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Device For Charging
Three 12V Batteries

Earthquake Indicator
Using Arduino

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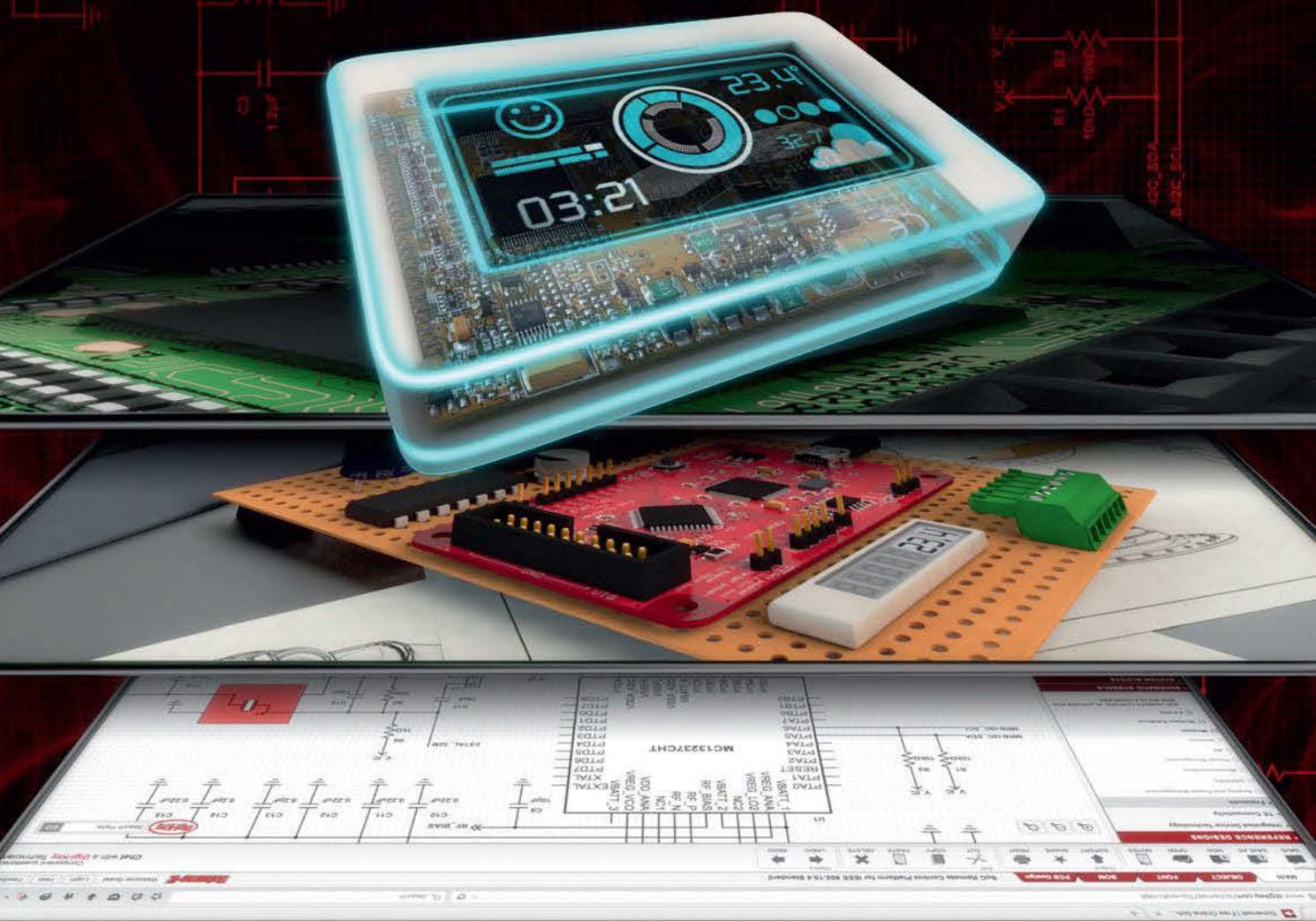
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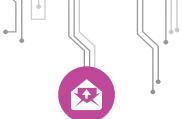
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FEEDBACK

YOUR SUGGESTIONS

ARTICLES ON ADVANCED CONTROLLERS

I thank EFY team for providing excellent tutorials and website links. I suggest increase in number of pages and introduction of advanced controllers and development boards for learning in each issue. There should be five or more articles on such development boards as BeagleBone, Banana Pi and Intel Galileo boards.

Pamarthi Kanakaraja

Through email

EFY. Thanks for the feedback! We already carry articles based on Arduino and Raspberry Pi. We will certainly keep your views in mind while selecting the articles submitted to us for publication and also while developing new projects in EFY Lab.

AMERICAN CARRIER STRIKE

In 'American Carrier Strike Groups: An Electronic Perspective' published in September 2015 issue, on page 74, under 3D air-surveillance radar section, regarding 3D surveillance radar it is mentioned that computer-controlled planar-array radar varies its frequency instead of nodding the antenna up and down.

It is wrong! The nodding action of the beam is achieved by the phase shift method of the array and not by changing the frequency.

Vijesh C.N.

Through email

The author B. Kamalanath replies: What the reader has mentioned is true for radars where the RF energy is fed in parallel to the transmitter elements such as in AN/SPY-1 radar (explained under the section in the second part of the article). Here, the phase of the parallelly fed signals will be varied to form a waveform in the

desired direction.

But the AN/SPS-48 radar (mentioned in the article) uses frequency scanning. That is, the RF energy is series fed to the transmitter elements.



FROM FACEBOOK

EFY's Electronics Design Community

I took Electronics as a subject while in the Army from 1967 to 1970 here in the United States. One of the things I missed the most was the famous electronics magazines like Popular Electronics and Radio Electronics. I want to thank you for picking up where they left off. I enjoy your publication very much.

Steve Griffith

EFY is great! Just increase the number of articles in Do-It-Yourself section and videos in the accompanying DVD.

Neeraj Prasher

'Spot An Error' AWARD Winners

In Innovation section, in 'A One-Stop Shop for Custom-Made LTE Stack' article published in November 2015 issue, under technical specifications the acronyms for FDD and TDD are incorrectly mentioned as Frequency Division Multiplexing and Time Division Multiplexing instead of Frequency Division Duplex and Time Division Duplex, respectively.

Siddharth Kaul

In 'ATmega16A Based GPS Receiver' DIY article published in November 2015 issue, the statement 'GPS receiver used for this prototype is a marine GPS receiver MR-600 and a sunrom GPS receiver (1216) with an active antenna' is wrong. It gives the impression that both the receivers are required but, actually, either one should suffice.

Deepak Nair

Corrections

In 'Automatic USB-Controlled Power Switch' DIY article published in November 2015 issue, in Fig. 3, the D+ and D- terminals of CON4 should be interchanged.

Bhenkateswar Mahanta

In 'FreeRTOS on PIC18F4520 MCU' DIY article published in November 2015 issue, under Application of FreeRTOS running on an MCU section, the RD0, RD1 and RD2 pins are not for Port B. These are the pins on Port D.

Rishad P.K.

EFY. Thanks for pointing out the mistakes! But regret inability to include under 'Spot an Error' award category since the emails were received after the deadline.

Due to this, the wavefront is changed by changing the frequency of the RF energy and not by changing the phase.

OBJECT COUNTER

In the source code of 'AVR Based Programmable Object Counter' DIY project published in August 2015 issue, the `#define F_CPU 8000000` line is missing. Also, the default clock frequency or on-chip oscillator frequency of AVR (ATmega16) is 1MHz. To access the external oscillator we have to change the fuse bits, which is not mentioned anywhere in the article.

Visweswara Rao

Through email

The author Ashutosh M. Bhatt replies:

It is not required to include the line `#define F_CPU 8000000` anywhere in the source code. Actually, the AVR Studio compiler tool takes care of all the issues regarding clock frequency. It generates hex code relevant to selected crystal frequency. You may select desired clock frequency as per your crystal connected in the circuit. If you buy a new ATmega8/16/32 microcontroller then it is required to program the fuse bits for the external crystal.

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Ques. WHAT ARE COLOUR SENSORS AND WHICH SENSORS ARE MOST PREFERABLE?

Pamarthi Kanakaraja

Ans. The colour sensor product family provides red, green, blue and clear (RGBC) light sensing for precise colour measurement, determination and discrimination. A sync input allows for greater accuracy by enabling the colour sensing to be synchronised with an external event. For example, in LED solid-state lighting, the sync input enables the colour reading to be synchronised with the PWM signal and illumination of the LEDs. Colour sensors are available with a built-in infrared (IR) blocking filter for accurate colour measurement by minimising the effects due to unwanted IR light sources in sunlight and other light sources.

Colour sensors from ams AG are available in TCS series as RGB light-to-voltage converters (TCS3103, TCS3104), programmable colour light-to-frequency converters (TCS3200, TCS3210), with sync input for colour-sensing synchronisation and in-package IR-blocking filter (TCS3404, TCS3414), colour light-to-digital converter I2C (TCS34715), colour light-to-digital converter I2C and IR filter, etc.

EMX has a number of colour sensors available in ColorMax-1000 series. A sensor can recognise 15 colours and RGB intensity. Details are available on their website www.emxinc.com/color_sensor.html

Q2. WHAT IS THE DIFFERENCE BETWEEN SSP AND SPI IN ARM PROCESSOR?

Pamarthi Kanakaraja

A2. Synchronous serial port (SSP)

module is a serial interface useful for communicating with other peripherals or microcontroller devices. SSP is a controller that supports the serial peripheral interface (SPI), 4-wire synchronous serial interface (SSI) and micro-wire serial buses. It uses a master-slave paradigm to communicate with peripheral devices. These peripheral devices may be serial EEPROMs, shift registers, display drivers or A/D converters. An SSP module can operate in one of two modes:

1. Serial peripheral interface (SPI)
2. Inter-integrated circuit (I2C)

SPI is a hardware/firmware communications protocol developed by Motorola and later adopted by others in the industry. It is a serial communications interface used by many microcontrollers that enables the controllers and peripheral devices to communicate with each other to transfer data at high speeds.

The SPI bus, which operates at full duplex (means, signals carrying data can go in both directions simultaneously), is a synchronous type data link set up with a master/slave interface. It is usually used only on the PCB.

SSP peripheral is a multi-protocol peripheral, which is also able to function as an SPI interface. Since the SSP interface is newer and more versatile, the SPI interface is not recommended for new designs.

Q3. HOW TO SYNCHRONISE RTC WITH A PC VIA ARDUINO? PLEASE PROVIDE THE LINK FOR THE SAME.

Mahesh Kumar

A3. To use a real-time clock (RTC) with an Arduino board, first make Arduino ready by uploading the program to the board. The program will receive the time from the PC in a special

format and write it on the RTC. To see the current time of the RTC you need to send a command using the serial port.

To send the time from PC, you just need to run a batch file. Change the COM number in the batch file. Do not forget, your PC's serial port should be free. If serial communication of your Arduino IDE is open, close it first and then run the batch file.

Now, if you send command on the Arduino's serial port, you will see the same time as your PC. For your reference please follow the link www.instructables.com/id/Synchronise-DS3221-RTC-with-PC-via-Arduino/

Q4. CAN I USE ATMEGA16 AND ATMEGA8 CHIPS WITH AN ARDUINO UNO BOARD THAT IS TO BE PROGRAMMED?

Vignesh Vicky

A4. You cannot use Arduino Uno board directly with ATmega16 and ATmega8. To work with ATmega16 and ATmega8 using Arduino IDE one has to use Arduino-compatible boards. Among the boards that are fully or almost fully compatible with both the Arduino hardware and software, including being able to accept 'shield' daughterboards, is the Elektor Platino Universal AVR board (compatible with ATmega8, ATmega16, ATmega32, ATmega88, ATmega164, ATmega168, ATmega324, ATmega328, ATmega644 and ATmega1284), which supports 28-pin and 40-pin AVR devices. The board features multiple footprints for user interface elements like LCDs, pushbuttons, rotary encoders, LEDs and buzzer, and is supported by an extensive library. Bootloaders are available for all supported processors.

Answers compiled by EFY senior application engineer, Nidhi Kathuria. 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

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USEFUL WEBSITES

MICROCONTROLLER PROJECTS

This month we have a few websites that introduce you to electronic projects based on different microcontrollers (MCUs)

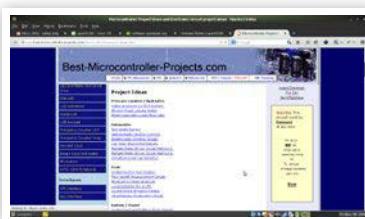
Compiled by **NIRAJ SAHAY**



eeweb.com

Cofounders Joe Wolin and Cody Miller formed Aspen Labs LLC in 2007 with the goal of creating a business media company that focuses on the needs of engineers. In 2010, they partnered with Digi-Key Corp. and launched EEWeb, a premier electrical engineering community for hardware designers. The website has a lot of useful information along with projects related to MCUs.

www.eeweb.com/projects/browse/microcontroller



best-microcontroller-projects.com

If you are looking for MCU projects and resources, look no further. Here you have MCU Tools Projects and Tutorials designed by John Main, a professional electronics design engineer based in the UK. Each project includes a source code, description and schematics that you can use as a basis for starting your own projects or just use these stand-alone.

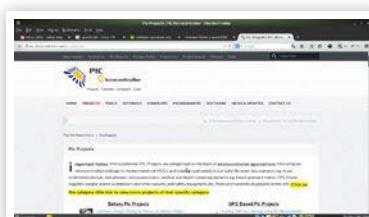
www.best-microcontroller-projects.com/microcontroller-project-ideas.html



electronicsforu.com

www.electronicsforu.com serves as a storehouse of information for the electronics and technology industry. It has the latest news and information about new products in the electronics sector, not to forget the hugely popular EFY-tested circuits, reproduced from *Electronics For You* magazine. There is also a section on MCU projects, which has been always an area of interest for the visitors of the website.

www.electronicsforu.com/newelectronics/microcontrollers



pic-microcontroller.com/pic-projects

This website has good content related to different MCUs. It is maintained by a young engineer for sharing his projects and tips and tricks using MCUs. The site has hundreds of projects that can be useful for hobbyists as well as students.

www.pic-microcontroller.com/pic-projects

arduino.cc



www.arduino.cc/playground/Projects/Ideas

Arduino is an open source physical computing platform based on a simple MCU board. Arduino official website has a section where you can find a list of Arduino based project ideas. The list is helpful for both the novice and the experienced. Project Ideas section has been divided into three categories (easy, intermediate and advanced) for easy navigation.



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RIGHT CAPACITORS FOR THE RIGHT MARKET

Japanese capacitor major Nichicon aims to strengthen its foothold in the Indian market with its innovative and market-driven product ranges

Japanese capacitor manufacturer Nichicon is ramping up its presence in India. Having entered the Indian market back in 2012, it has forged alliances with some of the major distributors of capacitors along with setting up its own sales office in India.

Headquartered in Kyoto, Japan, the company has a widespread global presence with 16 manufacturing units, of which 11 are in Japan, four in China and one in Malaysia, and sales offices in the USA, the UK and Asia-Pacific region. The company manufactures aluminium electrolytic capacitors, film capacitors and circuit products, catering to four key markets, namely, automobiles, white goods and industrial inverters, energy, environment and medical, and telecom.

The company has registered gross revenue of US\$ 892 million, with Japan and Asia contributing to as much as 38.4 per cent and 47.7 per cent, respectively. The company claims to have introduced advanced products ahead of the needs of its customers in the market by focusing on technological resources that they specialise in, such as aluminium-etched foil manufacturing technology, electrolyte development and film deposition technology.

Key market segments to cater

Nichicon has identified the capacitor needs of the key markets and will be fulfilling that through the introduction of new products and technology. Here are some of the requirements:

Automobiles and automotive-related equipment:

- High temperature support (installed in engine rooms)
- Vibration resistance (automotive environments)
- Low temperature ESR characteristics (cold-climate support)

White goods and industrial inverter equipment:

- Miniaturisation (miniaturisation of equipment)
- Charging/discharging support (motor drive circuits)
- Higher withstand voltages (higher efficiency of equipment)

Energy, environment and medical equipment:

- Long life (making wind power generation maintenance-free)



- Higher withstand voltages (higher efficiency of equipment)

Telecommunications equipment:

- Thinner (thinning of mobile equipment)
- Lower ESR (instantaneous supply to semiconductors)

Innovative products on offer

The company claims to be thriving on the back of its R&D capabilities and ahead of market innovations. It has been proactive when it comes to introducing products in the market that are linked with the current requirement or demand of consumers. Here are some of the latest innovations that they are offering.

Addressing the high temperature high voltage withstand need of renewable energy sector. As the industrial market makes advances in efficiencies and energy-saving functions, higher voltages are required. This creates a demand for higher voltage aluminium electrolytic capacitors that are used in the control circuits of power supplies. The need is particularly prevalent in renewable energy-related fields such as solar and wind power generation.

Nichicon has met these needs with its LGN series of compact snap-in terminal-type aluminium electrolytic capacitors, which can withstand rated voltages of up to 500V and are guaranteed to operate at 105°C and therefore suitable for the power electronics market, where energy-efficient operations are a priority. Recently, they developed a new electrolyte solution for aluminium electrolytic capacitors that is capable of withstanding voltages of 750V and higher with operating temperatures of 105°C. Primary ap-

plications for this product will include high-voltage converters and will cater to power electronics market, where energy-efficient operations are a priority.

Shaping up ultra-slim capacitors to fit into tablets and mobile devices: With the rapid expansion of tablets and mobile devices, there has been a wide range of peripheral equipment developed that takes advantage of these products' networks. This field is demanding increasingly smaller components that offer more advanced functions. It is also crucial that components use space effectively in order to fit into the shapes of this peripheral equipment.

Nichicon's previous cylindrical-shaped EDLC measured $\varphi 6.3 \times 9L$ mm and had the industry's highest capacitance of 1F. A new ultra-slim $\varphi 4 \times 30L$ mm product has been developed recently. Despite its thinness, it still has a capacitance of 1F. The EDLC's ultra-thin shape allows it to fit into small spaces and makes it ideal for applications like stylus and other peripherals used with tablets and mobile devices. It can also be used for backup power in wearable technology. And with its ability to be charged on very slight electrical currents, it holds promise for application in the field of energy harvesting.

Introducing ultra-compact capacitors for power and resource efficiency: Due to the increasing needs for power and resource efficiency in industrial machinery, equipment is becoming increasingly smaller. The components also need to be smaller. Nichicon has introduced the industry's smallest class of snap-in terminal-type aluminium electrolytic capacitors till date. Potential applications include inverters for power electronics and switching power supplies. These ultra-compact capacitors are guaranteed to operate at 105°C and are ideal for space-efficient circuit design.

With renewed focus on increasing manufacturing activities in India, especially in the electronics sector, such innovative capacitors will be more and more in demand. All sectors that the company is targeting, be it renewable energy, tablets and mobile devices or industrial power supply, are gathering pace and are looking for such innovative solutions. Perhaps, the time is ripe for Nichicon to ramp up its presence.



World's first commercial quantum computer beats conventional computer

A controversial machine bought in by Google and NASA, and named the world's first commercial quantum computer, has beaten a conventional computer in a series of tests, according to researchers at Google.



World's first commercial quantum computer

They also said that they had proof of it using quantum physics to work through a type of maths that is crucial to artificial intelligence (AI) and is much faster than a conventional computer.

Governments and leading computing companies such as Microsoft, IBM and Google are trying to develop what are called quantum computers because using the weirdness of quantum mechanics to represent data could unlock immense data-crunching powers. Computing giants believe quantum computers could make their AI software much more powerful and unlock scientific leaps in areas like materials science.

NASA hopes quantum computers could help schedule rocket launches and simulate future missions and spacecraft. The computer is installed at NASA's Ames Research Centre and operates on data using a superconducting chip called a quantum annealer, which is hard-coded with an algorithm suited to what are called optimisation problems. These are common in machine-learning and AI software.

Fire-fighting robot that can shoot water, foam

A remote-controlled fire-fighting robot, known as Turbine Aided Fire-fighting machine or TAF 20, was recently unveiled in Sydney. It is capable of shooting a stream of water at 90m (295-feet), as well as spraying foam or mist at 60m (197-feet). The robot has a high-powered fan that can clear smoke from a room.

The robot will aid fire

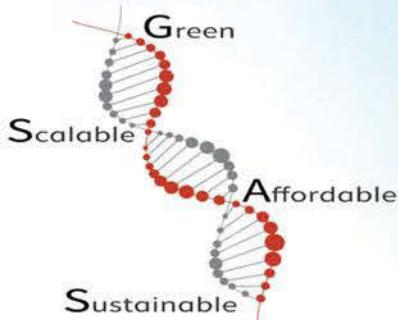
and rescue NSW fire-fighters while managing hazardous fires and other emergencies where they cannot safely approach the flames, for example, when there is a danger of explosion and bushfires.

The robot will be based at Alexandria in inner Sydney and can be quickly deployed by road or air when and to where it is needed.



Fire-fighting robot

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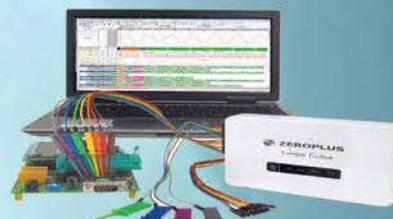
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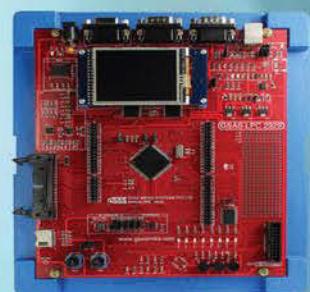
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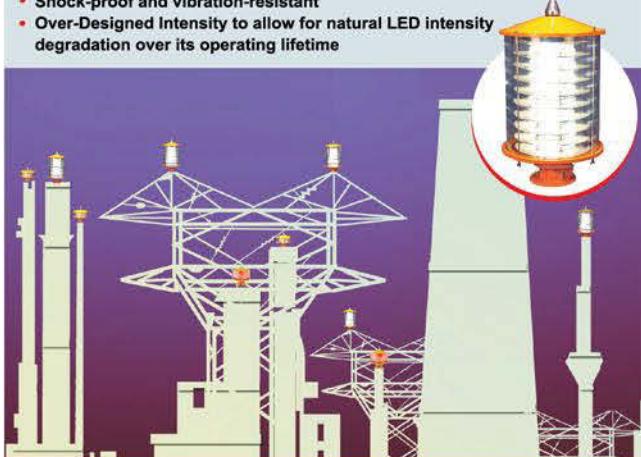
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THE BINAY LED OBSTRUCTION LIGHT IS UNDER ACCEPTED PATENT, AND AS SUCH IS A PROPRIETARY PRODUCT



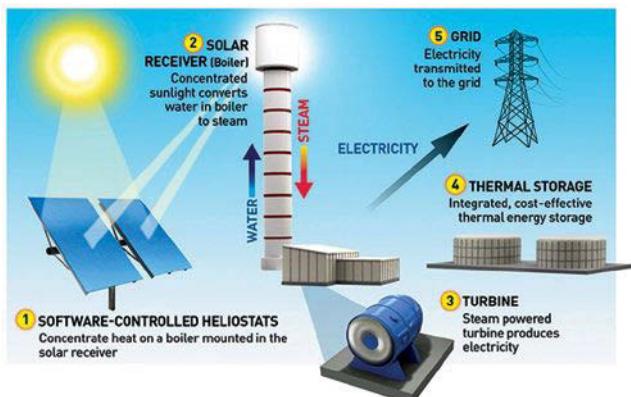
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Hydricity, the breakthrough in solar

Scientists at Purdue University and Federal Polytechnic School of Lausanne have developed Hydricity, which combines solar thermal plants with hydrogen production technology to synthesise energy at a greater scale and escalated efficiency.



A conventional solar thermal plant (Image courtesy: www.kimroybailey.com)

In this technique, a hybrid system uses solar energy to simultaneously generate steam by heating water, as well as hydrogen by electrolysis. Steam generated is used to run turbines as in a conventional solar thermal power plant, and hydrogen produced is stored away for future use.

Solar power is mainly harnessed by using solar power cells that convert light into electricity, or solar thermal power plants, which use the Sun's heat to generate steam, which is then used to run turbines to produce electricity. Both these processes are only fairly efficient, with an average efficiency of around 30 per cent. Hydricity is an attempt to efficiently harvest solar power that could meet the world's need for energy.

According to the team, the overall efficiency of Hydricity is 35 per cent, with 50 per cent efficiency in hydrogen production and 46 per cent efficiency in immediate electricity generation. Boost from the average 30 per cent is achieved by a series of high-pressure and low-pressure turbines, connected successively.

Electrical circuits inside living plants developed

Researchers at Linköping University, Sweden, have created analogue and digital electronics circuits inside living plants. The group at Laboratory of Organic Electronics (LOE), led by Prof. Magnus Berggren, has used the vascular system of living roses to build key components of electronic circuits.

Plants are complex organisms that rely on the transport of ionic signals and hormones to perform necessary functions. But, these operate on a very slow time scale, making

interacting with and studying plants difficult. Combining plants with electronic functionality would make it possible to combine electric signals with the plant's own chemical processes. Controlling and interfacing with chemical pathways in plants could pave the way to photosynthesis based fuel cells, sensors and growth regulators, and devices that modulate the internal functions of plants.

These are some steps taken to merge the fields of organic electronics and plant science. The aim is to develop applications for energy, environmental sustainability and new ways of interacting with plants.

Device to harvest energy from walking

Researchers have demonstrated a universal self-charging system driven by random body motion. By walking or running, the system uses the tribo-electric effect to generate electricity by physically manipulating two materials with opposing surface charges. The current is enough to power sensors, microcontrollers, memories, arithmetic logic units, displays and even wireless transmitters.

More complicated electronics like smartwatches, mobile phones, navigation systems, tablets, personal computers and sensor nodes in the Internet of Things can also be charged using the same system if high-frequency mechanical agitations are utilised to drastically improve tribo-electric nanogenerator's (TENG's) output power.

To embed TENGs into an electronic system for practical applications, the team devised a system that includes a TENG, a power-management circuit and a low-leakage energy-storage device. The power management circuit is designed to solve the impedance mismatch problem. It can achieve 90 per cent board efficiency and 60 per cent total efficiency, about two orders of magnitude improvement compared with direct charging.

Sensor that can detect oestrogen levels in body fluids

Oestrogen is one of the main hormones that regulates the female reproductive system. Researchers at Victoria University of Wellington, New Zealand, have developed a sensor that can detect low levels of E2, one of the primary oestrogen hormones, in liquids like saliva.

The sensor sends an electronic signal in the presence of oestrogen and, with further development, can test oestrogen levels in body fluids or test waterways for oestrogen contamination that might pose a risk to humans and the environment.

It has a simple design, gives real-time readings, could be integrated into an electronic monitoring system and uses very little power. It uses small snippets of DNA called aptamers to latch onto oestrogen molecules.

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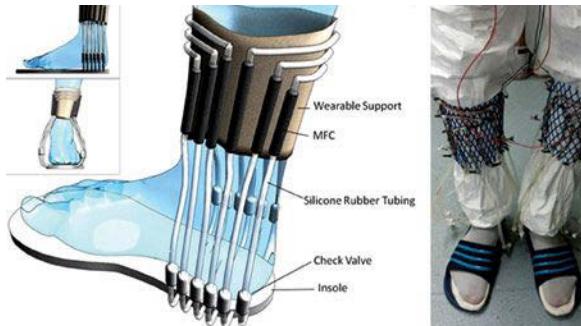
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Urine-powered socks can send a text

Robotics professor Ioannis Ieropoulos and his team at University of the West of England in Bristol, UK, have managed to turn human waste and locomotion into electrical power with a bit of help from microbes.



Urine-powered socks (Image courtesy: www.twitter.com)

According to the scientists, this is the first time anyone has combined microbial fuel cells with wearable technology. The socks produced enough electricity to power a specialised wireless transmitter that sent out the message 'World's First Wearable MFC' every two minutes.

The idea behind the creation was to create a self-contained system for generating power, with an eye toward survivalist scenarios.

Self-healing gel for foldable electronics

Researchers at University of Texas, Austin, USA, have developed a self-healing gel that repairs and connects electronic circuits, paving the way for the development of flexible electronics.

The new material has high conductivity, and strong mechanical and electrical self-healing properties.

Until now, self-healing materials have relied on application of external stimuli such as light or heat to activate repair.

The research team created the self-healing gel by combining two gels: a self-assembling metal-ligand gel that provides self-healing properties and a polymer hydrogel that is a conductor A.

To construct the self-healing electronic circuit, the gel would not replace the typical metal conductors that transport electricity, but could be used as a soft joint, joining other parts of the circuit.

3D-printed rotors that freeze seawater into drinking water

GE has long been an expert in steam turbine technology for desalination of water, but in 2015, it began to miniaturise the process.

A press release from the company explains, "As part of

the water desalination technology being developed with the US Department of Energy, researchers are using the same steam turbine turbomachinery 3D printed in a miniaturised form to compress and stream a mixture of air, salt and water through a hyper-cooling loop that freezes seawater. By freezing the mixture, the salt naturally separates in solid form, leaving just ice. The ice is then melted, leaving clean water."

The design is a low-cost, low-energy way of creating drinking water, and GE will continue to test the technology through mid-2016 to assess its feasibility.

Renesas GR Kaede Design Contest conducts grand finale in Bengaluru

Renesas GR Kaede Design Contest 2015, the second edition of the popular design contest organised by Renesas and EFY, conducted the grand finale at Shangri-La Hotel in Bengaluru on December 16, 2015. The top-three projects



Renesas contest winners

were on sign-language recognition using sensor gloves, smart agriculture system and Upasana diagnostic toolkit for Asha workers. The most innovative project was awarded to ATM Transactions Using Iris-Recognition Technology. Final winners will be announced at DevCon 2016, Bengaluru, to be held in January.

Thermally-durable lithium-ion battery reduces thermal resistance

Hitachi Ltd and Tohoku University's Advanced Institute for Material Research group have developed a basic technology to reduce the internal resistance of all-solid-state lithium-ion batteries using a complex hydride as a solid electrolyte under the project titled 'Collaborative Research for Next Generation Innovative Battery.'

With reduced internal resistance, charge-discharge performance of the battery improves and can well operate at temperatures as high as 150°C. The battery does not require a cooling system, which results in reduction of overall costs.

The new battery was found to have a discharge capacity of 90 per cent of theoretical value from a prototype of the lithium-ion battery with the capacity of 2mAh and the energy density of 30Wh/L during experiments.

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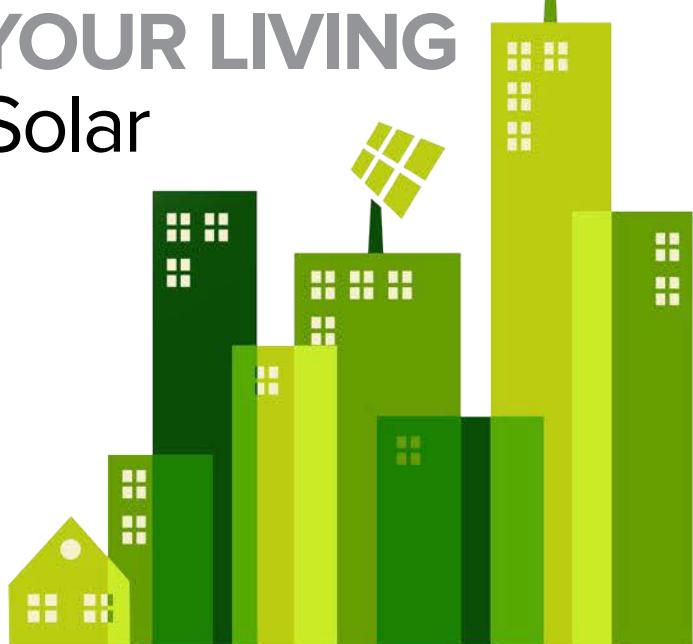
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MODERNISE YOUR LIVING With Solar



Tanya Batra is vice president - marketing, Sunkalp Energy



Today, lifestyle is changing at a very fast pace, while accepting ways to save energy. However, using grid electricity is not the solution as it is too costly. Electricity generation is done using either thermal resources like coal, gas or diesel, or through other renewable sources, which involves a lot of investment. The major chunk of electricity is generated using thermal resources, which lacks both in quality and quantity due to the scarcity of initiatives to produce large amounts of natural gas and coal in India.

Corruption and theft in Coal India has forced it to miss many targets, leading to the requirement of mining new deposits. Hydro-electric power projects have slowed down in northern regions owing to ecological and environmental conditions in public interest. Thankfully, solar energy can be looked at for our growing electricity needs.

