before connecting the load verify that the voltages at test points are as per table. ●

The author is a freelance writer and circuits designer

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Matchbox Capacitor Tester

KAUSHIK HAZARIKA

Checking of an electrolytic capacitor without an LCR meter is not free from hassles. Here is a simple solution for checking the serviceability of a capacitor.

Circuit and working

Fig. 1 shows the circuit diagram of a simple capacitor tester which can be housed in a small matchbox. It is basically an oscillator circuit comprising two transistors, BC558 (T1) and BC548 (T2), and a few other components. The frequency of oscillation, which is in audio range, depends on value of the capacitor under test. The tester can check the serviceability of capacitors in the range of $1\mu\text{F}$ to $2200\mu\text{F}$.

Construction and testing

An actual-size, single-side PCB for the capacitor tester is shown in Fig. 2 and its component layout in Fig. 3.

Connector CON1 in the circuit is for inserting the capacitor under test. Four-pin berg strip female connector is used here to accommodate different sizes of capacitors. LS1 is a small speaker used as headphone (shown in Fig. 4). Assembled PCB of the circuit can be enclosed in a matchbox as shown in Fig. 5.

After wiring, do verify that voltages are as per Test Points table.

For testing the capacitor, insert it in CON1. If the capacitor is good, a

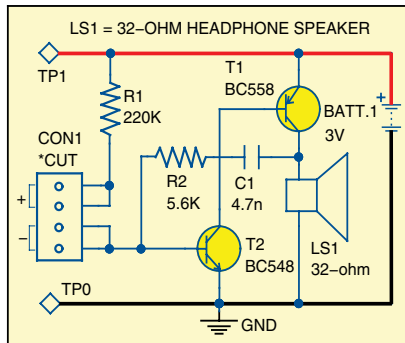


Fig. 1: Circuit diagram of the capacitor tester

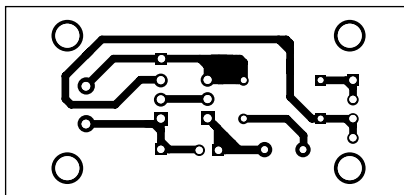


Fig. 2: An actual-size PCB layout for the tester circuit

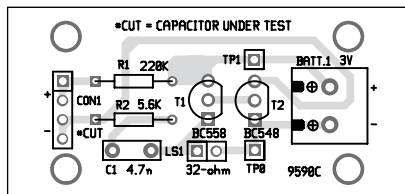


Fig. 3: Component layout of the PCB

Test Points

Test point	Details
TP0	0V
TP1	3V

fire-siren like sound is produced. A continuous beep is produced if the



Fig. 4: Earpiece of a headphone

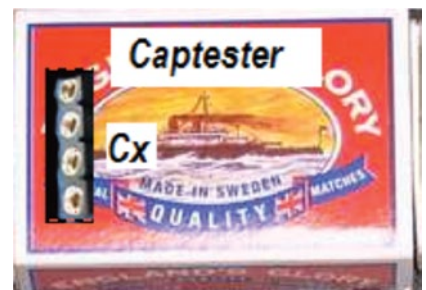


Fig. 5: Capacitor tester in matchbox

PARTS LIST

Semiconductors:

- T1 - BC558 pnp transistor
- T2 - BC548 npn transistor

Resistors (all 1/4-watt, $\pm 5\%$ carbon):

- R1 - 220-kilo-ohm
- R2 - 5.6-kilo-ohm

Capacitor:

- C1 - 4.7nF ceramic disk

Miscellaneous:

- LS1 - 32-ohm headphone speaker
- CON1 - 4-pin connector
- BATT.1 - 3V button cell
- 2-pin terminal connector

capacitor is short. ●

The author is a regular contributor to EFY

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Crystal-Controlled AM Transmitter

JOY MUKHERJI

This is a very simple and easy-to-make AM transmitter for the shortwave band. It can be used as a simple cordless microphone as well.

Circuit and working

Fig. 1 shows circuit diagram of the crystal-controlled AM transmitter. It is built using an electret microphone (MIC1), low-power audio amplifier

LM386 (IC1), 2-way DIP switch (DIP1), transistors PN2222A (T1) and 2N3866A (T2) with a heat-sink and a few other components.

The circuit transmits on 6.4MHz and 7.2MHz. The output is selected to a single crystal frequency with the help of DIP switch DIP1. Operation of the circuit is simple.

Transistor T1 and its associated components make up a Colpitts oscillator with resistors R1, R2, R3 and R4 providing biasing and capacitors C2

and C3 the feedback. Transistor T1 amplifies tiny oscillations present in the crystals at the fundamental frequencies of X_{TAL1} or X_{TAL2} . IC1 is used as series modulator.

Amplified audio from electret microphone MIC1 is directly coupled to the collector of transistor T1. The audio signal is superimposed on the carrier frequency by varying the DC input to the oscillator. Due to careful design, 100% modulation is obtained by speaking into the microphone. Transistor T2 is a simple emitter-follower that is used as a buffer between the oscillator and the outside world. The crystal-controlled AM transmitter is only 40mW amplitude modulated, but modulation peaks can rise to 160mW with full modulation.

Construction and testing

An actual-size, single-side PCB for the crystal-controlled AM transmitter is shown in Fig. 2 and its component layout

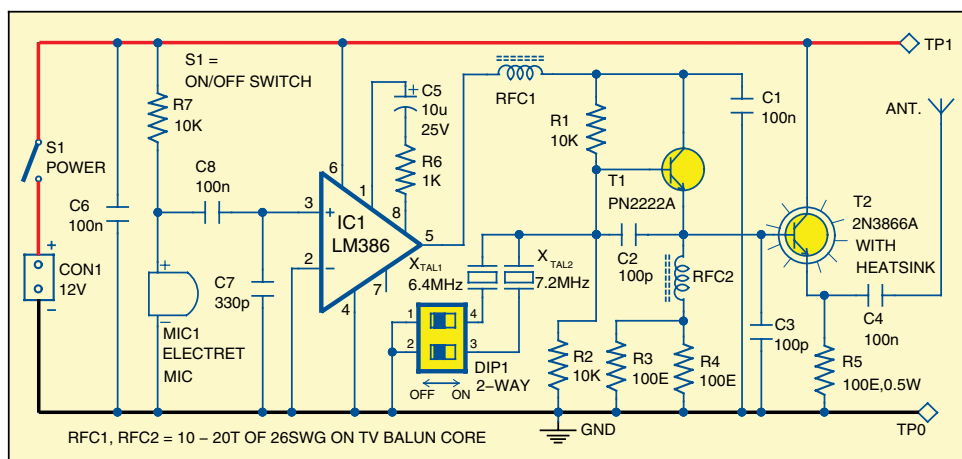


Fig. 1: Circuit diagram of the crystal controlled AM transmitter

PARTS LIST

Semiconductors:

- IC1 - LM386 low-power audio amplifier
T1 - PN2222A npn transistor
T2 - 2N3866A npn transistor with heat-sink

Resistors (all 1/4-watt, $\pm 5\%$ carbon, unless stated otherwise):

- R1, R2, R7 - 10-kilo-ohm
R3, R4 - 100-ohm
R5 - 100-ohm, 0.5W
R6 - 1-kilo-ohm

Capacitors:

- C1, C4, C6, C8 - 100nF ceramic disk
C2, C3 - 100pF ceramic disk
C5 - 10 μ F, 25V electrolytic
C7 - 330pF ceramic disk

Miscellaneous:

- S1 - On/off switch
DIP1 - 2-way DIP switch
MIC1 - Electret microphone
 X_{TAL1} - 6.4MHz crystal
 X_{TAL2} - 7.2MHz crystal
CON1 - 2-pin terminal connector
RFC1, RFC2 - RF choke (10 turns of 26SWG wire on TV balun)

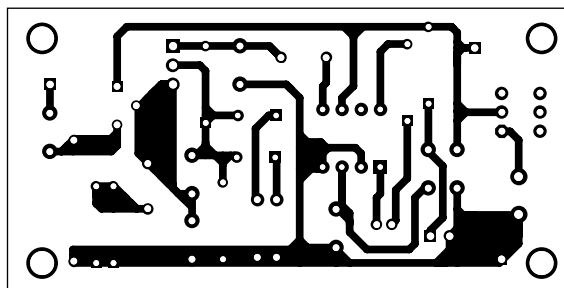


Fig. 2: An actual-size PCB layout for the transmitter

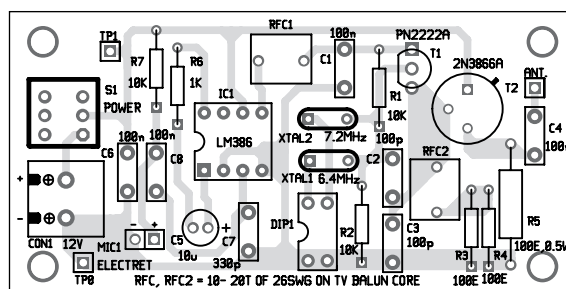


Fig. 3: Component layout for the PCB

Test Points

Test point	Details
TP0	0V
TP1	12V

in Fig. 3. Use a 7.5-metre long wire for the antenna. A regulated 12V hum-free power supply or a 12V battery should be used. Enclose the circuit in a small plastic box.

Before using the circuit, verify test point voltages are as given in the table. ●

The author is an electronics hobbyist and a small-business owner in Albany, New York, USA. His interests include designing radio-frequency circuits

Peripheral Driver with Fixed Regulators 78xx and 79xx

PETRE TZV PETROV

Drivers for peripheral devices should have over-current, over-voltage and over-heating protections. Nowadays, a large variety of low-cost, fixed-voltage regulators (such as 78xx and 79xx series) are available which offer these protections and more. These can be used as electronic on/off switches and drivers for such peripheral devices as DC motors, incandescent lamps, electromagnetic relays and power LEDs, besides others. The drivers can be with single polarity, dual polarity, half bridge and full bridge. This article discusses one such application.

Circuit and working

Fig. 1 shows circuit diagram of a bipo-

lar half-bridge driver built using ICs 7812 and 7912, but it can also be built with other similar regulators. The circuit will work with any 78xx and 79xx series of regulators using 5V to 24V supply. The circuit works with symmetrical as well as non-symmetrical voltages. For example, we can have $\pm 12V$, or $+12V$ and $-9V$ (or any other voltages within the regulators' range), if needed.

In this case, IC 7812 (IC1) works as a switch and regulator for the positive input voltage V_1 , while IC 7912 (IC2) works as switch for the negative input voltage V_4 . Diodes D1 through D4 protect the regulators from reverse voltages. Diodes D3 and D4 are obligatory only if there is a danger of reverse voltage from the capacitors connected to the regulators.



The $+V_2$ voltage is controlled by transistors T1 and T2. When T1 and T2 are on, voltages V_2 , V_3 and V_7 are present. In that case, you have $V_3 = 12V$ and $V_7 = 12V - 0.7V = 11.3V$. Similarly, when T1 and T2 are off, voltages V_2 , V_3 and V_7 become zero. When the signal at point A on input connector CON1 is high positive (say, above 3V), transistors T1 and T2 are on. When the signal at point A is low or negative (say, below 0.8V), transistors T1 and T2 are off.

The $-V_5$ voltage is controlled by transistors T3 and T4. When T3 and T4 are on, the voltages $-V_5$, $-V_6$ and V_7 are present. In that case you have $-V_6 = -12V$ and $V_7 = -12V + 0.7V = -11.3V$. When T3 and T4 are off, the voltages

$-V_5$, $-V_6$ and V_7 are zero. When the signal at point B is highly negative (say, $-3V$ or less) the transistors T3 and T4 are on. When the signal at point B is not so negative (say, $-0.7V$ or more), transistors T3 and T4 are off.

If you activate points A and B at the same time, voltage V_7 will be zero. The control signal at point A can be made TTL or CMOS compatible with selection of appropriate resistors R1 and R2 and transistor T1. The control signal at point B is negative and is not TTL or CMOS compatible.

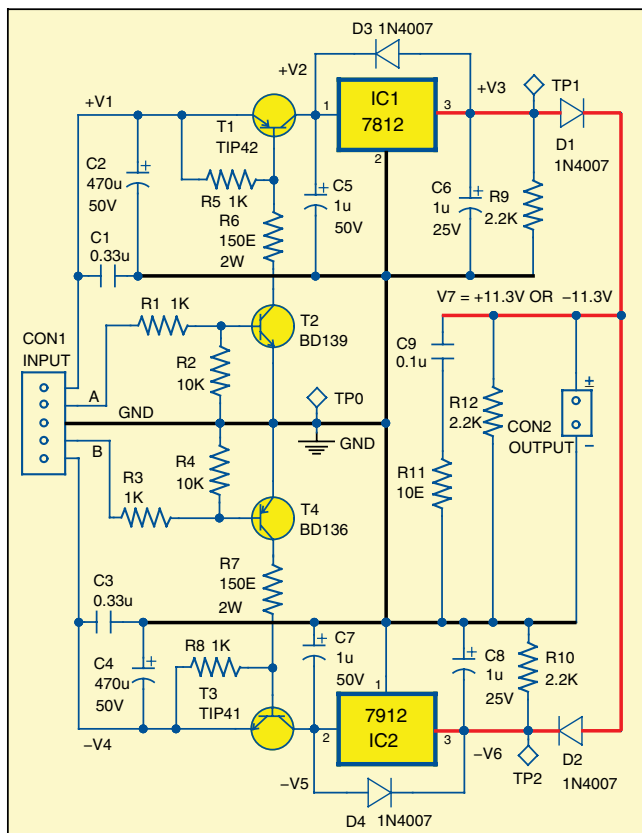


Fig. 1: Circuit diagram of peripheral driver with fixed regulators

Test Points

Test point	Details
TP0	0V
TP1	+12V
TP2	-12V

PARTS LIST

Semiconductors:	
IC1	- 7812, 5V regulator
IC2	- 7912, -12V regulator
T1	- TIP42 pnp transistor
T2	- BD139 npn transistor
T3	- TIP41 npn transistor
T4	- BD136 pnp transistor
D1-D4	- 1N4007 rectifier diode
Resistors (all 1/4-watt, $\pm 5\%$ carbon, unless stated otherwise):	
R1, R3	- 1-kilo-ohm
R2, R4	- 10-kilo-ohm
R5, R8	- 1-kilo-ohm
R6, R7	- 150-ohm, 2W
R9, R10, R12	- 2.2-kilo-ohm
R11	- 10-ohm
Capacitors:	
C1, C3	- 0.33 μ F ceramic disk
C2, C4	- 470 μ F, 50V electrolytic
C5, C7	- 1 μ F, 50V electrolytic
C6, C8	- 1 μ F, 25V electrolytic
C9	- 0.1 μ F ceramic disk
Miscellaneous:	
CON1	- 5-pin connector
CON2	- 2-pin connector

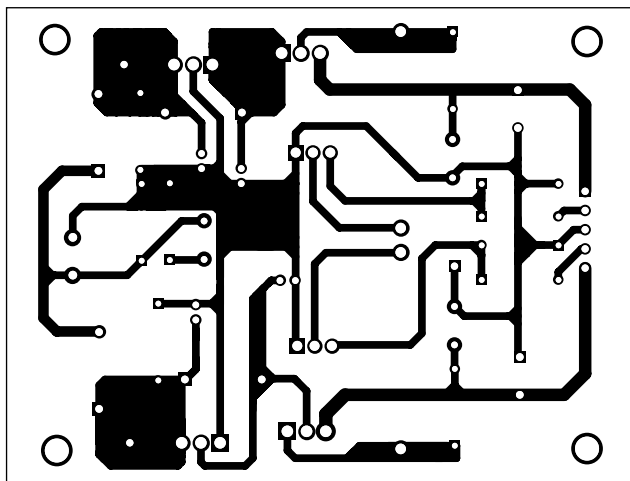


Fig. 2: An actual-size PCB layout for the driver circuit

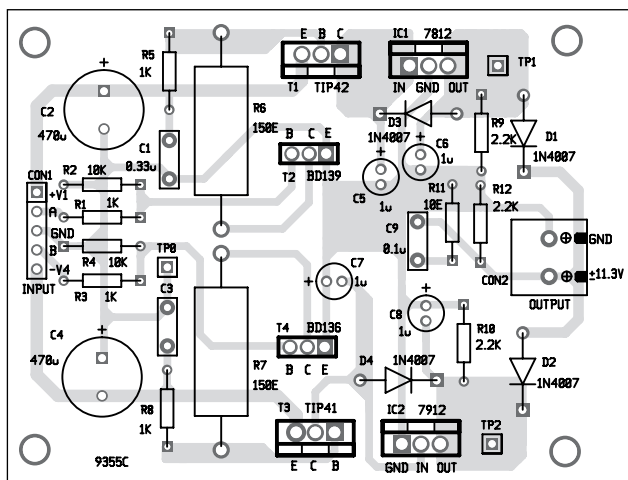


Fig. 3: Component layout for the PCB

We should use an appropriate voltage converter to drive the signal from TTL/CMOS signals. With appropriate additional logic the signals at points A and point B are controlled with one TTL/CMOS signal.