Solar energy offers multiple benefits over grid electricity, both economically and environmentally. It has increased the interest level of people in both commercial and industrial sectors. But there is a lot of confusion about the commercials

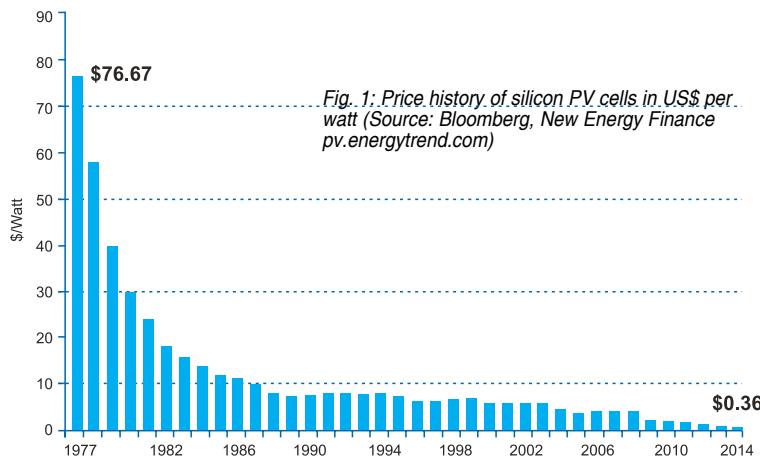


Fig. 1: Price history of silicon PV cells in US\$ per watt (Source: Bloomberg, New Energy Finance pv.energytrend.com)

How much to invest for a typical 40kW system

Initial investment: ₹ 2,711,000

Benefits offered: Accelerated depreciation and net-metering arrangement

Period considered: 25 years

Expected IRR for 20 years: 20 per cent

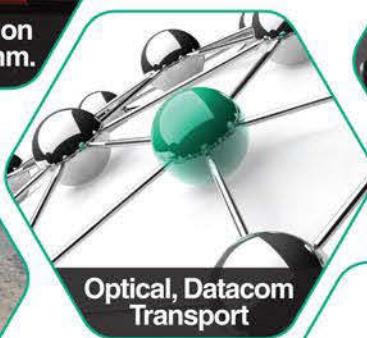
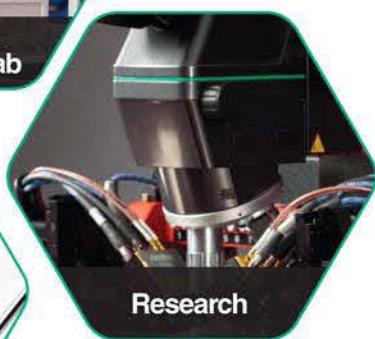
Area of consideration: New Delhi (savings vary area-wise, depending on the tariff in that particular state)

Estimated generation per kW per day: Four units conservative and five units ideal

Note: Five units of electricity in a day can power a TV for two hours, two fans for 16 hours, two lights for four hours and a refrigerator for one whole day

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of solar power. When it comes to roof-top solar installations, people are concerned about the high upfront costs involved and do not want to risk taking the first step.

Are you really aware about the investments to go solar and the commercials of it? Let us find the answers here.

Drastic reduction in costs of solar PV panels

Solar energy is generated through solar photovoltaic (PV) panels that are installed on rooftops. Major cost involved in any solar system is the cost of these solar panels. In early 1977, per watt cost of these panels was US\$ 76.67 as shown in Fig. 1. Over a period of time, this price dropped considerably to US\$ 0.36 in 2014.

Although the graph in Fig. 1 represents the fall in prices (popularly called Swanson Effect), prices may vary as per the make (brand) of a particular solar panel. Typical price per watt of a good Indian-make solar panel can vary from ₹ 32 to ₹ 37, whereas for a solar panel from Tata Power the price can go up to ₹ 45 per watt. The price is further expected to fall over the next two years.

Note. The rooftop solar systems that are being talked of here are grid-tied and grid-interactive type where solar power thus generated can be transferred to the grid.

Cost varies with size

The government's initiative to increase installation of solar systems by allowing the sale of energy generated has created a commercial sense of solar power. This commer-

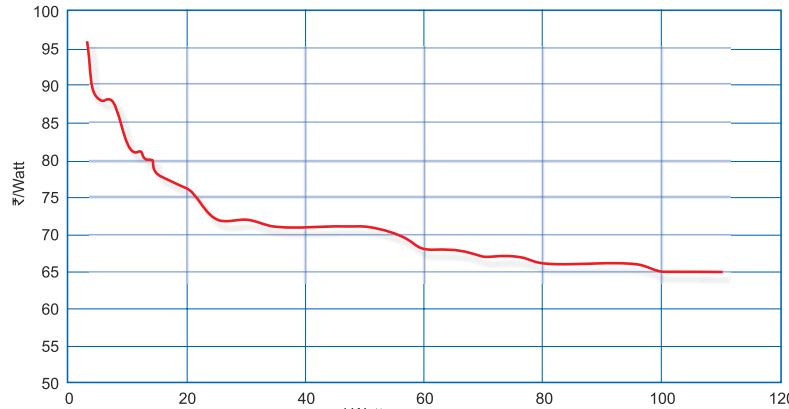


Fig. 2: Typical system cost per watt of solar (data gathered by Sunkalp)

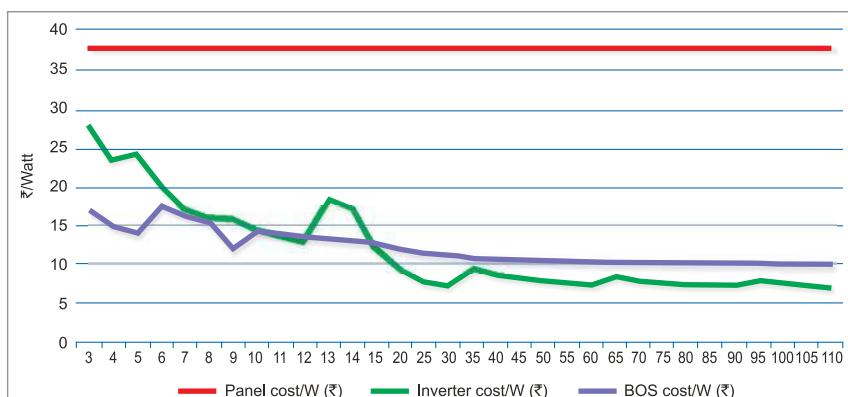


Fig. 3: Cost per watt for each component (data gathered by Sunkalp)

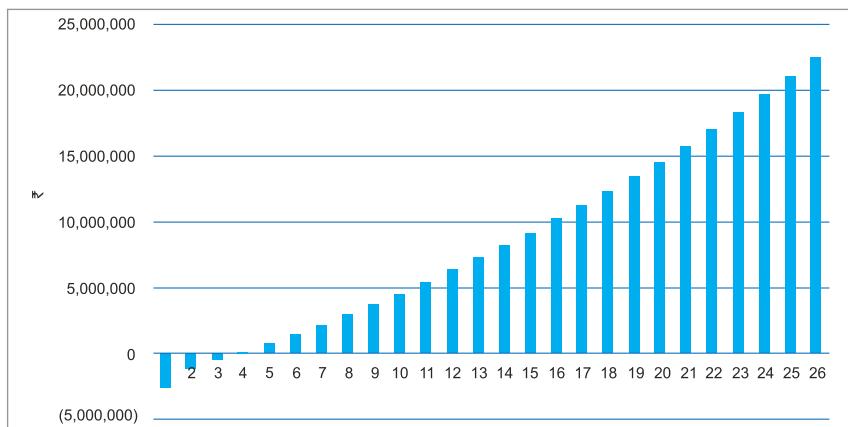


Fig. 4: Cumulative cash flow for a 40kW system



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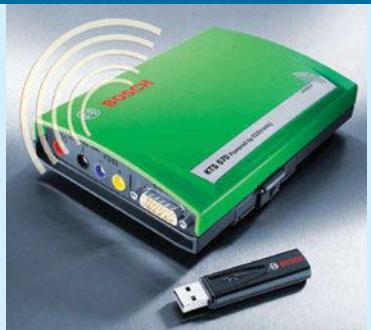
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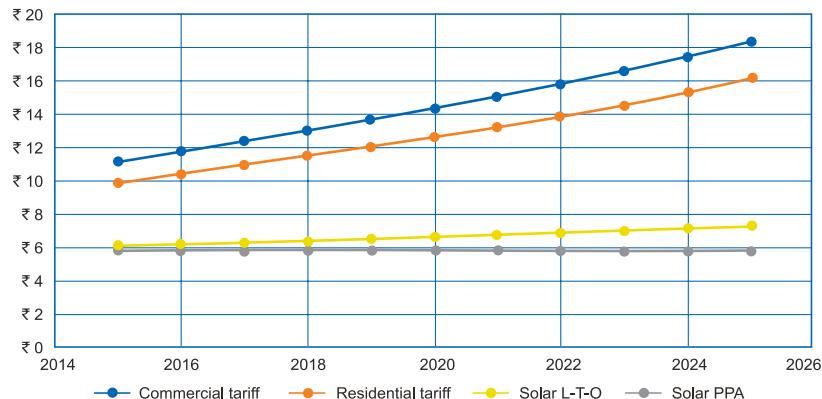


Fig. 5: Comparison of tariffs for different models

cialisation of solar energy increases as the size of the solar power system increases.

Also, cost per watt of energy from a solar system reduces considerably with reduction in cost per watt of the inverter. Panel cost reduces only marginally with an increase in system size. What does result in a drastic reduction in costs is drop in inverter costs. If you see Fig. 2, a considerable dip is seen in price per watt if the system size goes beyond 20kW, after which the price drops only marginally.

The investment

Let us now look at a representative cash flow of a solar power system for a typical 40kW system. If the initial investment is about ₹ 2,711,000, the benefits that you can expect include the facility of net-metering, giving you a return of about 20 per cent annually for 20 years, depending upon the per unit cost of the energy generated and the load used. To understand this better, please see the example given in the box on first page of this article.

Fig. 4 clearly shows that the money gets recovered in only four years, beyond which electricity is free. The quantum that can be saved (cumulatively) is as high as ₹ 2 million.

This cash flow was calculated (Fig. 5) assuming that grid tariff

will rise at a conservative five per cent per annum. Historically, it has been higher than that. Solar tariffs would either rise at two per cent per annum in PPA mode or remain the same in loan mode, in which 30 per cent cost of the system is paid upfront.

You can comfortably say that solar makes great sense at this point and can result in high savings. It is not the cost of installation that has been holding back end customers from going solar, it is the high cost of trying something for which there is lack of demonstration available.

Today, there are multiple sites in New Delhi (and elsewhere) where grid-connected solar PV systems have become a reality. National Productivity Council is one such site.

Also, since standardisation has not been seen in the industry yet, an aggregator (like Flipkart, or Solar-City in the USA) might do the magic in enabling massive uptake. Sunkalp Energy has shifted to the aggregator model (through online portal) and Ministry of New and Renewable Energy also seems to be following this approach.

So, when installation of solar becomes more common, end customers will be able to install their own systems. All they would need to do is, select their components and services online and have the solar system set up in no time. EFY

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WHY E-WASTE Cannot Be Taken Lightly



Arnab Bandyopadhyay is M.Tech (IEC) from IIT Delhi. He has 34 years of experience in different fields of electronics, including five years in e-waste management

Electronic waste (e-waste) or waste electrical and electronic equipment (WEEE) is a term used to cover all electrical or electronic equipment and their parts that have been discarded by their users as waste without the intent of re-use. E-waste includes a wide range of products; almost any household or business item with circuitry or electrical components with power or battery supply can form e-waste.

E-waste contains various materials including hazardous, valuable and scarce metals. Common hazardous materials found in e-waste are heavy metals such as lead, mercury and cadmium and chemicals like ozone-depleting CFC or various flame retardants.

A gold mine

In addition, e-waste contains many valuable materials such as copper, iron, aluminium and plastics, and precious metals like gold, silver, palladium and platinum, which can be recycled. In fact, up to 60 elements from the periodic table can be found in complex electronic products, and many of these are recoverable. So from a resource prospective, e-waste is a potential urban mine that could provide a great amount of secondary resources for manufacture, refurbishment and recycling.

Toxic e-waste dumped in a landfill



URBAN MINE: AN ESTIMATE OF MATERIAL VALUE OF E-WASTE IN 2014

Material	Quantity (kilotonnes)	Price (million Euros)
Precious metals:		
Gold (Ag)	0.3 (300 tonnes)	10,400
Palladium (Pd)	0.1 (100 tonnes)	1800
Silver (Ag)	1	580
Metals:		
Copper (Cu)	1900	10,600
Iron, Steel (Fe)	16,500	9000
Aluminium (Al)	220	3200
Plastics:		
PP, ABS, PC, PS and others	8600	12,300
<i>Estimated total price: € 48 billion</i>		

For instance, according to United Nations University (UNU), a worldwide leading institute in e-waste research, gold content in the estimated e-waste generated in 2014 is roughly 300 tonnes, which is approximately 11 per cent of the global gold production from mines in 2013 (2770 tonnes, according to USGS 2014).

According to UNU-IAS, it is estimated that the total amount of e-waste generated globally in 2014 was 41.8 million metric tonnes (MT); India's share being 1.7MT. The amount of e-waste has been forecast to increase to 50MT by 2018. A report by United Nations Environment Program (UNEP) mentions that the amount of e-waste being produced from goods like mobile phones, laptops and computers could go up by 500 per cent over the next decade in some countries including India.

The intrinsic material value of global e-waste generation in 2014 alone was estimated at € 48 billion. Material value is dominated by metals like gold, copper, iron, silver and palladium and plastic contents. Refer table above for a detailed estimate.

The danger

Harvesting e-waste can be dangerous if it is not recycled using state-of-the-art technol-

ogy. It is not just waste, it is a cocktail of some very toxic substances such as mercury, lead, cadmium, arsenic, beryllium and brominated flame retardants. Toxic materials in electronics can cause cancer, reproductive disorders, endocrine disruptions and many other health-related problems if this waste stream is not properly managed.

Uncontrolled discarding or inappropriate waste management/recycling generates significant hazardous emissions, with a severe impact on health and environment. This is the biggest challenge, in particular, in developing and transition countries, where backyard recycling with open-sky incineration is done to recover copper from cables, cyanide leaching to release gold, acid cooking of circuit boards and the like.

The poisonous residues being dumped in drains and rivers is a common practice. Most environmental damage and health impacts related to e-waste arise from improper

Health hazards caused due to the presence of toxic materials found in e-waste

E-waste contains some very toxic substances whose effects on humans are devastating as detailed below:

- Lead (Pb) is toxic to kidneys and its accumulation in the body eventually affects blood, nervous and reproductive systems. Children's mental development can be impaired by even low-level exposure to lead.
- Mercury (Hg) is known to harm developing fetuses and is passed through mother's milk to newborns. It can cause brain and kidney damage in adults, too.
- Cadmium is a carcinogen and long-term exposure to it can lead to kidney and bone damage.
- Beryllium causes acute or chronic beryllium disease, a deadly ailment affecting the lungs.
- Brominated flame retardants have been linked to fetal damage and thyroid problems.
- Incineration of PVC produces dioxins, some of the most hazardous carcinogens.
- Hexavalent chromium damages kidney, liver and DNA. Asthmatic bronchitis has been also linked to this substance.

collection and treatment approaches.

Refer box above for the various health hazards that are caused due to different toxic materials in e-waste.

Dangerous effects of improper e-waste disposal is not limited to humans; it hurts the planet and all its inhabitants including animals, birds, sea mammals and aquamarine life. Virtually every living organism is

impacted by the dangerous chemical pollutants that are released into the atmosphere and underground water when e-waste is improperly disposed.

Polluted soil and air contaminates vegetables, crops, flowers, grasses, herbs, plants, saplings, shrubs and trees. Everyone and everything exposed to toxic pollutants in e-waste is at risk. **EFY**

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HOW ELECTRONIC NOSE Is Better Than Ours



Akul Sabharwal is an electronics and communication engineer. He is currently working as R&D head at Sammi Electronics India Pvt Ltd

An electronic nose, or e-nose, is a device that identifies specific components of an odour and analyses its chemical makeup to identify it. It is engineered to mimic the mammalian olfactory system but is better in some respects.

How it works

Air sample is pulled by a vacuum pump and led through a tube into a small chamber consisting of an electronic sensor array. A transient response is produced as the volatile organic compounds in the sample interact with the surface of the sensor's active material. A steady-state response is reached within a few minutes, which is then sent to a signal-processing unit.

A washing gas, like an alcohol vapour, is applied to the array for approximately one minute to remove the

odourant mixture from the surface and bulk of the sensor's active material.

At last, reference gas is applied to the array to prepare it for a new measurement cycle. The pattern of responses across all sensors in the array is used to identify the odour.

An e-nose includes three major parts:

1. Sample delivery system
2. Detection system
3. Computing system

Sample delivery system. This enables the generation of headspace (volatile compounds) for a sample. The system then injects it into the detection system of the e-nose.

Detection system. A sensor set is the reactive part of the system. Adsorption of volatile compounds on the surface of the sensor causes a physical change in the sensor, where it experiences a change in electrical properties. A specific response is recorded by the electronic interface, transforming the signal into a digital value. Recorded data is then computed based on statistical models.

Computing system. This system works to combine the responses of all sensors.

Sensors

A sensor array is the key element of an e-nose. In most e-noses, sensors are sensitive to volatile molecules but in different ways. However, in bio-e-noses, receptor proteins that respond to specific odour molecules are used.

The most commonly-used sensors are:

Conductivity sensors. These can be classified as follows:

Metal oxide sensors (MOSeS).

Adsorption of gas molecules provokes changes in conductivity. This conductivity change is the measure of total volatile organic compounds adsorbed.



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- Temperature rating -40 to +85°C and -40 to +105°C

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- Power rating 150 to 1000 K Var
- Current rating 200 to 1250 Arms
- Conduction Cooled and Water Cooled

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CUSTOM DESIGNED CAPACITORS AVAILABLE ON REQUEST.

Conducting polymers. Conducting polymer gas sensors operate based on changes in the electrical resistance caused by adsorption of gases onto the sensor surface.

Piezoelectric sensors. Adsorption of gas molecules onto the surface of the polymer leads to changes in the mass on the sensor surface. This, in turn, produces a change in the resonant frequency of the crystal. This change in frequency is proportional to the concentration of the test material.

Surface acoustic wave (SAW). These are a class of micro-electro-mechanical systems (MEMSes) that rely on modulation of surface acoustic waves to sense a physical phenomenon.

Optical sensors. These are more complex than typical sensor array systems having transduction mechanisms based on changes in electrical resistance. Optical sensors work by means of light-modulation measurements.

Cyranose 320

Cyranose 320 is a handheld e-nose developed by Cyrano Sciences of Pasadena, California, USA, in 2000. It is based on sensor research performed by Prof. Nathan Lewis of California Institute of Technology, USA. Applications researched using Cyranose 320 include detection of chronic obstructive pulmonary diseases and other medical conditions as well as industrial applications generally related to quality control or contamination detection.

Cyranose 320 utilises the NoseChip array of nanocomposite sensors and advanced pattern-recognition algorithms to detect and recognise the chemical vapour of interest. In combination, these technologies enable rapid detection and identification of substances based on their respective chemical profiles.

For each method, it provides simple, clear, actionable results

such as Accept or Reject, Mixture Identified or Contaminated. Each measurement is assessed based on a statistical quality rating of one to five stars.

More about the e-nose

It is a cheap and non-destructive instrument that can be operated by non-specialists. As the process is automatic, the cost of each measurement is low.

Measurement cycle of the e-nose should be faster so as to increase throughput. Sensitivity and selectivity of the e-nose is still far from a mammalian nose.

COMPARISON OF E-NOSE WITH BIOLOGICAL NOSE

Biological nose	e-nose
Inhaling	Pump
Mucus	Filter
Olfactory epithelium	Sensors
Binding with proteins	Interaction
Enzymatic proteins	Reaction
Cell membrane depolarised	Signal
Nerve impulses	Circuitry and neutral network

The e-nose has applications in the following areas:

Medical diagnosis and health monitoring. This can be further categorised into the following:

Respiratory diseases diagnosis. Human breath contains thousands of volatile organic compounds in gas phase. An e-nose can diagnose respiratory infections such as pneumonia. It does so by comparing smell prints from the breath of a sick patient with those of patients with standardised readings.

Urinary tract infections. An e-nose can be used as a potential diagnostic tool for patients affected with kidney diseases, by distinguishing traces of blood in urine samples.

Cancer detection. An e-nose is capable of distinguishing the breath of

a healthy person from a person with cancer. The device is promising because it can detect cancer before tumours become visible in X-rays.

Environmental monitoring.

This includes analysis of fuel mixtures, detection of oil leaks, testing ground water for odours, identification of household odours, identification of toxic wastes, air-quality monitoring and monitoring factory emissions, among others.

Application in food industry.

An e-nose has the following applications in this area:

Analysis of fruit ripening. Fruit ripening is associated with accumulation of aromatic volatile substances during ripening. An e-nose can help remove rotten fruits at the appropriate time. This can help in avoiding storage losses due to rots and fruit diseases.

JPL e-nose. This is a full-time, continuously-operating event monitor used in International Space Station. It is designed to detect air contamination from spills and leaks in the crew habitat. It can also be used to monitor cleanup processes after a leak or spill.

An e-nose can be used for detection of explosives, in space applications, research and development industries, quality-control laboratories and process and production departments.

It can also be used in the field of crime prevention and security. It has the ability to detect drug odours despite other airborne odours capable of confusing police dogs. It may also be used for bomb-detection at airports. Through careful placement of several e-noses and effective computer systems, authorities can triangulate the location of bombs to within a few metres of their location in less than a few seconds. It can also be used in the detection of harmful bacteria and detection of drug odours. **EFY**



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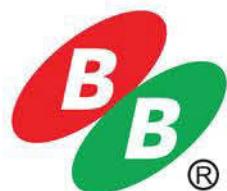
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Start a Change



IS THE CONNECTED WORLD A Bane or A Boon?



Saif Ahmad
is founding CEO
at Hallwaze Inc.

Intelligent devices and their ever-growing networks encompassing our daily lives have emerged as the utopian idea for our tech-savvy generation. As predicted by research firm IDC, by 2020 there will be more than 28 billion objects with data-exchange capabilities.

The Internet of Things (IoT) is already on its way to materialise as the next big tech trend. Its enormous growth rate can be estimated from a report by Gartner Inc., which indicates that the use of IoT devices in 2015 was up by 30 per cent from 2014 with over 4.9 billion connected devices. Further, according to IDC, the IoT market is expected to hit US\$ 7.1 trillion by 2020.

The security threat

The IoT is central to smarthomes, smart shopping, smart transportation and smart healthcare. Embedded software, hardware devices and communication services are getting interconnected, forming a complicated network of information, most of which is stored in the Internet. With increased proliferation of Internet networks, security has emerged as the most critical factor in its existent infrastructure, as devices are vulnerable to sophisticated hacking activities.

In fact, the perilous security condition has facilitated the protrusion of a massive IoT security market side by side. According to a forecast by Technavio, the global IoT security market will grow at a compound annual rate of 54.93 per cent over the period 2014 to 2019. Hence, the IoT is offering the business world increasing security risks besides opportunities.

With billions of connected devices, security attacks and data thefts will emerge as a daunting challenge for the industry. Our sensitive personal information will become vulnerable in cloud domain.

The IoT has decentralised entry points for malware, exposing a smartnetwork to potential security threats. As loads of devices are interconnected in a smartsystem, a minute security glitch in a device may create a loophole for the entire network, exposing every bit of information within it.

A report by Cisco on cyber security threads has identified a number of aspects related to IoT security. It reveals that IoT devices could be used as infection vectors to spread malware across organisations.

Infection could lead to denial-of-service attacks, causing serious damage to life and property. As IoT devices are increasingly used in extremely-sensitive

industries such as health, these now form critical parts of life-saving mechanisms and emergency systems. Any failure in such devices in a critical juncture of life and death could lead to the loss of life of a patient.

With remote sensors and monitoring materialising as the core of the IoT, data control and ownership in business organisations will become more sensitive. This will drive compliance issues to become pertinent across every industry vertical. Unique compliance frameworks developed and customised according to the unique requirements of businesses will emerge.

For adequate data protection, development of new security frameworks will gain an evolutionary trend, as these will have to evolve consecutively to deal with new and evolving security threats. In fact, the evolutionary nature of the IoT is set to complicate the industry. With a huge number of players in the IoT, enterprises will have to follow multiple standards and protocols along with a large number of compliances.

The benefits

Despite its complexities, the IoT has been successful in creating hype primarily because of the advantages it offers. Cost saving, improved process operations, higher productivity, obtaining real-time information, forming massive networks to overcome geographical boundaries and innovations in businesses are the primary advantages offered by this new technology.

The IoT brings down the operational cost of a business substantially, as it sidelines the need for expensive infrastructure by encouraging an extended utilisation of the cloud. Businesses are becoming more automated, resulting in efficient and agile process structures. The IoT eradicates possible human

errors as human intervention becomes less relevant in business.

By improving these aspects, businesses can ensure higher productivity and reap better profits out of their operations. The IoT has facilitated business expansion across large geographical locations and offers more pervasive services or products to customers. As it improves supply chain management and facilitates real-time tracking, enterprises gain radical advantages to manage their businesses through the IoT.

The way forward

To harness the potentials of the IoT optimally, threads and complexities in this technology must be addressed intuitively. Threat-centric and automated approaches to security must be leveraged to gain maximum advantage out of smart IoT networks.

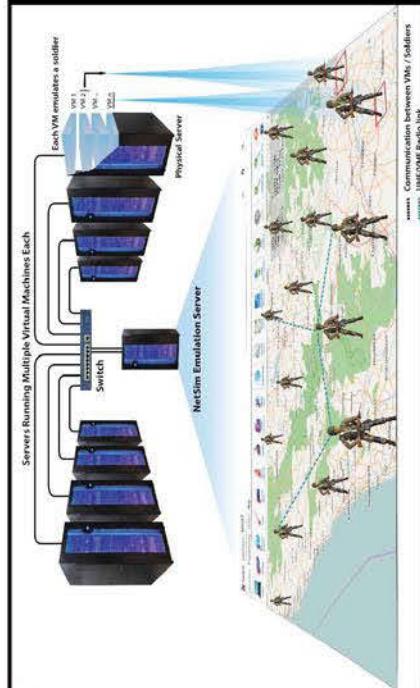
Operational technology (OT) of used devices must be integrated to IT platforms within businesses after intensive scrutiny and research. As OT layers in these devices are the most vulnerable entry points for malicious agents, more intensive technology must be developed aimed at increasing its integrity with Internet security protocols.

Increased operational efficiency offered by the IoT could offer a win-win situation to businesses as well as consumers, while improving their quality of life. Effectual intelligence can be generated using combined information from smart devices.

However, the emergent network structure is also advocating sheer vulnerabilities to the whole infrastructure. As sensitive information critical to businesses as well as personal lives of users will be exposed in the network or in the cloud, without a strong and properly maintained security infrastructure, fear of data leakage to malicious entities will always exist. **EFY**

Where can you use it?

- Military radio networks
- Satellite link analysis
- Metro rail networks
- R&D in protocol design
- SCADA system comm. networks



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Part 1 of 2

WEARABLE DEVICES: Essential Inputs for Design Engineers



S.A. Srinivasa
Moorthy is CEO,
Andhra Pradesh
Electronics and
IT Agency

With the increase in usage of smartphones, opportunities for applications using mobile phones have also increased. This coupled with connectivity options such as Bluetooth and Near Field Communication and add-on devices to the phones have become very popular as these offer unique solutions. These devices can work as a simple radio-frequency identification reader to a sophisticated medical device. While the devices use conventional electronic circuitry, product packaging and usage are completely different. Right from the material used to the product shape and size have to be carefully selected to ensure safety of the wearer.

Most of these devices are small and irregular in shape. Engineering these needs special skills and manufacturing these needs special equipment and processes. Designers need to follow special design practices for wearable designs to be realised as successful products. There are very few books available for designers to design wearable products. This article tries to help design engineers to get an overall view of the design and manufacturing process of wearable devices.

Since wearable devices are normally made in large numbers and are miniature in size, use of contract manufacturing is recommended. The focus is on the design process and what designers should look for when they design wearable devices to be made by contract manufacturers. While this list is not exhaustive, it gives a fairly good view of the complexities involved in the wearable device design.

Defining wearables

Wearable devices are no different from classic embedded systems that we are all familiar with. Block diagram

of a wearable device is shown in Fig. 1. It has following four blocks:

1. Power supply and management circuit
2. Core processor
3. Analogue interface [analogue front-end (AFE) covering sensor inputs and actuator outputs]
4. Communication interface (wireless and wireline)

What differentiates wearable devices from conventional embedded systems is the power management circuitry. Most wearable devices are battery-operated (either primary or chargeable) and need special circuitry to control power consumption.

Power management circuitry alone cannot optimise power consumption. It is the combination of the power management circuit and the device software in the system that results in optimal power consumption.

To a large extent we can say that, the processing power needed by wearable devices is very low, as most devices just collect data from sensors, store and send it to the central application for processing. The central application could be a smartphone or, in the case of the Internet of Things, cloud-mounted software. This is essentially done to ensure that the battery lasts long and data is processed in a central location by a more powerful processor.

Most integrated circuits (ICs) use very high-speed complementary metal-oxide semiconductor (CMOS) technology. In CMOS technology, power consumption of an IC goes up as the operating frequency of the processor goes up. So most wearable devices use low-speed controllers, and sections of the microcontrollers (MCUs) can be shut down or operated at a low speed when not in use.

We also need to remember that, some wearable devices that are used in medical applications (like insulin pumps or carry-on ECG probes) need to be designed in a controlled way, as these are approved by



regulatory bodies like FDA/CE. Most device vendors do not recommend their devices for medical usage to avoid getting sued in case of any failure.

Classifying wearables

Wearable devices can be classified into the following four major categories:

Sports and fitness. Sports and fitness devices primarily track movement (using accelerometers) and, in some cases, heartbeat. While worn, these normally track motion and not body parameters.

Personal health monitoring.

These devices track heartbeat, body heat, blood oxygen (SpO_2) and ECG (single or 3-lead) signals and, in some cases, have special sensors. These devices normally track body parameters and therefore need to be highly reliable, as readings may be used for lifestyle adjustments.

Tracking and monitoring. These devices have GSM/GPS functions and are primarily used for tracking the wearer, mostly in geo-fencing applications.

Medical applications. These are high-end devices that are typically worn by patients who need controlled dosages, periodically. These devices are regulated and controlled by regulatory agencies. For this, manufacturers need to follow strict processes during development and manufacture. Importance of the rigid process is to ensure that these devices are traceable and, in case of problem, the root cause can be analysed up to the component level.

Most wearables can handle very low analogue signals and therefore have substantial analogue circuitry to process these. These are also real-time devices and synchronise their operations to the time or date for data collection/measurement. Their functionality can be represented by the flowchart shown in Fig. 2.

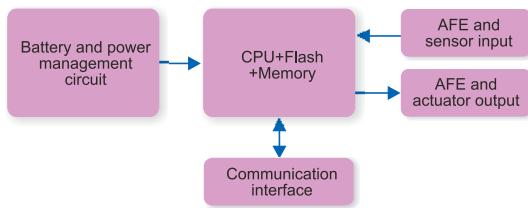


Fig. 1: Parts of a wearable device

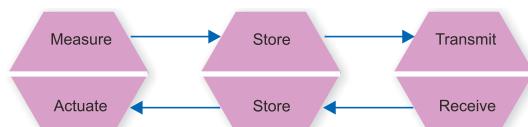


Fig. 2: Flowchart showing the functionality of wearable devices

Essential design elements

Let us now take a look at some generic design elements that impact a product. These impact both design and manufacture of wearable devices. A product's performance, its manufacturing and usage characteristics all depend on how well the design is done.

First, let us understand the life cycle of a wearable product so that it is easy to understand the issues involved and how these can be addressed. Fig. 3 shows the typical life cycle of a wearable device. A device essentially goes through four major phases as shown in the figure. While the design, manufacture and use phases are sequential, support phase is basically concurrent, addressing the manufacture and use phases. The reason for taking a life-cycle based approach is to show how designs need to address issues that crop up in subsequent stages.

Design phase. During this phase there are a few things that designers need to know for a successful wearable design. These are:

1. Almost all wearable devices have sensors that use a very low signal level. This necessitates that the designers be very strong in analogue and mixed signal (combination of analogue and digital signals) circuit designs.

2. Since most wearables are battery-operated, designers need to be conversant in low-voltage analogue designs as well as power-conversion techniques (like boost regulators).

3. Intricate knowledge of MCUs used and how their power management is implemented is essential. To reiterate, an increase in processor speed increases power consumption, so managing the processor speed dynamically is crucial for optimal consumption of power.

4. In-depth understanding of the battery types used, their charging characteristics, their behaviour against temperature variation, safety limits and different charging circuits is a must. It is important for designers to know circuit simulation tools like Simulation Program with Integrated Circuit Emphasis (SPICE), as with these tools, they can evaluate the circuitry before committing to the design.

One important thing that a designer needs to keep in mind is the accuracy of the models used in simulation. A wrong or an inadequate model will produce wrong results.

5. With most wearable devices being small in size, the impact of components on neighbouring components in the PCB is very critical. A good example would be the vibrators used in a wearable device that produce strong physical vibrations and also have a magnetic field. Any device nearby that is sensitive to stray magnetic fields can produce wrong results when the vibrator is working.

Designers tend to miss issues like these and struggle to solve them when the actual product runs into trouble. So it is important they understand the components used along with their characteristics.

6. With miniature designs come miniature components and their own specific challenges. Compo-

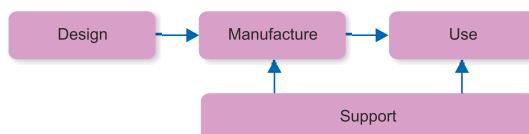


Fig. 3: Typical life cycle of a wearable device

nents like capacitors and coils have precise dimensions and need to be placed correctly.

Another key component that most designers underestimate is miniature connector. While there is no dearth of miniature connectors, these come with a big restriction on the number of insertions. This is due to connector geometry. In most cases, the number of insertions is in the range of 30 to 40 cycles.

If the assembly process takes more insertion cycles, it can reduce the active life of the connector. (When I was designing a movie camera, we had three to four connectors that were getting cycled 20 to 30 times during the assembly process. The connectors started failing when the final system assembly was done, leading to a complete revamp of the assembly and test process.)

7. Designers should completely understand use cases. If their devices need special chargers or special supplies, they need to plan that as part of the product. With proliferation of USB based charging, most devices tend to supply the product without chargers. However, all chargers are not the same. So if your device is expecting a special treatment, then that has to be provided. If not, the device should be tested for chargers available in the market to ensure there are no surprises.

8. Most wearable devices are waterproof (in technical jargon these are called IP67 compliant). This essentially means that the device enclosure design has to be leak-proof up to a depth of at least 50 metres when submerged in water. This needs skill and experience. The manufacturing process should be able to

reproduce protection for each piece that is manufactured. It is advisable that a relevant subject matter expert is hired as a consultant to review the design and ensure the packaging is leak-proof.

9. Another challenge that designers face is: How will the software team develop the software if the wearable device design is going to take time to get the prototypes ready?

I suggest that, make the wearable circuit in a large PCB format with bigger components that are used in the design and have test points, so that software developers get the actual target hardware to develop software and do not have to wait for the final miniature version. I have found this approach very useful as it reduces development time considerably despite an additional investment in the hardware.

10. With size being the premier constraint, sometimes volume and shape of the product forces designers to use a complex architecture for the design. Most wearable devices today use a mix of PCBs and flexible circuits to realise the final design. This approach needs a good understanding of these two materials and also how to use these.

The contract manufacturer (electronic manufacturing service or EMS) must be identified as soon as the design is started. Challenge with flexible PCBs is that, every time you revise these, there is substantial up-front expense (non-recurring expense) involved, and multiple revisions can drive up development costs.

Manufacturing phase. The second important stage is the manufacturing phase. A product will be successful only when the design and manufacturing teams work together. When wearable devices are designed, it is important that, at the start of the project, the EMS partner

is decided. Let us see some challenges that wearable products face in this phase.

A conventional SMT process invariably is inadequate for wearable devices due to the following reasons:

1. Miniature size of the product with very less volume and space available inside the enclosure leads to a complex assembly process.

2. In most cases the battery consumes the major volume, leaving little space for the electronics. This leads to very tight packaging and, unless adequate precautions are taken, yields can be a challenge.

3. The smaller PCBs and the use of flex cables sometimes calls for development of special jigs and processes like ultrasonic soldering of flex cables.

4. With reduction in size, many times a product has to be manufactured using packing techniques like chip on board (CoB); normal IC packages and dies that are packaged in standard packages with leads increase the volume manyfold as compared to using the die directly. In a CoB process, the die is directly soldered to the PCB and requires special equipment. Unfortunately, this technique is the only way by which product volume can be reduced substantially.

With component size being the biggest deciding factor, it is important that the designer works with the supply chain of EMS vendors to select the right package size so that, apart from the realisable design, availability of components is also guaranteed. EMS vendors usually have a very good supply chain. They ensure there are no shortages, so that increased lead time does not impact the production schedule.

In the second part of this article, we will discuss the testing phase, wearable system software and development phase.

To be concluded next month...

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MAX 8550 :
3-IN-1 SMD
REWORK
STATION



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Role of IT in WEATHER FORECASTING



Deepak Halan
is associate
professor at School
of Management
Sciences, Apeejay
Stya University

Fig. 1: Snapshot of Hurricane Weather Research and Forecasting (HWRF), one of the most sophisticated numerical computer models now being run on NOAA's supercomputers (Source: www.noaanews.noaa.gov)

The weather has a profound impact on a person's mood. Research shows that higher temperatures raise a person's mood, while weather encompassing wind or little sun tends to make a person feel depressed. As temperature rises, intergroup conflicts and interpersonal violence are known to increase, even though only marginally. These findings hold well not only for higher temperatures but also for rainfall.

Global warming is being caused by an increase in the average temperature of Earth's surface. For life to exist on Earth, an average temperature of 15°C is maintained by the natural greenhouse effect. Without this effect, the average temperature would be -18°C. This average temperature rose by about 0.9°C during the last century. Scientific studies indicate that average temperature will rise further by 1.1°C to 4.5°C during the 21st century, depending upon an increase in greenhouse gases emissions. As a result, net cereal production in South Asian countries is projected to decline by four per cent to ten percent by the end of this century.

Melting glaciers could seriously affect five billion people in Himalaya-Hindu-Kush region. There could be more intense rainfall resulting in floods and more dry days in a year, causing drought. Deaths due to heat waves, water-borne and vector-borne diseases like dengue are also expected to increase. The tsunami that occurred in 2004 took millions of lives and caused destruction worth billions of dollars.

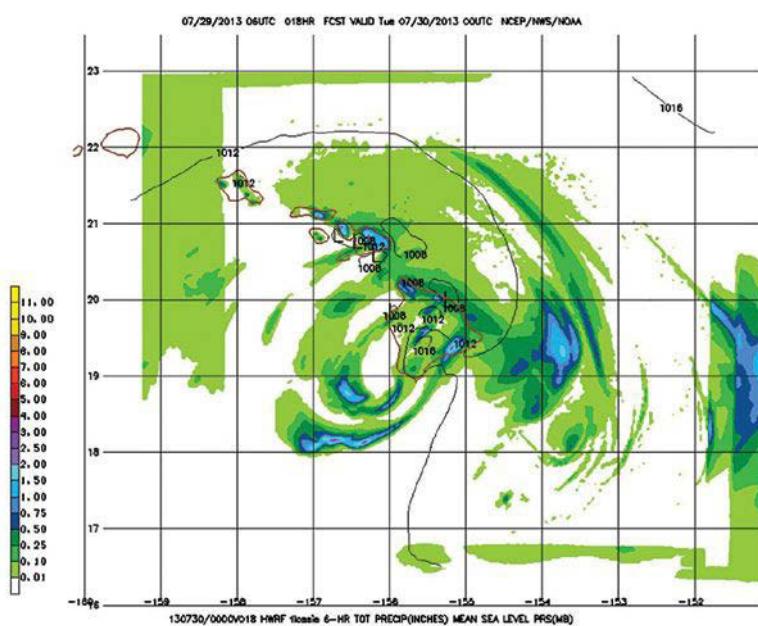
This is merely a glimpse into the repercussions of climatic changes and it makes us realise how important it is to be able to predict the weather. Powerful computers are playing a key role in making accurate weather and meteorological forecasts. However, Earth's atmosphere follows complex non-linear rules of fluid dynamics. Despite meteorologists having comprehensive knowledge of the current weather, it is actually challenging to calculate a forecast before the next change in the weather actually happens.

Therefore there is need for more sophisticated information technology (IT) in the form of supercomputers and advanced software to handle complex weather equations. For example, National Oceanic and Atmospheric Association (NOAA) uses a supercomputer called Theia, which can make as many as quadrillion calculations per second and has 28,000 computer cores.

Computer cores enable very-high-speed calculations. Each computer chip has multiple cores, so the chip can do multiple calculations simultaneously. In a supercomputer, the chips are interconnected. Hence a task like predicting the weather of New Delhi a week from now is split among thousands of chips and tens of thousands of computer cores.

Historical role played by IT

Back in 1916, World War I ambulance driver, Lewis Fry Richardson, imagined a worldwide system of weather prediction in which Earth was divided into 64,000 cells. Each cell was to report its weather





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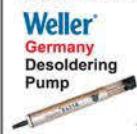


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INFORMATION TECHNOLOGY

conditions into a single central control area, wherein a computer would calculate the weather forecast for that cell. On completion of all calculations, cell-wise data would be posted and the process would restart.

In this way, 64,000 people processing a constantly-evolving set



Fig. 2: Staff programming ENIAC at University of Pennsylvania, USA, circa 1946 (Source: www.fortune.com)

of numbers would be able to arrive at non-linear equations essential to forecast the planet's weather.

This method gave birth to two technologies that are currently in use, namely, 64,000-microprocessor supercomputers used by the government and large enterprises and computer-controlled mobile communication grids similar to those used in mobile phone networks.

It was John Mauchly, a computer scientist, who pioneered the usage of Electronic Numerical Integrator and Computer, or ENIAC, the first electronic general-purpose computer, as a tool to facilitate long-term weather prediction.

How weather maps are created

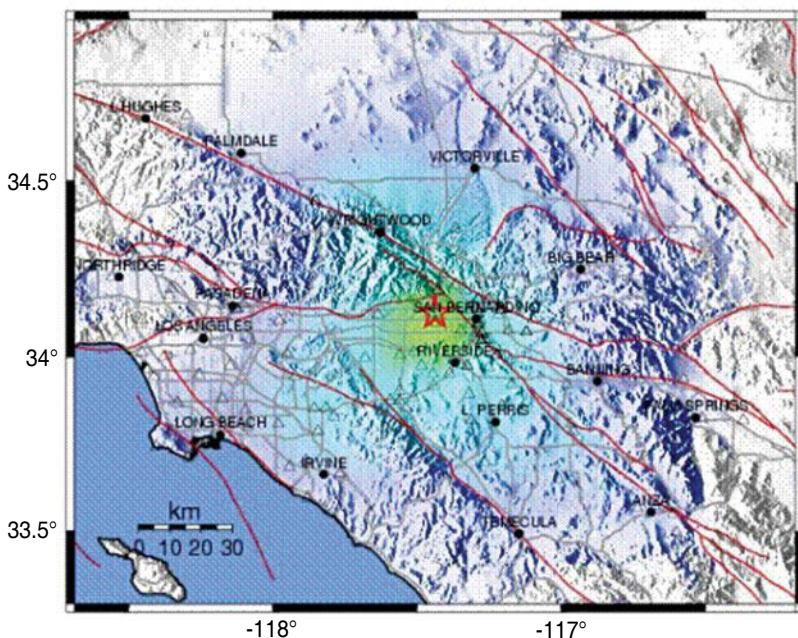
Using various gadgets, instruments and tools, meteorologists state the present conditions of the atmosphere. These are then plotted on weather maps by computers to showcase the complete condition of the atmosphere around the globe. Quality control is achieved by computers, which rectify possible errors in the data related to weather. This leads to higher accuracy and reliability in reports.

To begin with, advanced computing systems are fed data to draw independent weather maps for the seven levels of the atmosphere used in forecasting. Once data has been analysed in the form of maps, IT is used to provide inputs by way of drawn maps, to determine the weather in each of the seven-layer grid. Thereafter, processing is carried out, that is, the various number crunching and tracking of the dynamic weather conditions. Final output encompasses the different types of weather maps based on a number of data points that have been collected and analysed.

Numerical forecasting is a term that refers to the usage of mathematical equations to forecast the weather and is based on a large number of very-high-speed calculations that only supercomputers are capable of performing. It is inferred that these equations are more multifaceted than those used in aerospace engineering.

On an average, National Weather Service (NWS) receives as high as 100 million weather observations every day. Data on a number of different variables such as wind speed, air temperature, barometric pressure and humidity is collected from many sources including land based observation points and ships moving around in the ocean. This information is then fed into a supercomputer, which usually has two sets of several fast processors capable of parallel processing. The

CISN Rapid Instrumental Intensity Map Epicenter: 1.3 mi N of Fontana, CA
Thu Jan 6, 2005 06:35:27 AM PST M4.4 N34.12 W117.44 Depth: 4.2km ID: 14116972



Processed: Wed Jan 12, 2005 06:29:32 PM PST.—NOT REVIEWED BY HUMAN

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/ Heavy	Heavy	Very heavy
PEAK ACC (%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Fig. 3: A computer-generated shake map (Source: www.trinet.org)

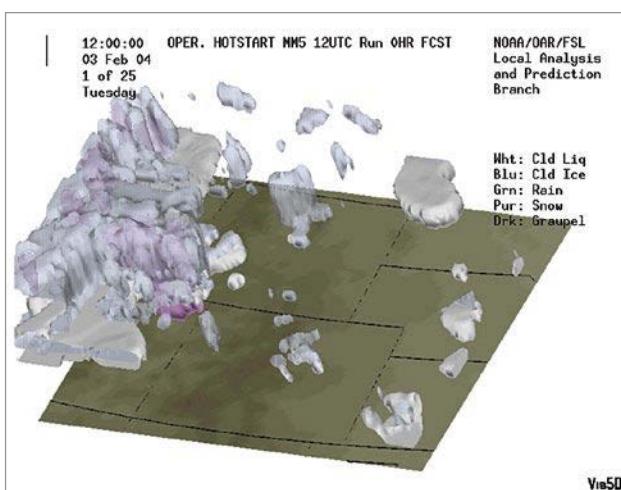


Fig. 4: A 24-hour cloud forecast loop from LAPS using MM5 as the forecast model (Source: www.laps.fsl.noaa.gov)

first set performs weather-related calculations used in forecasting, while the other set is continuously looking for ways to improve the supercomputer's software, thereby making weather predictions more accurate and meticulous.

TriNet is a five-year-old collaborative project focused on producing a better, more effective, real-time earthquake-information system for southern California, USA. A high-tech system developed by TriNet has the capability to provide instantaneous damage reports for emergency relief in certain areas of greater Los Angeles area (USA). At its core, Tri-Net system consists of a broad array of earthquake sensors linked to computers. When an earthquake occurs, seismographs automatically record and transmit data to a computer at California Institute of Technology. The computer synthesises a shake map from the entire ground-motion data, which immediately informs emergency managers about the worst-shaken location. Emergency relief can then first be provided to the most severely affected areas. The shake map also indicates where the ground did not shake, thus enabling emergency crews to establish relief shelters and hospitals in areas near destruction points.

IBM's Deep Thunder

Deep Thunder is a research project by IBM that aspires to develop short-term local weather forecasting using high-performance computing. The project belongs to the same family as Deep Blue system that beat world chess champion Garry Kasparov in May 1997. It uses information gathered by NWS but focuses on much smaller geographic areas than NWS and that too in greater detail.

Deep Thunder takes data and puts it through a numerical model, which predicts the weather. It works

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*Fig. 5: India's Param Yuva II supercomputer
(Source: www.crazyengineers.com)*

on software called Local Analysis and Prediction System (LAPS) that can process up to a million separate pieces of information each day. This entire system consists of several hardware and software components in an integrated environment, namely, a high-performance computer system (IBM RS/6000 SP), a forecasting model (such as RAMS, MM5 or WRF), a data-assimilation package (like LAPS), visualisation software (Data Explorer) and associated peripherals.

LAPS software developed by Forecast Systems Laboratory (FSL) of NOAA is a data assimilation and analysis package, which takes in local, national as well as global data from various sources such as satellite, radar and aircraft. LAPS functions as a pre-processing assimilation step, therefore resultant grid data from LAPS is used as initial conditions for the model. It executes serially on a single processor and does more than just model initialisation.

LAPS provides a high-resolution view of the atmosphere in its current state and derived products (like icing, visibility and clouds) and variables (like heat index and buoyancy), which prove useful for a wide array of real-time applications. It produces surface analysis and three-dimensional (3D) wind, temperature, cloud and moisture analyses, and also incorporates facilities to assess data quality.

Deep Thunder's power can be

gauged by the fact that it can produce highly-accurate weather predictions within the narrow ranges of a single city. The system was used during 1996 Atlanta Olympics to successfully schedule weather-affected events like sailing and the closing ceremony. It is also proposed to be used for 2016 Summer Olympics in Rio de Janeiro, Brazil.

How India forecasts its weather

Param was the first mission taken up by C-DAC for the development of a high-performance parallel computer and was completed in July 1991. Later, Param Yuva II was launched in 2013, which was capable of performing at a peak of 524 teraflop per second and was used for research in weather forecasting and seismic data analysis.

In 2015, India achieved another milestone with the release of supercomputer Bhaskara. This supercomputer assists meteorologists in research and predicts the weather, which includes effective forecast of tropical cyclones, heavy rainfall and cloud-burst events. Bhaskara enables Earth System Science Organisation-National Centre for Medium Range Weather Forecasting (ESSO-NCMRWF) to make very high-resolution 10-day deterministic weather forecasts and probabilistic forecasts from a 44-member ensemble prediction system. This is within the generally accepted time window of about five hours from the standard observation time with a horizontal resolution of 1.5km and probabilistic forecasts using an ensemble prediction system.

Bhaskara is powered with IBM iDataPlex supercomputer that has a peak computing power of 350 teraflops with 67 terabytes of aggregate memory. This takes the total ESSO high-performance computing facility to a peak computing power of 1.14 petaflops.

Conclusion

The tsunami disaster that devastated the world a few years ago could have been less lethal had better tsunami-warning systems been in place. Scientists studying tsunamis have their computers working as fast as possible, but they still cannot quite figure out how the killer waves behave or predict when and where these will strike next.

Computer modelling of tsunamis is very complex as it involves solving the full 3D motion of water. However, by using computer models of wave motions based on the known terrain of the undersea floor, scientists have managed to generate tentative maps that display the havoc a big tsunami could cause.

The IT industry needs to take up tsunamis forecasting based on effective computer modelling as an opportunity. In 2010, the storm and mudslides in Rio de Janeiro killed more than 200 people and rendered thousands homeless. This calamity made the city embrace IBM Deep Thunder weather-forecasting system in order to be better geared up for such future disasters.

Apart from saving lives, weather forecasting has a number of applications and uses. For example, public utility companies that provide, say, electricity can benefit vastly from forecasts. This can help identify areas where incoming storms are likely to damage poles, transformers and power lines. Hence, the required number of maintenance staff can be quickly transported to areas near disaster sites to carry out repair work and radically decreasing downtime.

In the area of agriculture, sophisticated weather-forecasting supercomputing systems can decide the best times to plant, irrigate and harvest crops, based on dynamic weather conditions of the various farm locations. This is likely to result in better crop prices, less water and manpower wastage for farmers. **EFY**



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To Connect The World



Janani Gopalakrishnan Vikram is a technically-qualified freelance writer, editor and hands-on mom based in Chennai

Lightning-speed connectivity is something many of us take for granted, as also the ability to connect anywhere, anytime using our mobile networks. However, we are only a gifted fraction of the world's population. Describing an image of the Earth's wireless data coverage (2G, 3G, 4G and beyond), shown by Facebook's chief technology officer Mike Schroepfer at their F8 conference, Mark Andersen of *Air & Space/Smithsonian* magazine wrote, "The image looks like that famous 'Earth at night' NASA photo montage, revealing patches of the planet where artificial illumination shines brightly in the dark, leaving vast stretches of Earth's landmass in darkness." Plain truth, because only 40 per cent of the world's population is connected to the Internet!

The Internet is as important to the remaining folks. It could mean better healthcare, livelihood, safety and a lot more. Sadly, it is difficult to connect them. How do you connect indomitably-tall peaks or barren dessert lands, places that have limited power supply and experience harsh weather conditions?

We do not need to be economics *gurus* to guess that no telecom company will

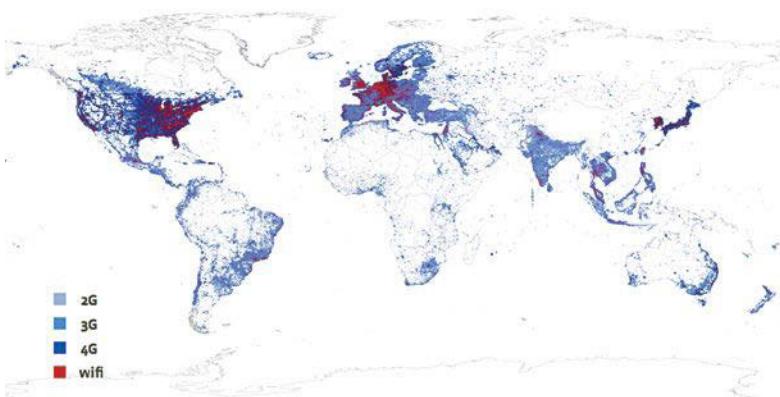


Fig. 1: Earth's wireless coverage heat map (Courtesy: Facebook)

be ready to lay cables or erect a bunch of mobile towers where population is so sparse that their investment will not be justified.

Today, we seem poised to change all this because tech companies across the world, ranging from Google and Facebook to Saankhya Labs, seem upbeat about connecting the rest of the world. Either because it would make business sense to them or as a social responsibility, they are now investigating off-beat connectivity options like low-orbit satellites, solar-powered balloons and drones that act as mobile towers, self-powered Wi-Fi and chips that make use of television white space.

Join us as we explore this wonderful world that promises a better, safer life for the unconnected billions (popularly termed as the other three billion)!

Google is flying balloons...

Let us begin with the story of how sheep farmer Charles Nimmo, from Leeston, which is a small town in New Zealand, got connected to the Internet in 2013, and how many more are slated to be connected in the years to come. The answer is Project Loon, a loony-sounding but sensible project by Google.

Google's idea is to use a network of balloons to provide connectivity to the remote parts of the Earth, without spending exorbitantly on terrestrial infrastructure. The helium-filled balloons are launched into the stratosphere, where these fly around 20km above the Earth's surface. In the stratosphere, wind mainly moves in horizontal layers, and not up and down. This makes it easy to steer the balloons dynamically using software, pushing these into the required layers to form a network of balloons. The balloons stay aloft for a few months, after which these are steered to collection points on the Earth and replaced.

Each balloon carries a box containing



Fig. 2: Google is flying Internet balloons (Courtesy: Google)

The Internet hurries to Harisal

Harisal is a medium-size village in Maharashtra that was recently earmarked for a major digital transformation. Maharashtra government together with Microsoft hopes to connect the village and make it smart, with facilities ranging from telemedicine and cashless markets to banking and education. While all this sounds too good to be true and some educated villagers are quite excited about getting jobs through this digitisation, news reports show that most villagers are not very hopeful.

The region faces severe load-shedding and power voltage is so low that bulbs barely light up a small room. Apparently, villagers are sometimes even reprimanded for running motors to pump water or watching television at home. Government officials, however, claim that this is likely to change as they have plans for more electricity from a nearby grid and also from renewable sources. Speaking to *NDTV* in November, the officials stated that BSNL had finished laying fibre-optic cables, and Indus would erect a mobile tower right outside the *panchayat* office. Although there might be issues along the way, they are confident that everything will be ironed out and villagers are sure to benefit from the connectivity.

This is a typical example of the situation in most Indian villages. Even when technology is on its way to their homes, they still face innumerable other troubles, which make the benefits hard to reap. What we need is a concerted effort by various departments, ranging from electricity to telecommunications, with a lot of help from technology companies and cooperation of the villagers, to make India truly digital. However, at EFY, we are confident that Indians can do it, and hope to see some of the pieces fit in place this year.

circuit boards to control the system, and radio antennae to communicate with other balloons and with Internet antennae on the ground. There are also lithium-ion batteries to store solar power, generated by an array of solar panels, mounted on a light aluminium frame, which flies with the balloon. With all this, the balloons provide Long-Term Evolution (LTE) based connectivity to a ground area of 80km diameter, by sharing the mobile spectrum with

telecommunications companies.

People can connect to the balloon network directly from their phones and other LTE-enabled devices. The signal is then passed across the balloon network and back down to the global Internet on the Earth. This ability to use standard mobile devices to connect is what makes Project Loon appear more attractive than satellite or white space based systems that require special devices.

Loon has been tested suc-

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cessfully in remote parts of New Zealand, California's Central Valley and northeast Brazil, and is soon expected to be tested over Indonesia and Sri Lanka, too.

However, the project is not without problems. Dr Suresh Borkar, telecom consultant and member of faculty at Illinois Institute of Technology, Chicago, remarks, "Google's Project Loon, being based on a comparatively unpredictable and unreliable approach of using balloons in the stratosphere, is likely to stay in the experimental and prototype stage, as evidenced by the fact that Google, its primary innovator, has also invested heavily in satellite based initiatives!"

... While Facebook wants to play with drones

As of now, Facebook's efforts seem to be three-pronged. There is Free Basics, an open platform to provide basic Internet services like news, maternal health, travel, local jobs, sports and communications, for free, to people who cannot afford it. The problem with this is that, it depends on existing mobile networks, and can therefore not go everywhere.

Then, there is Innovation Lab, which helps developers understand network conditions across the world, enabling them to ensure proper functioning and good performance in all geographies.

However, the most interesting part of this effort—as far as this story is concerned—is Connectivity Lab, which aims to provide affordable Internet access to remote, sparsely-populated areas, using technologies like drones, satellites, mesh networks, radios and free space optics (FSOs).

In a white paper titled 'Connecting the World from the Sky,' Facebook authors explain that different technologies work for different population densities. While wireless mesh networks might work in dense, urban environments, medi-

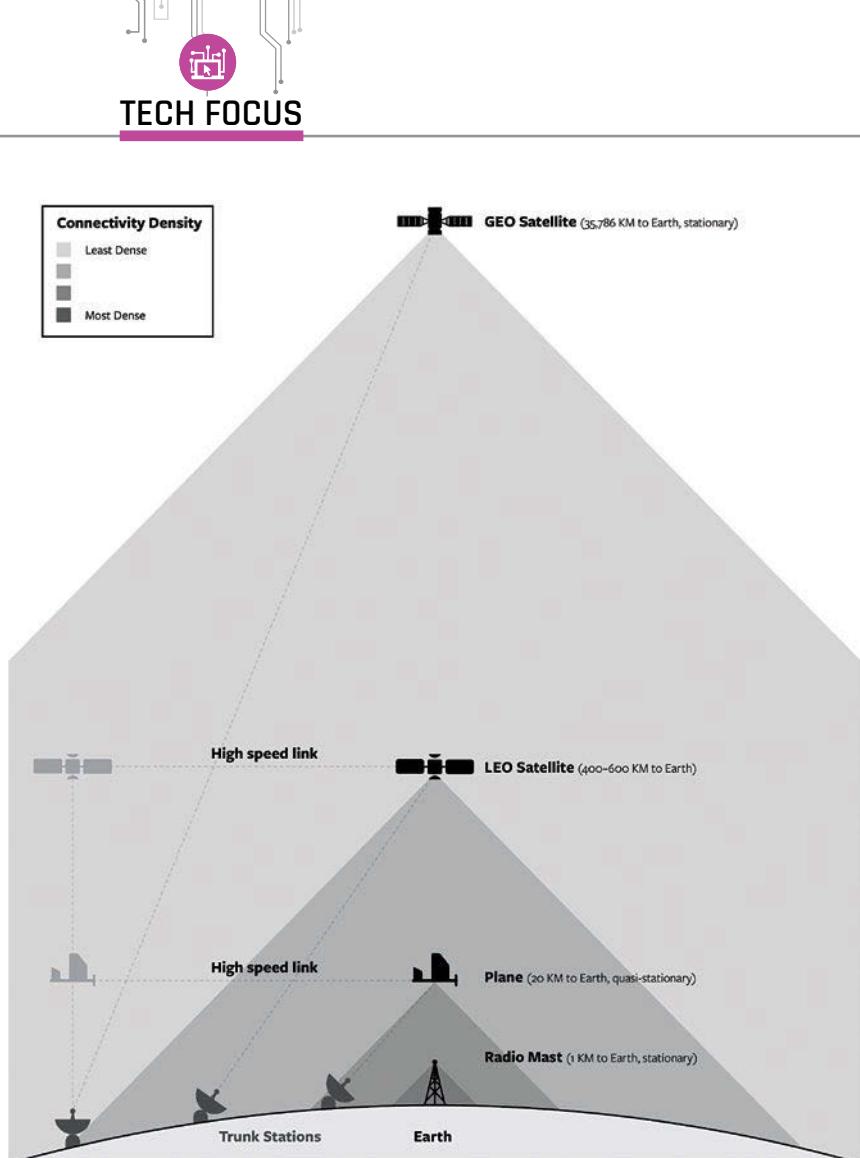


Fig. 3: Facebook plans to use different platforms to serve different population densities
(Courtesy: Facebook)

um-density areas could be connected with unmanned, high-altitude and solar-powered aircraft that have long endurance.

For sparsely-populated and difficult terrains, satellites that beam Internet access to the ground are probably the only solution. Although satellite based solutions are expensive today, the company keeps its hope high as space based methods of connectivity are becoming smaller and cheaper to launch.

Boosting speed. Facebook is exploring the use of FSOs to boost the speed of Internet connectivity. According to the white paper, "FSO is a way of using light to transmit data through space. These are basically invisible laser beams in the infrared

part of the spectrum."

Whatever be the connectivity platform, FSO can help boost the speed. Apparently, the lasers used in FSO systems provide extremely high bandwidths and capacity comparable to terrestrial fibre-optic networks while consuming very little power. However, there are some challenges in accurately orienting its narrow optical beams, which must be overcome before an FSO can be used to the user's benefit.

"An FSO is appropriate for inter-satellite (backbone) connectivity and may be impractical for access to user devices. For communication with user devices, there are issues relating to sending narrow beams, additional hardware and software

in both the user device and the satellite, keeping the beam aligned when the user moves, additional optical circuitry, optics/electronics interfaces and so on. These are not just challenges but involve significantly more cost and complexities especially in user devices. Also, key proposals of sharing the spectrum with mobile systems for access will not be possible," explains Dr Borkar.

High-altitude drones. Facebook's drone idea sounds very similar to Google's balloons. Just that they chose drones instead of balloons because they have more endurance and can also be steered more accurately. At an altitude of around 20km above ground, solar-powered drones would be able to cruise easily and conserve power, and broadcast signals powerful enough to cover a city-size territory with a medium population density.

A high-profile team is working to finalise the communication equipment payload of the drones and also figure out how FSOs can be used to make the solution more effective. Once again, Dr Borkar helps tone down our expectations: "The drones will be flying at lower levels than the satellites. Hence, the number of drones will be significantly larger than satellites to provide continuous coverage, which will likely be approximately six or seven times. This creates major issues including path control for drones, handovers and network management."

Peak or trough, satellites will reach you

Since decades, satellites have proved their usefulness in connecting remote areas. But, due to the heavy costs involved, these have been used more for military and commercial purposes than for civilian communications. Plus, traditionally, geostationary-Earth orbit (GEO) based systems have had major latency issues because of the large distance of links, making these

India is the third-largest Internet user base in the world, comprising around eight per cent of the world's Internet users, which is less than 20 per cent of our population (Courtesy: www.internetlivestats.com/internet-users-by-country)

useless for real-time applications like voice-conferencing, video-conferencing, machine-to-machine (M2M) communications and cloud computing.

However, in recent times, companies like SpaceX, OneWeb and O3b Networks have started promising affordable, high-speed communications with satellites in low- and medium-Earth orbits (LEO and MEO, respectively).

SpaceX. This company hopes to put in place a 4000-satellite network in LEO by 2030, and if this really happens, all you would need is a handy receiver to connect from just about any spot on the Earth.

Satellites have always been costly business, and SpaceX plans to change this. One of the major cost-points is the rocket, which goes up in flames on re-entry, so it can be used only once. So the company's scientists are now trying to develop a reusable rocket, which puts the satellite in space and returns to a barge, from where it is can be safely steered to shore and reused. They also plan to make smaller, lighter satellites, so that the overall cost will make more economic sense than laying fibre-optic cables.

OneWeb. OneWeb, backed by big names like Virgin Group, Qualcomm, Airbus Group, Coca Cola and Bharti Enterprises, has its own share of game-changing plans to launch

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around 650 Internet-providing LEO satellites at 800km and 950km, by 2018. Its satellites are designed with lesser components and with a lighter weight, so these can be mass manufactured and also launched easily.

Another notable aspect is their patent-pending Progressive Pitch technology, which enabled them to gain use of the priority spectrum allotted by United Nations International Telecommunications Union in 1997. In order to use the spectrum, OneWeb had to work out the challenge of not interfering with GEO satellites. Their Progressive Pitch technology helps them do this by gradually and slightly tilting their satellites as they approach the Equator to make sure they never cause, or receive, interference.

Dynamic spectrum sharing (DSA) is also becoming a mature field since 4G LTE introduced priority based structures both for control signals and user traffic.

Airbus Group's infrastructure would be used for manufacturing the satellites, while Arianespace will help in deploying these on time. Coca Cola will set up millions of access points across the Earth.

OneWeb's architecture will provide layer-2 and layer-3 services, which any telecom company can use to extend its network. Users can connect from anywhere in the world using a small and affordable, solar- or battery-powered OneWeb device. Thanks to Bharti's involvement, this technology promises to wave its magic wand over India, too.

O3b Networks. A lesser-known player, O3b Networks' motto is 'fibre speed, satellite reach.' The Google-backed company serves customers in around 180 countries with low-cost, high-speed, low-latency Internet and mobile connectivity with a scalable constellation of 12 MEO satellites, designed, integrated and tested by Thales Alenia Space.