In brief, when signal at A is high, you get $+12V - 0.7V = +11.3V$ at CON2 and when signal at B is low (negative), you get $-12V + 0.7V = -11.3V$ at CON2.

Construction and testing

An actual-size, single-side PCB for the peripheral driver with fixed regulators 78xx and 79xx is shown in Fig. 2 and its component layout in Fig. 3. After assembling the circuit on PCB, enclose it in a suitable plastic box. Fix 5-pin connector CON1 for input signal and 2-pin connector CON2 for output. A

suitable common heatsink may be used for T1 and IC1. The same for T3 and IC2.

Before inserting the load, first verify that the test point voltages are as per table. ●

The author was a researcher and assistant professor in Technical University of Sofia (Bulgaria) and expert-lecturer in OFPPT (Casablanca), Kingdom of Morocco. Now he is working as an electronics engineer in the private sector in Bulgaria



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How to Assemble Your Own 3D Printer



ANKIT GUPTA

3D printing, getting popular for making usable objects, is the reverse of traditional machining where material is removed from a block by drilling, cutting, chiseling, etc for making objects. In 3D printing, an object is created by laying successive layers of material as per requirement. This article describes how you

can assemble a simple 3D printer for yourself, like we did in EFY Lab, and then make use of it. But before that, you should know some basics of 3D printing.

The process of printing 3D objects starts with making a virtual design of the object you want to create, using one of the supported computer aided design (CAD) software. A 3D scanner can also be used to copy an existing

object. The scanner makes a 3D digital copy of an object and puts it into a 3D modeling program. This 3D model file is sliced into thousands of horizontal layers which are then printed by a 3D printer, layer by layer, creating the entire 3D object. 3D printers generally employ one of below-mentioned methods.

Fused deposition modeling (FDM).

This is the most popular method used in DIY type 3D printers. Here a plastic filament or wire is made to pass through an extrusion nozzle (Fig. 2). The nozzle tip is heated to melt the filament or wire. The nozzle can be moved in all three directions, precisely, using stepper motors. The object is produced by extruding melted material to form layers upon layers of the object. The material hardens immediately after extrusion from the nozzle. The process is also known as fused filament fabrication (FFF). The printer shown in Fig. 1 is an assembled FDM based 3D printer.

Selective laser sintering (SLS). In this method high-power laser is used to fuse small particles of plastic, metal, ceramic or glass powder to form an object. The laser selectively scans and fuses the material layer by layer as per the 3D model design. Once a layer is

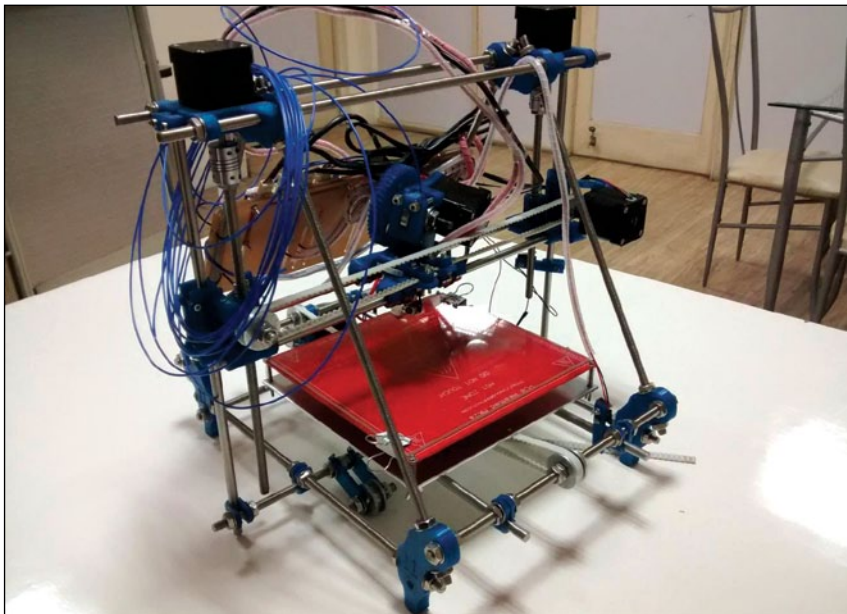


Fig. 1: LM8UU Prusa Mendel 3D printer

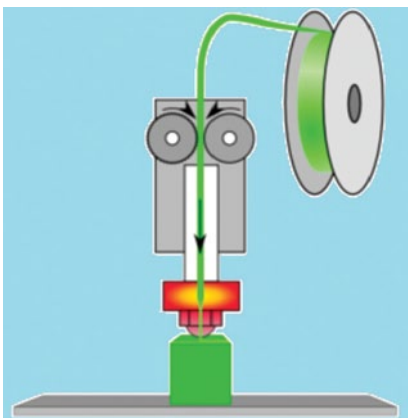


Fig. 2: Fused deposition modeling

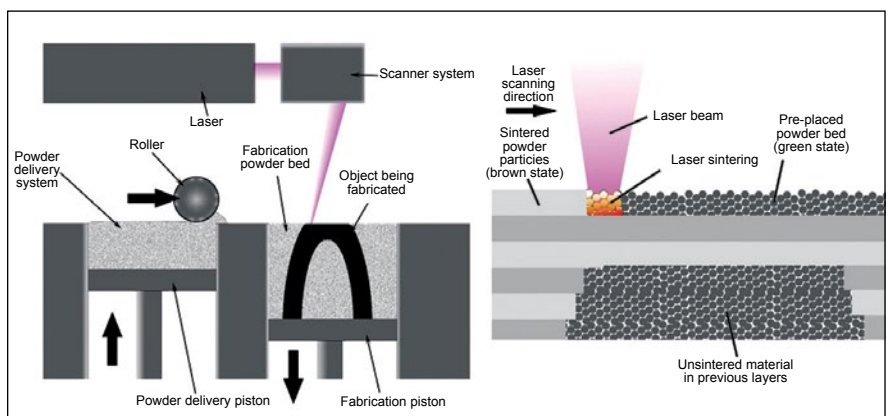


Fig. 3: SLS system

3D printed rocket parts

NASA recently tested the most complex rocket engine parts ever designed by them, which were designed with additive manufacturing, or 3D printing, according to an IANS report. Apart from helping engineers build and test a rocket injector with a unique design, additive manufacturing also enabled NASA to test faster and smarter, according to the agency. Each part was built by layering metal powder which was fused together with a laser. Whereas with a traditional manufacturing method 163 individual parts would be made and assembled, with 3D printing only two parts were required!

completely printed, the bed is lowered by one layer thickness and new layer of fused material is applied. The process is repeated until all the fused layers have been laid. Fig. 3 shows an SLS system.

Sterolithography (SLA). This method employs ultraviolet curable photopolymer resin and an ultraviolet laser to build the object's layers. The laser beam scans a selective surface area of the resin to solidify it as per the 3D design model. Once a layer is printed, the platform descends by a distance equal to the thickness of a single layer. And the laser scans again to print the second layer. Fig. 4 shows and SLA system.

How to build a DIY 3D printer

The printer described here is the LM8UU Prusa Mendel 3D printer. The basics of building any FDM based DIY printer will be more or less the same. The printer has three major parts: electronics (and electrical), software and mechanics.

Fig. 5 shows the complete electronic and electrical system that runs a 3D printer. Sanguinololu board is the heart of the whole system. It controls different stepper motors for moving the nozzle in X and Y directions, moving the heat bed in Z direction and extruding the material from the nozzle.

Fig. 6 shows the stepper motors used. The board senses extruder's and bed's temperature through thermis-

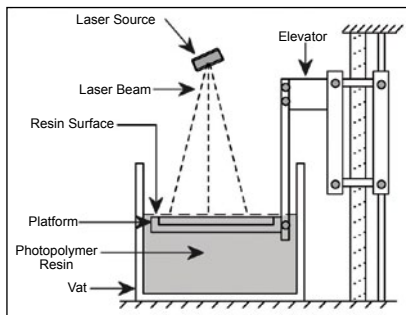


Fig. 4: SLA system

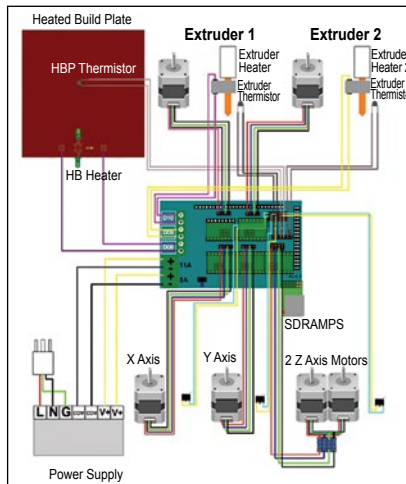


Fig. 5: Electronic and electrical system

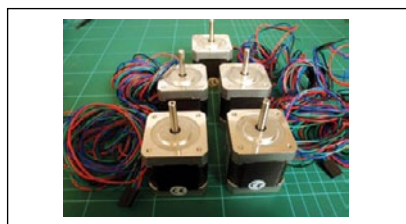


Fig. 6: Stepper motors



Fig. 7: Endstop

tors. Endstops are used (like stoppers) by the printer to determine the boundaries. Fig. 7 shows an endstop.

The temperatures of nozzle and heat-bed can be monitored through



Fig. 8: ATX power supply

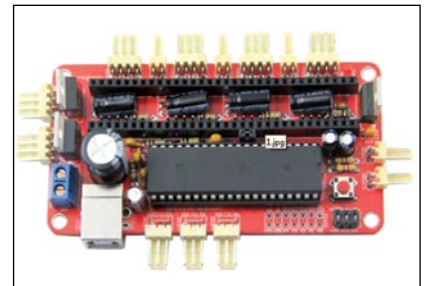


Fig. 9: Sanguinololu board

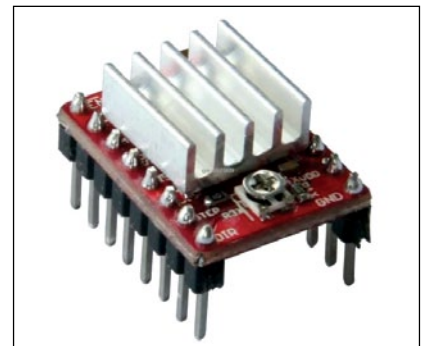


Fig. 10: Pololu board with heatsink



Fig. 11: Heat-bed

software as explained in software section. The software program, which connects to the board through USB interface, is used for loading the 3D model file for printing and testing

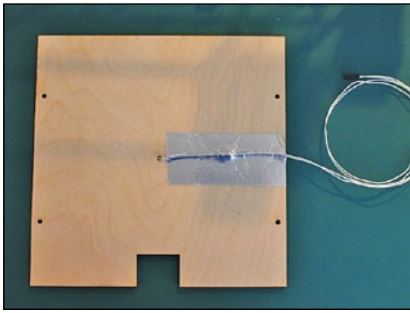


Fig. 12: Thermistor attached to heat-bed



Fig. 13: Extruder assembly

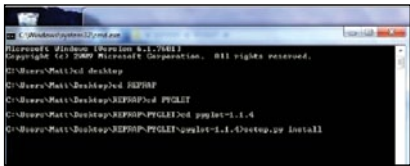


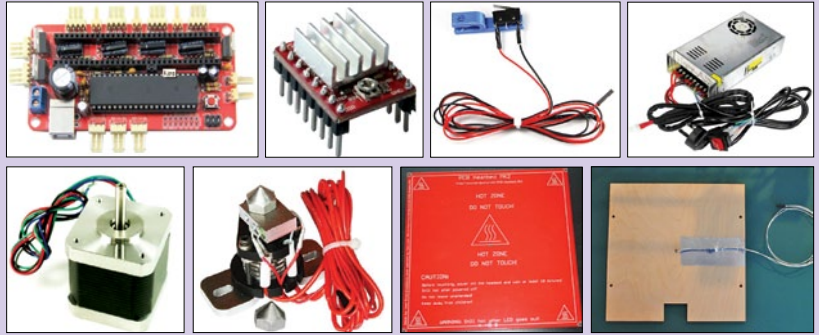
Fig. 14: Installing Pyglet

various operations. The overall system is powered by 12V, 400W ATX power supply (Fig. 8).

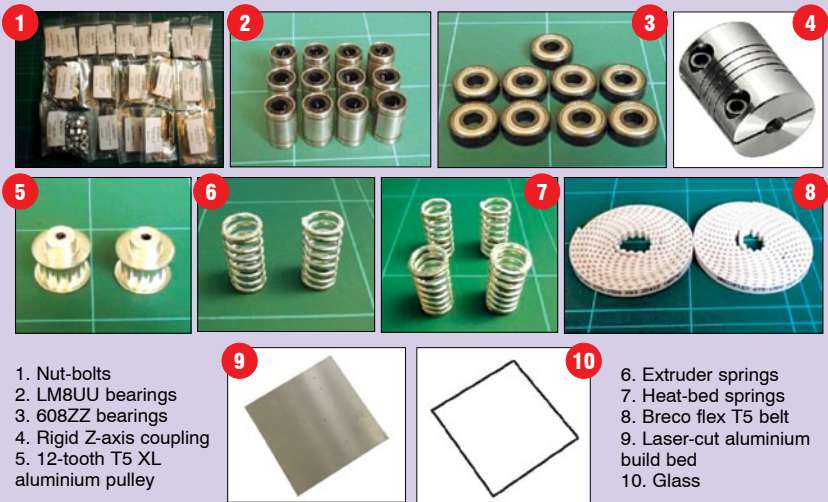
Sanguinololu board. Sanguinololu board (shown in Fig. 9) is a low-cost, all-in-one electronics solution for Reprap and other CNC devices. It features an onboard Sanguino clone using the ATMEGA644P microcontroller, though an ATMEGA1284 can be easily substituted. The board is developer-friendly with expansion pins supporting I²C, SPI, UART and ADC functions. Sanguinololu has a very flexible input power supply that ranges from 7V to 30V.

Pololu board. The stepper motors are powered by Pololu boards that are mounted over Sanguinololu board. These are carrier boards or breakout boards for Allegro's A4988 DMOS microstepping driver with translator and over-current protection. The stepper motor driver lets you control a bipolar stepper motor at up to 2A output cur-

Electronic/electrical parts



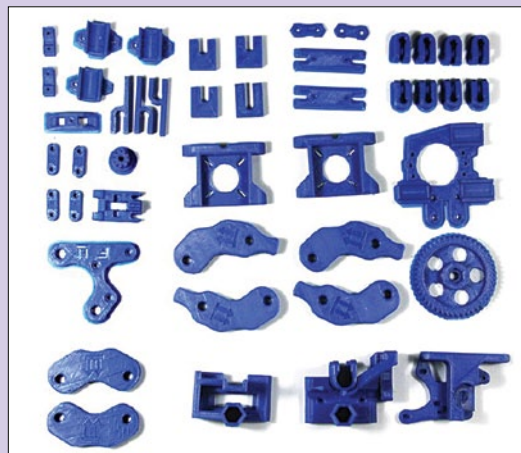
Mechanical parts



1. Nut-bolts
2. LM8UU bearings
3. 608ZZ bearings
4. Rigid Z-axis coupling
5. 12-tooth T5 XL aluminium pulley

6. Extruder springs
7. Heat-bed springs
8. Breco flex T5 belt
9. Laser-cut aluminium build bed
10. Glass

Printed parts



rent per coil. Fig. 10 shows a Pololu board with heatsink.