One of its divisions, O3B Mari-

Light to the rescue...

Some years ago, Dr Harald Haas of University of Edinburgh proposed that LED bulbs could be used to transmit data. Li-Fi or light fidelity is a wireless communications technology like Wi-Fi, but it uses light from LED bulbs instead of radio waves to transmit data. A chip fitted in the LED bulb makes it flicker on and off thousands of times per second to communicate the zeroes and ones that make our data. The light is switched on and off so fast that it is not visible to the human eye. Current demonstrations of Li-Fi show that it is 100 times faster than Wi-Fi, and Haas believes it has the potential to achieve data densities 1000 times greater than Wi-Fi. His company is ready to commercialise the technology in the near future.

Velmenni, an Estonian start-up also revealed recently that they have started trialling Li-Fi in offices and industrial environments in Tallinn. Last year, NASA, too, started researching on how Li-Fi can be used in outer space. According to NASA, "One of the primary advantages of visual light communications (VLC) over radio-frequency bandwidth limitations is that the visible light spectrum is 10,000 times larger. A VLC network provides a wireless or fibre-less light-photon medium with virtually unlimited data transfer and significantly-reduced security risks. It also operates with reduced energy requirements, thus making it a green technology."

Li-Fi sounds interesting to trend-watchers because it could free up the crowded radio spectrum. Dr Haas also claims that it could help connect remote locations using transmitters and solar panels installed on hilltops and rooftops. However, some experts feel that it still has a long way to go as its efficiency is reduced when light is blocked, say, under foggy conditions. Once these problems are ironed out, Li-Fi does promise to reveal a whole new connected world, perhaps in the next decade.

time, has been attracting attention of late, with its interesting offering for improving connectivity on ships. Although satellites have long been used for mobile connectivity on ships, these have been problematic because there are black spots on oceans, which are not covered. Plus, when the ship changes direction, it takes some time to link up with the satellite network again, all of which tends to irritate customers with frequently-interrupted connectivity.

To avoid this, O3b's satellite beams follow the ship on its normal route, so that the ship is always maintained within the beam centre. O3b receives latitude/longitude updates on two-hour intervals via in-band or out-of-band channels, and beam-tracking updates in real time if the ship has to change course.

Inmarsat. An early example in this space, Inmarsat serves a limited set of customers for high-bandwidth applications, using LEO satellites. It is now readying its next-generation constellation, Global Xpress, which promises to remove the black spots in ship-to-shore communications, and ensure reliable, high-speed

broadband connectivity to ships.

Inmarsat is working with Rolls Royce on their autonomous, cargo-carrying drone ship project, and with Ericsson to facilitate sharing of cargo, logistics and vessel-operational data to help streamline the maritime supply chain. You could think of this as something like a maritime extension of the Internet of Things.

Mobile might continue to rule

"The telecommunications landscape is replete with limited successes of several innovative satellite based communication systems including Iridium, Teledesic and Globalstar. It may be noted that consistent with market needs and technologies available at that time, their goals were comparatively modest—providing basic voice capabilities to customers. The business model for these initiatives broke down since competing mobile systems provided lower-cost alternatives, albeit allowing selective coverage instead of universal coverage.

"The claim of current satellite based initiatives like SpaceX and OneWeb—that cost structures have

changed, allowing viability of satellite based systems—is untenable, since the corresponding cost structure of competing mobile systems has also significantly changed,” says Dr Borkar.

He explains that the large number of low-orbit satellites needed, with corresponding complexities and costs for management, make the business models of OneWeb and SpaceX somewhat questionable.

Other blocking factors include discrepancies in frequencies of operation, non-viability of real-time and interactive applications as well as high-bandwidth data applications due to limited capacity and bandwidth issues, and political differences and regulatory issues between different countries.

Dr Borkar adds, “These satellite based systems cannot compete with mobile systems, with their range of capabilities at different price points. This gives significant competitive advantages to different generations of mobile systems, from 2G to 5G. Clearly, there is a market for bicycles as well as cars in the telecommunications business.”

Dr Borkar’s strong faith in mobile systems is rooted in constant innovations, therein. Evolution of mobile systems, especially 2G Global System for Mobile (GSM) communication, 3G Wideband Code Division Multiple Access (WCDMA)/ High-Speed Packet Access (HSPA), 4G LTE and 5G Next-Generation Networks (NGNs), are illustrations of continuous innovation for providing viable solutions to evolving market needs. Advances include Cooperative Multi-Point (CoMP) systems, multiple-input-multiple-output (MIMO) antennae, cloud based service creation and network management, and operations at extremely-high frequencies.

5G Wireless network is being positioned very well for meeting the advanced needs of the market in the 2020+ time frame, including mo-

bile multimedia and differentiated customer experience. These include ultra-high-definition (UHD) video, everything connected, sensor based M2M communications, smartcities, ubiquitous computing, real-time and cloud based services and instantaneous communication regardless of distance.

Coming to the question of how this helps in universal connectivity, Dr Borkar explains, “Mobile systems are scalable and can provide a range of viable options from low-cost voice services to extremely-high-bandwidth advanced services.

“5G NGN specifically is being designed to operate all the way from the lower frequency range of the 3G/4G spectrum in the 700MHz range to as high as 100GHz frequencies. Using a range of mobile systems including macrocells, microcells and picocells, it is well-positioned to provide selective as well as universal geographic coverage across the globe.

“In fact, due to advantages of seamless handovers, pico or femto cells are expected to be a better option than the currently ubiquitous Wi-Fi systems, especially for mobile devices. Wi-Fi has had its days, since nomadic access from devices like laptops without automatic handover to the mobile network has been the market norm.”

He adds, “There are applications where base stations based terrestrial networks are not feasible, for example, over the ocean, remote locations, high mountains and so on. For such niche markets, it is likely that SpaceX and OneWeb will combine and provide viable solutions.”

Eyes on television white-space

Another trending technology in this space is the utilisation of television white-space. From Google and Microsoft to indigenous companies like Saankhya Labs, and various universities including Indian Institutes of Technology (IITs), researchers are

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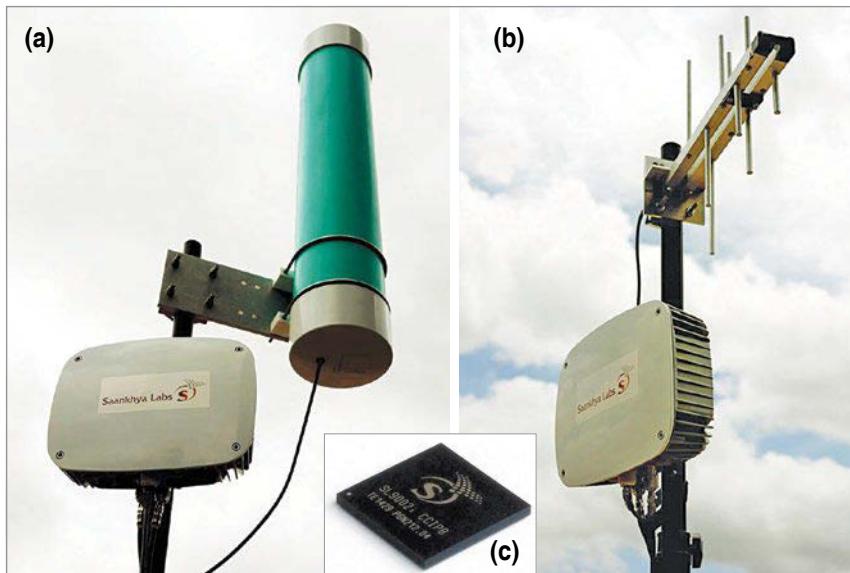
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*Fig. 4: (a) TVWS base station, (b) TVWS customer premises equipment (CPE) and (c) Pruthvi chip
(Image courtesy: Saankhya Labs)*

beginning to believe in the white-space approach to connecting areas where traditional broadband is not feasible.

White-space refers to the gaps left by television networks. Usually, television networks leave gaps between channels for buffering purposes, leading to some unused frequencies in the wireless spectrum. This space is similar to what is used for 4G, and can therefore be effectively used to deliver broadband Internet. White-space broadband is somewhat like Wi-Fi, just that it can travel a much longer distance of approximately 10 kilometres.

"The unused TV spectrum in the ultra-high-frequency (UHF) band, called white-spaces, has very good propagation characteristics, which makes it attractive for long-range communications at low power. These properties make this spectrum particularly attractive to provide affordable wireless broadband connectivity to large rural and remote areas, which are not served today.

"A single television white-space base station can reach households that are as far away as 5km to 10km, depending on antenna height. Bridging the broadband digital di-

vide between rural and urban areas is a must have for the success of Digital India, and television white-space modems play a vital role here," explains Vishwa Kayargadde, co-founder and chief scientist, Saankhya Labs.

You need special modems to use television white-space, and Saankhya Labs is a forerunner in this industry. Pruthvi is a semiconductor chipset developed in India by Saankhya Labs. It is a unique class of chip called software-defined radio (SDR), which allows the same hardware to be used for different types of wireless communication by loading appropriate software.

Pruthvi contains highly-specialised signal-processing central processing units (CPUs) and hardware engines designed by Saankhya from the ground up. These CPUs are very powerful and can perform tens of giga operations per second in a small silicon area while consuming low power, which allows broadband wireless communication to be performed by embedded software running on this chip.

Pruthvi SDR has been used in various applications, including UHD set-top boxes, television

dongles, video-distribution/surveillance drones, satellite receivers and Saankhya's Meghdoot base stations and user modems that provide rural broadband using television white-space.

Meghdoot is a complete VHF/UHF base station modem consisting of radio-front-end and baseband processing, powered by Pruthvi.

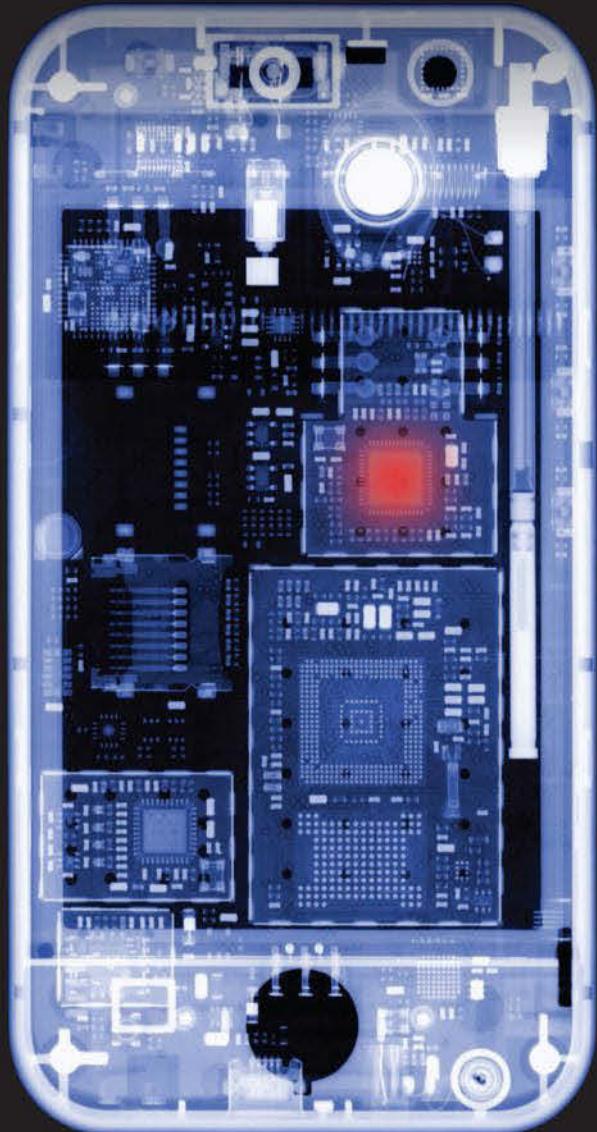
"Unlike other solutions powered by field-programmable gate arrays (FPGAs) and general-purpose digital signal processors (DSPs), Saankhya's solution is the first television white-space modem to be powered by a communication system on chip (SoC). Also, being a designed-in-India and made-in-India solution, we have several advantages besides easy access to the local market," says Kayargadde.

The company is currently performing pilot tests of their solution at various locations in India, in collaboration with various IITs. Unlike the USA, the UK, Singapore and several other nations, India is yet to release television white-space spectrum for unlicensed access. It is expected to be released in the near future. Until that spectrum is made available for unlicensed access similar to the Wi-Fi spectrum, large-scale proliferation of television white-space devices is unlikely to happen.

However, television white-space is a very promising technology for connecting rural areas. It has been tested successfully in several university campuses and districts across the world, after Microsoft, BBC, BT and Nokia launched a consortium to support the project in 2011.

Microsoft 4Afrika is also betting big on white-space technology to connect interior regions of Africa, and so is Google.

Kayargadde believes that it will do wonders for India, too, even better than balloons or drones. He says, "Television white-space modem technology can be used to provide

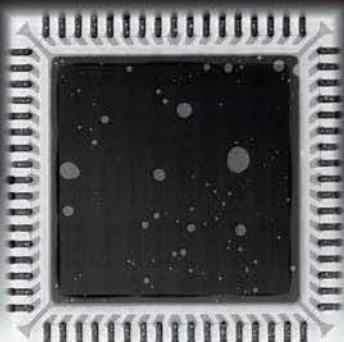


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connectivity between any two points on the Earth or in the air, like a balloon or a drone. However, in the Indian context, unlike Project Loon, in one of the deployment scenarios proposed, the television white-space modem technology could effectively provide last-hop wireless connectivity from the nearest optical-fibre node to rural/urban areas.

“High-speed optical connectivity is being made available at most *panchayats* by National Optical-Fibre Network (NOFN) project, Bharat-Net. Connectivity to high-speed optical backbone makes the television white-space modem solution quite unique to enable Digital India.”

Building connectivity in Africa with digital BRCK

Bad weather, harsh terrain, poverty, name the problem and it is there in Africa. Yet, BRCK has found a way of providing connectivity to the remotest corners of this continent. And guess what their website proudly proclaims: “If it works in Africa, it will work anywhere!”

BRCK is basically a ruggedised router that can work under extremely-bad weather conditions and with very unreliable power supply.

According to the company, “It is a rugged, cloud-managed, full-featured modem/router with built-in fail-overs and programmeable general-purpose input-output (GPIO) expansion. If there is a way for you to connect, BRCK will help you get up and stay up, no matter where you are.”

This makes it a perfect tool for connecting rural areas. In Africa, for example, BRCK is being used extensively to provide connectivity to rural schools, so children can have access to good educational content.

All you need to do to get BRCK up and running is insert a 3G data-enabled subscriber identity module (SIM) card and the device starts broadcasting Wi-Fi signals, enabling up to 20 devices to connect to the

Internet. It works in more than 140 countries.

In case you do not have a SIM, you can opt for BRCK vMNO for global connectivity without SIM cards. There is an external GSM antenna port, which helps improve reach along the edge of a signal range. The battery, which can be charged using solar power, car battery, computer or regular power source, lasts for eight hours in full-power mode and much longer when used in low-power mode.

Plus, the robust BRCK system is designed as a platform that you can build on. You can write your own custom software for it through the application programming interface (API), connect sensors and other hardware through its Arduino-compatible GPIO ports, upgrade the 4GB onboard storage and do much more.

The most interesting part is that BRCK can be managed on the cloud. So this was, say, a non-profit organisation somewhere in New Delhi can install BRCK in a school in a Himalayan village, remotely manage its settings, push content and apps to it, among others.

Innovative devices to extend the reach of BharatNet

India is also gearing up to the connectivity challenge. We are aware that the current government is committed to take broadband connectivity to all 250,000 villages. While BharatNet, the ₹ 720 billion NOFN, will be the backbone of the project, private and government-funded companies are simultaneously developing appropriate devices to improve last-mile connectivity. Kayargadde explained one scenario using television white-space to us earlier.

Wi-Fi products launched by Centre for Development of Telematics (C-DoT) in July 2015 are also good examples of this trend.

One device is a long-distance Wi-Fi system, which can solve connectivity issues in rural areas, hilly

terrain, highways, tunnels, dense forests and others.

The other is a solar-powered Wi-Fi device, which will reduce dependence on grid power. It has also developed a smart green power supply solution that can make broadband solutions self-sustainable.

These cost-effective solutions help improve the reach of Bharat-Net, beyond *panchayats*, to the remotest corners of the country.

Indeed, it is heartening to learn of such efforts closer home, because universal connectivity is not something we can distance ourselves from, and watch the world develop. It is a real problem faced by real people, in our own country, and requires each of us to empathise with the situation and do our bit, as engineers, entrepreneurs, philanthropists or volunteers.

While signing off, Dr Borkar leaves us thinking about how economics matters at the grassroot level. He says, “Primary issues for a product or service to customers are affordability and capabilities that can be provided at that price-point to consumers. The goal of any commercial enterprise is to make profit. For providing the Internet to customers, currently price-points are higher than what almost two-thirds of the people can afford.

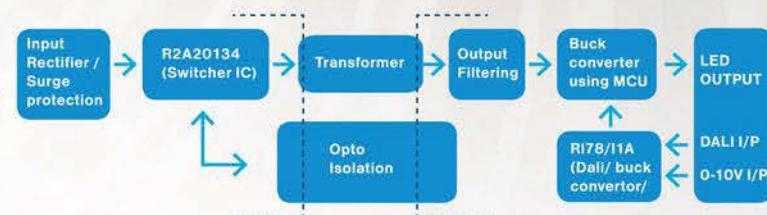
“Although making universal broadband Internet available to all may be a laudable goal, economic reality dictates the imperative of providing scalable and affordable Internet with a range of prices and corresponding performance and capabilities.

“High tele-density of 2G GSM wireless system in India is a prime example of a basic voice technology being priced within the buying power of most people. Unless availability of the Internet is considered a fundamental right with significant support by the government, universal broadband Internet connectivity will stay a dream.” **EFY**

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TOUCHE: AN AFFORDABLE LIFE-CHANGER

For The Visually-Challenged



Priya Ravindran
is a technical
Journalist
at EFY

The world is becoming digital. We wake up every morning on seeing the time on our clock/watch. We turn on the television or e-readers and catch up on news. We leave for work, go to the station and the display tells us how long before the train arrives. At office, we spend most of the day working on our laptop. Let us not forget that the whole day we have a companion with us, the smartphone. Imagine if, just for a day, you had to stay digital-less.

"No WhatsApp! No browsing! No e-books!" Just reading this, I am sure, must have given you the creeps. We do not even give a second thought to these tasks that have become a way of life today. But there are people out there who need someone to read the digital data out loud; they need special books printed for them to read content that is always outdated and a scribe for every examination.

The question that prompted it all

Is there any way to make their life easier, to make them technology-enabled? Those in the know might say that there are

Touche e-reader



What is Touche

Touche is a stand-alone e-reader and note-taker combined, and a mini-computer for the visually-challenged. It converts digital information (ASCII) into tactile (feel-able) Braille. Apart from its own keyboard for data entry, contents of your smartphone, computer or memory stick can be fed to the device. It mechanically produces Braille dots that change according to the information being received. Touche can also output information to a Braille embosser if a hard copy is needed, or send information back to a phone or a computer.

devices that do the job. Yes, there are and these are made by foreign companies using German or Japanese technology, or by Indian companies that borrow their technology. No wonder then that the already overburdened visually-challenged find the US\$ 2000 per line Braille converters unaffordable. Can we find an alternative to this? This is the question Paul Gerard D'Souza, a freelancer who invents new technologies and devices, set out to answer.

We know the problem, what do we do

We need a device that can take in digital text and convert it to Braille. The first part is easy—use a computer or smartphone to type out the content. Transfer this data to the device via Bluetooth, USB or a pen-drive and throw in some memory to store it. D'souza used customised software to convert this digital text into signals, and a processor to control this.

Let us now take a look at the other side. The display demands a tactile surface on which small projections are made to appear and recede, giving the user the Braille reading interface.

Braille display matrix has fixed dimensions, and different dot combinations

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represent different letters. The scale cannot be changed. Braille dots are spaced 2.5mm apart within a cell, and cell-to-cell pitch is about 6.25mm.

D'Souza needed to create a mechanical system that would drive the pins according to the data and, for this, he used actuators. Electronic signals drive the actuators, each of which drives a pin on Braille display. Sounds simple, but try to implement it and the complications begin.

First and foremost, the display has to show enough data for a person to read. Touche has a 20-character display, with each character comprising dots or pins arranged in three rows of two columns each; this means fitting in 120 actuators within one line. When the reader feels the data, pins have to withstand a pressure of 15 to 20 grams.

Small solenoids and motors cannot bear this pressure, others are too big, consume huge current, or are too costly. D'Souza came up with the idea of using appropriately-positioned micro-motors, the ones used as vibrators in mobile phones that cost around ₹ 15 each.

But with these being about 4mm in diameter, size and stability became serious issues. The trick was to use these only to indicate logical states and distribute and stack these in other available free space. To shift the selection from the motors to the pins on the display, he used a system of connecting levers. To refresh data and load in the next set, he designed a system of mass lifting.

How Touche was born

With the mechanical system used, converse operation turned out to be easy. D'Souza added a Braille keyboard to make sure the visually-challenged could also write and not just read digital data.

Touche is a refreshable Braille display. All it needed was a smart combination of electronic and mechanical principles, many of which

Igniting the Spark of Inspiration



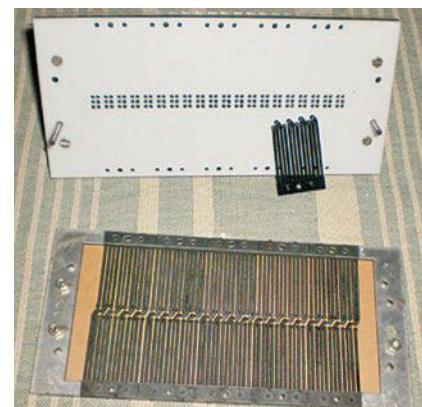
"I was listening to an orchestra play the music of a hymn from the movie Titanic as the ship began to sink. While listening to the music, I was running my finger over the music score and trying to correlate what I was hearing with the dots and lines on the score. While doing that, I felt inspired with the thought that if the dots could come out of the page, someone who is blind would be able to read music."

"The same day, I listened to someone speak about the exorbitant cost of printing Braille literature and the huge amount of storage space required for Braille matter when compared to storage of normal books. This led me to try and figure out how I could make a device that would produce Braille dots using digital information. I did think of a few solutions but my ideas were dismissed as being impractical when reduced to Braille-size specifications. I used their discouragement as a challenge and produced a display prototype to prove that it could be done."

—Paul Gerard D'souza is a freelancer with 20 years of experience in inventing. His inventions range from agro-machines to watch escapements, perpetual calendar, large date mechanisms and other inventions for the visually-impaired



Side view of the motor assembly under the pin plate



Pin-plate assembly: single module and complete assembly

the inventor was right to patent.

The device can now take in digital data, store it in its memory, access it line-by-line and convert it to Braille. Once refreshed with a simple press of a button, the next set of 20 characters is loaded. With all procedures involved for a line display, refreshing takes less than 100 milliseconds.

Touche costs one-tenth of other similar devices. It has been built using easily-available and serviceable components. Most importantly, all key components have been manufactured using locally-available workshop facilities.

Ask D'Souza and he says that the biggest challenge lay in convincing fabricators and producers of components, of the need to stick to specifications and the levels of accuracy he desired. With his unconventional approach, willingness to invest in something new with an eye for detail, overcoming mind-blocks and getting people's support turned

out to be difficult. It took him six years to finally achieve his vision.

Touche has been demonstrated at Centre for Development of Advanced Computing (C-DAC), and Kanthari, a branch of Braille Without Borders, in Trivandrum, Kerala. It has found appreciation from visually-challenged users and was displayed to the public at a Mini Maker Faire in Bengaluru.

The designer aims to convert the set-up to use a single-board computer, to make it compatible with all software and input formats. With a few other enhancements in mind, he intends to release the product in the market in early 2016 and sincerely hopes to make the lives of the visually-impaired a lot easier and better. **EFY**

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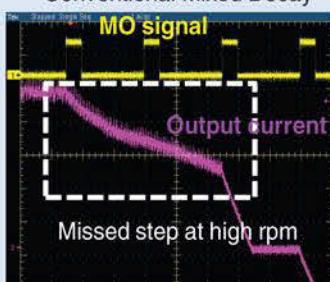
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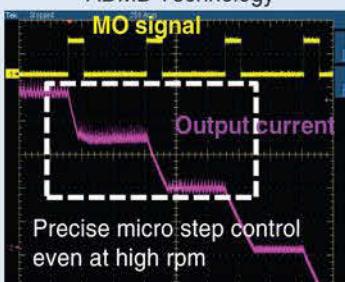
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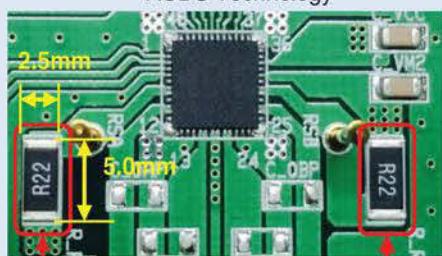
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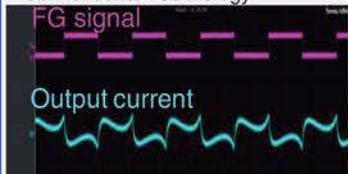
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Toshiba original

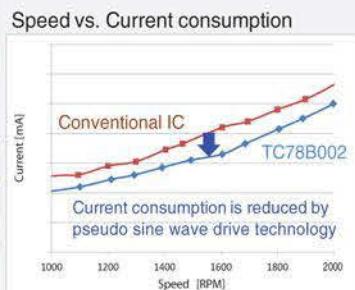


Driver type
TC78B002 Series

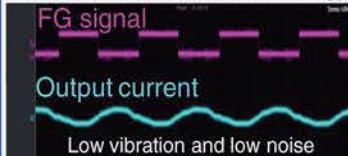
Conventional Technology



Pre driver type
TC78B006 Series



Pseudo sine wave drive Technology



3 Phase Server Fan

Features

Sensor less drive

Low vibration / Silent

Lead Angle Control



Driver type
TB67B008 Series

Fan of Home Appliance

► Features

Pseudo Sine wave drive

Low vibration / Silent



Driver type
TB67B000HG

Lead Angle Control

High efficient



Controller type
TB6634FNG



What Drives SPECTRUM ANALYSERS



Dilin Anand is a senior assistant editor at EFY. He is B.Tech from University of Calicut, currently pursuing MBA from Christ University, Bengaluru

While incremental specification enhancements are taken as a given in any field driven by technology, the past year has seen some interesting advances on the side of improving test and measurement (T&M) productivity. We have seen support being integrated into the equipment for some of the newer standards, better automation features as well as a renewed focus on making T&M a much better experience for the engineer. This article takes a look at the trends for the latest line of signal and spectrum analysers.

Significant improvements in bandwidth and frequency

We are seeing some significant increments in specification enhancements. "Recently, spectrum analyser lines of equipment have improved their capabilities by moving forward from featuring frequency coverage of around 20GHz to enter the millimetre range of up to 50GHz. Thus their frequency range has been enhanced quite a bit," explains Vishal Gupta, senior applications specialist (RF/MW), Keysight Technologies. The modular PCI eXtensions for Instrumentation (PXI) form factor now features up to 26.5GHz of coverage, too.

Newer equipment come with higher analysis bandwidth. The UXA branded line from Keysight can handle up to 510MHz of real-time analysis bandwidth. This is a significant increase as the best bandwidth topped at 160MHz in 2014, adds Gupta.

"Using analysers for frequencies

Signal or Spectrum Analysers

Spectrum and signal analysers have come a long way from where these were a few years ago. Until recently, while most signal analysers came with basic spectrum analyser capabilities, these were unable to perform as well as a real spectrum analyser. However, things have changed now with the integration of a lot more features throughout equipment lines. "We do not call these spectrum analysers anymore, we now call them signal analysers," says Vishal Gupta, senior applications specialist (RF/MW), Keysight Technologies.

above 6.0GHz is a big challenge for designers. The most exciting feature/function of the spectrum analyser is to make the single-side-band noise phase to be 100dBc/Hz at offset up to 10Hz, which is rather hard to achieve," explains Chandmal Goliya, director, Kusam Electrical Industries Ltd.

Equipment like Spectran V5 real-time spectrum analysers (RTSAs) from Aaronia AG allow continuous analysis and even real-time data streaming (for example, USB to hard disk).

"This allows all data of a desired high-frequency band to be recorded without any blind spot (for example, complete data traffic of a mobile phone tower). Real-time bandwidth can reach up to 200MHz (existing systems can reach only up to 110MHz). An ultra-fast direct-digital-synthesis sweep in S-area is possible even with 10GHz bandwidth," explains Naveen Sharma, technical manager, Scientific Mes-Technik Pvt Ltd.

Size reduction still a focus area

For some time now, there has been an emphasis on size reduction, which has continued to the point that we now have handheld instruments, explains Gupta.

Goliya reiterates, "We think the handheld spectrum analyser is a good application for the market that values portable and lightweight equipment for outdoor use and constantly changing workplace requirements."

Satish Thakare, chief technology officer, Scientech Technologies Pvt Ltd, feels that, "Traditional spectrum analyser instruments available in the handheld and bench-top form factors are still popular, but modular instruments are finding wider acceptance in the market due to cost, flexibility and scalability advantages."

Three clicks or less

Rufus Danesh, project engineer at Analog Arts, says, "What makes modern signal

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SIGNAL ANALYSERS

Signal Analysers	Company	Features	Application
M9393A PXIe performance vector signal analyser	Keysight	<ul style="list-style-type: none"> -168dBm/Hz displayed average noise level (DANL) with preamplifier and noise corrections Frequency extension to 50GHz (minimum frequency of 3.6GHz) with option FRX 40MHz (standard), 100MHz or 160MHz analysis bandwidth, and optional wide-band IF output with option WB1 	<ul style="list-style-type: none"> Aerospace and defence manufacturing and depot test Wireless device design validation and manufacturing
R&S FSW85 signal analyser	R&S	<ul style="list-style-type: none"> Frequency range: 2GHz to 85GHz Low phase noise: -137dBc (1Hz) at 10kHz offset (1GHz carrier) Up to 2GHz analysis bandwidth Real-time analysis up to 160MHz bandwidth High-resolution 31cm (12.1-inch) touchscreen for convenient operation Multiple measurement applications can be run and displayed in parallel 	Ideal for analysing radar systems

SPECTRUM ANALYSERS

Spectrum Analysers	Company	Features
Spectrum Rider FPH handheld spectrum analyser	R&S	<ul style="list-style-type: none"> Frequency ranges from 5kHz to 2/3/4GHz; upgrade via keycode Eight-hour battery life Measurement accuracy of typically 0.5dB between 10MHz and 3GHz
TE-3000	Antenna Technology Communications Inc. (ATCI)	<ul style="list-style-type: none"> Frequency margin from 5MHz to 1000MHz (terrestrial), from 950MHz to 2150MHz (satellite) Button and touchscreen control More than eight-hours battery time Compatible with analogue, digital (DVB) satellite standard
PSA Series 2 (PSA1302, PSA2702)	Aim TTi	<ul style="list-style-type: none"> Frequency PSA1302: 1MHz - 1300MHz, PSA 2702: 1MHz - 2700MHz USB interfaces for flash drives and PC connection Resolution bandwidth (RBW): 15kHz, 280kHz, 1MHz or auto Button and touchscreen control
PSA Series 5 (PSA3605, PSA6005)	Aim TTi	<ul style="list-style-type: none"> Frequency PSA3605: 10MHz- 3600MHz, PSA6005: 10MHz - 6000MHz USB interfaces for flash drives and PC connection 300Hz to 10MHz (1:3:10 sequence) or auto Button and touchscreen control
RTSA7500	Berkeley Nucleonics	<ul style="list-style-type: none"> Frequency range from 100kHz to 8/18/27GHz Real-time bandwidth (RTBW) up to 100MHz Real-time FPGA triggering for detection of elusive, time-varying signals
RF Explorer 6G Combo	RF Explorer	<ul style="list-style-type: none"> Frequency range from 15MHz - 2700MHz, 4850MHz - 6100MHz Pocket size and lightweight Frequency resolution of 1.0kHz Average noise level of 0.5dBm

analysers much more exciting than the previous generation is their easy integration within a framework of a

computer. Most new instruments are supported by powerful application software, which can run on various

operating systems. In a sense, this feature enables the instruments to form an analysis network that can be controlled from a central post.”

We are now quite rooted in the era of touchscreens for test equipment, with newer equipment coming with touchscreens as big as 36 centimetres. These screens have also enabled an era of user interface (UI) improvements.

While engineers previously had to click through and dig deep into menu structures to reach specific functions, Gupta claims that newer Keysight equipment allows him or her to modify something with three clicks or less. “Better UI also enables enhanced pulse-measurement capabilities for white-band radar and electronics warfare applications,” he adds.

Another support which is now available is the possibility to obtain any movement, location and alignment. “This is ideal for automatic measurements. Such instruments feature a gyroscope and acceleration sensor as well as a digital compass and an optional integrated global position system,” adds Sharma.

Support for newer standards and markets

A recent trend in the radio frequency (RF) spectrum analyser market is to provide integrated test solutions that feature many

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capabilities, including a spectrum analyser with modulation analyser. "Such instruments with power meters cover the complete life cycle of base-station and mobile-station testing from development to maintenance. Research indicates that around 62 per cent of the spectrum analyser market revenue comes from the RF segment. It is anticipated that, with evolving end-user technologies, most spectrum analysers will be RF-compatible in the future. Technologies like 3G/4G deployments, increasing complexity of mobile handsets and Long-Term Evolution (LTE) development efforts are expected to drive the growth in the RF spectrum analyser market in the foreseeable future," explains Thakare.

Want to build a Wi-Fi network that has a longer range, while using less power than existing Wi-Fi? You can try out IEEE 802.11ah wireless networking protocol to do so.

Vishal says that software like Keysight X-series measurement applications let you add on necessary capabilities to support test equipment.

In addition to this, newer standards such as Data Over Cable Service Interface Specification 3.1 (DOCSIS) and 5G analysis are now being supported, too. Newer equipment also adds support for custom in-phase quadrature (IQ) modulation analysis, which supports engineers working on proprietary standards that are non-standard.

Madhukar Tripathi, senior manager, marketing and channel sales at Anritsu India Pvt Ltd, explains that Common Public Radio Interface (CPRI) measurement will be required since LTE deployment is in full swing across the globe. A key need is the ability to analyse the uplink RF spectrum from ground level via CPRI optical-fibre

Major contributors to this report

- **Chandmal Goliya**, director, Kusam Electrical Industries Ltd
- **Madhukar Tripathi**, senior manager, marketing and channel sales, Anritsu India Pvt Ltd
- **Naveen Sharma**, technical manager, Scientific Mes-Technik Pvt Ltd
- **Rufus Danesh**, project engineer, Analog Arts
- **Satish Thakare**, chief technology officer, Scientech Technologies Pvt Ltd
- **Vishal Gupta**, senior applications specialist (RF/MW), Keysight Technologies

link, as it can reduce operational cost and increase response time to resolve interference issues. This eliminates the need to call a tower crew to climb to the top of the antenna, and connect a spectrum analyser to the RF sniffer port to look for interference.

"Our MS2830A spectrum analyser is now capable of supporting development and production of equipment for both E-band (70GHz/80GHz) wireless back-haul as well as automobile collision avoidance radar (77GHz/79GHz)," explains Tripathi.

"We also say the launch of two new electromagnetic field (EMF) measurement antennae to the handheld spectrum analyser family like MS2720T, LMR Master S412E is useful for regulatory authorities, monitoring agencies, survey agencies and mobile operators," he adds.

Danesh feels, since the majority of applications for signal analysers—whether these are spectrum analysers, oscilloscopes or voltmeters—are within a laboratory environment, we have still some way to go before we have a true standard set of specification and support for wireless devices that is universally agreed upon. Other new features also lack standardisation in the true sense.

Professional versus educational

There used to be important differences between the features of instruments intended for professional applications and those for

other markets. These days, however, the gap is closing quickly. Low-cost instruments enjoy similar functionalities as the more expensive equipment. Danesh strongly believes that we will soon see the performance of a high-end signal analyser in a device at a fraction of the cost.

He adds, "One area for signal analysis that is becoming popular, particularly for hobbyists, is the application of the instruments to analyse wireless satellite communications. Software support, available with the newest devices, makes this application both fun and easy."

"For the education market, we have launched simple instruments to make the frequency characteristic analysis for students, who can use this analyser to check network parameters in low-frequency ranges, for example, amplitude-frequency, phase-frequency, frequency discrimination and S11, S12 parameters of network. The function is similar to a simple network analyser," explains Goliya.

The overall trend

In recent years, specifications such as integration, automation, portability, remote control and ease of use are becoming important features of a spectrum analyser. "We believe this trend will continue for the foreseeable future," says Danesh.

Sharma feels that the next breakthrough could come in the form of usage of poly-phase filters. "These filters were not possible until today," he adds. **EFY**

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Choosing The Right EMBEDDED DEVELOPMENT BOARD



Biswajit Das is manager-R&D, EFY Labs

Development and prototype boards are computer boards that are used to develop or test electronic modules. These are used to evaluate programs for embedded devices such as controllers, point-of-sale (PoS) terminals, kiosks and information appliances.

Development boards combine a processor, chipset, memory and onboard peripherals with debugging features. Specifications for development boards include bus type, processor type, form factor, number of ports, port type, memory and operating system.

Factors to keep in mind

There are a number of conventional benchmarking factors that we all use in sorting through alternatives. These include capabilities of the target controller (speed,

power consumption and on-chip peripherals), available features (memory being the major consideration along with supported communication protocols), onboard peripherals and technical support (compiler tool chain and sample applications) from the vendor.

There are a number of other considerations that should drive us while looking at development boards. Described below are a few of these:

Open design. Take any popular development board that has been registering an active user community, timely enhancements and hundreds of developers working towards porting new applications to the board. Openness in a design has got more to do with the mental satisfaction of the buyer.

What is the general selection criteria for MCU based development boards

Serviceability. It is important that the boards can be repaired if and when something goes wrong. To this end, packaging of the MCU needs to be considered. It is important to consider whether the MCU is a through-hole part-mounted in a socket or is it surface-mounted. And if it is surface-mounted, can it be replaced when needed?

Pedagogy. Educational value and cognitive loading effects of the board must be taken into account. Big and fancy development boards may offer a tremendous amount of features and look really cool, but if these features diminish what the student understands of the core technology, then these may be detrimental to the cause.

Reliability. One of the main goals of development boards is to ensure that we have an operational development board for each and every experiment. Any time spent attempting to fix the board can take away a lot of critical and important time.

Programming support/options. Newer MCUs allow in-circuit programming while these are located in the system. Options may include an external programmer or a self-programming mechanism.

Processor support (single or multiple). If one is working on multiple controller families or different part numbers, this factor becomes critical because having separate development boards for each controller may not be feasible all the time. A proper decision to this effect can save money.

Cost. Obvious factor; compared to the value to the user, costs should be at par.

Design control. There is nothing more frustrating than selecting an appropriate development board only to have the manufacturer



T. Anand,
managing director,
Knewron Technologies

make a change that ultimately forces a new development board to be selected. It is therefore necessary to have some type of design control over the development board that is ultimately chosen.

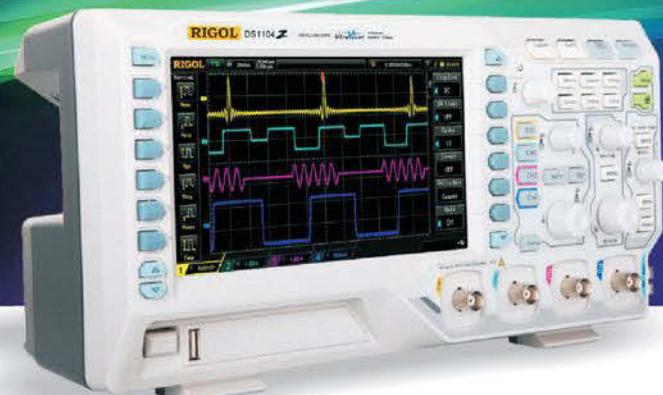
Debugging capabilities. Depending upon the kind of work to be done on the development board, JTAG, single-wire debug or whatever else is necessary to enable users of easy debugging and faster development should be considered.

System clock options. Whether the board gives multiple clock options such as internal RC oscillator plus external crystal installed or only one can make or break some of the developments. This is not very critical as compared to all other factors.

Form factor. While development boards are ultimately used for development purpose, their form factor is critical. A board that is much bigger in size and difficult to move around may not be preferred, while a small-size handy board that can be taken anywhere in the pocket or a small box could help engineers develop things whenever they want.

Readiness for final integration. Like I said before, many a time, development boards are just a perfect fit for the final product and can have everything that the final product requires. In such cases, making another board may not be warranted (except where outline of board, form-factor, etc are different). Thus, the development board can directly go into the product box. In such cases, this becomes a very important factor since it has high potential to save manufacturing money and time.

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**TABLE I
MCU BASED DEVELOPMENT BOARDS**

Name	Architecture	Flash memory	Clock speed	Features	Make	Figure
Arduino Due	ARM	512kB	84MHz	AT91SAM3X8E MCU, 54 3.3V I/O, 12 analogue inputs, four UARTs, two DAC outputs, two USBs	Atmel	
STM32F4- Discovery	ARM	1MB	—	MEMS audio sensor, 3-axis digital output accelerometer, USB OTG FS	ST	
LPCXPRESSO Devboard, LPC1549	ARM	256kB	72MHz	Based IDE and GNU C/C++ tool chain available in free and pro versions, integrated JTAG debugger	NXP	
MSP-EXP430G2 LaunchPad	MSP430	16kB	16MHz	Integrated USB-powered flash emulation tool	TI	
ATSAMC21J18A XPLAINED PRO	ARM	256kB	48MHz	Embedded debugger, digital I/O, CAN/LIN transceiver, Xplained Pro extension	Atmel	
FRDM-KL25Z ARM, KINETIS, KL25Z, FREEDOM	ARM	128kB	48MHz	MKL25Z128VLK4 80 LQFP MCU, Arduino-style headers, cap-touch slider, accelerometer, open SDA	Freescale	

One such path-breaking philosophy surrounds Arduino's business model, which goes like this: "It does not matter anymore whether your product is open source, someone in another country is going to open it up and reverse-engineer it anyway."

So how does one sustain in this volatility? "Basically, what we have is the brand," says Tom Igoe, an associate professor at Interactive Telecommunications Program at New York University, USA.

Looks. Steve Jobs once said, "I do not need engineers. I need artists." What is a product that is low on looks, usability and visual appeal? Sophisticated looks and smart finishing contribute to mass appeal even for a product meant for a technical audience.

Clarity on user segment/intended apps. Very often than not, it is noticed that people stuff development boards with anything and everything since it is not too clear what the hardware is meant to do and what sort of audience does it cater to. This is a direct contributor to the fact that most companies are unable to come up with cost-effective hardware. Moreover, we are often unaware of the real computational capabilities of the board.

Avoiding premature optimisation. Optimisation is something

that you should keep back for the end product. It is very common for the project scope to be refined or redefined at every stage of your project. Due to client demand for more flexibility in the product we have to keep a lot of related options open while freezing the development board instead of trying to optimise prematurely.

MCU based development boards

Some development boards are general microcontroller (MCU) specific and are available from semiconductor manufacturers. These boards include Arduino boards, STM32-Discovery kits, TI Launchpad (MSP-EXP430G2), Xplained boards from Atmel and others. Additionally, some economically-available boards are designed by local companies.

In both cases, MCU development boards come in two flavours, one being MCU evaluation boards where focus is on evaluating MCU capabilities. Second category is application/feature specific where the board is designed for the purpose of evaluating certain features of the MCU and is usually focussed on some specific application area.

Single-board computers

Today, single-board computers

(SBCs) can be grouped into two main categories: proprietary and open source.

Proprietary SBCs are generally designed for use in end applications or as a reference to be evaluated. These are often industrialised designs that have gone through the same type of testing that an end product requires and are often integrated into end product designs.

Open source SBCs, on the other hand, offer users access to both the hardware design and layout as well as access to the source code used on the board. This is ideal for all users as they can easily understand how the software and hardware operates and adopt the design to meet their end designs requirements or simply learn how a piece of hardware or software works.

Current SBCs come with a wide variety of processor types, most with GPUs onboard. These processors range from X86 based processors from the traditional PC space (AMD and Intel) to ARM processors that have traditionally been used in the industry and more recently mobile spaces.

The most prevalent form of software used on SBCs is Linux with numerous derivations including Android, Ubuntu, Fedora, Debian and Arch Linux, as well as FreeBSD and

TABLE II
COMPARISON BETWEEN DIFFERENT SINGLE-BOARD MICROCOMPUTERS

Name	SoC	Architecture	Supported OS	Onboard Storage (MB)	External Storage	HDMI port	Other video Port	Ethernet Port	Wi-Fi	Standard USB (2.0/3.0) ports	Figure
Humming-Board-i2eX	Freescale i.MX6 Dual	ARM Cortex-A9	Linux, Android	—	microSD mSATA	Yes	—	GbE	—	USB 2.0	
Raspberry Pi's B+	Broadcom BCM2835	ARM11	Linux (Raspbian), Android	—	microSD	Yes	Composite	10/100	—	USB 2.0	
Banana Pi M3	Allwinner A83T	ARM Cortex-A7	Linux, Android	—	microSD SATA 2.0	Yes	Composite	GbE	a/b/g/n	USB 2.0	
Intel's Galileo Gen2 development board	Intel Quark SoC X1000	x86 Quark	Linux, Windows	8MB flash + 8kB EEPROM	SD	—	—	10/100	—	USB 2.0	
NanoPC-T1	Samsung Exynos 4 (4412)	ARM Cortex-A9	Linux	8GB flash	SD	Yes	—	10/100	—	USB 2.0	
ODROID-C1	Amlogic S805	ARM Cortex-A5	Linux, Android	eMMC module optional	microSD	Yes	—	10/100/1000	—	USB 2.0	
pcDuino-3Nano	Allwinner A20	ARM Cortex-A7	Linux, Android	4GB flash	microSD	Yes	—	GbE	—	USB 2.0	
Cubieboard 4	Allwinner A80	ARM Cortex-A15x4	Linux, Android	8GB eMMC	SD	Yes	VGA	GbE	b/g/n	USB 2.0 USB 3.0	
BeagleBone Black	TI Sitara AM335x	ARM Cortex-A8	Linux, Android, Windows	4GB eMMC	microSD	Yes	—	10/100	—	USB 2.0	
OLinuXino A20 LIME2	Allwinner A20	ARM Cortex-A7	Linux, Android	4GB flash optional	microSD	Yes	—	1000	—	USB 2.0	
Radxa Rock	Rockchip RK3188	ARM Cortex-A9	Linux, Android	8GB flash	microSD	Yes	AV-output	10/100	b/g/n	USB 2.0	

Windows CE.

Programming/debugging tools are also often free and open source, such as those based on Eclipse IDE. Other tools that are tailored to a specific processor often used by professionals include ARM's DS-5 or vendor-specific tools such as Freescale's CodeWarrior or Texas Instruments' Code Composer Studio.

While SBCs can be used for most

purposes, many have originally been designed for a specific purpose or application. A perfect example of this is Raspberry Pi, which was developed as an educational tool to help encourage and strengthen students' programming skills.

BeagleBoard and BeagleBone were also developed to help educate and promote the benefits and usage of open source hardware and soft-

ware in embedded computing.

Atmel's SAMA5D3 Xplained has been designed for rapid prototyping development, and RIOTboard focuses on Android development to enable the development of the Internet of Things (IoT).

Other well-known boards include PandaBoard, OlinuXino as well as a whole host of Allwinner ARM system on chip (SoC) based SBCs.

**TABLE III
ARDUINO FOOTPRINT-COMPATIBLE BOARDS**

Name	Processor	Maker
SaintSmart Mega 2560	ATmega2560	SainSmart
Freeduino SB	ATmega328	Solarbotics Ltd



Fig. 2: The world's cheapest computer, CHIP

**TABLE IV
SPECIAL-PURPOSE ARDUINO-COMPATIBLE BOARDS**

Name	Processor	Maker
ArduPilot	–	ArduPilot
WIOT (Wireless Internet of Things)	–	–

**TABLE V
SOFTWARE-COMPATIBLE ONLY**

Name	Processor	Maker
Boarduino	ATmega168 or ATmega328	Adafruit

**TABLE VI
NON-ATMega BOARDS**

Name	Processor	Maker
Leaflabs Maple	STM32 (Cortex-M3)	LeafLabs
Freescale Freedom	Kinetis-L (Cortex-M0+)	Freescale
Sakura	Renesas RX63N	Renesas
GR-KAEDE	RX64M	Renesas

The long-term success of an SBC relies heavily on the performance-price ratio. The best performance-cost ratio comes from ODROID-U2, ODROID-X2, Raspberry Pi model B+, UG802, MK802, Cubieboard, VIA APC and HAckberry Board. The best RAM-cost ratio can be found in ODROID-U2, Hackberry Board and Raspberry Pi model B+.

Arduino-compatible boards

Although hardware and software designs are freely available under copy-left licences, developers have requested that the name Arduino be exclusive to the official product and not be used for derivative works without permission. As a result, a group of Arduino users forked Arduino Diecimila, releasing an equivalent board called Freeduino. Tables III, IV, V and VI enlist some common Arduino-compatible boards.

The future of development boards

Many of today's SBCs have the capability of modern-day PCs and tablets. This trend will continue as more powerful processors make their way into the embedded computing market as ever-increasing performance-price ratios rise, as well as additional manufacturers enter into this wild-west frontier of supporting open source hardware and software for both DIYers and professionals alike.

An additional trend we will continue to see is the availability of more accessories or add-on boards to be added to current SBC plat-

forms, giving users more options to control and have access to the outside world.

Professional engineers, on the other hand, can take these accessories and quickly add additional functionalities to their SBCs to develop working prototypes for currently on-hand projects.

CHIP. The world's cheapest computer, costing US\$ 9, is slimmer than a credit card. It is a tiny chip that can be used for editing documents, browsing the Internet and playing games. If used rightly, CHIP is capable of powering a wide range of small connected devices where cost-effectiveness and portability are of prime importance. It offers limited features when compared to other advanced computers, but considering the price, it is a very good buy.

System on module (SoM)/computer on module (CoM). This is a more appropriate choice for building embedded products. It is a complete embedded computer built on a single circuit board. With Moore's Law in action, microprocessors and memories have moved to smaller process nodes within two years, which is less than the expected standard product life time.

Customers' demands, which include advanced performance, low power consumption and compact machines, necessitate frequent design updates to the embedded platform. These design updates add to the development cost. By using pin-compatible SoMs for embedded development, we can escape from this deficiency.

Pin-compatible modules from Toradex enable plug-and-play for scaling-up platforms based on future technologies and market requirements. New modules can be easily connected to existing carrier boards; the application software may need some minor updates. **EFY**

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What's New In The Latest MICROCONTROLLERS



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Targeting the simple application tier, microcontroller (MCU) vendors continue to drive their products to break new limits of cost, current drain and size, while adding features to ease development, hoping to entice embedded system developers. What do the latest MCUs offer this year? Let us take a look.

IoT-targeted MCUs

"New or established, every semiconductor vendor needs a new paradigm to solve four critical issues in the Internet of Things (IoT), namely, design time, differentiation, time to revenue and design cost," explains Alexandru Voica, senior technology specialist, Imagination Technologies, in an interview with EFY. He adds that, in the IoT market, consumers have high expectations; devices need to be affordable, power-efficient and must work out-of-the-box.

IoT-targeted MCUs look mostly at network connectivity in the form of wired (Ethernet) or wireless (Wi-Fi, Bluetooth or others), lower power and a wide range of sensors like temperature, motion or humidity.

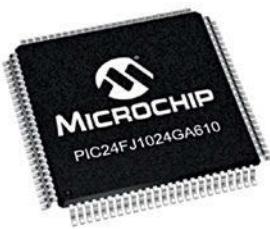
T. Anand, managing director, Knewron, says, "I would bet mostly on addition of communication standards like Wi-Fi and Bluetooth Low Energy (BLE). An upcoming chip from Espressif Systems has both Wi-Fi and BLE put together in

Chip: PIC24FJ 1024GA610/GB610 family

Company: Microchip

Features:

- PIC24F 16-bit MCU featuring large dual-partition flash with live update capability
 - Includes up to 1024kB flash, 32kB RAM, USB and advanced peripherals
 - A combination of features makes it ideal for always-on applications and applications that require high memory
- Architecture:** 16-bit



one system on chip (SoC), ESP32, which could be another game-changer."

Ingenic M200 is another good example of an innovative SoC built from the ground up for wearable devices. It implements a power-saving hardware architecture where a high-performance microprocessor without interlocked pipeline stages, having a central processing unit (CPU) clocked at 1.2GHz, tackles most of the heavy-lifting, while less-demanding tasks are handled by a secondary low-power 300MHz MIPS CPU.

Besides the usual migration to higher-density technology node (90nm and beyond) to deliver more features, last year memories and computing power in the same or smaller die area (following Moore's Law) also saw the first ARM Cortex M7 core product as well as the first low-power ARM Cortex M4 as a mix of low power consumption and power-processing performances. This suits perfectly the new wave of wearable products' requirements, according to Franck Martins, MCU marketing and application, senior manager, GC&SA region at ST Microelectronics.

However, Aravind Navada, senior engineering manager, Integrated Systems and Transceivers Group, Analog Devices, India, has a very different perspective. He says, "In my opinion, there is no such thing as an IoT-targeted MCU.

What's new

- New MCUs on 40nm process node
- Semiconductor firms moving up from silicon level to platform level
- New tools being delivered to lower software development and maintenance costs
- Tamper-protection and encryption features are coming with the chips. Some examples are BroadSAFE, SafeAssure and hardware safety modules
- Support for newer communication interfaces
- Better peripheral and sensor integration

SOME POPULAR MCUs AVAILABLE IN THE MARKET

Product/Family	Company	Features	Applications	Architecture
PIC24FJ 1024GA610/GB610 family 	Microchip	<ul style="list-style-type: none"> • PIC24F 16-bit MCU featuring large dual-partition flash with live update capability • Family includes up to 1024kB flash, 32kB RAM, USB and advanced peripherals. A combination of features makes the part ideally suited for always-on applications and applications requiring high memory 	—	16-bit
Apollo ultra-low-power MCU 	Ambiq Micro	<ul style="list-style-type: none"> • Features active mode current in the order of $34\mu\text{A}/\text{MHz}$ when running from flash and sleep mode current less than 150nA • Available with a range of memory options from 64kB to 512kB of embedded flash memory • Includes 10-bit ADC • Offered in both BGA and WLCSP package options 	<ul style="list-style-type: none"> • Wearable electronics • IoT devices • Wireless sensors • Consumer medical devices • Consumer electronics • Smartwatches • Smartmeters • Battery-powered applications 	32-bit
Arduino Yun 	Arduino	<ul style="list-style-type: none"> • Based on ATmega32u4 and Atheros AR9331 • The board has built-in Ethernet and Wi-Fi support, USB-A port, micro-SD card slot, 20 digital input/output (I/O) pins (of which seven can be used as PWM outputs and 12 as analogue inputs), 16MHz crystal oscillator, micro-USB connection, ICSP header and three reset buttons • Onboard Linux distribution 	—	8-bit
EFM8LB1 [EFM8 Laser Bee 8-bit (MCUs) family] 	Silicon Labs	<ul style="list-style-type: none"> • Pipelined 8-bit 8051 MCU core with 72MHz operating frequency • Up to 29 multifunction I/O pins • One 14-bit, 900 kspS ADC • Up to four 12-bit DACs with synchronisation and PWM capabilities • Two low-current analogue comparators with built-in reference DACs • Internal calibrated temperature sensor ($\pm 3^\circ\text{C}$) • Internal 72MHz and 24.5MHz oscillators accurate to $\pm 2\%$ • Four channels of configurable logic • 6-channel PWM/PCA • Six 16-bit general-purpose timers 	<ul style="list-style-type: none"> • Optical network modules • Precision instrumentation • Industrial control and automation • Smartsensors 	8-bit
MSP430FR2633 	Texas Instruments	<ul style="list-style-type: none"> • Lets designers build HMI with capacitive buttons, sliders, wheels or proximity (BSWP) sensors • Features non-volatile memory and can support 16-button self-capacitance as well as 64-button mutual-capacitance modes • Wake-on-touch hardware on chip can continuously scan up to four electrodes while CPU is shut down 	<ul style="list-style-type: none"> • Thermostats • White goods • Electronic access control • Small appliances • Lighting control • Personal electronics • Electronic door-locks 	16-bit RISC
SMART SAM E70	Atmel	<ul style="list-style-type: none"> • Has up to 2048kB of flash and 384kB of configurable SRAM, and offers up to 114 programmable I/O pins as well as an ultra-low-power real-time clock and 32-bit ultra-low-power real-time timer • Dual 12-bit analogue-to-digital converters with analogue front-end offering offset and gain error correction • Twelve general-purpose 16-bit timers 	<ul style="list-style-type: none"> • IoT or smartenergy gateways • Industrial automation • Building control applications 	32-bit
TMPM066FWUG, TMPM067FWQG, TMPM068FWXBG (under development) 	Toshiba	<ul style="list-style-type: none"> • ARM Cortex-M0 core • Maximum frequency: 24MHz • Built-in USB device controller • Small pin packages • Multiple serial interface function including SPI, I2C (fast mode plus) and others • Bit-banding 	<ul style="list-style-type: none"> • Tablets • PCs • Digital equipment • Industrial controllers • Office automation equipment • Sensor hubs 	—

MCUs in general are an integral part of IoT use cases. While the IoT encompasses a lot of applications (both battery-powered and line-powered), MCUs in the future

would see integrated connectivity (both wired and wireless)."

Rise of Type-C

Navaneethan Sundaramoorthy, co-

founder and CMO, Uncanny Vision Solutions, explains that the most exciting feature for him in the last 18 months has been the introduction of universal serial bus (USB) Type-C in-

How modern MCUs achieve even lower power consumption

MCUs have dramatically dropped their RUN currents, allowing themselves to run more often, thereby allowing more features to be designed into the application software. In the past 18 months, we have seen MCUs with low-power libraries, gate-level optimisation and power gating on a rise. Performance-per-watt levels have evolved in many embedded applications to enable power-efficient designs, which help end users to conserve energy. Energy trends and power management are thus the key technology trends that designers are looking for nowadays.

—*Sanjay Gupta, director, automotive MCU, India Design Centre, Freescale Semiconductor India Pvt Ltd*

Key ingredients to a successful IoT recipe

- Low power performance (mainly for a battery-operated device)
- Medium to high D-MIPS performance (to operate under real-time constraints, some medium to high embedded complex software)
- Enough communication interface (SPI, I2C, USART) to connect to various sensors
- Display controllers (LCD/TFT/MIPI)
- Small package for optimised PCB form factor
- USB for battery charging and data communication
- Flexible memory configuration option (flash/RAM) for over-the-air upgrade

—*Franck Martins, MCU marketing and application, senior manager, GC&SA region at ST Microelectronics*

terface in MCUs from Cypress, Texas Instruments, NXP and others. “While USB Type-C has just entered the market in late 2015, it is going to rapidly reach more than a billion consumers within the next 18 months—starting with smartphones, personal computers and tablets,” he says.

“USB Type-C is the biggest change in USB interface and, as described by many industry observers, it will soon be the one cable to rule them all. With its ease of use through reversible connections, higher power-carrying capability and flexibility to carry multiple types of data (video, USB, etc), it is going to pervade lots of electronics,” Sundaramoorthy adds.

Packing high-end performance

Baikal-T1 processor is the first Russian offering for the communications market to use a MIPS P-class Warrior CPU, boasting highly-competitive properties in terms of performance, technology node and compatibility.

Martins says, “Though the upper boundary level of MCU has been constantly pushed up in the past few years, thanks to higher speed

and processing power likewise, with the latest introduction of ARM cortex M7 (STM32F7) and STM32 enhanced architecture element such as ART accelerator, there is still a quantic barrier made up by the operating system (OS), which cannot be run out of MCU platform. Only a microprocessor unit (MPU) with a memory management unit (MMU) can operate iOS or Android OSes.”

Voica says, “We now have chips available, like M-class M5150 MCU, which integrate digital signal processing (DSP) and single instruction multiple data (SIMD) functionality, virtualisation support and advanced security features plus an MMU and cache controllers, which enable these to run full-fledged OSes like Linux.”

“Nevertheless, it is true that more functionalities previously handled by MPUs are managed by the MCU. For instance, the sensor-hub function (fusion of various environmental sensors data) that was implemented by the main AP (application processor or MPU) is now covered by a dedicated MCU with outstanding power-consumption benefit for battery-operated devices such as smartphones,” adds Martins.

Reducing manufacturing costs

“Broad technology changes in the last 18 months are mostly incremental and evolutionary such as continued lower power and better integration with more features like camera interfaces,” explains Sundaramoorthy.

Newer MCUs come with integrated functionality that was previously handled by external components. This allows design engineers to reduce their bill of materials (BoM). Availability of multi-standard support for communication standards, sensor fusion or hardware based security are all small but definite steps towards a more integrated, smaller and less expensive end system.

While cost savings are very minute on an individual level, these greatly add up with volume. Moreover, these simplify or solve many other problems faced while placing numerous components onto a circuit board that has to shrink with each successive generation to keep up with customer requirements.

“If everything is integrated together in a module, overall size and cost of the IoT solution will also be extremely less, thereby making products competitive. Engineers today are looking for MCU-integrated modules, where they can write their own applications,” explained Dhiraj Sogani, general manager and senior vice president, Systems Business Unit, at Redpine Signals Inc., in an interview with EFY. Redpine Signals has solutions coming up where an MCU will be integrated inside modules for vehicular communication.

The vision

The features we would like to see in more MCUs are in the area of vision capabilities. Adding computer vision to IoT MCUs will dramatically increase their applicability in broad areas including security/surveillance, drones, robotics and so on.

Key features needed in MCUs to support computer vision are integrat-

ed image or camera sensors with newer technologies like RGB-IR sensors for better low-light sensitivity and faster processors like ARM Cortex-A series processors to handle more computationally-intensive vision processing.

Newcomers like STM32F4x9 with HW graphic acceleration (Chrom-ART accelerator) and MIPI support are good for applications with displays. Embedded hardware with PDM-to-PCM conversion (DF-SDM on STM32L4), together with low-power batch-acquisition mode, allows voice-recognition feature to run efficiently on STM32 platform.

Driving ultra low power

With significant integration and lower cost requirements, MCUs have been going down process nodes more aggressively than in the past.

Navada explains that most MCUs announced in the last 18 months have brought power consumption down by going to deeper sub-micron processes and adding features such as power shut-off. Wireless connectivity and MCUs are now showing up either in a single package or on monolithic silicon as MCUs and connectivity are going hand in hand. Finally, power management features such as buck converters are getting integrated into MCUs to allow better power efficiency.

As mentioned above, the fact that dynamic power and area reduce at advanced geometries and aggressive integration requirements, lower process node such as 55nm and below are becoming common place. “Requirement of integrated flash puts a brake on going down all the way to the most aggressive process geometries used by micro-processors. Aggressive power shut off, multi-voltage and low-voltage designs are some of the architectural changes seen in reducing power consumption,” adds Navada.

Martins further explains that

What is the difference between CPUs and MCUs?

Versatility of MCUs is being proven yet again as MCUs find their way into new applications that are driving semiconductor growth. These play a major role not only in terms of speed and performance, but also in terms of intelligence at a higher level. These are the primary broad advances in the new MCUs. Unlike CPUs, which advance technology node, MCUs with their peripherals and multi-functional capabilities have to address a wide range of applications used in different industries. For example, in automotive, MCUs have to be reliable, as these are high-performing. AURIX MCU for automotive has ten cores, four of which are core-checkers for ensuring that six multi-cores are properly working at all times in the harsh automotive environment. With advances in technology and small node size, cost difference between 32-bit and 8-bit or 16-bit is becoming less significant. It is foreseeable that 32-bit architecture is becoming the mainstay architecture for MCUs.

—**Vishal Malhotra**, national sales head - automotive, Infineon Technologies, India, and **Andy Wong**, senior regional marketing manager for Industrial Microcontroller (IMC), PMM division, Infineon Singapore APAC

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- **T. Anand**, managing director, Knewron
- **Vishal Malhotra**, national sales head - automotive, Infineon Technologies, India

process technology improvements (going towards smaller technology lithography) tend to further lower internal core voltage to minimise dynamic power consumption, but not without control over leakage current responsible for consumption in low-power/standby mode. He adds, “Power consumption cannot be judged only from datasheet values but rather depends on real application profile results. There are many embedded MCU features that contribute to optimise power consumption with batch-acquisition mode, ART accelerator and DMIPS (to execute the same code in less time, which leads to less power consumption), highly-flexible clock speed and source selection, along with scalable internal voltage.”

The future

As we already know, the line between MCUs and SoCs is getting blurred. Looking at the advances that have happened, blurred seems to be an understatement. Cores are now available from firms like Imagination Technologies, which allow MCU or embedded controller developers to build MCUs that can go so far as to execute full-blown OSes like Linux.

When can you start using such chips in your project? For starters, Microchip has already announced on their website that the CPU at the heart of their PIC32MZ family has been upgraded to a MIPS M5150—a Warrior M-class processor core that comes with full hardware virtualisation. **EFY**

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AMERICAN CARRIER STRIKE GROUPS: An Electronic Perspective



B. Kamalanath
is a technical writer. He is also a research scholar, pursuing Ph.D in military technology

In the last four parts of this article we covered air defence warfare, electronic warfare (EW), under-sea warfare, strike warfare and air operations. In this concluding part, let us take a look at command and control (C^2) operations as well as cruise control operations.

Radar—A revisit

All surveillance and navigation radars are situated high up in the mast. In the age of sail ships, observers used to sit high up in the mast. Who can forget the observers ringing the bell after seeing the iceberg in the movie Titanic? Radars sitting high up in the masts give a greater radar horizon. Radar horizon is the maximum range at which radar can detect a target against the curvature of earth.