Heat-bed. The heat-bed (Fig. 11) normally heats up to 110°C when powered through the dedicated connection on Sanguinololu board. The power sup-

ply should be able to deliver at least 300W and wires from the power supply to the Sanguinololu board should be capable of handling 20A or slightly more current.

Thermistor. A thermistor is at-

tached to the heat-bed using aluminium tape. The thermistor should poke through the central hole in the bed, about 1mm. Tape the thermistor securely and run the cable to the right (Fig. 12). The cable is connected to Sanguinololu board for monitoring the temperature of the heat-bed.

Extruder. The extruder's nozzle end heats up when enabled by the Sanguinololu board. The extruder assembly has an in-built thermistor to monitor and control the temperature of the hot end. A stepper motor rotates to push the raw material in the nozzle from the cold end; the speed can be controlled. The material melts when pushed through the nozzle's hot end and gets placed on the heat-bed as per 3D model design. Fig. 13 shows the nozzle (extruder) assembly.

Software

All the software required for a DIY type 3D printer is available at:

<http://www.nextdayreap.co.uk/reap-downloads/>

The Sanguinololu board comes with boot-loader preinstalled. You just have to upload the 3D printer firmware. For that, first install Arduino development environment on your computer and add the Sanguinololu board in it. Download Sanguino software from: <https://code.google.com/p/sanguino/downloads/list>

Copy the downloaded software in the Arduino installation directory under Hardware folder. The Sanguino boards will start reflecting in the boards menu of Arduino IDE. Now, select the board in the Arduino IDE corresponding to the microcontroller on the Sanguinololu board. Download the 3D printer firmware (Marlin or Sprinter), open it in the IDE and click on Verify/Compile button. Click on Upload button to upload the firmware in the Sanguinololu board. Note that you might have to make some changes in the Configuration.h file as per your printer.

Once the firmware is uploaded, you just need software that can slice the 3D model design (.STL file) to make the .gcode file. This .gcode file is

then given to the 3D printer for printing the object, layer by layer. The software that you can use here is Pronterface. Follow the steps below to install Pronterface and dependencies.

1. Install Python Environment & Dependencies. Download and install the 'python-2.7.2.msi' from <http://python.org/ftp/python/2.7.2/python-2.7.2.msi>

2. Download and install PYSerial for serial communication from <http://pypi.python.org/packages/any/p/pyserial/pyserial-2.5.win32.exe>

3. Download and install Python 8 for Python from <http://downloads.sourceforge.net/wxpython/wxPython2.8-win32-unicode-2.8.12.0-py27.exe>

4. Download and install PYReadline also for serial communication from <http://launchpad.net/pyreadline/1.7.1.7/+download/pyreadline-1.7.win32.exe>

5. Now, install Pyglet. Download it from the link <http://pyglet.googlecode.com/files/pyglet-1.1.4.zip>

6. Extract the files. Run command prompt and navigate to the extracted directory. Type 'setup.py install' and press enter as shown in Fig. 14.

7. Download and install Pronterface from www.nextdayreap.co.uk/downloads/klient-Printrun-d9a3363.zip

Mechanical assembly

Mechanical assembly is the most critical thing in DIY type 3D printers as all the parts need to work precisely to print an object properly. Mechanical assembly instructions and architecture will differ from model to

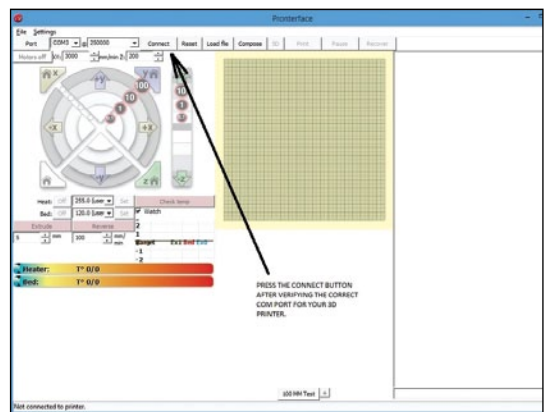


Fig. 15: Setting COM port and baud rate

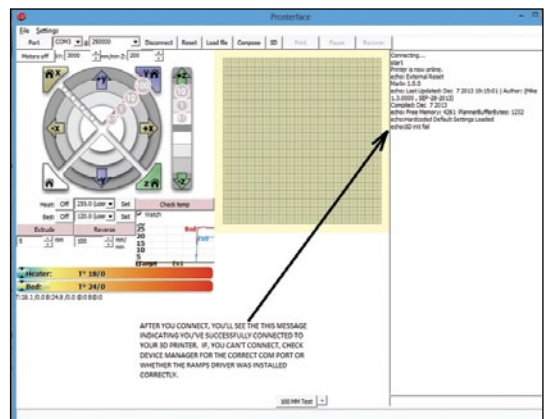


Fig. 16: Successful connection to 3D printer

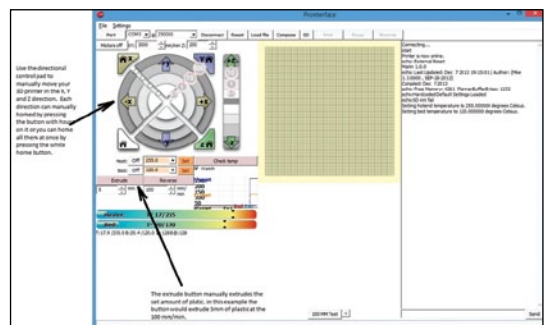


Fig. 17: Manual control of 3D printer

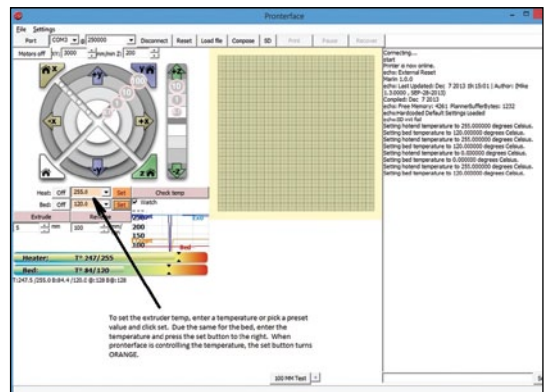


Fig. 18: Setting temperature of nozzle and heat-bed

model. You may take help of Google to search for the kit or parts required to assemble your printer and further instructions, if required. The LM8UU Prusa Mendel 3D printer assembled at EFY required parts that are shown in the box on previous page.

Print a part

If you have done the mechanical assembly and software upload, the major task is over. Now you just have to use Pronterface software to print any 3D object. Start by connecting your 3D printer via USB cable to a computer that has Pronterface software installed already. Connect the ATX power supply to the 3D printer and switch it on.

Run Pronterface software. Once the software is up, computer screen will look like as shown in Fig. 15. Select the COM port to which your 3D printer is connected and set the baud rate to 250,000 (as shown in Fig. 15). Next, click on Connect button. You will see message in the right column of Pronterface indicating that the printer has successfully connected as shown in Fig. 16.

Once connected, you can use Pronterface to manually control the X, Y and Z axis movements as shown in Fig. 17. You can also manually control the extruder motor using Pronterface, but be sure that the heater is turned on before doing so. The distance and speed of the manual control is set right below the Extrude button.

To set the temperature of the nozzle or heat-bed, use the pull-down menu and select the temperature and then use Set button as shown in Fig. 18. To turn the heating off, simply select the Off button. You can monitor the temperature of

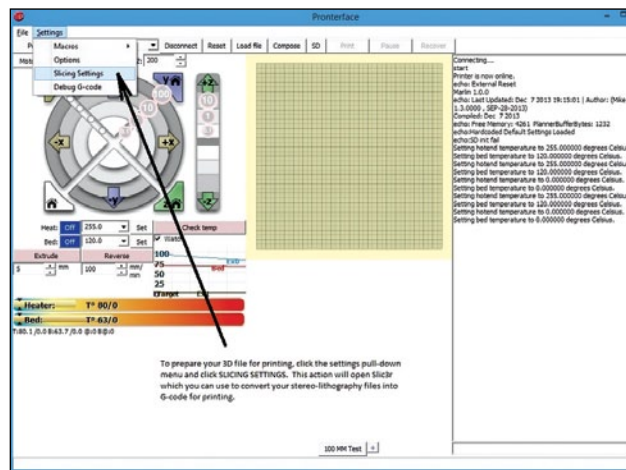


Fig. 19: Selection of Slicing Settings

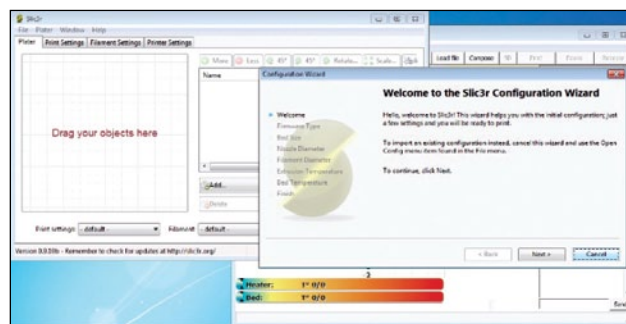


Fig. 20: Slic3r configuration wizard

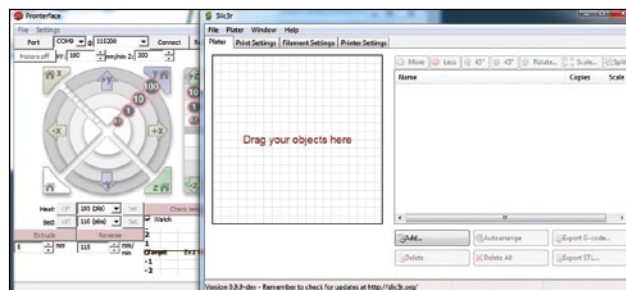


Fig. 21: Dragging the .stl file

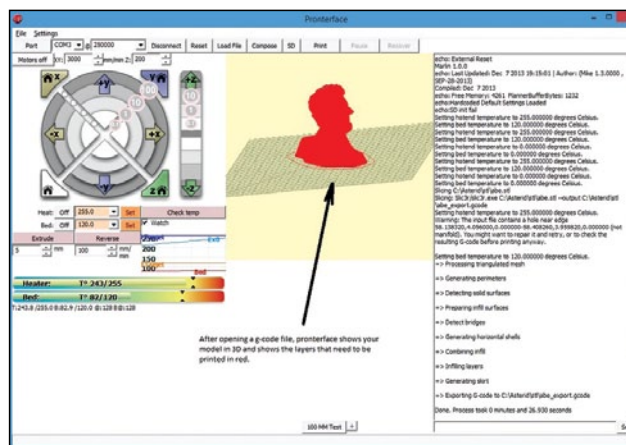


Fig. 22: Loading G-code file

the nozzle and bed by selecting 'Watch' option and then viewing the graph of real-time temperature value. Or, you can select 'check temp' to view the actual temperature in the console on the right side.

From the pull-down menu in the toolbar select Settings and then Slicing Settings as shown in Fig. 19. This will open the program Slic3r as shown in Fig. 20. Slic3r is the program to convert a digital 3D model into printing instructions for your 3D printer.

If this is the first time you are opening Slic3r, you will be prompted with the Slic3r configuration wizard. Select Cancel on this wizard.

Drag your .stl file of the object you want to print in the box as shown in Fig. 21. Click on the export G-code button and your G-code will be ready to load. Your 3D printer uses G-code to know what to print. The slicing program will convert a stereolithography (.stl) file of a 3D model into the necessary G-code that your printer can understand. Once the file has been exported into the needed G-code format, you can open that file in Pronterface for printing.

Open the G-code by navigating File menu and then clicking Open. Browse the folder you exported the G-code file into and select that file and then press OK. When Pronterface loads the file it will appear on the graph in the graphical user interface as shown in Fig. 22. Now you just have to click on Print on the Pronterface toolbar and your printer will start printing the 3D object, layer by layer.

Happy printing! ●

The author was a technical editor at EFY when he wrote this article. He has moved on since then to work on his own

USB MP3 Player



ANIRUDDH KUMAR SHARMA

If you go to the market to buy an MP3 player with USB compatibility, it will cost around 500 rupees or more. But you can assemble one for yourself for 150 rupees or less. All the components, including the module, are readily available as a kit form with many electronics spares shops.

In this article you will find instructions to assemble and use the USB MP3 module supplied by Shenzhen Vire Silicon & Technology Co. Ltd, China. The module comes with a remote control also for users' convenience.

This versatile module features USB player, SD card player, FM player and an auxiliary input. Besides the USB MP3 module you get two 3.5mm female jack sockets, USB female cable or port, IR receiver and 5V regulated DC

supply in the kit for this DIY project.

Just connect the components as mentioned in the text below.

Here we shall be discussing all the features which has been tried and tested successfully except the SD card holder connections, as this feature is rarely used. Connect the below-mentioned points to the USB female connector:

GND- Ground

DP - Data Plus (+)

DM - Data minus (-)

5V - 5V supply

Connect audio out and IR receiver portion as indicated below:

L - Left channel audio out

AG - Analogue ground

R - Right channel audio out

G - Ground for IR receiver

IR - IR out of the IR receiver

3.3V - 3.3V supply for IR receiver

Almost all the IR receivers have their IR, GND and Vcc pin-outs facing the receiver from front. The manual switch connections are optional; these can be connected using tactile switches to ground:

V+ - Volume Plus

Mode - Mode(USB/Aux/FM)

V - Volume Minus

P - Play/Pause

Connect a regulated +5V to the point 5V and GND. Connect the aux in connection as shown:

L - Left channel audio in

G - Analogue ground in

R - Right channel audio in

An antenna can be connected to the point shown for the FM reception.

Just make the connections, as indicated above, and connect the output to any PC multimedia speaker and enjoy the music. ●

The author is a B.Tech in electronics and communication engineering. Currently, he is an R&D manager at BB Power Tech, India. He likes exploring new circuits

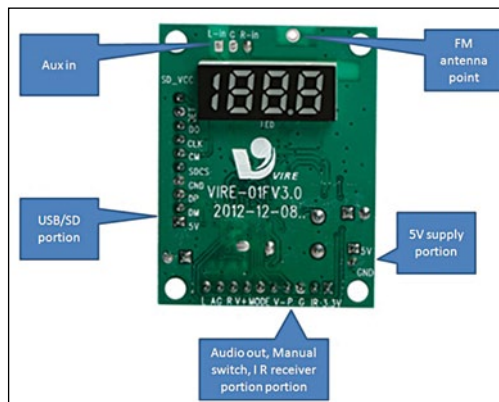


Fig. 2: The USB module with its various connection points



Fig. 1: The module and the remote control



Fig. 3: The author's prototype

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Software to Help You Select Inverter for Your Home



BASKAR K.

Choosing the right ratings for the inverter and its battery to be used at home is not that

easy. There are many parameters that you need to know before buying an inverter, such as load requirement, size of the inverter, back-up time, size of battery, etc. Presented here is a program in Python that helps you select the right inverter based on some common parameters. This article also describes how to create a standalone application so that you can run the program without Python software, if needed.

Software program

Python is a high-level programming language with rich syntax. There are lots of packages available for Python. We used wxpython package for graphical user interface (GUI).

First you need to install Python; we installed its 2.7.6 version. You can download it from the link <https://www.python.org/>. Then you need to install wxpython package. You can get wxPython3.0-win32-py27 for 32-bit Python 2.7 version or wxPython3.0-win64-py27 for 64-bit Python 2.7 version from www.wxpython.org/download.php.