But presence of so many communication and detection equipment in the mast in interference. This requires

certain systems to be turned off when another system is working. If the turned-off system is an important system, and if the enemy knowingly or by chance chooses to attack during this window, the result can be catastrophic.

C^2 operations

Whatever may be the strength of force, it is only the right commands given at right times can make the force lethal. The commander who commands the carrier strike group (CSG) must know what is happening around him, the strengths and the weaknesses of the group.

For example, what will happen if the commander issues a command to launch a surface-to-air missile (SAM) when stocks of SAM have been exhausted? He must know the threats and his capabilities, and must be present in the carrier to command the CSG.

For effective command, the commander requires an efficient C^2 system. Backbone of C^2 systems is the communication systems that include voice links and datalinks.

Communication systems

The mast of the carrier is littered with numerous antennae—protected by radomes—for various communication systems and datalinks present in the CSG. Almost all sorts of antenna systems are seen in the carrier right from whip antennae situated in the flight deck to wire-fed fan antennae present above the superstructure. A plethora of communication systems operating at various frequencies and following various techniques of transmission could be found in the CSG.

Terrestrial radio communication. It has both military and non-military radio communication facilities operating in MF, HF, VHF and UHF bands. Military communications are secured through encryption



Fig. 30: Radars in the mast of the carrier. The reader may try to identify the radars present in the masts of the carrier. This image covers many radars and also an ECM module (Image courtesy: US Navy)

and are used to communicate with CSG members. Even if the enemy intercepts military communication, they will not be able to understand the message.

VHF is used for ship-to-ship or helicopter-to-ship communications. Military HF and MF have a range of around 300km. VHF and UHF, due to their high-frequency-induced attenuation, have a range of around 100km.

Non-military radio communication is not secure. It is used to communicate with harbours, ships and aircraft of civilian or neutral origin. Non-military UHF systems can be used up to a range of 50km; all other band systems have the same range as that of their military counterparts.

Satellite communication systems. Aircraft carrier, being the commanding ship of the CSG, has a variety of dedicated satellite communication systems for various purposes. Long-distance communications are carried out through the USA's defence satellite communications system (DSCS), a dedicated satellite based communication network. This high-capacity global system uses SHF band geostationary communication satellites that orbit equidistantly around the world.

On the other hand, short-distance communications are managed by fleet satellite communication (FLTSATCOM). Typically, this type of communication is between two CSGs or intra CSG communication or shore-to-CSG communication.

Satellite communication is carried out in two modes: receipt and broadcast. Receipt mode requires the recipient to send an acknowledgement message for each message it receives. Whereas, broadcast method, also called do-not-answer mode, does not require an acknowledgement message.

In the latter mode, the CSG can

keep on receiving the data that are sent to it. The great advantage is that the CSG can preserve radio silence. Because, the moment it sends an acknowledgement message, the enemy electronic support measure (ESM) systems can find the CSG's location. Through this mode, the CSG can receive situational updates without revealing its position.

Tactical digital information links (TADIL)

These tactical datalinks are the bridge between C² systems of individual ships. Through these datalinks, Aegis ships exchange data between them and also with the carrier, so that overall C² is maintained.

HMS Sheffield—a destroyer of the UK—was sunk during Falklands War by Argentine aircraft launching French-made Exocet anti-ship missiles. It is said that at the time of attack, the ESM module of the EW system was not on due to interference problems with satellite radios. Had the ESM been on, perhaps, that ship could have survived the attack

Link-4A. When airborne early warning (AEW) aircraft detect incoming enemy bomber, F-18 aircraft on patrol are instructed to fly towards the general area of the incoming enemy bomber. On reaching the area, these are vectored (giving directional commands) to intercept the bomber.

These are vectored through a datalink. The aircraft computer display in the pilot's head-up display

(HUD) shows the waypoints to be followed to intercept the bomber.

Link-4A is one such data link. It is a non-secured two-way datalink used for providing vector commands to combat aircraft. It operates in UHF band at a data rate of 5kbps. It follows time-division techniques. Also, aircraft are communicated during the following processes: automatic carrier landing system (ACLS), air traffic control (ATC) and during combat strikes.

Generally, Link-4A's transmissions are not secure and could be jammed by enemy ECM. On the positive side, it is considered easier to operate and maintain. Because of these reasons, this very old datalink is still being used by the US Navy. In a carrier, there are ten channels for this link and the typical range is as far as 500km.

Link-11. Link-11 is a half-duplex high-speed encrypted datalink. It operates in HF and UHF bands. It facilitates computer-to-computer digital data communication between aircraft and ships. Even if the signals are intercepted by the enemy, these cannot be understood by them because of the encryption. Data can only be decoded at the receiving terminal.

Positional information of the transmitter is also sent along the data so that the receiver can know the sender's position. This feature is an important aspect of combat communication. Typically, data sent by a ship to the aircraft is received by appropriate receivers in the aircraft. There, these are decoded by decoders and sent to the aircraft computer.

Then, information is displayed to the pilot in a format that he or she can understand. Data can be anything like waypoints that have to be followed for reaching the new destination or positional data of the enemy combat aircraft.

Combat aircraft have an

electronic system called moving map display, which displays the map of the terrain over which the pilot flies. As the pilot flies ahead, the map also scrolls up accordingly. Waypoints are updated in the display through this datalink. In the carrier, there are 62 Link-11 datalink channels available. Each datalink is capable of communicating as far as 300km.

Link-16. Link-16 is a node-less, jam-resistant, high-speed, encrypted digital datalink. It operates in 960MHz-1215MHz band. Based on TDMA technique, it is used by aircraft, ships and even ground forces to exchange their tactical pictures in near-real-time.

Typically, commanders of the CSG at sea can even get tactical pictures around ground forces operating deep inside enemy territory. Link-16 supports exchange of text messages, imagery data and provides two channels for digital voice communications with a data rate of 2.4kbps and/or 16kbps in any combination. The range is around 500km and there are 255 Link-16 datalink channels available in the carrier.

Officer-in-tactical command information exchange sub-system (OTCIXS). This is a two-way UHF satcom based datalink system for intra- and inter-CSG communication. This link supports the exchange of targeting information for multi-targeting of sub-surface, surface and aerial targets. A ship can get radar track data from other ships through this link even while not using its radar at all. This is called over-the-horizon (OTH) targeting.

Tactical data information exchange sub-system (TADIXS) downlink. This is a shore-to-ship one-way satellite datalink for the ships to receive mission plans for launching Tomahawk Land Attack

Missiles (TLAMs).

Sonobuoy datalink. This datalink connects sonobuoys with the under-sea warfare system present in destroyers. These dispensable sonobuoys are dropped by the submarine hunting helicopters in the areas suspected with enemy submarine activity. The under-sea warfare system deduces the submarine scenario through these datalinks.

C² systems

In a carrier, the storey above the flight-deck is called flag bridge. Commander of the CSG controls all operations from a command centre called tactical flag command centre



Fig. 31: A GCCS-M display (Image courtesy: US Navy)

(TFCC), situated in this bridge. In naval parlance, flag indicates something related to the commander of a fleet.

Commander of the CSG gets instructions from his high command through a satellite based C² system called global command and control systems-maritime (GCCS-M). Through this system, commander of the CSG provides situation reports to his high command.

A system called advanced combat direction system (ACDS) creates the tactical picture around the CSG. Display of the ACDS gives the CSG commander the tactical picture around the CSG for taking combat decisions.

Similarly, captain of the carrier has another parallel ACDS display at his command centre called combat direction centre (CDS) from where he or she gets the tactical picture around the carrier.

Global C² systems-maritime (GCCS-M). GCCS-M is a system that receives, processes, displays and manages data on the readiness of neutral, friendly and hostile forces in near-real-time. It does this via external communication channels, local area networks and direct interfaces with other systems. Any information the CSG commander required for the mission, be it intelligence or meteorological data, is sent through this system from the higher ups. It is through this GCCS-M system that the commander of the CSG takes orders from the higher command and passes situation reports to the higher command.

For a CSG commander, GCCS-M aids in the decision-making process by displaying relevant tactical information. For example, the CSG is anchored 300km from enemy shore. Job of the CSG is to neutralise an enemy nuclear missile base situated 200km inland. The condition for neutralisation is that the missile base readies itself for a nuclear missile launch. But, how will the CSG commander know that the nuclear missile base is ready for missile launch?

This information can only be gathered by people of the likes of a man drinking a Vodka Martini and who is addressed as 007. Purely, the data he collects is intelligence related. Such information is not available through the CSG's resources for the CSG commander. So in this case, intelligence has to be supplied by the high command to the CSG commander.

If the enemy nuclear missile base readies for a missile launch, the



Fig. 32: ACDS display (Image courtesy: US Navy)

CSG commander is issued an order to neutralise that base. This is done through GCCS-M. For such information exchanges, datalinks TADIXS and OTCIXS play a vital role.

The CSG commander can also access information through special wireless Internet systems. CSG is a node in secure internet protocol router network (SIPRNET), non-secure internet protocol router network (NIPRNET) and joint worldwide intelligence communication system (JWICS).

SIPRNET is a military Internet system owned by Department of Defence (DoD) of the USA. It has only restricted access. Through this Internet, classified information is passed through packet switching.

NIPRNET is a type of Internet that is used to exchange sensitive but non-secret information between privileged users and at the same time provides them Internet access. Again, Internet Protocol routers are owned by DoD of the USA.

JWICS is DoD's, top-secret version of the Internet, together with its secret counterpart, SIPRNET.

Previously, GCCS-M was implemented through high-performance UNIX workstations because of their capability to run GCCS-M specific software. The trend of availability of increasing computing power and increasing software versatility is leading to a migration of GCCS-M towards off-the-shelf systems.

ACDS. This is a centralised,

automated C² system. It is used to collect and correlate combat information on the air, in the surface, sub-surface and EW environments. It acts as a central repository of all tactically significant targets (detected by radars and sonars)

for the CSG.

ACDS is a comprehensive system and contains many computers, a display system with many consoles. It integrates on a mainframe computer the information from carrier's sensor systems, datalinks, navigation/air traffic control systems and weapon systems. This system is operated by 23 crew members.

Computers running application-specific software collate and correlate data. All surface and air search radar tracks and sonar tracks are communicated to the ACDS by Aegis ships of the CSG through datalinks. The respective ships derive their coordinates from their navigation systems called inertial navigation system, cross referred by a GPS.

This they send with their identification data while sending track data. ACDS, after receiving all data, correlates it with various similar tracks and positional coordinates of that ship. For example, two ships present in the CSG but sailing at different locations might have sent track data of the same enemy aircraft to the ACDS. In reality, these tracks are nothing but the track of the same aircraft taken from different locations.

ACDS, after correlation, classifies that track as the same aircraft by comparing the positional coordinates sent by the ships. This is called grid-locking. Like this, the ACDS displays the tracks accord-

ingly to provide an overall tactical picture around the CSG. This gives the CSG commander the capability to identify targets, classify these and prioritize threats for easy decision making.

Based upon the threat, the commander initiates engagements like vectoring combat aircraft to targets, or launching SAM from a destroyer, or launching anti-ship missile from a destroyer.

Generally, all constituent ships of the CSGs are delegated with responsibilities to deal with threats occurring in their sectors. In one Aegis cruiser, the air defence command centre of the CSG, there is an air defence warfare commander working full-time. His or her commands are executed by the captains of Aegis cruisers and destroyers.

Similarly, there are commanders for underwater warfare, surface warfare, EW and strike warfare. The CSG commander can also exchange targeting information and engagement orders, not only within his or her CSG but also with other CSGs.

Cruise-control operations

Cruise-control operations involve navigation and propulsion operations, and are carried out in a similar way as commercial shipping navigation.

Navigation. Navigation was done through compass in the olden days; then emerged sextants and printed navigation charts. These printed navigation charts are like a detailed map but for sea routes, and indicate depth of a certain area in the sea, width of straits and other information. Now, these charts are the tools of the past and are only used as a fallback option today. Their roles have been taken over by a system called electronic chart display and information system (ECDIS), which takes inputs from electronic navigation charts (ENCs) and displays the area of interest.

These ENCs have complete

hydro-graphical information like navigational hazards, depth of a particular place, width of the navigable channel and a lot more, as electronic data.

GPS is used to find out the precise position of the carrier and other ships. This positional information is fed to the ECDIS, which displays all relevant data so that the navigator gets the complete idea of his or her position and surroundings.

Radar AN/SPN-67, which is also used in a ship self-defence system (SSDS) is used for navigation. Along with this radar, a radar called AN/SPS-64 is also used for navigation. This radar operates on a fixed frequency of 9GHz and has a peak power output of 20kW. Its antenna can rotate at speeds up to 33rpm, which provides a high degree of target resolution and also allows target information update for every two seconds.

After detecting contacts through this radar, a system called automatic identification system (AIS) helps in identifying the nature of the contact. AIS is a system that all sea-going non-military vessels must possess. It relays its identification in radio frequency (like identify friend or foe, or IFF).



Fig. 34: A helmsman on the bridge of a carrier (Image courtesy: US Navy)

Generally, the required instructions for navigation are given by the captain from the combat direction centre (CDC). Necessary information like a copy of navigation radar displays is available at the bridge, which is the command centre for sailing the carrier. This bridge is the first storey above the flight deck. From here, sailors called helmsmen, control the sailing operations. Aegis escorts also have similar navigation radars and helmsmen controls.

Propulsion. A carrier's propulsion power comes from the electricity generated from two scaled-down nuclear reactors. These produce a shaft horsepower of 140MW to drive



Fig. 33: Screen behind the woman sailor is ECDIS (Image courtesy: US Navy)

propeller shafts. Electronic systems that are used in controlling the nuclear chain reaction and associated functions of normal reactors are also found in the carriers.

These reactors can work continuously for 20 years without requiring any refuelling.

With the aid of these reactors, carriers can reach speeds of 55kmph with ease. In naval parlance, sailing at this speed is like driving a Formula One car, and almost 100 thousand tonnes of mass sailing at this speed is something unimaginable.

Other vessels of the CSG are not nuclear powered but are powered by diesel-fuelled gas turbine engines. Controls of these propulsion systems also resemble industrial-class designs with military standard.

Russian carriers: The other side of the coin

Definitely, American CSGs are a force to reckon with. But one cannot forget Prince Hector or Karna while speaking about Achilles and Arjuna, respectively. So, such a detailed literature on American carriers will not be complete without mentioning the Russian carrier force.

Traditionally, Soviet Navy's and later Russian Navy's speciality is that these are a submarine dominant forces. Though there are very much capable surface vessels in their navies, dominance of their submarines is greater. As water is the best antidote for fire, submarines are a perfect match capable of standing toe to toe with the CSG. But it did not restrict Soviet Union to try its part on carriers.

Basically, pioneers in naval technology are Britons. British Empire

sustained with the strength of their navy. World's first carrier, HMS Argus, was a British ship. Many of the novel naval innovations are theirs, such as radars and sonars. After the 1970s, the UK restricted itself to small carriers with aircraft, known as Harrier, capable to take off vertically.

Britons installed a ramp called ski jump at the edge of the carrier. Harriers run through this ramp to get air-borne. Indian Navy is also operating such a carrier called INS *Viraat* and a handful of Harriers.

Strangely, Russians clubbed American and British practices. Russian aircraft take off by running through the ski-jump like British, and land by tail-hooking arrestor wires like Americans. But Russian carriers are not meant for strike operations. Their purpose is to protect Russian nuclear submarines that carry nuclear warheaded intercontinental ballistic missiles (ICBMs) from the American long-range anti-submarine aircraft.

Russian carriers are designed entirely to operate alone unlike American carriers. The present Russian carrier Admiral Kuznetsov has the features of an entire CSG, but is scaled down. The carrier has a dozen or so fighter aircraft, sonars, early-warning helicopters and even phased array radars like American Aegis ones. There are also anti-ship cruise missiles (also with land-attack capability) to hit targets at a range of more than 500km.

It is the most-protected carrier in the world. There are eight AK-630 close in weapon systems (CIWSs). There are 192 3K95 Kinzhal ready-to-be-fired SAMs of 15km range and capable of being launched every three seconds.

Apart from this, there are eight Kashtan CIWS-SAM combos. One combo contains two guns and 32 ready-to-be-fired 3K87 Kortik SAMs. So in total there are 24 CIWS and 192 + 256 SAMs.



Fig. 35: INS Vikramaditya, the Indian aircraft carrier (Image courtesy: Indian Navy)

Who can forget the climax aerobatic stunts of Arnold Schwarzenegger flying an aircraft like a helicopter in the Hollywood movie True Lies? That aircraft is the US version of The Harrier

Literally, these systems form a defensive bubble around the carrier against cruise missiles and also aircraft. A Soviet-era carrier called Admiral Gorshkov even had an automatic landing system to guide their now-retired Yakolev-41 aircraft, Soviet's answer to British Harriers.

This very same carrier has entered the Indian Navy as INS *Vikramaditya* and will serve the Indian Navy in the years to come. The carrier was intensively modified and refurbished for the Indian Navy. Now, it has become almost 80 per cent new. It also has an automatic landing system and will be getting a capable air defence system.

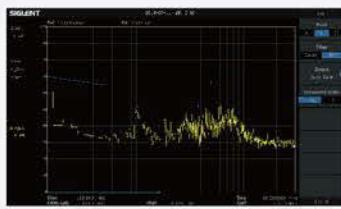
The CSG so far has been think-

ing about ways to tackle cruise missiles. But the Chinese development of a ballistic missile called DF-21D has changed the basics itself. This missile is said to have been developed to specifically target US Navy's CSGs. This ballistic missile will re-enter the atmosphere after its post launch flight through space.

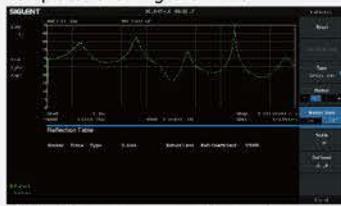
Until this point, there is no difference between this missile and other ballistic missiles. But this DF-21D—after re-entry—will open its target seeker and look for the carrier. The enormous size of the carrier's fight deck will be spotted by the seeker. The missile will then descent towards the carrier at a speed of 5-mach to 6-mach. At such speeds intercepting it will be very difficult. In the years to come, it will be interesting to see what the Americans are going to do to counter this missile.

In short, it is an eternal duel between Aircraft carriers and the means to counter aircraft carriers. As long as the carriers remain in the scene, this duel will be on. As long as this duel goes on, both sides will use intelligent electronic systems as their weapons. **EFY**

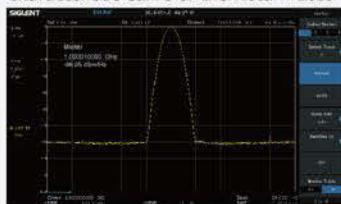
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Phase Noise	<-98 dBc/Hz@1 GHz, 10 kHz offset	
Amplitude Precision	< 0.7 dB	
TG-SSA3000X (Opt.)	Tracking Generator Kit	
EMI-SSA3000X (Opt.)	EMI measurement kit	
AMK-SSA3000X (Opt.)	Advanced measurement kit	
Refl-SSA3000X (Opt.)	Reflect measurement kit	
UKitSSA3X (Opt.)	Utility Kit: N (M) -SMA (M) cable, N (M) -N (M) cable, N (M) -BNC (F) adaptor (2 pcs), N (M) -SMA (F) adaptor (2 pcs), 10 dB attenuator	
RBSSA3X20 (Opt.)	Refl-SSA3000X, RB (1 MHz~2 GHz), N (M) -N (M) adaptor (2 pcs)	
SRP5030 (Opt.)	Near Field Probe: H field probe (4 pcs), N (M) -SMA (M) cable, N (M) -BNC (F) probe	



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Manufacturing:

My Vision Is To POSITION ANDHRA PRADESH On The WORLD MAP For ELECTRONICS Manufacturing

Andhra Pradesh aims to attract investments to the tune of US\$ 5 billion in the ESDM sector and create employment for 400,000 people by 2020. N. Chandrababu Naidu, chief minister of Andhra Pradesh, shared his vision to develop the electronics industry into an important growth engine for the entire state, in a conversation with Sudeshna Das, senior executive editor, *Electronics Bazaar*. He aims to do this through effective use of the state's talent pool, continuous skills enhancement, by promoting innovation and future technologies, as well as by creation of excellent infrastructure

Q. What is your vision for the electronic system design and manufacturing (ESDM) industry in the state?

A. India is one of the largest consumers of electronics goods. Demand for electronics hardware in the country is projected to touch US\$ 400 billion by 2020. This will create an import bill of US\$ 296 billion (on a business-as-usual basis)—greater than India's projected oil import bill at the time.

We are now on the verge of an electronics manufacturing revolution

in India. The sector has been identified as one of the focus sectors under Make in India programme.

My target is to attract investments to the tune of US\$ 5 billion and create employment for 400,000 people in the ESDM sector by 2020, in Andhra Pradesh.

My vision is to position Andhra Pradesh on the world map for electronics manufacturing, similar to how the erstwhile state was firmly placed on the world information technology (IT) map.

Q. What unique strengths of the state will investors in the ESDM sector and in electronics design, specifically, find attractive?

A. Ever since my government took over, we have given priority to infrastructure and industrial growth. Apart from leveraging our long coastline through port-led development, we have focused on setting the platform for manufacturing through 24x7 quality power supply, developing industrial land banks and promoting our skilled resource base.

Andhra Pradesh is the first state in south India to offer 24x7 power to industry. We have identified an industrial land bank of 300,000

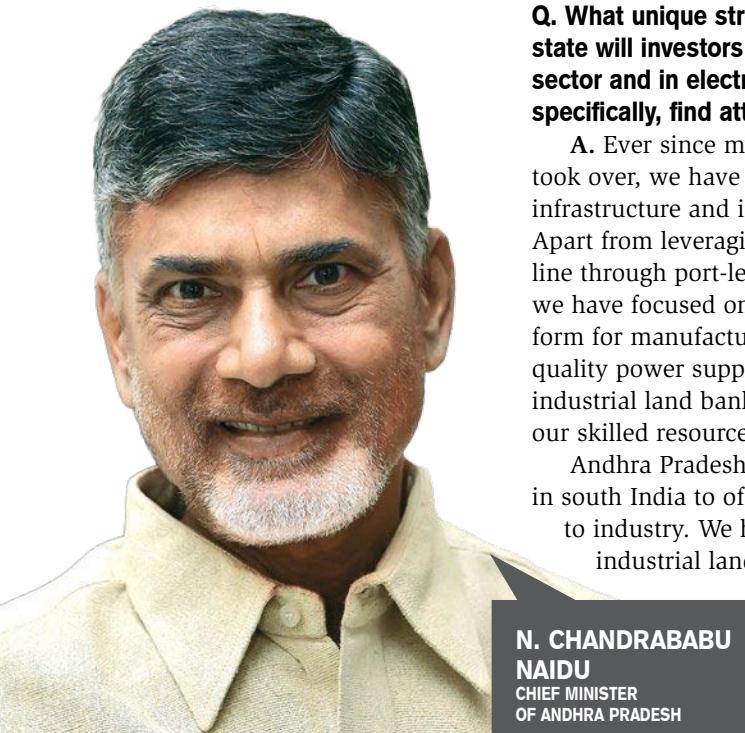
acres, and are targeting to add another 700,000 acres. We are planning to set up 20 electronics manufacturing clusters (EMCs) across the state.

The state houses 368 engineering colleges and 78 industrial training institutes (ITIs). We also have upcoming institutes of excellence such as IIT at Tirupati, IIIT at Sri City and NIT at Tadepalligudem. We have also set up Andhra Pradesh State Skill Development Corp. (APSSDC), and are partnering with private companies such as Siemens and Mitsubishi to set up skills development centres in the state. We are working on aligning the curriculum to industry needs.

We also have a very attractive electronics policy with best-in-class fiscal incentives that provide subsidies in areas such as land, power, skills development and taxes. Our policy complements and tops-up the incentives provided by the government of India, which makes it an extremely compelling proposition for investors in the sector. We have also established a new agency—Andhra Pradesh Electronics & IT Agency—that offers a single-window facility to ESDM companies.

Q. What is the Andhra Pradesh government's strategy to achieve the goals stated in Andhra Pradesh Electronics Policy 2014-2020?

A. Our strategy to make Andhra Pradesh a global electronics manu-



facturing hub rests on building core physical infrastructure, providing best-in-class policy instruments, developing a pool of skilled manpower and providing the most conducive business environment.

We plan to develop a mega electronics hub in Visakhapatnam, a hardware park in Kakinada and 20 EMCs across the state, including in the greenfield capital city of Amaravati. Four districts, namely, Nellore, Chittoor, Visakhapatnam and Krishna, have been designated brownfield EMCs.

Q. What are the steps taken by your government to ensure ease of doing business in the ESDM sector?

A. I am pleased to inform you that within 15 months of the bifurcation of the state, Andhra Pradesh has made an impact through its investor-friendly initiatives. It has been ranked second among states in the country with regards to ease of doing business as per World Bank's report for Department of Industrial Promotion & Policy.

We have a single-desk portal that provides all clearances and approvals within 21 working days to set up an industry in the state. Apart from this, we have introduced labour reforms, permitted self-certifications under relevant laws and online systems for registration and filing of returns of state taxes. We have also declared the electronics hardware industry as an essential service under Andhra Pradesh Essential Services Maintenance Act.

Our vision and continuous push is to transform the state into the best investment destination, not just in India but to compete with the best countries.

Q. What is the current investment status in the ESDM sector of the state, and what is the projection for this financial year?

A. My government believes in being proactive and following a targeted approach for attracting investments. Over the past 15 months, we have gained significant traction in the mobile manufacturing sector.

Foxconn has started manufacturing mobile phones from Sri City. Recently, Xiaomi's first made-in-India smartphone was launched; it was manufactured in Andhra Pradesh. Three of India's leading handset companies, namely, Micromax, Celkon and Karbonn, are also setting up manufacturing units in Tirupati.

I want to create a mobile manufacturing hub in Andhra Pradesh. Already, with the interest shown by mobile manufacturing companies, I am hopeful that six to seven million phones will be manufactured in the state by next year (2016), and around 30,000 to 40,000 new jobs will be created in the sector.

Q. What is the status of the different thrust areas mentioned in Andhra Pradesh State ESDM Policy 2014-2020 such as establishing 20 EMCs, a centre for excellence on fabless semiconductors and the like?

A. We have identified six locations, namely, Visakhapatnam, Vijayawada, Kakinada, Sri City, Tirupati and Anantapur, that are available for investors to start manufacturing units immediately. We will continue to identify and add EMCs in the state. Discussions are on with semiconductor companies to set up fabless semiconductor facilities, and there are plans to create a silicon campus, too.

Q. How does your government plan to ensure policy implementation for promoting electronics and IT in the state?

A. As I mentioned earlier, Andhra Pradesh has set up an agency (Andhra Pradesh Electronics & IT Agency) exclusively to address the needs of the electronics and IT industries. This is headed by professionals from the industry, who will help in understanding the needs of the companies and, hence, enable us to make the process of setting up and doing business in Andhra Pradesh easy. The agency is tasked with the responsibility of creating the ecosys-

tem needed for electronics manufacturing within identified clusters.

Q. How will the state foster entrepreneurship and an innovation culture in the ESDM sector?

A. Andhra Pradesh has laid heavy emphasis on promoting innovation and developing an entrepreneurial and start-up culture in the state. We have released an innovation and start-up policy with a target to have an entrepreneur in every family in the state. We want to incubate 5000 companies and start-ups, and have also proposed to mobilise a venture capital fund to drive innovation.

Andhra Pradesh is the first state in India to have a dedicated innovation society to foster innovation and entrepreneurship. The society has adopted a two-pronged approach:

1. Facilitate the setting up of innovation hubs in multiple locations where incubators help entrepreneurs to pursue their ambitions. We have provided state-of-art environment and infrastructure for the benefit of such entrepreneurs.
2. Facilitate the setting up of incubation centres at universities and institutes of higher education, with an aim to establish 100 innovation hubs across the state by 2020.

Q. What are the initiatives taken by Andhra Pradesh government to promote e-governance?

A. I have always been a keen proponent of using IT in governance. My focus is to make Andhra Pradesh the top state in terms of the quality and number of e-services in India.

We have Mee Seva project, which has been recommended by Department of Administrative Reforms and Public Grievances (DARPG) for country-wide replication. Currently, 311 services are being offered through Mee Seva. Another 150 services are being identified. With more than 4000 kiosks and a dedicated network to support the service, Mee Seva is one of the most robust citizen

service-delivery platforms. We target setting up 10,000 Mee Seva centres to ensure coverage across the state.

Providing gigabit connectivity to all villages is also my priority. Through Andhra Pradesh Fibre Net, we aim to deliver affordable broadband to everyone by 2018. Our objective is to bridge the digital divide through rural e-commerce and digital literacy.

With e-Pragati, Andhra Pradesh will become the first state in India to conceive and execute a state-wide enterprise architecture. The project has a one-government approach and uses the best principles of enterprise architecture. It is a comprehensive framework for implementing e-governance and provides e-services to citizens of Andhra Pradesh. e-Pragati will extend to 33 secretariat departments and over 300 government agencies in the state, and seeks to provide 745 services under one roof.

Q. What are the innovative marketing plans and platforms (like electronics bazaars) offered by Andhra Pradesh government to promote the ESDM sector in the state?

A. We have adopted a multi-pronged approach for marketing and branding the state as an ESDM destination. Our marketing is centred on concrete strengths of the state, including availability of a large industrial land bank, single-desk facilitation, 24x7 power, best-in-class policies and skilled manpower.

Additionally, visits by state government delegations to various countries and forums are being leveraged to gain media traction, and there is focus on our outreach programmes with electronics industry leaders. Separately, we also work with trade journals such as *Electronics Bazaar*, and participate in various exhibitions, conduct targeted road shows and investor activation campaigns.

Q. What are the outreach activities taken up by the state to ensure ef-

fective communication with ESDM ecosystem partners, including industry and academia?

A. The primary outreach activities fall into the following categories:

1. Periodic meetings and interaction with investors and those in the industry for addressing their needs
2. Targeted outreach campaigns to activate a broader investor ecosystem
3. One-to-one outreach to specific investment targets. This is the mainstay of our approach to attract marquee investors to the state

Additionally, with the formation of Andhra Pradesh Electronics and IT Agency, which is dedicated to promoting the electronics and IT industries, we will be able to reach out to existing and prospective investors in a more focused way.

Q. What initiatives has Andhra Pradesh government taken to facilitate the growth of the strategic electronics segment, besides announcing Aerospace and Defence Manufacturing Policy 2015-20?

How does your government plan to roll out different initiatives related to this?

A. Andhra Pradesh is one of the first states to proactively come out with an attractive aerospace and defence manufacturing policy. The state is already home to strategic electronics facilities run by Bharat Electronics Ltd, including its new Defence Systems Integration Complex, which is coming up in Anantapur district.

We plan to leverage these facilities to develop the necessary ecosystem to manufacture electronic components and build a supplier ecosystem in collaboration with small- and medium-size enterprises, which will invigorate the strategic electronics segment in the state.

We are now very keen on leveraging the interest of global aerospace and defence majors in setting up

manufacturing facilities in the state. These initiatives, we believe, will help develop and foster the strategic electronics segment in the state.

Q. What are the plans for skills enhancement in this sector, with special focus on micro, small and medium enterprises?

A. We have formed two societies, Society for Innovation and Society for Electronics and IT, which will work with educational institutes to upgrade the curriculum and ensure that students are industry-ready. We have also set up Andhra Pradesh State Skill Development Corp., which, in partnership with the industry, will work towards developing a significant base of skilled workers ready for industrial absorption. We will focus on setting up skill development centres at major industrial parks and clusters to facilitate continuous upgradation of skills.

Q. What is your message to the ESDM ecosystem partners?

A. Andhra Pradesh is poised for tremendous growth, and our journey has begun. The electronics industry is an important growth engine for Andhra Pradesh. The state has the second longest coastline in the country, and we are developing world-class ports to leverage this strategic advantage.

Our vast industrial land bank, 24 × 7 quality power supply, best-in-class policy instruments, conducive business environment, availability of water for industries, abundant talent pool, along with the state's focus on promoting innovation and future technologies, makes it one of the best investment destinations for the ESDM sector.

I am personally committed to positioning Andhra Pradesh on the electronics manufacturing world map, and I welcome ESDM industry leaders to make the state their business hub. **EFY**

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Components:

After 10nm, The Industry Could MOVE AWAY FROM SILICON

Design tool vendors often get to play with technology nodes long before the rest of the world even know these exist. In this interview, we sit down with a thought leader in the electronics design automation industry to get a glimpse of what is coming up. Walden C. Rhines, chairman and CEO of Mentor Graphics, speaks with Dilin Anand of EFY



Q. What are the three most exciting achievements in the electronics industry right now?

A. There are three big things happening. First, we are seeing the most prolific new technology nodes in our recent history.

Second, we are seeing new types of tools coming up in the automotive sector to solve new problems in the value chain.

Finally, digital chips have grown so big that engineers are facing challenges with their verification.

Q. Where have we reached with process nodes in the semiconductor industry?

A. We have seen the best advances in technology nodes in the last few years, whose effects will ripple across the entire electronics industry. Semiconductor vendors are ramping up development on chips based on 28nm, 20nm, 14nm and 10nm process nodes. Looking at the future, we are also working with design tools for the next-generation 7nm process node.

Q. What are some challenges that are being faced with the next generation of process nodes coming in?

A. Every generation has new physics that we have to worry about. For example, Calibre PERC tool is used to help solve the effects of electro-migration, as the current drags the metal along with it. This could go on and, if undetected, cause the wire to fail.

When we reach nodes after 10nm, the industry could move away from silicon. In 7nm, for example, indium-gallium-arsenide (InGaAs) could be part of the flow that we use to build new models. Work on design tools and on calibre rule decks to check those tools always happens earlier, and we are currently working on 7nm and 5nm nodes.

Q. What are some of the biggest challenges that can be expected in 7nm nodes?

A. One of the biggest problems with 7nm is that, because extreme ultraviolet will not be available at the time of introduction, foundries will have to use triple etching or triple patterning, or even quadruple!

Self-assigned double patterning is another technique that could be used.

All these require a more complex process, but it also requires the designer to take into account the effects caused by these. For example, a given etching might be defined in one layer, then another and so on,

**WALDEN C.
RHINES**
CHAIRMAN AND CEO,
MENTOR GRAPHICS

but it would ultimately be affected by the layer being etched.

Q. Could you tell us about some benefits that are enjoyed by today's design tool users?

A. Companies have discovered in the past year that, by using Tencent yield enhancement, they can save tens of millions of dollars in cost of components, by rapidly identifying defects in the layout that affect their yield. They are able to analyse every chip that fails in test and compare it to the layout. This lets them figure out if it is a systematic or random issue, following which maths tools analyse and bring out correlation.

The next is that, without emulation, most networking companies would have been unable to continue as complexity of data networking is now so great that simulation is no longer possible.

Q. Are there any similar examples from the foundry side?

A. The foundry industry has found that, by requiring their customers to use a tool called Calibre PERC, they could assure that customers' designs had protection for electrostatic discharge (ESD).

What previously happened was that every customer had his or her own different techniques to check. As a result, when wafers came back, ESD destroyed those wafers and these customers would tell foundries that the yield was low.

Q. What are the new tools coming up in the automotive sector?

A. New tools are now available that enable embedded software development capabilities for automotive design using standards such as automotive open system architecture (AUTOSAR). We are now also seeing new analysis tools for connectivity in a car, as well as tools for documentation and even to help technicians with wiring.

For electronics manufacturing ser-

vices, design for manufacturing and assembly markets we see that, as design complexity increases, these companies start facing issues in library management. So that is another area where problems can be solved.

**ENGINEERS
WORKING ON BIG
DIGITAL CHIPS NOW
HAVE TO ADOPT
EMULATION TO
JUST HANDLE THE
ENORMOUS AMOUNT
OF VERIFICATION
NEEDED**

Q. How has an increase in digital chip complexity affected the design process?

A. Engineers working on big digital chips now have to adopt emulation to just handle the enormous amount of verification needed. To help in solving these new challenges, we saw the introduction of integrated simulation and emulation as well as a big advance in power analysis introduced in cooperation with ANSYS.

Additionally, it is now also possible to design for test in the emulator itself.

Q. What is the roadmap for system design tools, and how does it compare to chip design tools?

A. Traditional chip design tools are growing at the same rate as the semiconductor industry. However, since system design is at an early stage, it is growing at two to three times as much.

Looking at the systems-side roadmap, we can expect design tools made to handle the integration of optics and computer systems, backplanes and printed circuit boards. EFY

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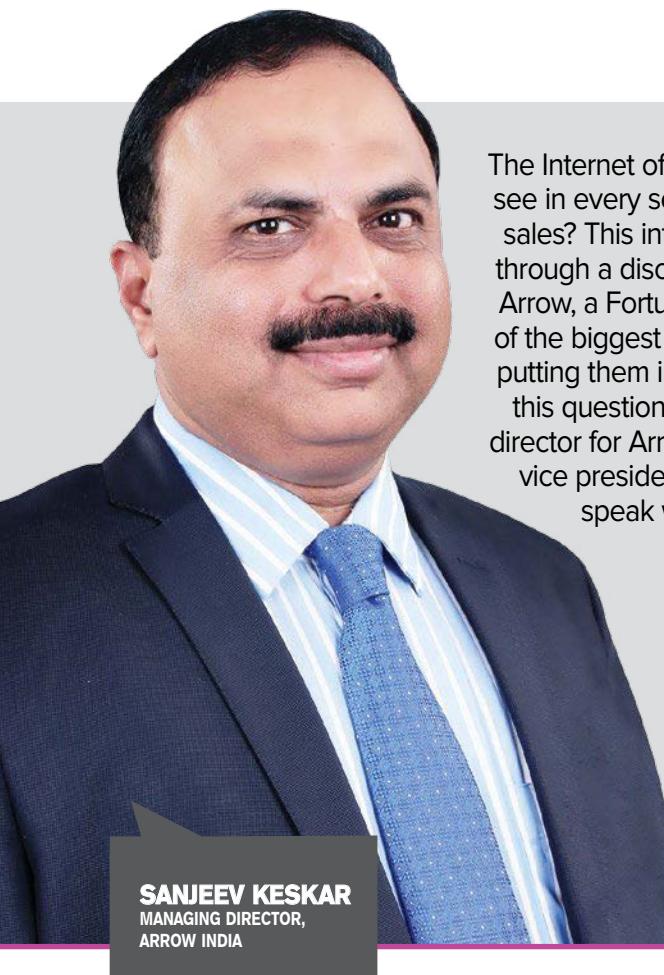
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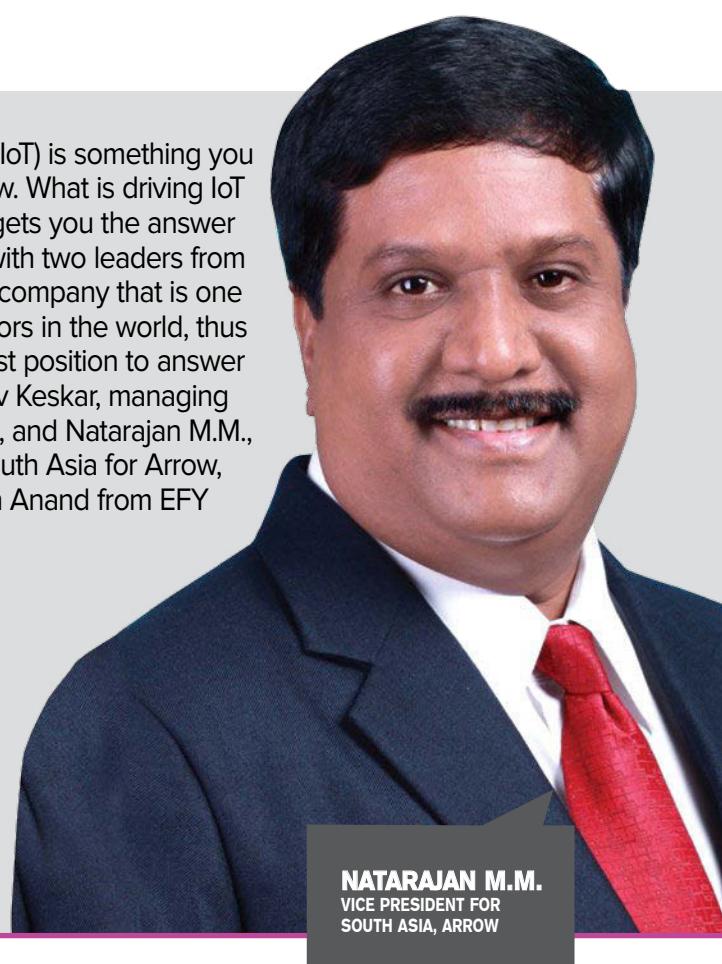
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FOR YOU

The Internet of Things:

MAINTENANCE And SERVICING Are Two Important Elements Currently DRIVING THE IoT In India



SANJEEV KESKAR
MANAGING DIRECTOR,
ARROW INDIA



NATARAJAN M.M.
VICE PRESIDENT FOR
SOUTH ASIA, ARROW

The Internet of Things (IoT) is something you see in every sector now. What is driving IoT sales? This interview gets you the answer through a discussion with two leaders from Arrow, a Fortune 500 company that is one of the biggest distributors in the world, thus putting them in the best position to answer this question. Sanjeev Keskar, managing director for Arrow India, and Natarajan M.M., vice president for South Asia for Arrow, speak with Dilin Anand from EFY

Q. What, according to you, will be the biggest driver of IoT-enabled products in India?

A. Maintenance and servicing of equipment are two important elements that are currently driving the IoT in India. Any machine that requires maintenance can automatically message its manufacturer

about the impending situation. The message will then go to a cloud, following which diagnostics will be carried out automatically.

The end result is that, instead of sending a technician out to every site to check if the equipment has a fault and then making another trip with the needed parts, the techni-

cian will now only need to visit those places where a problem has been identified and he or she will also know exactly how to solve the issue.

Q. What is driving it at the mass consumer front in India?

A. Geographical distances are

too big in India. This combined with the high density of population points us to water filters, since that is a very big element in the country. Having a sensor that monitors the purifier status and alerts technicians automatically should work very well. We already have a lot of water purifier brands that could implement this technology and improve their customer satisfaction.

Q. Which application area do you expect to open up on a global scale?

A. Applications like wearables are very promising. This will open up a huge domain so that the physician or doctor will be able to read and identify any physical parameters on the body and provide an accurate diagnosis accordingly.

In cases like an emergency, the patient and the doctor will get an alert saying the body needs maintenance or attention. This can also be extended to the exercise industry.

Q. Most of these are going to be expensive solutions. Do you see some place where the IoT could help reduce the cost of a premium product?

A. In the automotive sector, a smartphone connected to the instrument cluster of a two-wheeler could help enable navigation systems without adding to the cost of making a two-wheeler. Developing an automotive-grade infotainment system by itself would be expensive, but by using an existing solution to enable the feature would be extremely cost-effective for the end user.

Q. Which top three IoT products are driving component sales right now?

A. Tire-pressure-monitoring systems are definitely driving a lot of sales.

Energy meters with automatic

reading combined with an integrated Global System for Mobile communications module to transmit periodically is another.

Tracking devices designed to show where you can track your kid through your mobile is the third that is also popular.

Q. Since you deal with a lot of semiconductor players, what, in your experience, are they focusing on at the moment in the IoT space?

A. While the four key elements are sensors, actuators, connectivity and data management, battery life and software compatibility are also important.

INDIA IS IN A UNIQUE POSITION FOR THE IOT SPACE BECAUSE OF ALL SMART ENGINEERS AND START-UPS THAT ARE WORKING ON A VARIETY OF DESIGNS

ZigBee, sub-gigahertz, General Packet Radio Service and Long Term Evolution connectivity are what many are looking at, but we are seeing controllers with Bluetooth Low Energy and Wi-Fi integrated right into these, too.

At an architecture level, even the 8-bit and 16-bit are evolving. Everyone is taking the approach of the system on chip, where you require minimum peripheral components for a specific target application.

Q. What about the analogue-to-digital front?

A. A lot of peripheral analogue-

to-digital converters as well as microcontrollers integrated with sensors are popular, too. We have already seen conventional sensors for temperature, pressure, acceleration, motion and speed. Now, we are seeing gesture sensors that can be put into a treadmill or automotive.

You might remember semi-autonomous motorcar (SAM) from last year that allowed the driver to accelerate with his head, while controlling the brakes and steering with movements of his neck. That is one example.

Q. What are your views about the IoT and India?

A. India is in a unique position for the IoT space because of all smart engineers and start-ups that are working on a variety of designs for medical, machine to machine and wearables. The biggest challenge that I have faced is caused by the sheer number of start-ups here. They are very large in number, so we have to spend a lot of resources on working out how to identify the right company with whom we should engage, or whom we should select by balancing priorities.

Q. How is the semiconductor industry helping drive the adoption of newer technology by these start-ups?

A. Today, we have modules and not just chips like we used to. It has become very easy to interface with any application if you have a serial peripheral interface or universal serial bus port.

System on module are also available from many vendors for start-ups to get started with their build and design. This way, they can get customer acceptance easily, and only then do they need to develop and integrate it with their customers' requirement. **EFY**

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LED lighting:

PRIORITY Is To Change Consumer Behaviour Towards Buying ENERGY-EFFICIENT LED LIGHTING PRODUCTS

A vision that both the Indian government and the industry share is to promote the use of LED bulbs. Success can be achieved by implementing the Shared Energy Savings and Guaranteed Energy Savings models designed by Energy Efficiency Service Ltd (EESL), a government-run energy services company (ESCO). Saurabh Kumar, managing director, EESL, shares his views about this model and the role of EESL in a conversation with Sudeshna Das, senior executive editor, *Electronics Bazaar*

Q. How do you define ESCO model?

A. Let me start with the energy conservation legislation landscape. The first and only legislation was Energy Conservation Act, 2001, which was created by Bureau of Energy Efficiency (BEE). The legisla-

tion clearly said that energy conservation is essentially a market based phenomenon. If you save energy, you save cost and recover investments in greener technology within a certain period of time.

It is a commercially-viable process, but even for that, you need to create some regulatory framework and that is why regulations were framed. Therefore BEE has created different policies, introduced several labels and set standards.

It was presumed that, just as consumers purchase energy-efficient products like five-star-rated air-conditioners, and refrigerators, institutions too need complete energy-saving solutions.

For example, an office requires air-conditioning, fans and lighting, which together need an energy-saving solution. That is exactly what ESCO does. It conducts an energy audit

of your facility, suggests adopting an energy-efficient solution, makes upfront investments for it and recovers the same over a period of time, by way of tremendous savings in the energy bill.

This has not been happening in the country and therefore the government decided to set up EESL, in order to establish ESCO model in India, show results and handhold the private sector through its adoption process.

The main objective was to establish a business model that can build confidence among all ecosystems including facility owners, financial institutions and suppliers of energy-efficient products or solutions.

Q. Why did EESL focus on LED?

A. First, it is the easiest solution to implement—if I give you an LED bulb, you can just go home, fit it and switch it on.

Second, it offers tangible results immediately, which is quite important for any business.

So, if streetlights are changed to LEDs, the quality of light gets enhanced and this is visible.

We also focus on this area with



SAURABH KUMAR
MANAGING DIRECTOR,
ENERGY EFFICIENCY
SERVICE LTD (EESL)

the objective of establishing it as a mainstream business, handholding those in the private sector and encouraging domestic manufacturing.

Q. How does EESL facilitate this?

A. We have two ongoing schemes in the lighting domain. These target household consumers through Domestic Efficient Lighting Programme (DELP) and address the need to make streetlights more energy-efficient by working with different municipal areas.

Essentially, if you look at the lighting market in the country, it is very price conscious. The number of CFL bulbs sold every year is about 400 million, 90 per cent of which go into the domestic sector. So, in total, we are talking about a consumer market segment of 300 million CFL lighting products. Also, even when consumers want to buy LED lights, they are not sure about the returns on investment.

We came out with DELP to aggregate volumes across the country. Under this programme, we distribute LED bulbs to consumers in a way that is affordable to them and they get attracted, too.

We also create awareness by launching campaigns on how this programme can help consumers in saving electricity.

Consumers can pick up LED bulbs from our distribution centres by paying just ₹ 10 and the balance amount for the bulb's price is recovered over nine to ten instalments along with the electricity bill.

As a service agency, we designed this service model and help the distribution companies to file a petition before state regulatory commissions for approval. After approval, entire roll-out, including procurement, awareness generation, planning and distribution is managed by us. Our plan is to distribute about 150 million LED lamps by 2015 end.

We have linked distribution with the unique consumer authentication

number of the electricity bill. Only four bulbs are distributed against each bill. This helps check the propensity for unauthentic reselling of distributed bulbs.

In streetlight programmes, we are dealing directly with municipal corporations. Otherwise, the model is the same.

Q. How do you ensure the quality of the distributed LED bulbs?

A. We have a very robust quality control system that operates at three stages. In pre-procurement phase, bulbs are tested at NABL-accredited laboratories.

IF YOU SAVE ENERGY, YOU SAVE COST AND RECOVER INVESTMENTS IN GREENER TECHNOLOGY WITHIN A CERTAIN PERIOD OF TIME

Second, we do random quality checks during procurement.

The third is that, we have found a unique way of controlling quality. With all suppliers, we keep around 50 per cent of the contract value as a bank guarantee over the warranty period. For example, if the warranty period is eight years, it is kept for eight years. If it is a ₹ 1 billion order, you need a bank guarantee of ₹ 300 million to ₹ 400 million.

Because to the three-stage quality-assurance system, total number of failures was only 500 out of eight million distributed bulbs.

Q. How does EESL promote Make in India?

A. We follow the government's guidelines for the same. Suppliers of LED bulbs under different EESL programmes need to have a manu-

faturing unit in India.

In addition to that, if the wafer of the bulb is manufactured in India, the supplier will have special procurement preference. Unfortunately, no company manufactures LED wafers in India, currently.

Even the bidding price is so controlled that it is hardly possible for traders, who just import and package the products here, to meet our requirements. Therefore most bids are won by domestic manufacturers because companies can reduce costs only when they have a domestic manufacturing facility.

Therefore only domestic manufacturers will be able to compete in this market. Moreover, in order to encourage small-scale local manufacturers, in particular, 20 per cent of our orders are reserved for them. This, in turn, encourages new brands and offers new opportunities for upcoming enterprises.

After following these guidelines, the number of manufacturers has doubled in the last three years.

Our programmes also help companies to enhance brand visibility among consumers through our distribution system. As we directly reach end consumers, the brand connect happens.

Q. What is your vision for LED lighting ecosystem in the country?

A. EESL runs one of the largest LED lighting promotional programmes in the world. The other large programme was in China, where the government provided a subsidy of US\$ 300 million.

Under EESL programme, over the next two years, we aim to distribute about 200 million LED bulbs and nine million streetlights. Total investment will be US\$ 1.2 billion.

Our priority is to change consumer behaviour towards buying more energy-efficient LED lighting products and make it a national priority. Therefore we work more as a facilitator rather than a regular seller. **EFY**



Thermoplastics:

THINNOVATION Is The DESIGN CHALLENGE In Mobile

SRIDHAR N.B.
DIRECTOR, SALES AND
MARKETING (INDUSTRIAL),
DSM INDIA PVT LTD

We have always talked about how process nodes and newer semiconductors are helping with miniaturisation, but that is not the full story. This interview takes a look at the other side of miniaturisation, of the materials that allow you to build such small-scale objects in the first place. Sridhar N.B., director, sales and marketing (industrial), DSM India Pvt Ltd, speaks with Dilin Anand of EFY

Q. How are materials helping with increased miniaturisation of electronics?

A. Miniaturisation and, linked to that, thinnovation, is the design challenge in mobile. Newer materials that have the strength to be used in thinner structures while maintaining strength results in reduced size of components, while putting more features into these. For example, newer connectors have to deliver more power and signals in a small form factor.

One of the best ways to achieve this is through next-generation thermoplastics that can not only deliver on specifications but also open the door to completely new designs and concepts as we have seen in some recent consumer devices.

Q. Could you give us an example of thinnovation making an impact in electronics?

A. When we talk about thinnovation, over the past few years, thickness of smartphones has

reduced by 12 per cent per year, on average. One of the latest developments to enable this trend is the new-generation universal serial bus (USB) Type-C connectors.

These connectors need to carry more power than previous-generation connectors in a much smaller form factor. So performance properties of the materials used for holding all conductive elements together are especially critical.

Reliability is a key requirement, so the industry is looking for

plastics that are tough, reliable and rigid, with high flow.

Stanyl and Stanyl ForTii are examples of plastics that have been approved by global electronic manufacturers for the USB Type-C line of connectors.

Q. How are the materials used in USB Type-C connectors different from those used in previous-generation ones?

A. Due to thinner walls and a smaller pitch, the thermal plastic material for USB Type-C needs to have better mechanical strength and balance between stiffness and toughness. Due to higher power for charging (USB power delivery), higher comparative tracking index (CTI) is necessary to provide higher safety and minimise risk of fire.

Liquid crystal polymer, or LCP, is the major material used in the previous generation, but this does not work in USB Type-C due to lower CTI.

Q. How do alternative materials compare to the above?

A. Many component producers have begun developments in new USB-C connector designs using LCPs. Traditionally, LCPs were often favoured in thin-wall electronics because of their excellent flow properties. But in many cases, USB Type-C connectors are likely to fail stringent tests with respect to their electrical properties, especially resistance to surface tracking, expressed as CTI, and also mechanical properties. High-performance polyamides 46 and 4T offer the best balance of mechanical and electrical properties and precision moulding.

Q. What are some new designs and concepts possible through next-generation thermoplastics?

A. High-performance materials can enable freedom of design

in components like connectors and sockets, as well as antennae and frames.

Antennae need to be thinner and lighter, while still remaining structurally sound. This is especially important given the proliferation and increasing integration of components and the trend towards higher frequencies. Special laser direct structuring grades is an example of a suitable answer for the challenges of antennae.

Q. How does upgrading to a new material help solve industry challenges?

A. Frames, whether for smartphones or tablets, need to be

ing). Thinner (and lighter) frame walls with excellent durability are always welcome, too.

Q. What are the parameters that must be considered when looking at materials for printed circuit board (PCB) surface mount technology manufacturing?

A. The first thing engineers consider is the melting temperature and heat-deflection temperature of resin, which needs to be 280°C or higher (260°C is needed for lead-free reflow soldering, but the hot-spot might be 10 ~ 20 degrees higher).

Second, after soldering, the component should not warp, which can lead to loose-contact with the board, affecting final PCB performance. Hence, the material should have balanced stiffness as well as low internal stresses after moulding. So materials with higher flow and good weld strength are preferred.

Q. What should an engineer consider when looking at materials for connectors?

A. There is no standard answer for connector requirement because it depends on connector design. Some connectors need to have higher toughness (elongation at break or EAB) due to hinge function/design, while some connectors need to provide high mechanical strength. For the miniaturised connector, high flow and low warpage are also needed.

The second key criteria is how the component is soldered on to the PCB—surface mount or pin through hole—based on which you need to select the material with the right melting point, so that it is compatible with the soldering process. Choice of material can range from standard engineering plastics like PBT/PET/PA6/PA66 to high-heat resins like PA46/PA4T/PPA/LCP. **EFY**

NEXT-GENERATION THERMOPLASTICS... CAN NOT ONLY DELIVER ON SPECIFICATIONS BUT ALSO OPEN THE DOOR TO COMPLETELY NEW DESIGNS

robust, reliable and durable. The real challenge for the industry is finding a way to achieve all this while reducing frame thickness and weight.

Stanyl ForTii is an example of a thermoplastic resin that addresses key industry trends like convergence and aesthetics. Engineers look for high stiffness and structural rigidity and excellent weld-line strength and low warpage.

The material should be easy to process, without the need for secondary operations (like deflash-

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A vast expanse of applications is driving innovation in micro-electro-mechanical systems (MEMS), feels Uday Prabhu, general manager, electronics product engineering and product management, Robert Bosch Engineering and Business Solutions Pvt Ltd. Let us find out how as he talks to Dilin Anand and Priya Ravindran of EFY about the growth and scope of MEMS technology

Q. How has MEMS technology grown in the last five years?

A. From a research and development perspective, MEMS has seen an explosion of sorts and quite a few diversifications. It started proliferating in the automotive segment, with regards to electronic stability programme.

The technology then exploded in the consumer space, with increasing demand for smartphones, gaming devices and wearables, so much so that companies currently manufacture about five million MEMS sensors each day.

Q. What are the primary enablers for the improvement of sensors?

A. MEMS is about how best we can integrate mechanical structures into printing on electronic substrates. People are now looking at the fundamental physics of sensing. The number of axes that we use determines the kind of resolution we can achieve with respect to gathering information about the moment, and we see an expansion in the sensing dimensions.

New sensing elements like pressure, humidity and other environmental parameters are coming

out. Any physical element that can be leveraged for sensing is now being transformed into MEMS. Also, upgrades in the process of production have resulted in smaller form factors.

Q. Please tell us more about these upgrades?

A. There is compression happening on a large scale. An increase in the number of transistors that can go into a chip has resulted in reduced size with higher functionality. Earlier, MEMS elements functioned exclusively as sensing elements.

Now, intelligence, which is the processor, is built into the MEMS chip itself.

This is the primary influencer for the wearables segment, with MEMS chips doubling as control units. Structural advances also help make finer measurements of acceleration, momentum and so on.

Q. What parameters should be taken care of while integrating a MEMS sensor into a wearable application?

A. It is very important to engage the sensor in the right manner. Take the case of Fitbit. The accelerometer has to be positioned along the direction in which acceleration is to be measured, for accurate measurement.

A rugged laptop has an accelerometer placed vertically. If the laptop is dropped, it immediately puts the hard drive in safe mode, to prevent damage or loss of data. Any change in its orientation will not protect the laptop.

Q. Available wearables have to be connected to a smartphone for analysis. With advancements, do you see the entire system compressed onto the MEMS set-up itself, without offloading data?

A. We have to look into three categories. Sensing and processing should follow their own evolution paths, with processing predominantly following the Moore's Law.

The communication roadmap also needs to accommodate this change, which means getting 2G/3G into smaller packages. However, their power requirements are very high and it is not possible to fit this into a small gadget.

Thus, there is a need for the other side, where we have multiple technologies. It is good to separate fast- and slow-moving

technologies. Otherwise our wearables will become obsolete very fast and may not support usage with a new, upgraded phone.

Q. What latest trends are being driven by MEMS?

A. Air-quality testing is a requirement that is catching up fast. In the case of outdoor pollution, focus is on pollutants from vehicles and industries, while in indoor, the onus is on proper ventilation.

The biggest problem is with regards to volatile organic compounds,

MEMS IS ABOUT HOW BEST WE CAN INTEGRATE MECHANICAL STRUCTURES INTO PRINTING ON ELECTRONIC SUBSTRATES. PEOPLE ARE NOW LOOKING AT FUNDAMENTAL PHYSICS OF SENSING

which are the fumes released from upholstery like furniture and plastic. These could also lead to gloominess in the environment.

From the perspective of representing air quality, there have been quite a few interesting applications. One such is the integration of MEMS sensors into a painting of Mona Lisa; when the air quality goes bad, her lips turn blue, and stay pink otherwise.

Another area is indoor location monitoring, where a measure of momentum helps arrive at the direction and coordinates of your movement.

Q. How does indoor location monitoring work?

A. In this case, MEMS are used as counters. A combination of sensors is used to determine not just your position but also the direction in which you should move. Three beacons are used to achieve triangulation and a conversation is carried out between the beacons and the connected device.

A simple time-of-flight measurement for this question-and-answer session gives you the position of the device, relative to the beacons. MEMS are used to find coordinates, while magneto sensors give the direction. These are then used to tell you the number of steps you need to take in a particular direction to reach your destination.

Q. Do you see any influence of MEMS in the telematics industry?

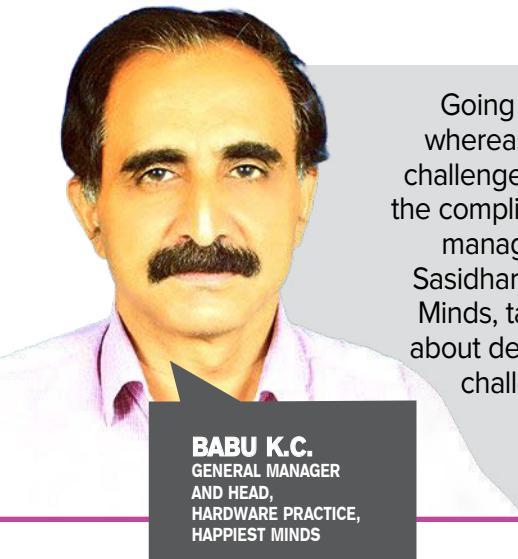
A. Yes! Adding to distance the direction measure from point A to B, the telematics industry is looking at a three-dimensional perspective of maps. Being called e-horizon concept, MEMS sensors can be used to provide information about the gradient or geography between places. It could be data on the altitude upfront or whether the surface is rocky. An auto-driving car could use this information to prepare itself for the drive.

Another application in this industry is for understanding how good a driver is. MEMS sensors are used to study and understand driving patterns such as how the driver accelerates, decelerates or applies brakes. This can be used for analysing driving patterns, maintenance of the vehicle and also to predict its life.

Also booming is the e-call concept, where data is used to interpret a crash or an accident and immediately alert emergency services, automatically. **EFY**

Disruptive technologies:

Arriving At A SPECIFICATION DOCUMENT... Is The BIGGEST CHALLENGE



BABU K.C.
GENERAL MANAGER
AND HEAD,
HARDWARE PRACTICE,
HAPPIEST MINDS

Going with the norm treads a relatively easy path, whereas going against the flow brings its own set of challenges. If all that you do is try to disrupt what exists, the complications are that much more. Babu K.C., general manager and head, hardware practice, and Divya Sasidharan, engineering manager, both from Happiest Minds, talk to Dilin Anand and Priya Ravindran of EFY about dealing with disruptive technologies and the challenges that crop up along the way



DIVYA SASIDHARAN
ENGINEERING MANAGER,
HAPPIEST MINDS

Q. Disruptive technologies, as the name suggests, disrupt what is already there. How challenging is it to go about creating a project description or design flow in this domain?

A. Given the product and system specifications, arriving at a specification document that is both agreeable to the customer and feasible from a design point of view is the biggest challenge when it comes to disruptive technology. With no base to work on, coming up with an optimum architecture is also a task.

At every stage, there might be problems regarding compatibility or how the system responds to change, and it is a constant trial-and-error process. It is all about being open-minded and ready to work with, or try out new methods.

Q. What is the most disruptive technology at the moment?

A. That would be the Internet of Things (IoT). There is a tendency to connect and manage almost all gadgets or equipment remotely through the Internet. We are getting several requests for proposals for developing IoT products. Almost all new designs call for Internet connectivity by default, and many companies are looking at adding IoT features to their legacy products.

Q. How would you go about choosing a processor for a design?

A. Factors like performance and interface requirements take prominence. Speed and power requirements, cost, availability of components and support for the chip from

the vendor are also parameters we need to take into account.

Q. What are the biggest technological challenges you face while working on these projects, and how do you solve these?

A. One of the biggest challenges we face is the space constraint on the printed circuit board (PCB). Customers generally desire the boards to be as small as possible with maximum features in it.

If you add other dimensions such as low cost, we have to rule out using high-density interconnects (HDIs); although density demands having these fitting components into a limited space without using HDIs or compromising on performance, signal integrity or thermal aspects is often quite challenging.

In terms of these aspects, each project poses a unique challenge and, to overcome this, we have to adopt a different strategy each time. We often have to risk deviating from guidelines.

Some other challenges we face are in managing thermal issues (especially in fan-less designs), passing electromagnetic interference(EMI)/electromagnetic compatibility (EMC) compliance tests and meeting power or cost budgets while selecting the right architecture for a design.

Overcoming these issues requires a highly-experienced and dedicated design team with a good set of tools and infrastructure to aid in developing and testing the designs.

Q. Are there any additional challenges that can be attributed exclusively to the disruption angle?

A. Managing design feasibility, processor/component and cost parameters and arriving at a balance is a challenge on its own.

Another difficulty comes while integrating analogue sensors with the board. While working with chips that are new in the market, there is always a risk of finding bugs or errors. You may even run the risk of a certain component not being ready for sale in the market when you go in for manufacturing. This is where the time-scale factor comes into play.

Q. Has there been any unique situation that you have come across?

A. We had to debug and fix a thermal issue on one of our customer's hardware. This was an x86 based design, running Windows.

The board used to crash after some time when exposed to temperatures above normal room temperature. Even though the board was designed for extreme temperatures, it was not working as expected.

We had to do a detailed thermal analysis, including thermal simulation using standard tools and also several tests inside a thermal chamber to identify and fix the problem,

by re-designing the heat-sink. In fact, we had to reduce the heat-sink area to fix this issue, whereas, generally, fixing thermal issues calls for increasing the heat-sink area.

Q. With challenges that come with working on disruptive technologies, how do you approach a project in this domain?

A. First thing we need is good engineers with the latest skill-sets and those who understand latest technologies and have the passion to work in these fields.

MANAGING DESIGN FEASIBILITY, PROCESSOR/COMPONENT AND COST PARAMETERS AND ARRIVING AT A BALANCE IS A CHALLENGE ON ITS OWN

We also require good lab infrastructure to test designs and good ecosystem that supports fabrication and assembly of boards.

We have a strong team in place already, most of them handpicked from the industry, and we regularly recruit top-notch engineers. We make sure that they understand the latest technologies and are capable of facing the many design challenges.

We have a good lab infrastructure and can do most design qualification tests in-house. We use external labs when it comes to EMI/EMC tests. We also make sure our designs are first-time right by doing multiple rounds of reviews at all stages of the design cycle.

Q. Would you share some ways of tackling the space-size challenge?

A. With the shrinking device sizes, we end up putting many features in a very small size. Compo-

nent selection becomes an important criterion whenever there is a space-size challenge. Optimised component placement and use of HDIs on the PCB help in arriving at the target size. PCB features such as trace width, via size, trace-trace clearance, have to be extremely minimised to achieve some form-factor requirements.