To run the application, just right

load	watts	Nos
load 1	3	1
load 2	0	1
load 3	0	1
load 4	0	1
load 5	0	1
load 6	0	1
load 7	0	1
load 8	0	1
load 9	0	1
load 10	0	1
load 11	0	1
load 12	0	1
load 13	0	1
load 14	0	1
load 15	0	1
load 16	0	1
load 17	0	1
load 18	0	1
load 19	0	1
load 20	0	1

DEVICE	WATTS
Coffee maker	900-1200
Ceiling fan	65-175
Window fan	55-250
Heater(portable)	750-1500
CPU(awake/asleep)	120/30 or less
Monitor(awake/asleep)	150/30 or less
Laptop	50-100

Fig. 1: Program output of inverter selection

load	watts	Nos
load 1	40	3
load 2	70	3
load 3	120	1
load 4	100	1
load 5	0	1
load 6	0	1
load 7	0	1
load 8	0	1
load 9	0	1
load 10	0	1
load 11	0	1
load 12	0	1
load 13	0	1
load 14	0	1
load 15	0	1
load 16	0	1
load 17	0	1
load 18	0	1

DEVICE	WATTS
Coffee maker	900-1200
Ceiling fan	65-175
Window fan	55-250
Heater(portable)	750-1500
CPU(awake/asleep)	120/30 or less
Monitor(awake/asleep)	150/30 or less
Laptop	50-100

Fig. 2: Example calculation

```

setup(
    windows = [
        {
            "script": "inverterApplication.py",
            "other_resources": [(24,1,manifest)]
        }
    ],
)

```

Fig. 3: setup.py script

```

<asmv3:WindowsSettings
  xmlns="http://schemas.microsoft.com/SMI/2005/WindowsSettings"
  <dpiAware>true</dpiAware>
</asmv3:WindowsSettings>
</asmv3:application>
<assemblyIdentity
  version="2.6.25.0"
  processorArchitecture="x86" replace with "*"
  name="Dropbox"
  type="win32"
/>
<description></description>
<dependency>
  <dependentAssembly>
    <assemblyIdentity
      type="win32"
      name="Microsoft.VC90.CRT"
      version="9.0.30729.1"
      processorArchitecture="x86" replace with "*"
      publicKeyToken="1fc8b3b9a1e18e3b"
    />
  </dependentAssembly>
</dependency>
<dependency>
  <dependentAssembly>
    <assemblyIdentity
      type="win32"
      name="Microsoft.Windows.Common-Controls"
      version="6.0.0.0"
      processorArchitecture="x86" replace with "*"
      publicKeyToken="6595b64141ccf1df"
      language="*"
    />
  </dependentAssembly>

```

Fig. 4: setup.py for 64-bit machine

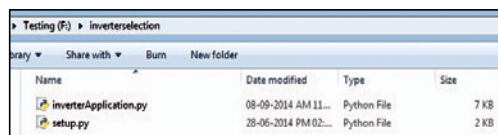


Fig. 5: Inverterselection folder

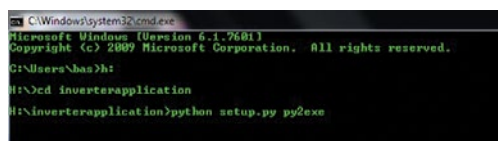


Fig. 6: Python, wxpython, py2exe for 32-bit

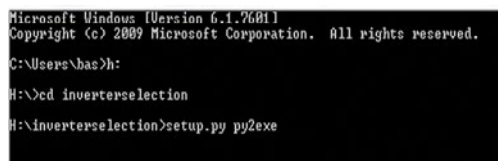


Fig. 7: Python, wxpython and py2exe for 64-bit

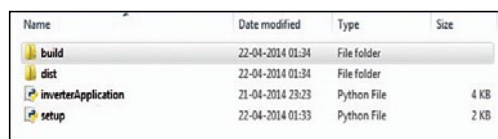


Fig. 8: build and dist folders

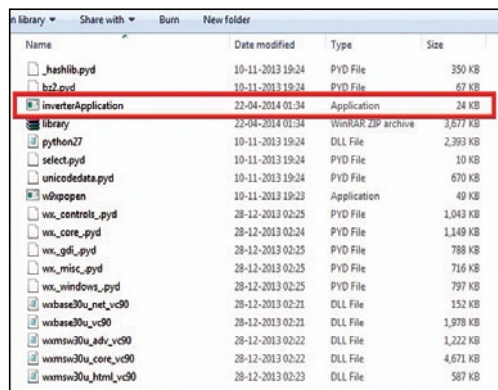


Fig. 9: Files under dist folder

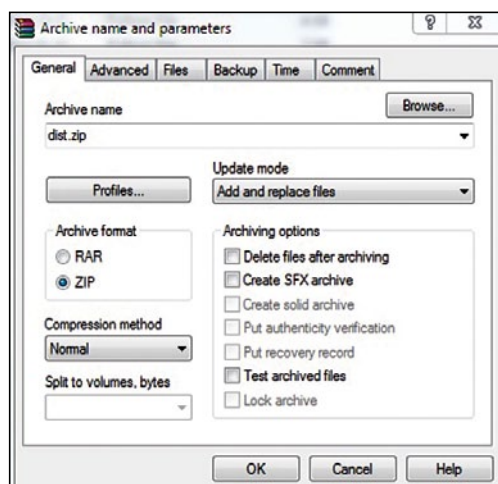


Fig. 10: Compressing dist folder

click on inverterApplication.py file, select Edit with IDLE option and press F5 key on the

keyboard. You will see the default program output window as shown in Fig. 1.

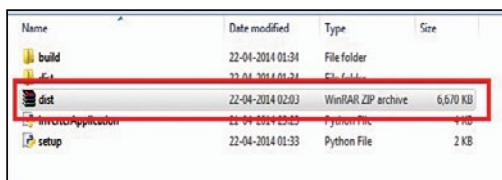


Fig. 11: dist.zip file



Fig. 12: NSIS compiler window

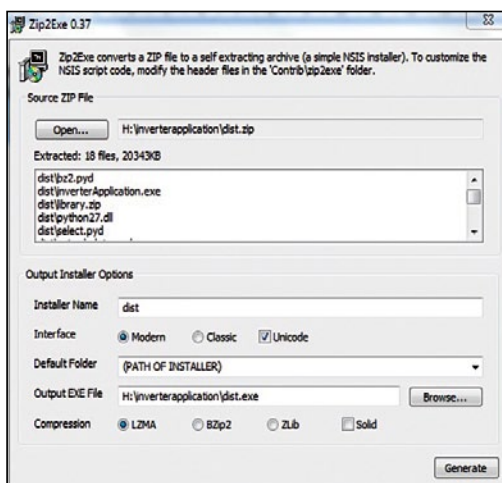


Fig. 13: zip2Exe installer

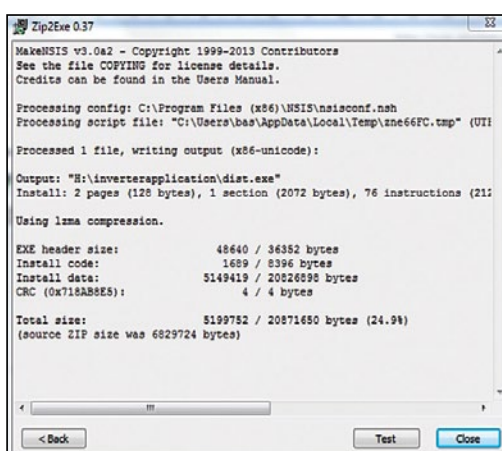


Fig. 14: zip2Exe installer

There are 20 edit boxes on left side of the screen for entering wattages of different electrical loads that you may like to connect to the inverter. You can enter the number of appliances corresponding to each load under Nos column. By default, power factor is 0.7, battery is 12V and back-up time is 3 hours. You can change these parameters as per your requirement.

Most people do not know the wattage of their electrical loads. So, the screen has a reference table on right hand side bottom showing the wattages of some common electrical loads.

Capacity estimations

Let us assume, you have three tubelights (40W each), three ceiling fans (70W each), one TV that consumes 120W and a laptop that consumes 100W. The total power required would be $(3 \times 40 + 3 \times 70 + 1 \times 120 + 1 \times 100) = 550$ watts.

Calculating inverter capacity. Normally, the inverters are available with VA (voltage x ampere) ratings. To know the VA rating of an inverter, you also need to know the power factor of the inverter. Assuming, the power factor is 0.7, which is true in most cases, the required VA of your

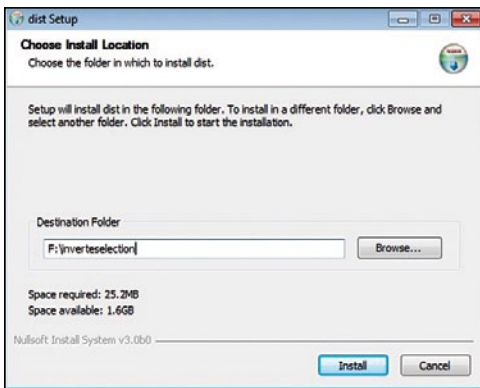


Fig 15: dist installer window

Name	Date modified	Type
build	22-04-2014 01:34	File folder
dist	22-04-2014 01:34	File folder
dist	22-04-2014 02:25	Application
dist	22-04-2014 02:03	WinRAR ZIP archive
inverterApplication	21-04-2014 23:23	Python File
setup	22-04-2014 01:33	Python File

Fig 16: dist application

EFY Note

The source code of this project is included in this month's EFY DVD and is also available for free download at source.efymag.com

inverter can be obtained by dividing the total power by power factor as follows:

$$VA = \text{Total power} / \text{Power factor} = 550W / 0.7 = 785.7VA$$

But 785.7VA is not a standard rating for any inverter available in the market. So you should select an inverter having a rating of next higher available value, such as 800VA.

Calculating battery capacity. The next step is to decide which battery to buy. The type and capac-

ity of battery would depend on the back-up time you require. A domestic inverter normally uses a 12V battery, but the batteries have different ampere-hour (Ah) ratings. If you want an inverter battery that gives three-hour back-up time, you can calculate the battery capacity requirement as follows:

Battery capacity = (Total power × Back-up time) / Battery volts

In this case,

$$\text{Battery capacity} = (550 \times 3) / 12 = 137.5Ah$$

Here Ah stands for ampere-hours.

But again, 137.5Ah is not a standard rating for the batteries available in the market. So, again, you should buy a standard battery with ratings slightly higher than this value, such as battery with 12V, 140Ah rating. The program output for this example is shown in Fig. 2.

Making a standalone application

You may not have Python software installed in your system to run this application. In that case, follow the steps given below to make a standalone application, so that you can run the program even without the software.

1. Download and install py2exe from the link <http://sourceforge.net/projects/py2exe/files/py2exe/0.6.9/>.

You can choose either 64-bit or 32-bit depending on the PC you have.

2. Create a setup.py file by downloading it from EFY DVD or from source.efymag.com. In the setup.py file, enter the script name as inverterApplication.py as shown in Fig. 3.

If you choose Python, wxpython and py2exe for 64-bit PC, you need to do some changes in setup.py file as shown in Fig. 4. Replace processor Architecture="x86" with processor Architecture="x86"

3. Copy the inverterApplication.py and setup.py files into a folder, say, inverterselection in your hard drive as shown in Fig. 5.

4. Now go to command panel and type as shown in Fig. 6 for 32-bit or as shown in Fig. 7 for 64-bit.

If there is 'msvc90.dll missing' error message, you can download the missing .dll file from <http://www.dll-files.com/dllindex/dll-files.shtml?msvc90> and put it in Python27/Dlls folder. If it still shows the same error, put the msvc90.dll file in c:/windows/SysWOW64 folder and reboot your system.

5. Now you should be able to see build and dist folders as shown in Fig. 8. If you open dist folder, you will see many other files, including inverterApplication file, as shown in Fig. 9.

6. Compress or zip the dist folder using WinRAR or a similar application as shown in Fig. 10.

The dist.zip file is created with reduced size as shown in Fig. 11.

7. To create an installer, you need to download NSIS software, which can be found at http://nsis.sourceforge.net/Main_Page. After installing the software, double click the NSIS icon and select 'Installer based on ZIP file' option as shown in Fig. 12.

Now, click Open button and browse your dist.zip file. Then click Generate button as shown in Fig. 13.

Finally, hit the Test button shown in Fig. 14.

After hitting the Test button the dist setup window will appear. Click Install button as shown in Fig. 15; dist application will be created as shown in Fig. 16.

Finally, delete both dist and build folders from the list shown in Fig. 16. Double click on dist application; an installation window will pop up. Click Install option. A new dist folder will be created. Under the dist folder you will find InverterApplication file. Double click on this file to run the application. You can also run the dist application file in some other compatible system without Python software. ●

The author is an M.E. from J.J. College of Engineering, Tiruchirappalli. His interests include space science, computer programming and digital art

Colour Segmentation Using MATLAB

PANKAJ RAUT

This is a program for colour separation in an image. The program can be modified for a specific application, such as colour

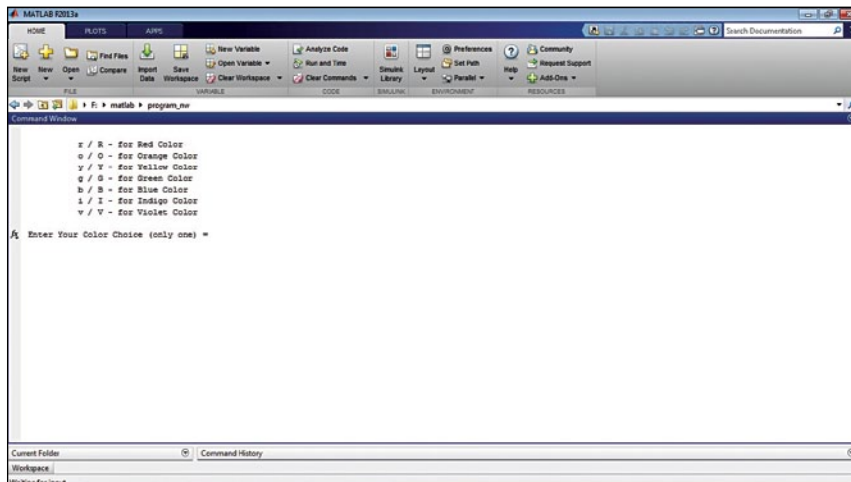


Fig. 1: Screenshot of the program output for colour selection

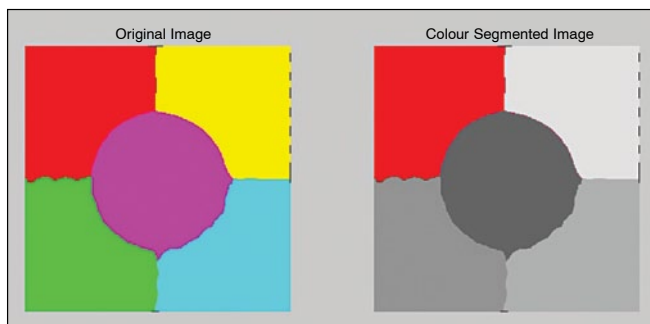


Fig. 2: Program output with red colour image

EFY Note

The source code of this project is included in this month's EFY DVD and is also available for free download at source.efymag.com

detection in processing industry (food, textile, etc) or robotic vision in automation industry.

The program was developed using MATLAB version 7.7 (or R2008b). MATLAB was used because it has digital image processing (DIP) tool which

is very easy to implement in this project.

Colour is related to light. Human eye perceives light as electromagnetic radiation with wavelengths approximately between 380nm and 760nm. The visible colour spectrum has violet, indigo, blue, green, yellow, orange and red (VIBGYOR) colours.

Approximate VIBGYOR colour wavelengths in nanometres (nm) are given below:

Colour	Wavelength (in nm)
Red	720-760
Orange	590-620
Yellow	545-590
Green	490-525
Blue	450-490
Indigo	420-450
Violet	380-420

The main application of this program is to separate each colour from the entire VIBGYOR colour spectrum in an image.

If you have an application that requires a specific colour detection or separation, this program would come handy for you. For example, if you want red colour from an image, run this program. It will prompt you to import an image into the screen. After importing the image, you need to select the first letter of the colour (see Fig. 1) to be separated. Select R option for red. You will get only red colour and rest of the image will be in various shades of grey, as shown in Fig. 2.

The advantage of this program is that it can separate each colour from the seven colours instantly.

Software

Some important functions used in the code are described below.

The code starts with the following function declaration:

```
function C = VIBGYORsegmentation(img)
```

User has to import an image in .jpg format. This is achieved by the following code:

```
[filename,pathname]=uigetfile('.jpg',  
'select an image');
```

Note that, the image imported by the user should be a colour image. The program outputs two images on the screen. The first image on left side of the screen is the original and the second on the right side is the colour-segmented image. The following codes are used to achieve this:

```
figure, subplot(1,2,1),imshow(uint8  
(img),[]);title('Original Image');  
subplot(1,2,2),imshow(uint8(C),[]);  
title('Color Segmented Image');
```

The author is a B.Tech (electronics and communication) student of Jawaharlal Nehru Technological University, Hyderabad. His interests include computer vision, sensors and electronics, social computing, robotics, optics and MATLAB

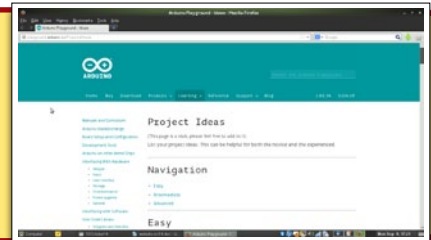
Microcontroller Based Projects

Building microcontroller based projects has always been of great interest to engineers and hobbyists. This month we bring to you some websites that introduce you to microcontrollers and offer various project ideas

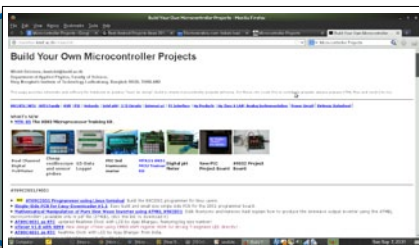
NIRAJ SAHAY

arduino.cc

This Arduino official site has a section where you can find a list of Arduino based project ideas. Arduino is an open source physical computing platform based on a simple microcontroller board. The list is helpful for both the novice and the experienced. The project ideas have been divided into three categories for easy navigation: Easy, Intermediate and Advanced.



<http://arduino.cc/playground/Projects/Ideas>



chaokhun.kmitl.ac.th

This site offers schematic diagrams and software for hobbyists and electronic engineers to build microcontroller based projects at home. It includes projects related to AT89C2051/4051, 8051 family, AVR, PIC, Motorola and Intel x86. The site is a part of King Mongkut's Institute of Technology, Ladkrabang, Bangkok (Thailand). The site is copyrighted by Wichit Sirichote, who is an associate professor of applied physics in the department of applied physics of the institute.

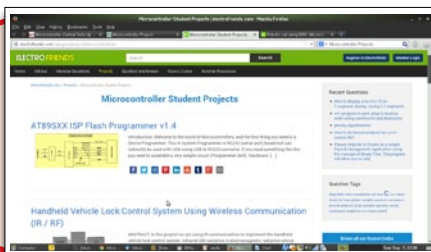
<http://chaokhun.kmitl.ac.th/~kswichit/>

electronicsforu.com

electronicsforu.com serves as a storehouse of information for the electronics and technology industry. The latest news, information about new products and a web search covering not less than 50,000 electronics websites are some of the facilities this portal offers. Not to forget the hugely popular EFM-tested DIY circuits and projects reproduced from Electronics For You magazine! There is a separate section for microcontroller based projects.



<http://www.electronicsforu.com/newelectronics/microcontrollers/>



electrofriends.com

This is a one-stop educational site for the students of electronics and computer engineering. It has projects using microcontrollers and the other basic electronic components. The site also includes projects and tutorials for computer students. It also allows you to submit your own projects and articles related to electronics and computers. The site does not have any forum but has a community page at facebook.com.

<http://electrofriends.com/category/projects/microcontrollers/>

best-microcontroller-projects.com

Here you will find microcontroller Tools Projects and Tutorials designed by John Main, a professional electronics design engineer based in the UK. Each project includes source code, description and schematics which you can use as a basis for starting your own projects or just use them stand-alone.



<http://www.best-microcontroller-projects.com/microcontroller-project-ideas.html>

Educational Products and Services Sector Needs Focus

The Indian education sector is growing rapidly as the Central as well as most state governments are going all out to educate their citizens. As late Nelson Mandela said, "No country can actually develop unless its citizens are educated." The focus of the current Central government on quality education and skill development would be energising the education sector further

ATITHYA AMARESH AND SNEHA AMBASTHA

The Indian education sector's size is expected to increase to over ₹ 6000 billion (US\$ 100 billion) by 2015 from ₹ 3411.8 billion (US\$ 56.77 billion) in 2012, due to the strong demand for quality education, according to a recent report. At present we have about 700 universities and 35,500 colleges for higher education in India. More than 85 per cent of the students in these universities and colleges are doing bachelor's degree programmes. And about one-sixth of these students are enrolled in engineering or technology degree programmes.

With this kind of growth expected in coming years, the competition amongst students to prove themselves as future professionals in the industry would also increase. This in turn would further increase the demand for hands-on training and skill development. This demand will open up many more business opportunities for the educational and training products providers.

In the annual budget for 2014-15, the government has set aside ₹ 837.71 billion for education. In addition to this, Prime Minister Narendra Modi's emphasis on skill development and 'make in India' together reinforces rising prospects for the education and training products industry in coming years. Manufacture of electronics products in India, in particular, is being given a top priority.

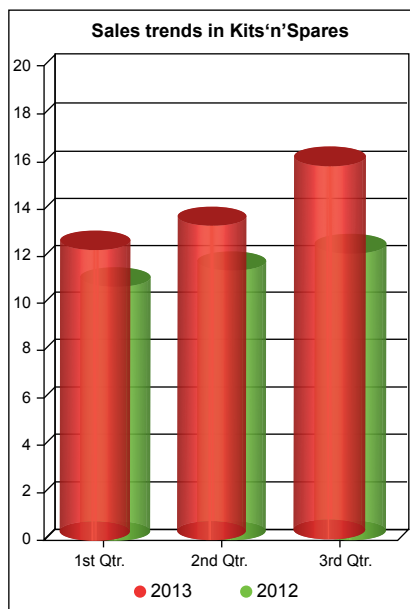


Fig. 1: Comparison of sales trends in first three quarters of 2012 & 2013

Industry today

The development kits and boards form an integral part of the education industry. In order to understand this better, it is imperative that we find out the role of these kits and boards in education and hands-on training.

Fig. 1 is a sample of the sales trends in the industry. It shows that there is definite growth in the awareness, and hence sales in this sector. But experts say there are some derivatives that have slowed down the growth as compared to the last few years. According to Nakul Chopra, director, Kits'n'Spares, "The educational and training kits industry faced a major boom of about 90 per cent in the FY

2011-12, but thereafter the growth seems to be very limited."

Agreeing to the above, Jayakumar Balasubramanian, director, Emertxe Information Technologies, tries to highlight the cause for the slump. He says, "In my perspective, there are multiple things happening in some kind of isolation. For example, there is a huge demand of training products amongst people to learn new things, either on their own or with some kind of an aid. Also, the hardware industry has become democratic and there are tons of players entering the field. But in the Indian context, the trend of this new way of learning has not become that popular amongst the students yet. We need to connect the dots."

Kapil Kumar Garg, co-founder and CEO, ThinnkWare, says, "As of now, there are two types of people selling the education and training products in India—the technocrats, whose products take care of the learning objectives of the kits, and then there are those who do not care about the learning outcomes of their products. Unfortunately, there is a lot of influence of the latter in the industry. These producers are merely providing the boards without any supporting documentation, like the content, application notes or data sheets of those products. They do this to cut corners—working on the learning outcome of a product increases the investment toward content development and product



Fig. 2: SWOT report

development. So when a person starts using the kit, he or she thinks he or she cannot utilise the product properly, and hence does not upgrade the product. The individual is afraid of going to the second level of the product, and this is where the cycle breaks. Whereas, someone who finishes a project with a level one product moves on to level two, level three and so on."

Huge market, yet much more to target

India, one of the largest higher-education networks in the world, has a sizeable number of engineering colleges, polytechnics and training centres. This implies a huge market for educational kits in India. Even if we consider only 5000 engineering colleges and around 1000 students per college, we can easily say that there are a total of five million engineering students in the country.

Sixty per cent of them, that is, three million, are from mechanical, electrical

and computer-science streams. If we take 10 per cent (which is a very modest number) of this figure and assume that on average they spend ₹ 1000 every year on these kits, the market is worth ₹ 300 million.

We should not forget that while the education sector drives the educational and training products market, there are other derivatives, including government policies, training providers and hobbyists, that influence this market.

Balasubramaniam shares, "Other users to the industry are the relatively senior professionals from the corporate world. These professionals, who have been a part of this industry for 5 to 10 years (or even more in some cases), buy these products to try out the latest updates from the industry and upgrade their skill set."

"Another segment is the budding entrepreneurs—engineers who want to turn their ideas into a working sample or prototype. They use these products to test and present the functionality

to investors or venture capitalists," he adds.

Government policies, schemes and regulations

Interestingly, there is no specific guideline or policy laid down by the government for the training and the education products industry yet. But as M.N. Vidyashankar, president, IESA, says, "There are lots of them that relate to this industry." When closely observed, these either relate to the whole electronics industry in general, or to the skill development industry in particular.

One common notion to which all the industry experts agree to is that, we need some sort of initiative that can connect students to the products available today. They agree that the main buyers of this industry, that is, the students, are generally unaware of the products available in the market, and we need to take an initiative to bridge this gap.

Since skill development in the field of electronics is already amongst the most looked-after initiative from the prime minister's bag this year, we reached out to Vidyashankar to find out if there is something that has been happening at the government's end. He shared, "Under the guidance and vision of DeitY, IESA and some others, industry experts have joined hands to spread awareness amongst students to bridge the gap between academia and the industry. This initiative was started during the months of May-June this year from a university in Coimbatore, Tamil Nadu, and about 12 colleges in Karnataka. The response was over-whelming. We are catching the students immediately after third semester, and we are also training the teachers. If you look at the best universities in the world, every hour of every lecture is backed by four hours of field work and lab work. While in Indian universities this ratio is not even 1:1. So we need to reverse this trend in India. We also took a log of whether industry, students and academia are

happy with the kind of inputs we are providing. Some of the industry leaders have come forward to interact with the academicians and students. Our aim is to build an environment and explore the synergies which are available to meet the kind of skilled personnel that the industry is looking for."

Some other initiatives

While the government of India seems to be taking initiatives for this sector at a slow pace, there are many multinational companies (MNCs) that are pro-actively working to reduce the skill gap. Companies like ROHM, Renesas, NI, Micrel, STMicroelectronics, Texas Instruments provide a free registration to their websites, using which one can get timely news regarding the new tools and kits available, free samples to build projects around these, and design simulators and get online support.

Some of these companies also conduct workshops, webinars, expos and design contests to provide a platform to future engineers so that they can make the best use of the kits and boards and come up with new ideas. They also provide various online training modules based on different kits and design solutions to make things easy. Further, companies are coming up with more and more development boards and providing these at affordable prices to encourage the involvement of the new generation.

There are training institutes, such as EFY Tech Centers, STQC, Young Brain India and CDAC, that provide short-term training on new kits and development boards like Raspberry Pi, Arduino UNO, PIC microcontroller boards and robotics kits in order to further bridge the gap between industry and the academia.

Challenges and suggested solutions

Some of the challenges that the industry experts list out are:

1. Scattered industry: They say a

lot of things are being done, but all in some kind of isolation. There is a dire need to connect these dots and bring the industry together.

Solution: Solution to this is to bring out a common platform specifically for the education and training products industry—a platform where people from the industry can interact and move together to impart skill and polish the future engineers of India.

2. Products without learning outcomes: A lot of these training and education kits' providers are now producing these kits without paying attention to their learning outcomes. This is not only discouraging potential buyers but also in a way discouraging many engineers from keeping up their self-learning urge.

Solution: The industry gurus suggest that either the government or a few key players from the industry should come forward and lay down some guidelines, specifically for the manufacturing and packaging of these products. It is a sensitive area with regard to its target buyers, and hence, a close vigilance and quality control is required.

Also, inclusion of the technical resources will give a good boost to the growth of the industry.

3. Awareness amongst students: One fact that every expert agrees to is the lack of awareness amongst the students for these products. A large number of students are 'ill aware' of the products available in the industry today. What little they know about them is either from their colleagues or teachers.

Solution: Again, a common platform needs to be created where students can find, compare and pick their products according to their specific needs and ideas. Also, workshops, trainings and seminars need to be conducted not only for the students but also for the institutes so that they can adopt such products and more people can join the bandwagon.

4. High rates of taxes: Several industry people quoted that high rates

Some Education and Training Kit Providers in India

Suppliers	Type of kits
Adormi Technologies Pvt Ltd	<ul style="list-style-type: none"> ➤ Robotics ➤ Automation ➤ Entertainment ➤ Computer
HPS Electronics	<ul style="list-style-type: none"> ➤ Alarms ➤ Automation ➤ Light Related ➤ Solar ➤ Audio and Musical ➤ Games ➤ Security ➤ Test and Measurement ➤ Programmers ➤ Development boards
Kits'n'Spares	<ul style="list-style-type: none"> ➤ Robotics ➤ GSM Based ➤ PIC Microcontroller Based ➤ PLC Based ➤ VLSI Based ➤ RFID Based ➤ Arduino Based ➤ Freeduino Based ➤ Programmers ➤ Alarms ➤ Development boards
Electro-Kits	<ul style="list-style-type: none"> ➤ Fun and Games ➤ Test and Measurement ➤ Programmers ➤ Security ➤ RF Based boards ➤ Lighting ➤ Development boards
Element14	<ul style="list-style-type: none"> ➤ Development boards
RS Components	<ul style="list-style-type: none"> ➤ Development boards

of taxes is a major bottleneck for the growth of the industry.

Solution: Considering the skill development role of the industry, government can come forward to provide relaxation in tax rates to help the industry grow further, as well as to invite more entrepreneurs.

5. Lack of industry intervention: While some initiatives have already been taken in this direction, there is still a gap between what the students need to learn and what the industry is offering.

Solution: As Dr Akhilesh Saurikhia, advisor, Ernst & Young, states, "There is scope for Indian players to develop products that suit the curriculum in schools and universities in India and sell customised products.

MAJOR CONTRIBUTORS TO THIS REPORT



Dr Akhilesh Saurikha,
advisor, Ernst & Young



Jayakumar Balasubramanian,
director, Emertxe Information Technologies



Kapil Kumar Garg,
co-founder and CEO, ThinnkWare



M.N. Vidyashankar,
president, IESA



Nakul Chopra,
director, Kits'n'Spares

Companies may offer products as per curriculum and for general interest."

Five years down the line

Saurikha states, "There is a wide scope for education-and-training-kits market to be shaped up in India. Indian companies will have an advantage in aggregating the demand for such products, which is spread out across various institutions and key cities in the country."

Vidyashankar concludes, "According to a number of studies, if the present rate of electronics use continues, by 2020 or 2022 the total demand for electronics will be around 400 billion dollars, and out of this 400 billion, about 300 billion dollars will need to be imported. Now think about this—can the country sustain this kind of import? Impossible! Hence, we need to focus on indigenous manufacturing. To meet this mark, the skill require-

ment will be of utmost importance. We just need to fine-tune the requirements of the industry with that being delivered from the institutes. We already produce the largest engineering manpower in the world; we just need to fine tune the skills and we have already started to focus on that."

Although this industry is not stagnant at present, the growth is very slow. Plenty of initiatives have been taken but in small chunks, and they do not affect the industry directly. All the challenges have to be met and the government will have to play a major role in helping this industry grow, as growth of this industry will lead to the growth of the electronics industry as a whole. ●

Atithya Amaresh is a senior correspondent and Sneha Ambastha is a technology correspondent at EYF

India's #1 Website For Electronics Engineers Working Across The Globe

Established: 1998 | Registered Users: 300,000+

Monthly Statistics

Page Impressions: 750,000+
Unique Techies: 150,000

electronicsforu.com

If it's electronics, it's here



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Manufacturing subsidy scheme may undergo revision

Prime Minister Narendra Modi's agenda of 'Make in India' has inspired the country and it is attracting attention from across the globe. Now the Department of Electronics and Information Technology (DeitY) has proposed that the electronics manufacturing subsidy scheme be revised to become more investor-friendly.

Modified Special Incentive Package Scheme (MSIPS) includes consumer durables, which is expected to attract big-ticket investments in the country. There are several big names like Panasonic, Samsung and Videocon which have already approached DeitY for the incentives that are offered to electronics manufacturers. DeitY is seeking industry's inputs on the revised draft of the policy, which was notified in 2012 and may expire in July 2015. An official said the policy may get an extension for three more years. He added, "The procedure is also being streamlined to reduce delay in processing of the applications plus the (investment) thresholds have been rationalised and additional verticals are being added."

The new added verticals are nuclear fuel cells, smart cards, capital equipment and white goods. A research paper by Consumer Electronics and Appliances Manufacturers Association and APCO Worldwide reveals that the total investment proposals under MSIPS are worth over 700,000 million rupees. However, as the paper noted, "Though it is a positive start, the policy needs 'incremental modifications' to attract much more investments." Senior director of APCO Worldwide Rameesh Kailasam thinks that, consumer electronics is the largest and the fastest growing manufacturing industry in the world.

The revised policy also proposes that Central taxes and duties be reim-

Animesh Sahay appointed senior director in CA Technologies

CA Technologies has appointment industry veteran, Animesh Sahay, as senior director of sales to lead its Enterprise and Telecom businesses in India. He brings with him more than 18 years of experience in the IT and communication industries. His charter includes ensuring the active participation of CA's global and Indian SI partners to maximise sales in India.

Analog Devices appoints Karthik Sankaran as GM

Analog Devices, a global leader in high-performance semiconductors for signal-processing applications, has appointed Dr Karthik Sankaran as general manager of the Embedded System Products and Technology (ESPT) group. He has more than 25 years of industry experience in areas spanning chip design, software development and management.

Aejaz Mir joins Syska

Aejaz Mir has joined Shree Sant Kripa-Led Lights Pvt Ltd, the flagship company of the dynamic brand Syska Led, as senior manager for Kashmir region. He holds vast experience in marketing and brand management, having worked with several MNCs in his career so far.

bursed for categories like solar cells, nano electronic components, chip components and discrete semiconductors. The Digital India project looks forward to a net import-export balance of electronics by 2020.

MNRE planning to support large PV projects

The Ministry of New and Renewable Energy (MNRE) has revealed a draft policy outlining a program to launch 25 new solar parks within next five years. It will support 20GW of large PV projects, with each park having capacity of 500 to 1000MW.

Considering the success of Gujarat's Charanka Solar Park, the policy emphasises partnerships with other state governments as well. States would allot the land and arrange the infrastructure for establishment of solar parks. Besides, the states would buy at least 20 per cent of the electricity from the projects.

In return, MNRE would contribute up to \$33,000 per MW or

30 per cent of the setting up cost of the solar parks as well as contribute \$41,000 per park for related expenses. As estimated by MNRE, total cost of programs and the processing fee to Solar Energy Corporation of India (SECI) will add up to \$665 million.

As per program, the state governments and the Central government's SECI will be termed as the developers. It also involves an option for the private developers to partner with the state governments and/or SECI, wherein the share of government entity would be 51 per cent of the equity.

Electronics Policy 2014-2020 unveiled by AP government

The Andhra Pradesh government has



Solar PV project

Calendar of Forthcoming Electronics Fairs/Exhibitions/Seminars/Events

Name, Date and Venue	Topics to be covered	Contact address for details
3rd Electronics Rocks 2014 October 10-11, 2014 Nimhans Convention & Exhibition Centre, Bengaluru	A platform for design engineers, R&D engineers, entrepreneurs, academicians, hackers and hobbyists including talks, workshops, discussions, product launches and design challenges	EFY Enterprises Pvt Ltd Phone: 26810601/2/3, +91-8800094213 E-mail: electronicsrocks@efyindia.com Web: www.electronicsrocks.com/
ElectronicAsia October 13-16, 2014 Hong Kong Convention and Exhibition Center, Hong Kong	In conjunction with 'HKTDC Hong Kong Electronics Fair (Autumn Edition)' highlights solar, displays and key components for smart devices	Hong Kong Trade Development Council (HKTDC) Phone: (852) 2584 4333 E-mail: exhibitions@hktdc.org Web: http://electronicasia.com/ex/05
DIGNATE 2014: International Conference on Emerging Trends in Electronics, Electrical and Computing Technologies October 18-19, 2014 India International Centre, Lodhi Road New Delhi	All the accepted and registered papers will be included in the conference proceedings	India International Centre Phone: +919654904107 E-mail: etect2014@dignate.com Web: http://www.dignate.com
OSI Days 2014 November 7-8, 2014 NIMHANS Convention Center Bengaluru	Open Source conference in Asia that aims to nurture and promote the open source ecosystem in the sub-continent	EFY Enterprises Pvt Ltd Phone: +91-08800 94211 E-mail: atul.goel@efyindia.com
Electronica/Productronica 2014 November 11-14, 2014 Munich, Germany	Electronic components, production equipment, systems and applications	MMI India Pvt Ltd, Mumbai Phone: (022) 42554700, 42554723 E-mail: Andrea.dsouza@mmi-india.in
Intersolar India November 18-20, 2014 Bombay Exhibition Centre, Mumbai	Exhibition and conference for the solar industry featuring photovoltaics, PV production technologies, energy storage and solar thermal technologies	MMI India Pvt Ltd Phone: (022) 42554700 E-mail: brijesh.nair@mmi-india.in
2nd EFY Expo- Western India Edition 2014 November 26-28, 2014 Bombay Convention & Exhibition Centre, Mumbai	For manufacturers, engineers and traders to source electronics components, products and services and to find latest offerings and dealers and distributors for products	EFY Enterprises Pvt Ltd Phone: 26810601/2/3, +91-8800094213 E-mail: efyexpo@efyindia.com Web: www.west.efyexpo.com
LED Expo 2014 December 5-7, 2014 Pragati Maidan, New Delhi	Exhibition and summit on LED lighting products and technology	MEX Exhibitions Pvt Ltd Phone: +91-9312285142 E-mail: info@themediexpo.com
2015 International CES January 6-7, 2015 Las Vegas Convention Center Las Vegas, USA	A mega consumer electronics event where new innovations and technologies are showcased	Consumer Electronics Association Phone: +1 703-907-7605 Web: www.cesweb.org
SPS Automation India February 5-7, 2015 Mahatma Mandir, Ahmedabad	Industrial control systems, sensor technology, ideal business platform	Messe Frankfurt Trade Fairs India Pvt Ltd Phone: +91 22 6144 5900 Web: www.in.messefrankfurt.com
Electronics For You Expo 2015 February 26-28, 2015 Hall 7 (A, B, C, D, E, F, G, H) Pragati Maidan, New Delhi	Covering complete electronics ecosystem, including innovation, manufacturing, design and sales	EFY Enterprises Pvt Ltd Phone: 26810601/2/3, E-mail: efyenq@efyindia.com Web: www.efyexpo.com
EFY Awards March 13, 2015 Bengaluru	To give recognition to the leading enterprises and individuals in the Indian electronics field	EFY Enterprises Pvt Ltd Phone: 26810601/2/3, +91-8800094213 E-mail: efyawards@efyindia.com Web: www.efyawards.com
International CES Asia, 2015 May 25-26, 2015 Shanghai New International Expo Center (SNIEC), China	Tech powerhouses to innovative startups, 3D printing, robotics, sensors, the Internet of Things and wearables	Shanghai New International Expo Center (SNIEC), Shanghai, China Phone: 703.907.7603 E-mail: afried@ce.org

Look up under 'Events' section in www.electronicsforu.com for a comprehensive list

Since this information is subject to change, all those interested are advised to ascertain the details from the organisers before making any commitment.

unveiled Electronics Policy 2014-2020 which aims at attracting \$5 billion investment along with employment creation of around 400,000 by 2020. The policy replaces AP Electronics Hardware Policy 2012-17 and aims to develop 20 electronics manufacturing clusters (EMCs) across the state in six years.

This policy focuses on semiconductors, mobile phones, LEDs, smart meters, FPD TVs, tablets, base stations, smartcards and sensors. The electronics hardware industry has been notified as an essential service under AP Essential Services Maintenance Act.

To attract more companies, the policy offers non-fiscal incentives under various heads like the Factories Act 1948 and the AP Shops & Establishments Act 1988 and fiscal incentives like registration and stamp duty, power subsidies, exemption of electricity duty, VAT/ CST reimbursement, investment subsidies and rebate on land cost. Some additional incentives are also integrated into this policy for mega projects having a minimum investment of 2500 million rupees, or those creating jobs for more than 2000 people in five years.

The policy also aims at skill creation and producing 250 PhDs in electronics by 2018. A high-level, empowered 'single window clearance unit' will be created and supported by state-of-the-art centralised round-the-clock help desk. The policy aims at reserving two clusters/areas for electronics hubs in the upcoming ITIR in Visakhapatnam.

Electronics Manufacturing Policy gets UP cabinet approval

The Electronics Manufacturing Policy 2014 has been approved by the Uttar Pradesh cabinet in order to attract further investments in the electronics sector. The policy looks forward to establishing electronics manufacturing clusters (EMCs) in the state and a semiconductor fabrication unit at an investment of around 350,000 million rupees. The plant is being jointly established by JP Associates, IBM and Tower Semiconductor Limited, Israel.

Snippets

APLAB gets SIATI Award for Excellence

The Society of Indian Aerospace Technologies and Industries (SIATI) conducted a survey and decided to present an award for the Excellence in Indigenous Development to APLAB. For this, all avionics related organisations like BEL, HAL and DRDO Labs recommended names of the deserving Indian industries and zeroed in on APLAB. The company was considered for the Award for their power systems development, which met the stringent military specifications, leading to independence from imports and thus saving of foreign exchange.

Maxim now supplying Xilinx UltraScale FPGAs

Maxim Integrated Products, Inc. is now the lead supplier for Xilinx UltraScale FPGAs. Maxim supplies the power management for three Xilinx FPGA reference designs, the Kintex UltraScale FPGA KCU105 Evaluation Kit being one of these. Maxim's products are up to 30% smaller compared to previous generations on the market.

FCI and Samtec have new strategic partnership

FCI Electronics and Samtec, the two leading suppliers of high-speed connectors and interconnect systems, announced the signing of a second-source agreement under which Samtec is licensed to manufacture, market and sell FCI's next-generation ExaMAX high-speed connector product portfolio.

Tektronix enabling engineering education

Tektronix has introduced special prices for its new education-specific TBS1000B-EDU series of oscilloscopes. This initiative will be making oscilloscopes super affordable for engineering colleges and universities in India, so one can own 70MHz oscilloscopes for just 29,000 rupees.

The policy has some key points which include 15 per cent capital subsidy, 5 per cent interest subsidy for 7 years, 100% exemption on stamp duty, 100% tax reimbursement on VAT or CST for 10 years and so on. A special incentive package will also be considered under this policy for those units which invest over 2000 million rupees in this sector.

This policy will help the state government to promote a number of industries for producing mobile devices, telecom products, consumer electronics, power electronics, IT systems and hardware along with the components like transistors, resistors, switches and more.

Haryana solar power policy gets government nod

Haryana Solar Power Policy 2014 has been approved by the Haryana government and will be valid till March 31, 2017. The policy targets achieving megawatt (MW) scale grid-connected solar power projects, roof-top grid interactive SPV systems, small-scale grid solar power projects, training programmes

on solar projects in ITIs and also introducing diploma courses on the same. The policy also aims to develop model villages for solar energy promotion and further R&D in the field of solar energy in engineering colleges.

The solar power generation capacity is required to be increased to 1300MW from present 8MW. Incentives will be provided by the state government to set up solar power projects.

Under the policy, the state will also develop SPV solar power plants to fulfil Solar Renewable Purchase Obligation. All efforts will aim to fulfil the entire requirement of solar power which is required to be purchased by the Power Distribution Licensee (DISCOM). By March 2017, HAREDA shall promote and also install 100MW grid-connected solar power project in two phases.

Bharat Electronics forms JV with French MNC Thales

Bharat Electronics Limited (BEL), a state-owned Indian company, and Thales, a French group, have entered

into a deal to form a joint venture (JV) in India. The JV named BEL-Thales Systems Limited will design, develop and manufacture radar systems for defence and civilian applications.

BEL is an electronics company which has nine factories in India. It is a public sector undertaking of the Indian government under the Ministry of Defence which primarily manufactures advanced electronic products for the Indian armed forces. Thales Group is a French MNC which is into designing and building electrical systems and providing services for the aerospace, defence, transportation and security markets.

This is the fourth time that Thales is forming a JV in India. Thales' existing JVs are with Samtel and Rolta. The JV with Samtel produces helmet-mounted sight and display systems. The JV with Rolta is into developing C4ISR systems.

Sony might restart manufacturing in India

Japan's largest consumer electronics exporter, Sony Corp, could restart their manufacturing in India. India is the fourth largest market, following China, the US and Japan, for Sony. But the company has no manufacturing unit in the country as of now.

Sony India's managing director Kenichiro Hibi said that the recent initiatives of the Union government could bring about a turnaround in the Indian economy. He said, "Sony is looking at India for long-term growth. While no decision has been made yet, the potential products for manufacturing in India could be both flat-panel televisions and smartphones."

Most of the Sony products available in India are sourced from Thailand, Malaysia, China and Japan. For past two decades the company has been ruling Indian market and it also had a manufacturing facility which was shut down in 2004. This fiscal year the company is targeting 120,000 million rupees sales in India. Recently, some manufacturing investment has been made by Japanese firm Panasonic in India, which is likely to be followed by Daikin, Sharp and Hitachi soon.

Check efytimes.com for more news, daily

NEW PRODUCTS

RECENTLY INTRODUCED IN INDIA, FROM NEAR AND FAR

TEST & MEASUREMENT

Field intensity meter

Model KM 828 field intensity meter introduced by KUSAM-MECO has LCD display and over-range indication. It can inspect particular objects or devices that radiate low-frequency electromagnetic waves, for instance, power cables, computer monitors, TVs, audio-visual equipment, electromagnetic ovens or electrical installations. Its measuring range is 0.1-400mG, 1-4000mG, 0.01-40 μ T, 0.1-400 μ T with accuracy of $\pm(3\%rdg+3digits)$. The frequency range is 30Hz~400Hz and the sampling time is 0.5 second. It has an ergonomic design and a holster to protect the instrument and carry it conveniently. Powered by 9V battery, it can operate at 0-50°C (32-122°F) and bear a relative humidity of $\leq 80\%RH$.

Kusam Electrical Industries Ltd, Mumbai

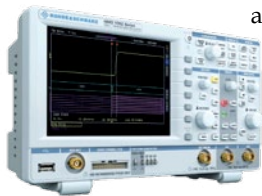
Phone: 022-24156638, 24124540

E-mail: sales@kusam-meco.co.in

Website: www.kusamelectrical.com

Mixed signal oscilloscope

Fanless operation, 1MPts of memory depth and a 1GSa/s real-time sampling rate—these are the key features of the new R&S HMO1002 mixed signal oscilloscope from Rohde & Schwarz. With a vertical sensitivity of 1mV/div and integrated 128k-point FFT, the instrument offers features that are exceptional in the three-figure price segment. Embedded developers, service and maintenance technicians and users in the education sector can benefit from a



comprehensive range of functions and many features that make everyday work more convenient.

R&S HMO1002 can be expanded at any time from 50MHz to 70MHz or even 100MHz bandwidth by means of a simple upgrade option. Its fanless design ensures quiet operation and makes the instrument less susceptible to faults. The oscilloscope's anti-glare display takes up approximately 40 percent of the front-panel area and is easy to read. A logic probe can be connected to the front panel.

An integrated pattern generator enables professional embedded developers to program protocol messages at up to 50Mbit/s. The three-digit digital voltmeter integrated into the instrument makes it possible to perform voltage measurements simultaneously on both analogue channels, with two user-definable parameters each. The digital component tester helps service technicians check the functionality of capacitors, coils and semiconductor elements quickly and easily. Teaching staff in the education sector will find the education mode in the R&S HMO1002 especially attractive.

Rohde & Schwarz, New Delhi

Phone: 011-42535400

E-mail: rsindia@rohde-schwarz.com

Multifunction instrument

Pacific Electronics now introduces a product which is versatile and can be used in any electronics laboratory for doing experiments in analogue and digital circuits.

The instrument includes a 30MHz CRO (DSO optional), 3MHz function generator, 0-30V/1A regulated power supply, frequency counter, AC millivoltmeter, curve tracer, voltmeter, ammeter, fixed DC power supply (+5V, $\pm 15V$), AC sources (5V, 10V, 15V, 20V), eight logic level selectors and indicators, clock generator and BCD 7-segment display outputs.

It occupies only 300x450x450mm space, reduces need for multiple instruments occupying much more space and minimizes the inventory. It is priced at approximately half the price of all the 13 instruments included in it.

Pacific Electronics Pvt Ltd, Secunderabad

Phone: 040-27791139, 9848058904

E-mail: audiogen@usa.net

Website: www.pacificelectronics.in



Spectrum analyser and RF recorder

Signal Hound has introduced an affordable real-time spectrum analyser and RF recorder, BB60C, which is simple and compact to use. It has frequency range of 9kHz to 6GHz, an instantaneous bandwidth (IBW) of 27MHz and sweep speed up to 24GHz/sec. The BB60C has improved spurious-free dynamic range (SFDR) by 20dB, flattened the noise floor and band transitions by more than 8dB.

BB60C is USB-powered, eliminating the need for external power supplies. It is portable, more accurate, flexible and occupies less space. It is a compelling choice for a broad range of applications including intermittent interference hunting, manufacturing process control, spread spectrum signal analysis, process automation and remote spectrum monitoring.

DT Techsolutions Pvt Ltd

Phone: +91-44-60502200

E-mail: sales@dttechsolutions.com



POWER SUPPLIES

Smart power modules

Fairchild has developed the FSB70xxx series of advanced motion SPM 7 mod-



ules to help designers meet needs like high performance and compact solutions for power motors under 100W worldwide, small electric motors like in dishwashers, air-conditioners and fans. These modules deliver industry-leading light-load efficiency up to 44%, robust on-module protection and superior thermal efficiency up to 12% better from junction to case. Additionally, the FSB70xxx series integrates an optimised gate driver for the built-in MOSFETs (using FRFET technology) to minimise EMI and losses, while also providing multiple on-module protection features including under-voltage lockouts, thermal monitoring, fault reporting and interlock function.

Its key features include high-performance inverter output stage for AC induction, brushless DC and permanent magnet synchronous motors, optimised for low electromagnetic interference, HVIC temperature-sensing built-in for temperature monitoring, separate open-source pins from low-side MOSFETs for three-phase current-sensing, active-high interface, works with 3.3V/5V logic, Schmitt-trigger input, HVIC for gate driving with under-voltage protection and interlock function, isolation rating of 1500Vrms/min.

Fairchild Semiconductor (India) Pvt Ltd, Pune
Phone: 91-20-4000-6333

Website: <http://www.fairchildsemi.com>

DALI power supply

GlacialPower has added the GP-DP004N-16V to its DALI product lineup. Outputting 200mA, it is enough for a full 64-device DALI network. Compatible with DALI standard IEC62386, the power supply takes universal AC input from 100V to 240V to provide constant voltage at 16V. With over-current and short-circuit protection, users are ensured safe power. The GP-DP004N-16V provides 200mA to the DALI bus.

DALI is the newest standardised lighting control system offering fine control, better lighting efficiency, logarithmic dimming and simplified topology for lighting networks. A DALI

network can have up to 64 independent devices, in up to 16 groups. Each DALI network needs bus power and the GP-DP004N-16V supplies this need with 200mA of current at 16V, enough to power a full DALI network (128mA) and have current left over to power DALI devices without integrated power supplies. As an established global standard, DALI products are inter-compatible with each other, making installing lighting control systems easy.

The GP-DP004N-16V is priced at ₹ 1740 (approx.)

GlacialPower, Taiwan

Phone: +886 2 2244-1227

E-mail: sales@GlacialTech.com

Website: www.glacialpower.com

COMPONENTS

Single-core microcontrollers

Introducing the powerful, single-core series for industrial real-time control design, Texas Instruments (TI) has launched the new C2000 Delfino 32-bit F2837xS microcontrollers (MCUs). These single-core MCUs are the first in the industry to offer four 16-bit analogue-to-digital converters (ADCs), enabling precision feedback in power control applications. They are pin- and software-compatible with the recently introduced dual-core C2000 Delfino F2837xD MCUs and help expedite development when scaling from higher-performance industrial control applications to mid-tier control designs.



The Delfino F2837xS MCUs are also the next-generation, single-core solutions for those using the preceding Delfino F2833x MCU series. Developers can utilise existing investments from the F2833x MCUs and transition to the software-compatible F2837xS MCUs, which provide greater CPU performance and more advanced analog and control peripherals.

Fully featured C2000 Delfino F28377S 32-bit MCUs (TMX320F28377S) are now sampling. Developers can evaluate the new Delfino MCUs using the Delfino F2837xD Experimenter Kit docking station

(TMDXDOCK28377D) for \$219, which includes the modular controlCARD (TMDXCNC28377D), or purchase the controlCARD separately for \$159.

Texas Instruments, India

Website: www.ti.com

Terminal block system

FCI has introduced the new NQ SMT wire-to-board spring clamp system as an extension of its terminal blocks portfolio. The clamp has a robust design, versatile modular system, secure electrical contacts, low wire insertion and high wire retention forces. Its user-friendly lever latch is engineered for effortless wire removal, while its compact industry-standard PCB design makes it a noteworthy space-saver.

With a low-profile 5.00mm height, the SMT spring clamp is highly ideal for LED devices and other compact applications, such as LED lighting modules. It is also suitable for consumer electronics, factory automation equipment and applications which require easy-to-use wire insertion and extraction methods. Two contact pitch sizes are available: 2.5mm with a current rating of 5A (150V) and 4.0mm with a current rating of 7A (300V). Both models are end-to-end stackable and feature 1 to 10 contact positions.

FCI OEN connectors, Cochin

E-mail: fci.oen@fci.com

Phone: 0484-4090871, +9198957 09609

Octal ultrasound pulser

The cost and size of ultrasound imaging machines can be reduced with the new STHV800 8-channel ultrasound pulser from STMicroelectronics. The proprietary SOI-BCD6 process technology enables the combination of low-voltage CMOS logic, precise analogue circuitry and robust power stages on the same chip, offering unprecedented level of integration. The monolithic, high-voltage, high-speed pulse generator with eight independent channels integrates a controller-logic interface circuit, level translators, self-biased high-voltage MOSFET gate drivers, noise-blocking diodes and high-power P-channel and N-channel MOSFETs for the output stages of each channel.



Each channel contains two output stages, one for pulsed wave (PW) and one for continuous wave (CW) operation, together with an integrated transmit/receive switch to guarantee effective decoupling during the transmission phase. The STHV800's fast and symmetrical output voltage transitions allow sharp images to be obtained without the need for complex and costly image-processing algorithms.

Key features of the STHV800 include an input voltage range of 1.5V to 3.6V and an output voltage up to $\pm 90V$, the ability to control pulses with durations as low as 10ns for maximum image sharpness, less than 10ps jitter to ensure accurate frequency response in ultrasound Doppler analysis, low second-harmonic distortion (less than -40dB) for higher image quality, and a design that does not need external reference capacitors. Housed in a compact LGA8x8 package, the STHV800 is now available in volume at a price of \$16 in quantities of 1000 units.

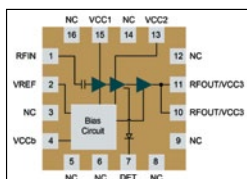
STMicroelectronics, Noida

Phone: 0120-2352999

Website: www.st.com

RF high-power amplifier

Microchip has announced its latest 2.4GHz 256-QAM RF high-power amplifier, the SST12CP21, which offers ultra-low EVM and current consumption for 256-QAM and IEEE 802.11n systems. The SST12CP21 delivers high linear output power of up to 23dBm at 1.75% dynamic EVM, with MCS9 HT40 MHz bandwidth modulation at 5V and 320mA current consumption. Additionally, the SST12CP21 delivers 25dBm linear power at 3% EVM with only 350mA current consumption for 802.11g/n applications. This performance significantly extends the range of 802.11b/g/n WLAN and MIMO systems, while consuming extremely low current at the maximum 256-QAM data rate. The



SST12CP21 is also spectrum mask compliant up to 28dBm for 802.11b/g

communication. Board space is reduced by the small 3x3x0.55mm, 16-pin QFN package that matches a popular pin-out.

The SST12CP21 power amplifier has a low operating current of 320mA at 23dBm and 350mA at 25dBm, which enables multichannel and higher data rate WLAN systems. This amplifier also features 50-ohm on-chip input match and simple output match, which is easy to use and reduces board size. Additionally, the integrated linear power detector provides accurate output power control over temperature and 2-to-1 output mismatch.

The SST12CP21 is available for sampling and volume production, in the popular 3x3x0.55mm, 16-pin QFN package. Pricing is \$0.754 each, in 10,000-unit quantities.

Microchip, India

Phone: 080-30904444; 011-41608631

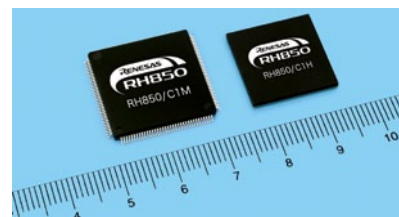
E-mail: asia.inquiry@microchip.com

Microcontrollers for motor control

Renesas Electronics Corporation has announced the new RH850/C1x series of 32-bit microcontrollers (MCUs), designed for motor control in hybrid electric vehicles (HEVs) and electric vehicles (EVs). Based on Renesas Electronics' 40nm process, the RH850/C1x series features the RH850/C1H and RH850/C1M MCUs, which enable embedded designers to enhance efficiency, reduce system costs and achieve higher safety levels for HEV/EV motor control systems.

The RH850/C1x can be used with the RAA270000KFT RH850 family power supply management IC, which is currently available in sample quantities. The power management IC integrates into one device all the power supply systems required for MCU operation, two external sensor power supply tracks and a full complement of monitoring and diagnostic functions, significantly reducing the user burden associated with power supply system design.

By integrating hardware peripherals dedicated for motor control into the MCU, designers can reduce overall system costs and meet performance requirements. HEV/EV systems are



now being designed to meet ISO 26262 functional safety standards. This system requirement is driving semiconductor products to incorporate a number of embedded features that allow system designers to meet their safety goals.

Renesas Electronics India Pvt Ltd, India

Phone: +91-8067208700; 011-66207300

Website: <http://in.renesas.com>

MISCELLANEOUS

Liquid level indicator & controller

Ascem has launched multifunction digital liquid level indicator and controller model LMC-01 based on a microcontroller. It has been indigenously designed, tooled and manufactured by Ascem with the help of their R&D department.

The equipment has a timer alarm and sensor-fail indicator. It eliminates the need of levelling the tank and makes the control of motor and pump convenient.

Ascem System, Vadodra

Phone: 0265-3022222

E-mail: sales@ascemindia.com

Solar-powered products

SunSwitch India has introduced modular solar home lighting systems and solar retrofits for home inverters to cater to the needs of both urban and rural markets in India.

AnantUrja (12V) and Surya Dhani (3.25V) are the two solar home lighting systems based on Li-ion battery. A customer can invest in pieces of the modular systems and add further modules, when needed. Pakshak is a solution for retrofitting home inverters with solar charging facility.

SunSwitch India (P) Ltd, Sahibabad (UP)

Phone: 1800-11-8090

E-mail: info@sunswitch.in



Live Video

Can you suggest a solution to relay a live event from one place to another along with sound? I am looking for hardware that would enable me to send the video and audio signals in real time either through the Internet or through cable up to a distance of three kilometres.

Rajiv Soni
C.L. Soni & Co.
Jalandhar

EFY: Please see 'Live Telecasting on Your Web' article published in May issue.

Projects for Students

As final (4th) year student of ECE, I have to do a project in this semester but I have no idea what to do and how? Can you please help me with any topic which would be best for an ECE student? Please also mention how I can do that.

Manish Kumar
Durgapur

EFY: We carry construction details of several DIY articles in each issue of EFY magazine. You may consult your friends and professors to select the most suitable project for you. If you need any help in hands-on training, please check efytechcenter.com

Charger Circuit

I want to make a battery charger circuit for a specific application.

There are two batteries of 12V, 3.2AH and the supply available is 35V-

40V DC, 0.25A approximately. I need a battery charger circuit which can use this supply to charge the batteries. When one battery is charging the other could be put to use. But after the first battery has been fully charged the circuit should start charging the second battery automatically.

Shubham Chaware
Nagpur

EFY: Please see 'Solar-Powered Home Lighting System' project published in April issue, which is designed to charge two 12V batteries one after the other.

EFY+ DVD

I am trying to install NI Circuit Design Suite from EFY+ DVD, but during installation it is asking for serial number! Where can I find the serial number?

Mohamed Rilwanullah
Through e-mail

EFY: Please follow strictly the steps given under 'Installation' section in the article in EFY Plus magazine.

If you do that, there would be no need of entering serial number and you can extend the validity of the software to 45 days.

Xbee Controlled Aircraft

The code of Xbee Controlled Aircraft circuit published in September issue is not opening in Arduino IDE. I checked the other circuit codes and they are opening perfectly. I am using FEL (Fedora Electronics Lab) OS.

Tanmay Dasgupta
Bilaspur, Chhattisgarh

'Spot An Error' Award Winners

In XBee-Controlled Aircraft project published in September issue, diode D1(1N4007) is used in the circuit but it is not mention in the parts list.

Shanmukhappa Javali

❑ In Lithium-Ion Battery Charger circuit published in September issue, in component layout of the PCB, IC1 is not printed anywhere. It should be printed between C4 and letters 1 and 24.

Praveena S. Javali

❑ In eStyle Buyers' Guide on page 12 in August issue, HP Omni 10 operating system is mentioned as Windows 8 instead of Windows 8.1.

Yogesh Shukla

❑ In DIY: Software section on page 111 in August issue, the code for turning on and off LED is wrongly shown in Arduino IDE (Fig. 9). The 12th line should be read as:

```
digitalwrite(ledPin, HIGH); //  
sets the LED on
```

Also the comments of 10th and 12th lines have got interchanged.

Anjaly Anto M.

The author Somnath Bera replies:

It's not a compilation problem. It could be a corrupted ino file which is not opening in the Arduino IDE.

The ino or the Arduino codes are all plain text files comprising 'C' codes. So you should try to open the code in plain gedit, or vi, or in nano editor to see whether it opens there or not.

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Q1. What are the differences between NE555 and LM555 ICs?

Mohd Waseem Ansari

A1. There is no difference between NE555 and LM555 ICs. Both these are 8-pin timer ICs with pin to pin compatibility. Both have the same sinking and sourcing output up to 200mA and maximum supply voltage of 18V. Both are available in PDIP as well as other packages. LM555CN is from National Semiconductor and SE555/NE555 from Signetics. Both work with similar arrangement of components at pins 2, 6 and 7 for monostable and astable modes. In short, they are interchangeable.

Q2. We want to set up a mini radio station for our institution and the local area within Bengaluru. It should have a range of about 16km but our budget for expenditure is ₹ 5000 only.

Praveen and Shubham

A2. Permission for community FM radio stations is granted by Ministry of Information & Broadcasting (Community Radio Station Cell) of the government of India. The licence is granted to well-established educational institutions including IITs/IIMs and non-profit organisations like civil society and voluntary organisations. Application forms and details of documents required can be downloaded from the website of Community Radio Stations Management Information System, Ministry of Information and Broadcasting.

Consultancy services are also available to provide entire range of services required for setting up a community radio station (CRC) starting with help in filing the application for licence and frequency allocation, up to the completion of the project of setting up the station. However, a budget of ₹ 5000 will be grossly insufficient for starting

a CRC as it will need studio facilities for proper functioning besides the transmitter.

However, if you are looking for just an FM or AM transmitter circuit, you will find quite a few in previous issues of EFY magazine.

Q3. I want to know what is the standard PCB track width and gap between tracks for normal and power supply lines? Which is the best free PCB design software available?

Vijay Kakul

A3. Proper distance between PCB tracks is critical to avoid flashover between electrical conductors. There are industry, mil and safety standards that prescribe different spacing and trace-width requirements depending on the voltage, current density, application and other factors. Standards for PCB industry developed by Institute for Interconnecting and Packaging Electronic Circuits (IPC), a US based trade association, are referred to world over. Note that these standards are voluntary rather than mandatory.

There are two factors to be considered: spacing between adjacent conductors and widths of the tracks. The conductor spacing considerations are generally based on breakdown voltage or flashover voltage between adjacent conductors. The conductor spacing is determined by the maximum voltage difference permissible between adjacent conductors, capacitive coupling and use of coatings.

In most of our applications, we make use of semiconductor devices operating at up to 24V normally. Therefore the problem of breakdown due to narrow spacing between conductors almost does not exist. Generally, a minimum gap of 0.18mm (0.007-inch) between tracks is enough, though 0.25mm (0.01-inch) is better. IPC-recommended clearances adjacent to conductors for different voltages are given in Table I.

The PCB conductor thickness and width determines the current carry-

TABLE I
IPC-Recommended Clearances

Voltage	Coated board	Uncoated up to 10,000 ft	Uncoated over 10,000 ft
0-50	0.13mm	0.64mm	0.6mm
51-100	0.13mm	0.64mm	1.50mm
101-150	0.40mm	0.64mm	3.18mm
151-250	0.40mm	1.27mm	3.18mm

ing capacity of the track. The IPC standard for the conductor thickness and width of the common 1 oz/square-foot PCB (1oz/sq foot copper – 0.035mm thickness) for different current

densities are given in the Table II. However, it is always advisable to use a bigger value due to the tolerance and variation of the PCB processes. If higher current carrying capacity is required, a 2 oz/square-foot or 3 oz/square-foot type of PCB is preferred. You can resort to thick soldering of tracks to increase the current carrying capacity of the track.

There are quite a few free software available for PCB designing, most popular of which are gEDA and EAGLE (Easily Applicable Graphical Layout Editor). Free version of EAGLE has, however, a limitation of size of PCB. You can make PCB layout up to the size of a post-card. It is very easy to use, with huge library of footprints of components. Although gEDA is open source software based on Linux with no restriction on size of PCB, it is not as widely used as EAGLE and the documentation tends to be scattered around and poorly organised in online community.

TABLE II
Conductor Thickness and Width

Current in A	Track width in mil/mm
1	10/0.25
2	30/0.76
3	50/1.27
4	80/2.03
5	110/2.79

Answers compiled by EFY joint director (training), Col. N.C. Pande (Retd). Letters and questions for publication may be addressed to Editor, Electronics For You, D-87/1, Okhla Industrial Area, Phase 1, New Delhi 110020 (e-mail: editsec@efy.in) and should include name and address of the sender

“The trend is moving towards solid-state illumination”

With LEDs and lasers becoming more efficient and environment-friendly, light sources are changing in digital light processing (DLP)-based products. Kent Novak, senior vice president & general manager, DLP Products, Texas Instruments spoke to Pankaj Vashisht of EFY about the advancement of DLP in non-display applications and new trends in DLP light sources



KENT NOVAK
SENIOR VICE PRESIDENT &
GENERAL MANAGER, DLP
PRODUCTS, TEXAS INSTRUMENTS

Q. What enhancements would a product inherit, if it is designed to run with a modern DLP chip?

General trends show that over time, newer chips are developed with higher resolution, better brightness and light efficiency. Specifically, use of microscopically small mirrors as reflectors inside the chips and changing tilt angles of the mirrors have achieved more brightness. As compared to previous generation, systems designed using these new chips are 50% brighter using the same power on the LEDs, increasing their light efficiency. Engineers who are designing consumer applications where battery life is more important, get more brightness with less power consumed by using a modern DLP chip.

Q. Is there any limitation on the size or resolution of the image while using DLP technology?

The size of the image mainly depends on the projector brightness, optics configuration and the distance between the projector and display surface or projector screen. DLP projectors can illuminate screen sizes of 25.4cm (10-inch) width to 30.5m (100-feet) width. The former is used in pico phones and the latter in cinema halls.

Q. What benefits can an engineer get by switching his current design to the newer DLP technology?

Faster switching speeds with DLP gives it an edge over other existing technologies. Whether it is cinema projection, 3D projection or 3D inspection, or spectroscopy, faster moving mirrors give the advantage of faster switching speed which, in turn, allows those applications to go faster. This imaging speed of DLP chipsets, when combined with consumer applications like digital cameras and projectors, results in highly reliable and accurate systems.

Q. How should a designer go about DLP-based product designing?

The DLP chip, or digital micro-mirror device (DMD), is an array of micro-mirrors that can be used for high-speed, efficient and reliable light steering. DLP technology can be considered in any application where light is steered or manipulated. Development tools and reference designs are available to engineers for ensuring a faster time to market.

Q. What advantages can DLP present for industrial, medical or automotive sectors?

In the industrial or automotive space, the traditional expectations are excellent colours, contrast and brightness. For example, in head-up displays for automotives, the common expectation is to have a wider and wider field of view with good brightness. You can have that with DLP technology while existing technologies can not do that. Medical applications like DLP-enabled hyperspectral imaging method opens up a wide range of possibilities in spectroscopy. DLP provides imaging technology with real time mapping and visualisation data to assist surgeons with performing difficult procedures.

Q. What are the trends in light sources for DLP-based products?

With the emergence of solid-state lighting, light sources have gained importance in DLP-based products. Many of the projectors today, whether cinema projectors or class-room projectors, still use bulb as a light source. But all pico projectors use LEDs because the most cost-effective solution to get more lumens is LED. All automotive solutions use LEDs as they fit best for the brightness that we need. Then there are laser-based projectors. The trend is moving towards solid-state illumination because more brightness per watt, or you can say brightness per rupee or dollar, is the main concern, and at the same time it is the right solution for the environment as well.

Q. How does DLP 3D projection really work?

DLP technology uses millions of microscopic digital mirrors that reflect light to create a stunning picture for the best projectors in the market. This imaging technology is so fast, it can actually produce two images on the screen at the same time—one for the left eye and one for the right eye. Then 3D glasses combine the two images to create an amazing 3D effect. DLP has enabled a single projector box to be able to display either 2D or 3D content simply depending on the content being run through it. This can greatly benefit classrooms, as they can future-proof projector purchase. They can purchase a 3D projector today, for no extra cost, and purchase 3D glasses when they are ready to beam 3D content. ●



ANDY WANG
SENIOR BUSINESS MANAGER,
ENERGY SOLUTIONS BUSINESS
GROUP, MAXIM INTEGRATED

“The deployment of smart meters is far from a one-size-fits-all undertaking”

Highly integrated SoCs are helping design energy meters with ease, but what are the design considerations and challenges for energy metering? And how can you select an SoC for designing energy meters? Andy Wang, senior business manager, Energy Solutions Business Group, Maxim Integrated talks to Pankaj Vashisht from EFY

Q. What are the key elements of smart meter design?

The ability of solid-state electricity meters to detect and prevent tampering can significantly improve control and cost recovery for utility companies. By enabling customers to better manage their own energy usage through incentive-based programs—such as direct load control, interruptibility rate agreements and demand bidding or buyback—smart metering can help utilities manage overall energy consumption patterns and cope with peak-demand challenges.

Q. What are the biggest considerations and challenges in designing these meters?

The deployment of smart meters is far from a one-size-fits-all undertaking. Manufacturers must account for the varying regulatory requirements of each region as well as the different functionalities and services required for different markets. For servicing global markets, the combination of different driving forces or elements presents significant opportunities and challenges. Therefore meter manufacturers need to be flexible, offering both low-cost metering solutions and high-end smart meter alternatives.

The biggest challenge in designing any energy meter is to make sure the metrology is stable and repeatable in terms of accuracy. When it comes to designing energy meters, the accuracy of the integrated smart devices is also very important, because it decides the reliability of the system.

Q. What are the benefits provided by highly integrated SoCs in designing energy meters?

Using these SoCs, one doesn't need to spend much on engineering resources. This is because the engineer does not have to start the design from scratch. SoCs lower the bill of material costs and provide rich feature sets for smart metering, and simpler upgrade paths with minimum hardware and operational costs. Their key strength is the family effect and scalability. Engineers can design with one product and easily migrate to different products in the family depending on their needs.

Q. What ensures stability and repeatability in terms of accuracy in energy meters?

The basic features like the dynamic range of the ADC, sample rate of the ADC and the processing power of the

microcontrollers account for the accuracy in energy metering. Also, the metrology compute engine (CE) ensures high-accuracy processing of all collected data. It is dedicated to computing the metering parameters from voltage and current samples.

Q. What new features do these SoCs bring to energy metering?

If you look at the whole family from low-end market to high-end market, when you go to the higher end, you will get more memory, which in turn allows the engineer to incorporate DLMS/COSEM stacks (communication protocols for smart meter), allowing you to communicate with the modems. Also, in some regions it is required to encrypt/decrypt the data, and for that these SoCs incorporate hardware accelerators.

Q. Any key parameters for selecting a SoC for energy-metering requirement?

Accuracy, memory size, processing power and amount of peripherals integrated are the key parameters to consider when selecting any metering SoC solution. An engineer should make sure it features field programmability, enables ease of integration with local devices such as thermostats, and supports a variety of sensor inputs with minimum hardware.

Q. What are the tools and guidelines available to design with SoCs?

From hardware perspective, there are reference designs, layout and hardware guidelines. All one has to do is leverage the technology with these SoCs and modify it, and just make sure the power supplied is stable and sensing circuitry is clean. From software perspective, we provide modulated source code, so one can take it from there and easily modify it depending upon end customer's requirements.

Q. How do you see the future of energy metering?

Looking into the future, I feel it is about more upgrades in the metrology along with the metering firmware. Products that most vendors vision are the products with increased integration of communications and security features. ●

“To produce electronic assemblies without a known profile is just asking for trouble”

Mark Stansfield, director, SolderStar speaks to Abhishek Mutha from EFY about the importance of controlled thermal processes and lead-free manufacturing and throws light on necessity of temperature profiling for electronic assemblies, different kinds of profiling and their benefits, and the future of thermal profiling



MARK STANSFIELD
DIRECTOR, SOLDERSTAR

Q. Why is thermal profiling necessary for lead-free manufacture?

When lead-free emerged as an established process, many manufacturers had major upheaval of their well-proven thermal processes. The available processing window is much tighter with lead-free, making the ‘one profile fits all’ much less likely. Profiling tools are now extremely advanced such that we can take a snapshot of what the thermal process is doing today and, using software simulation tools, it is possible to produce the optimal settings for engineering in a matter of minutes. Without correct settings on the machines, solder quality is impaired and components could be damaged.

Q. What is the difference between the two main kinds of profiles used today: Ramp-Soak-Spike (RSS) and Ramp-to-Spike (RTS)?

Use of an RSS or RTS profile is specific to the assembly being processed by the manufacturer. RTS is very common because it is quite simple to set up and easily achievable on most reflow ovens, however it is only suitable when the assembly does not have high mass elements within its design. If the assembly has big mass variations, or has high mass elements like aluminium PCB or large arrays, it may be necessary to employ RSS style profile. This technique has a more aggressive ramp, but longer soak period to allow the assembly temperature to more readily equalise before moving into the Spike/Reflow stage. Without this method, peak and time above liquidous temperatures within specification will not be possible due to large temperature deltas across the PCB.

Q. How does software complement thermal profiling equipment?

Profiling systems are definitely 50% a software product, if not more. Tools automatically calculate all process parameters from the raw data and display them against the working process windows defined by the solder paste or component specification, making the good/bad analysis very quick and easy. We have optimisation software that helps with finding optimal process settings. Additionally, we have a complete suite of QA tools to allow full documen-

tation of the profiling process and allow generation of SPC information from the data captured on the production lines.

Q. What is the significance of temperature-profiling systems?

I am a great believer in ‘you can’t manage what you don’t measure.’ To produce electronic assemblies without a known profile is just asking for trouble further down the line—either rework costs or early failures and unhappy customers. Not every company warrants investment in equipment to continuously monitor the production lines, but to not profile an assembly during the NPI stage and then performing some form of periodic checking is, to be frank, just not doing the job correctly.

Q. Why taking temperature profile measurements as the benchmark for process control not enough?

A soldering process is a dynamic thing, with many outside influences affecting the profile seen at product level, machine loading, flux build up, extraction performance change or machine failure. All these things can be measured and controlled with the adoption of a quality control procedure. As a minimum, verifying the machine before a new batch is sent through the line is common sense, but for long running production batches periodic checking would also be prudent.

Q. What is the future of thermal profiling?

The procedure of capturing a thermal profile, performing an optimisation step and verification of that step is well established and unlikely to change radically. What we are seeing from our customer base, especially with the automotive industries, is the need to measure and improve every part of the process, from performing initial machine capability to studies, to production level daily testing of all parameters within the manufacturing process. This need is central to our drive to provide measurement solutions within a common software platform for all the soldering techniques, additionally to provide the engineer with flexible instrumentation they can tailor exactly to their needs, both quickly and cost effectively. ●

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January	Electronics of Things	Industrial Automation Electronics	Rework Stations	Automated Test Equipment (AOI, etc)
February	Smart Grid	Smart Grid Electronics	Handheld T&M Equipment for Field Engineers	Thermal Imaging
March	Smart & Electric Vehicles	Automotive Electronics	How to Make Your Lab Static Proof	Function & Signal Generators
April	Smart Homes	Inverters & UPS-SOHO & Industrial	Digital Multimeters	Multimeters
May	FPGA (Programmable Chips)	Connectors & Terminals	FPGA Training Kits	Data Acquisition Systems
June	3-D Printers	Certification & Quality Labs	Desktop Manufacturing Equipment (SMT, Reflow Ovens, 3D Printers)	EMC Test Equipment
July	Raspberry Pi	PCB Industry in India: Suppliers & Manufacturers	Budget Friendly Oscilloscopes	Oscilloscopes
August	Security 2.0: Latest products	Aerospace & Defence Electronics	Wi-fi & RF Modules	Incircuit Test Systems
September	Smart Robos	Solar Electronics	EDA Tools for Circuit Design	Virtual Instruments
October	Open Source Electronics	Educational & Training Products	Development Boards (Microcontroller based)	Analysers (Network, Protocol, Spectrum, etc)
November	Wireless Communication Technologies (Zigbee, RF to 5G & beyond)	Security & Surveillance	Soldering / Desoldering Stations	RF Devices (Wireless Devices)
December	Smart Lighting	LED Lighting	Programmable Power Source	Power Analysers/Power Meters/Supplies

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