However, there is a limitation in manufacturing these boards in India as fabricators do not have sophisticated equipment to build these.

Cooling such high-density designs packed in a small area would be another challenge.

Q. How do you manage thermal issues in fan-less designs?

A. During the design phase, extensive thermal analysis is done starting with component-level heat calculations, followed by board-level tool based thermal simulation to estimate the amount of heat generated at maximum power.

Proper copper areas on the board, appropriate heat-sink designs and selection of right thermal interface material help keep the design cool even at extreme temperatures. In some cases, the enclosure also needs to act as a heat dissipater. The choice of enclosure material and proper thermal design becomes critical here.

Q. What compromises have to be made to comply with EMI/ EMC tests?

A. Appropriate ground references and proper return paths help in reducing electromagnetic emissions, which may add additional board area or number of layers.

Circuits may demand additional devices for ESD and surge protection. Chassis based systems may need gasket or copper strips to seal gaps to prevent radiations, which adds to the cost of the system.

Getting the design to pass EMI/EMC certifications might involve multiple re-spins, which impacts the development time and also adds to the development cost. **EFY**

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Computers:

TOTAL GRAPHICS POWER... Is The MOST SIGNIFICANT ELEMENT When Designing A PCB

JACKSON HSU
PRODUCT MANAGEMENT
DIRECTOR, GIGABYTE
TECHNOLOGY CO. LTD

Computers are taken so much for granted that even engineers occasionally fail to appreciate the factors that affect their product design. This interview should give you some insight into how motherboards and graphics cards are designed. Jackson Hsu, product management director, GIGABYTE Technology Co. Ltd speaks with Dilin Anand of EFY

Q. What design elements are used to improve performance in an over-clockered enthusiast motherboard?

A. Engineers have been using glass-fabric printed circuit board (PCB) to help protect against electrical shorts due to humidity. It works by reducing the gaps between PCB filaments. They also use 2x copper PCBs in their designs, which provide sufficient power trace paths between components to handle greater than normal power loads and to remove heat from the critical central processing unit (CPU) power delivery area. This is essential to ensure the motherboard is able to handle the increased power loading that is necessary when over-clocking.

All-digital power delivery is another improvement where digital controllers offer better precision in delivering power to the mother-

board's most power-hungry and energy-sensitive components, allowing users to get the absolute maximum performance from their CPU.

You may also see additional CPU fan pin headers located in various locations on the motherboard to connect a water pump and configured for continuous full-speed operation.

Q. What design improvements have been made to improve motherboard reliability?

A. In a technology called DualBIOS, the motherboard has both a main BIOS and a backup BIOS, making you protected from BIOS failure due to hardware malfunction, improper over-clocking settings or power failure during the update process.

Motherboards integrate the best-quality solid-state capacitors

(we use long life-span, durable, black, solid capacitors) that are rated to perform at maximum efficiency for a guaranteed minimum of 10,000 hours and provide ultra-low erythrocyte sedimentation rate (ESR), no matter how high the CPU loading. These come in customised jet black from Nippon Chemi-Con and Nichicon.

6x (30 μ) gold-plated CPU sockets are also used to improve the longevity of the CPU socket over time, without having any concerns about corroded pins and bad contacts. Plating thickness here is 15 times more than the industry standard.

Q. How do you improve electro-static discharge (ESD) protection in modern motherboards?

A. High-resistance integrated circuits (ICs) help protect the

motherboard against ESD. Moreover, each local area network (LAN) and universal serial bus (USB) port is paired with a dedicated protection filter that can withstand high ESDs, protecting your system from common electrical surges and even direct lighting strikes.

Q. What are the top three things a design engineer should know about designing graphics cards using graphics processing units (GPUs)?

A. It has been always a challenge balancing heat dissipation, temperature and performance. That is why we put so much effort here. Total graphics power (TGP) refers to the maximum amount of power that a graphics card can supply, which is the most significant element when designing a PCB. Its design can affect the efficiency of dissipation, thus the clock performance.

Balancing the system around noise is another important yet complex design element. Creating the best solution with a balance of noise, temperature and performance requires thorough evaluation of the demands of end-users to provide the best solution.

Q. What would be your advice for someone trying to balance noise and temperature on a card that they have tried to build?

A. Trying to get the balance between noise and temperature without sacrificing the graphics card performance is the most difficult task. We know that performance, TGP and GPU temperature are highly related. In order to provide

the best performance to end users, we provide high-performance cooling solutions.

Powerful cooling capacity lets GPUs maintain a low operating temperature with lower acoustics when the fan spins, without sacrificing performance. And we believe this is what the user wants in real life.

Q. Over the last five years, what are the biggest technological shifts that have helped drive card performance forward?

A. In order to ensure that only the best chips are used for those

CREATING THE BEST SOLUTION WITH A BALANCE OF NOISE, TEMPERATURE AND PERFORMANCE REQUIRES THOROUGH EVALUATION OF THE DEMANDS OF END-USERS TO PROVIDE THE BEST SOLUTION

aimed at over-clockers, stringent GPU gauntlet sorting ensures that only the strongest GPU surviving these tests are qualified for G1 gaming graphics cards for maximum over-clocking capability. This reduces chances of failure in GPUs under the stress of heavy computing requirements.

Thermal design is yet another important technology that differen-

tiates high-performance graphics cards from the rest. To qualify for a high-performance line, a cooling solution must be equipped with anti-turbulence inclined fans/fins, ultra-quiet pulse width modulation (PWM) fan and pure copper heat-pipe. Inclined fins help reduce excessive heat and turbulence.

Q. Are there any specifics that must be taken care of while over-clocking a graphics card?

A. Over-clocking could easily reduce the product life cycle. Therefore the quality of product (material and components) are extreme critical for over-clockers.

For high-end series graphics cards, we use UDV material to ensure quality and durability. So, over-clockers and gamers can enjoy their games.

Q. For hardcore builders, what tools would you recommend for temperature and acoustic measurement?

A. For temperature measurement, builders can use GPU-Z, or they can test using GIGABYTE over-clocking GURU software easily.

For the acoustic part, the best way is to build an anechoic chamber with a professional device; however, it is quite difficult to create such conditions in real life.

From what we have heard, users can now simply download some specific apps on mobile devices and do the measurement. Nevertheless, please note that environmental/background noise might be included and actual numbers might be different from official numbers. **EFY**

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MARK NORRIS
GENERAL MANAGER SE
ASIA & KOREA, NORDSON
ADVANCED TECHNOLOGIES
ELECTRONIC SYSTEMS

This interview shares some tips for managers and future business leaders, where we brief over acquisitions, team management and development. Mark Norris, general manager - SE Asia and Korea, Nordson Advanced Technologies Electronic Systems speaks with Dilin Anand of EFY

Q. How do you improve your technologies after an acquisition?

A. A very good example is that, in September this year (2015), we announced the acquisition of a company called Matrix, in Germany. When we approached Matrix, we quickly realised that while we were extremely strong in the handling of the substrate, they were really good at inspection and usage of certain algorithms to recognise defects. They also used software to interpret results and give these to the operator.

Our strength with offline x-ray is in terms of tube technology and detector technology. When we came to know about this, we immediately set up a plan with the company to take our combined strengths and do a classic 'one plus one equals three.'

Q. What should be kept in mind when considering acquisitions?

A. For us, it is really about acquiring companies that are complementary to what we already have. This enables us to share R&D re-

Business management:

Even If You Have A GOOD MACHINE And BAD SUPPORT, It Is Still A BAD MACHINE

sources and to implement sales and support through the existing sales structure of the parent company.

Q. What is a good business mantra in your line of business?

A. I always say that even if you have a good machine and bad support, it is still a bad machine. This is because a good machine lets people do their work and if they are waiting for the support team to fix a problem, the good machine just goes bad. So the ideal solution is

to have a good machine and great support. We cannot have our feet on the ground all over the world. We have direct application and support and direct field-support engineers, and we rely very heavily on local support.

Q. What would you say is a good strategy to build a support team?

A. We try to be focused and, in order to remain focussed, we have to make sure that we do not spread the knowledge too thin. We have dedicated application engineers for each product line so that they are completely focused.

The next line of service engineers has expertise in three different areas. So the further we go down, it spreads a bit and this helps ensure there is sufficient support coverage across products.

Companies need to be able to invest and should not just be interested in a quick sale, where they do not support the product or solution that they have just sold. It is always easy to sell one product and a salesman normally does that, hoping it would work. But normally if you sell the second, third and fourth machine, it is because of a good product combined with great service and support.

Q. What are your thoughts about leading a team?

A. People have to believe that if they say you are making a mistake, you will listen and act on that. Whether you are right or wrong, you will need to explain your actions. People need to know that there is a leader who is moving the company forward so that they can grow, and most importantly people just want to be trusted.

Trusting people and mentoring them is the key. If you are not developing people with whom you can be replaced, you are never going to be able to develop yourself and

do more and more things with the same effort.

Q. What is your personal mantra for managing your team?

A. Some people might say that my management style is a little bit aggressive. I believe that management is like having children. I wish I had realised this years ago because now I have two children. I realise that when you are managing people, not everybody is the same. I have two children and they are not the same. How you react to people will be the same as how they react to you.

**I THINK IT IS
IMPORTANT TO
GIVE PEOPLE THE
OPPORTUNITY TO
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AND TO USE THAT
KNOWLEDGE
WHEREVER THEY
THINK IS THE BEST
FIT FOR THEM**

With some people, you need to take time. Sometimes you need to invest in mentoring rather than lecturing, but sometimes you also need to bang your fist on the table. I think all great leaders understood that you need to have a bit of everything. At the end of the day, people have to trust you. People have to believe that when you say you have an open door policy, for that you should have an open door policy.

Q. How do you drive development within your team?

A. What I want is for my people to develop and learn more, and I

want to give people the opportunity to move. Under normal circumstances, spending ten years in the same company is not really ideal, but when your company is continually acquiring new companies and there is new technology coming into the company, then it is exciting and gives people the opportunity to move around between products and may be even geographically.

We give people the option to move to Europe or China for a two-year period. Some people choose to stay there forever as they continue to work for Nordson in another region. I think it is important to give people the opportunity to grow, to learn and to use that knowledge wherever they think is the best fit for them.

Q. Do you think information overload is a real problem with all consumer devices available these days?

A. We are being swamped with information. What many people do is, they make the mistake of allowing themselves to be swamped, and they do not use technology to make their lives easier. During this interview if I had got a message from my wife, I would have had to take my phone out and have a look at it and see who sent the message.

Today, all I have to do is take a look at my wrist, tap and tap again and I would have just informed her that I will call her later, using a smartwatch. Technology saves time. I can read emails on my watch, although my eyes are a bit worse for wear.

The only time it is disappointing is when I go to a restaurant and I see parents on their phones and children on their tablets, and no one is talking to each other. With my wife and children, absolutely nobody is allowed to use their phone at the table, which is why I have my watch. I can have a quick glance. **EFY**

Tools To Tackle Your DIGITAL And ELECTRONIC DESIGN CHALLENGES

ABHISHEK A. MUTHA

Digital Logic Design

This is a software tool for designing and simulating digital circuits. It provides digital parts ranging from simple gates to arithmetic logic units and state machines. Using this software, circuits can easily be converted into reusable modules, which may be used to build more complex circuits like CPUs. This software requires Java 1.7 or above.

McCAD tools

McCAD tools for electronic designs include three main software components, namely, EDS-Plus Bundle, SimPlus Bundle and 3SPICE. EDS-Plus Bundle is a fully-operational electronic design automation (EDA) system that produces manufacturable outputs. SimPlus Bundle is a fully-operational EDA system that allows you to create and simulate circuits. 3SPICE is a fully-functional circuit simulator based on industry-standard Berkeley SPICE3.

Circuit Sandbox (version 1.0)

Circuit Sandbox allows you to visually build Boolean logic circuits and then simulate their operation. You can create custom components from user-designed circuits. The software is written in Java for cross-platform functionality.

ZenitPCB (version 1.8.1)

ZenitPCB suite is for making printed circuit boards (PCBs). It comprises two main components: ZenitCapture and ZenitPCB. ZenitCapture schematic is an easy-to-use tool for creating schematic designs swiftly. ZenitPCB is a tool to create professional-grade PCB layouts. It is completely free to use, limited to 800 pins.

ZenitPCB GerberView can be used to view the created Gerber file.

Some popular resources

WinSCP (version 5.7.6). WinSCP is an open source, free SFTP client, FTP client, WebDAV client and SCP client for Windows. Its main function is file transfer between a local and a remote computer. The latest version improves interoperability with several SFTP and FTP servers and fixes several bugs.

Angry IP Scanner (version 3.4). This is a very fast IP address and port scanner. It can scan IP addresses in any range as well as any ports. It does not require any installation, and can be freely copied and used anywhere.

Password Safe (version 3.37.1). Password Safe is a simple and secure password-management application available under open source approved licence.

Eraser (version 6.0.10.2620). Eraser is an advanced security tool for Windows that allows you to completely remove sensitive data from your hard drive by overwriting it several times with carefully-selected patterns.

KeePass (version 2.30). A free, open source, lightweight and easy-to-use password manager, it helps manage passwords in a secure way. You can put all passwords in one database, which is locked with one master key or key file. You only have to remember one master password or select the key file to unlock the database.

EFY anniversary special

DipTrace (version 2.4.0.2) six-month trial included in the DVD. DipTrace, the schematic and PCB design software, can now be used for a period of 180 days from the date of installation. Users can access all features and libraries. The 3D library package is also included as an additional file for real-time 3D preview and export.

Note. A freeware version of DipTrace (version 2.4) has also been included in the DVD for Mac OS X users. Although the designs are limited to 300 pins and two signal layers.

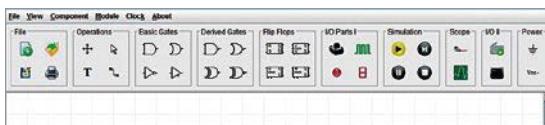


Fig. 1: Interface of Digital Logic Design tool

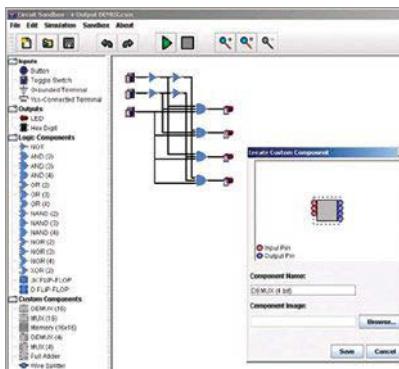


Fig. 2: Creating 4-output demultiplexer component with Circuit Sandbox

Osmond PCB (version 1.1.30)

Osmond PCB offers great power and flexibility with artificial limits and restrictions being banished. Particularly designed for Macintosh computers, it allows you to design boards of any size and shape and

with as many layers as you want. With a spatial resolution of 10 nanometers, Osmond gives the precision you need. You

can place parts anywhere on the board with any orientation. You can also run traces of any width along any path and at any angle. Once your design is complete, Osmond can produce standard Gerber (RS-274X) files and Excellon drill files that fabricators use to make boards.

Ellipse SCADA (version 2.29 b151)

By collecting information from any type of device, Ellipse SCADA allows you to monitor and accurately control plant floor processes, machinery and resources, managing production in a quick and efficient way. Real-time data is presented graphically, allowing information to be handled in several ways such as historical queries, reports generation and remote connection. EFY

The author is a senior technical correspondent at EFY

DipTrace For Your SCHEMATIC AND PCB DESIGN

PRIYA RAVINDRAN

The electronics industry is expanding like never before. But every application is dependent on that tiny block called printed circuit board (PCB), which is totally hidden by wires and connected devices. The next time you start a project, why not design your own PCB, instead of getting someone else to do it for you? Here is how you can do it with DipTrace.

DipTrace is a PCB designing software that helps you design a neat and tidy board that works as per your needs. But when so many such software are available why should you choose to go with this specific tool? Let us try to find an answer to this question by looking at what the software offers for every stage of designing.

Easier sub-section design. While designing a circuit, it is always comfortable to make small parts that you know would work for sure and then piece these together to form the complete circuit. But this is not as easy as it seems, as there are complications with making sure the signals flow correctly and with ensuring common ground connections.

You will find this problem easier to handle in DipTrace, where each sub-section can be designed on a separate sheet. The first sheet becomes the face of your design, to which the others can be linked hierarchically using connectors between sheets.

For nodes like power supplies or repeated ones in the design, you simply have to connect the nets to the same net port. The nets are then automatically linked across sheets, without wires. You can simply use a

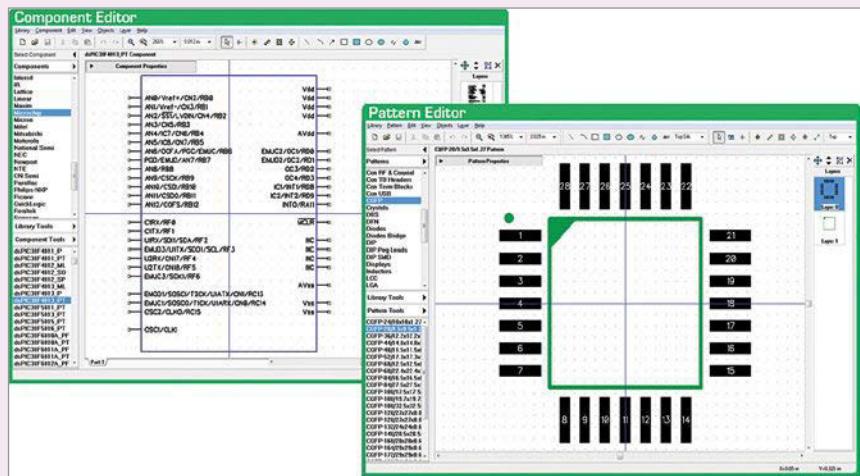


Fig. 1: Make your PCB from scratch

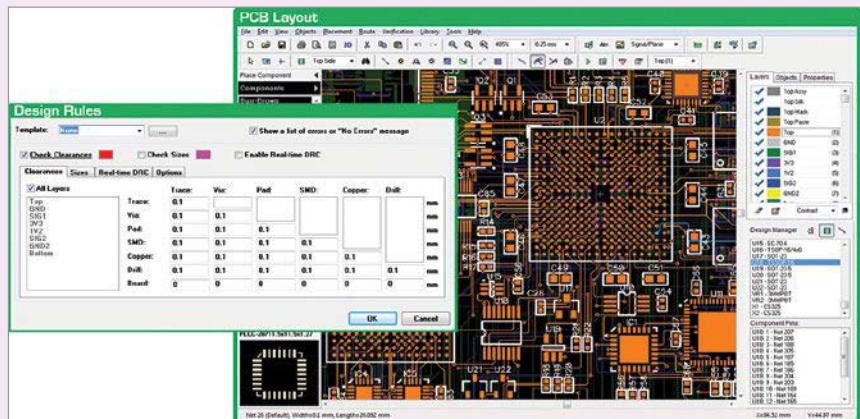


Fig. 2: Convert your schematic to a PCB layout

bus connection for groups of wires that go together. Nets on different sheets are connected by names, while buses on different sheets have exclusive connectors.

Once the schematic is complete, DipTrace allows you to cross-check parameters you might have missed, like shorts, or to super-impose pins by an electrical rule check (ERC) that is flexible in allowing you to choose the features you want to verify.

Pick and place your layout.

Moving from the schematic design to the PCB layout stage, you can take forward the same schematic rules or import design rules from an earlier project. On importing non-schematic rules, your PCB is ready with net classes, layers and design constraints.

One of the major issues in creating layouts is the size: whether it will fit within the board it has to be printed on. This process is smooth

with DipTrace, which lets you first draw a board outline in the required shape, manually pick and place whatever parts need to be fixed and then auto-place the rest. You can then add connections and fiddle around with your design to get the right component-connected layout.

Make the most of a customisable auto-router. Before you can begin routing your design, layers, via styles and net classes need your attention. These form the foundation of your board design, and with DipTrace you can customise and group your settings. The tool gives you the freedom to decide what signals should pass through which layer, choose colours, specify hole dimensions and manage via styles and net classes.

You can then decide how the auto-router should work, thus exercising complete control over your design, effortlessly. At any stage, you may save the settings in a rules file to use in a future project.

If you are going with the auto-router for routing your wires, there are grid based and advanced shape based options. You can set it up to work the way you want and it will automatically take care of your requirements.

If you choose to do it manually, you can select from available modes and, as you route, the tool warns you of design consistency errors. Thus, you take care of the design errors as you move along. You can always edit your work and even move nets between layers.

Remaining free spaces can use the copper-pour facility for low-impedance connections and additional heat-sinking. DipTrace allows you to organise different copper pours on a single layer, as well as connecting copper polygons on different layers into a single net.

A detailed procedure is available to verify the design. This includes checking for design rules and net connectivity. With errors shown at the exact location and different types

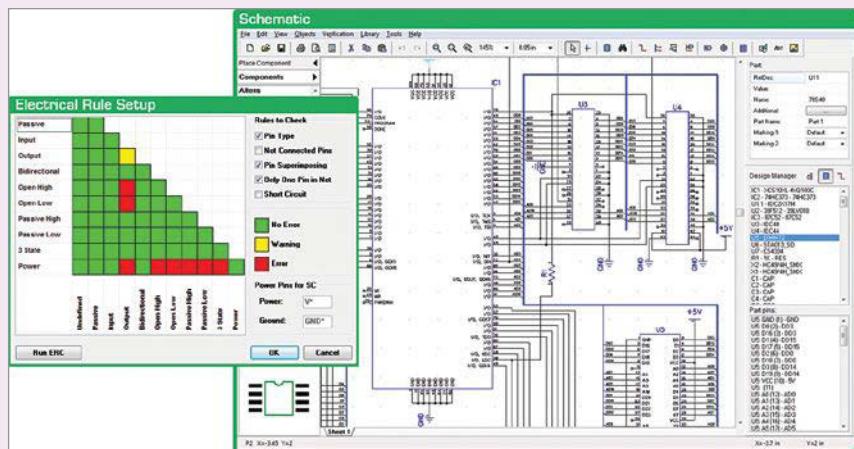


Fig. 3: Create a correct schematic with a rule check

Things you might want to know

- Offers support to Windows, Linux and MAC operating systems
- English being the primary interface language, you can change it to 21 other alternatives
- Provides free component/footprint libraries and 3D models
- If you are running it on MAC, install Xquartz beforehand
- Ace Converter and Pentalogix Viewmate are software to produce PCB using milling method and to view your Gerber, respectively
- You can purchase the proprietary version from www.diptrace.com/buy/online-store
- services@diptrace.com provides PCB design, manufacturing and library creation services
- Tutorials and videos to guide you available on their website www.diptrace.com

marked in different colours, rectifying these becomes easy.

Relate the schematic and the layout. While completing your layout is important, it is as important to ensure that the schematic and the layout are in sync. There might be cases when you have to add components after the layout has been designed. With compare-to-schematic, renew-design-from-schematic and back-annotation features, this procedure is relatively simplified.

Export for manufacturing.

Gerber files for printing PCBs can be exported layer-by-layer or in batches with DipTrace. You can even specify details like what components need to be exported to the files, what accuracy is needed and preview to visualise your configuration.

Numerical control (N/C) drill file that needs to be sent in to the manufacturer can also be generated with just a few clicks. Also, with 3D-preview-&-export module, you can

see the 3D model of the board with all components installed, rotate it, change parameters to see the effect and export 3D PCB in STEP format for mechanical computer-aided design integration.

Efficient and easy to use

Having seen how you can use DipTrace to design PCBs faster and better, one might wonder how the tool manages to do what it does. Let us now take a look at three features that make the design tool work its magic.

Component editor. Manage component library, make new components and edit old ones with this editor. You can design the component, choose its properties and functioning details.

For chips, you have the choice of different kinds of packages, too. You can even group pins based on their functionality and handle these as a single unit.

Pattern editor. Every component has a particular pattern (footprint) on

"We have purchased DipTrace recently. I would like to appreciate your entire team in bringing out such an outstanding product that features an award-winning UI, extremely simple to learn and wonderful, with videos for quick learning. It is an excellent tool that provides the shortest way to end-user products."

—S. Raja, scientist at Centre for Artificial Intelligence and Robotics (CAIR), Defence Research and Development Organisation (DRDO)



Fig. 4: Visualise how your PCB will look

the PCB on which it is placed. This is like the allotted place with required connections in order. This editor helps you make and edit these patterns, letting you specify the parameters. Pad specifications like position, shape and numbering can also be worked around using templates and special features.

Pattern editor also allows you to connect patterns to your 3D model for a wholesome picture.

Cross-module library management. With exclusive sections for components, patterns and 3D models, all libraries in DipTrace are organised into groups where both components and patterns can be stored. The structure of the libraries gives easy access to components. Also, with an efficient filter, you can search these by reference, designator, type or value.

Learn from first-hand experience

There are two factors that seem to be making users choose DipTrace. One is the graphical user interface (GUI) that is easy to use, easy to learn, intuitive and familiar. The other factor is export/import feasibility.

The process adds no complications and thus, users find DipTrace easy to work with when they want to use multiple software for different areas of expertise, like exporting files to Spectre for auto-routing.

There are also users who stick to the software as developers are active on various forums. Certainly makes it easy when you have doubts you want answered quickly, would you not say?

Interestingly, you can install DipTrace on multiple systems, but only one copy of the software should run at a time. A user on Parallax forum says, "I use DipTrace but also use Eagle to review designs for customers that use Eagle. I would definitely say that DipTrace is better of the two. I still struggle with certain things in Eagle, but DipTrace was easy to use from the get-go. I am still learning all the tricks, but throwing together a basic PCB in DipTrace is super easy and requires very few intelligence quotient points."

DipTrace developers are open to user complaints and appropriately react to the engineering community with improvements and updates.

Make the most of updates

DipTrace enjoys huge community support and offers good support to its users. The version with this month's DVD is DipTrace 2.4. Get accustomed to it quickly as the next version 2.9 is in Beta stage. It includes support for differential-pair routing, not just in designating nets as pairs but using it as a single unit while routing manually.

An interesting way of working with this tool is to use hot-keys or keyboard shortcuts. The latest version allows you to customise your hot-keys according to your comfort. With additional support to the modern open database (ODB++) and new-generation Gerber X2 formats, PCB manufacturing seems to be at its best. **EFY**

The author is a technical journalist at EFY

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The Sage Who Made SCIENTIFIC COMPUTING TRANSPARENT And AFFORDABLE

JAI SACHITH PAUL

Do you remember Julia, a dynamic programming language for technical computing that we had come across in an

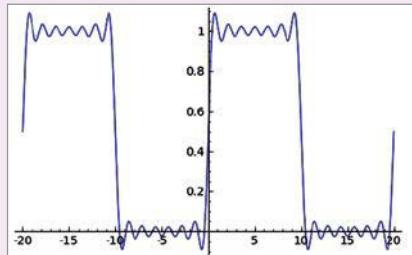


Fig. 1: A communication engineer can make use of Sagemath for signal processing

earlier issue of EFY? Now, let us have a look at SageMath (previously known as SAGE, an abbreviation for System for Algebra and Geometry Experimentation), a cross-platform, python based computer algebraic system for scientific computing. The latest stable release of this software, version 6.9, is bundled in this month's EFY Plus DVD.

Borne out of the frustration of a teacher

William Stein, who was then assistant professor at Harvard University, was unhappy with commercial mathematical software. The frustration was two-fold; one, the huge licence fee charged by commercial giants like MATLAB, Mathematica, Maple, Magma and others, and second, unavailability of the code.

As the code is hidden from the user, mathematicians were not able to cross-check and understand how the computer arrived at such a solution.

When Stein started designing SageMath, he quickly realised that there are a lot of mathematical software for various applications available as open source. Rather than reinventing the wheel, he

only needed to integrate all of these into a common interface. For this, he chose Python environment. However, the software has since evolved to get thousands of unique lines of code providing new functionalities, apart from just providing a common interface.

Some noteworthy features

SageMath software provides a unique environment for the computation and visualisation of scientific data. Two-dimensional and three-dimensional graphs of symbolic functions and numerical data can be made. Some interesting features are:

User interface. There are three ways in which the user can interact with the software. When the software is running on the server or local system, the user can access it with the help of a Web browser. A text based command line interface using Python has been developed. The user can also access the software as a Python library.

Support for parallel-processing. SageMath is a cross-platform software that allows parallel processing. Users can make use of multiple processors and multi-core processors for parallel processing. They can also use distributed systems to get their computational jobs done.

Use of Python. Instead of writing a new code for every mathematical application, the software reuses other open source software to get the work done. The new code is written only if none of the other software could meet the requirement.

MAIN PACKAGES IN SAGEMATH

Topics	Packages
Algebra	GAP , Maxima , Singular
Algebraic geometry	Singular
Arbitrary precision arithmetic	MPIR , MPFR , MPEI , NTL , mpmath
Arithmetic geometry	PARI/GP , NTL , mrank , ecm
Calculus	Maxima , SymPy , GiNaC
Combinatorics	Symmetrica , Sage-Combinat
Linear algebra	ATLAS , BLAS , LAPACK , NumPy , LinBox , IML , GSL
Graph theory	NetworkX
Group theory	GAP
Numerical computation	GSL , SciPy , NumPy , ATLAS
Number theory	PARI/GP , FLINT , NTL
Statistical computing	R , SciPy
Command-line shell	IPython
Database	ZODB , SQLite
Graphical interface	SageMath Notebook , jsMath
Graphics	matplotlib , Tachyon3d , GD , Jmol
Interactive programming language	Python
Networking	Twisted
Differential geometry and tensor calculus	Sage Manifolds

Use of Cython

Cython is a programming language based on Python. It has additional syntax for optional static-type declarations. The language allows the power of Python and C interchangeably in the same code. Apart from creating Python wrappers around natively-compiled code, Cython dramatically speeds up Python code. SageMath software is written in Python and Cython.

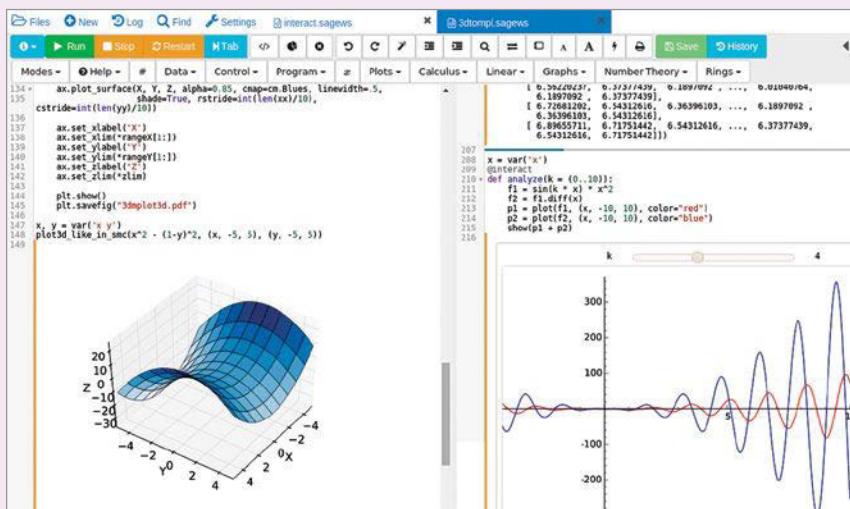


Fig. 2: Using SageMath, data can be represented in two and three dimensions

Additional functionalities are written as a new code and everything is glued together by a common interface.

Instead of inventing a new language for interfacing, the software makes use of Python as the gluing language to interact with all components. Python, being a well-known language in the scientific research community, is used to make the interface less complicated.

Necessity, the mother of all invention

The initial release of the software was made in early 2005. Whenever the scientific community felt the need for software to suit a particular mathematical application, the developers strictly followed the concept of release-early, release-often concept. This is the reason why there were more than 300 releases of the software in the last decade.

Reviews about the software in various forums suggest that developers' hard work has really paid off. "SageMath is easy to use and very

powerful. And I like the server-client principle behind it. Go on with the great work, SageMath motivated me to take the step from C to Python in just a few hours," comments Patrick Hammer, a user of the software.

"Sage is a work of art! It has a very clean syntax, is extremely well-documented and the coding is very clean. An average Python programmer like myself could create new functions in Sage. I have always wanted something like MATLAB but the price tag is a bit well... pricey for a 12-year-old. SAGE fits the bill perfectly," says Dhaivat Pandya, who was then just 12 years old.

Is Sage giving up the game to its open source rivals?

The answer is 'Definitely not!' It is true that there is a negative increase in the user community for the software. Some users have migrated to other open source alternatives. Still, SageMath software is immensely used among mathematicians and the scientific research community.

In one of the recent blogs, Prof.

Smith identifies the reasons for the fall in the number of users. First, installation is not that easy. Second, limited resources in terms of books and supplementing resources make its usage difficult. Third, the software is missing key functionality needed in support of undergraduate teaching.

Developers are constantly trying to sort these issues out and provide adequate solutions. In order to overcome the issues related to installation, a full Web application called SageMathCloud was developed.

Open access books have been written for undergraduate courses based on this software. The software has been made more suitable for undergraduate STEM (short for science, tech, engineering and maths) courses.

Shift in focus

Learning from the experience of diminishing popularity, developers of this software are now shifting their focus to the following three categories of users: engineers employed in various industries, researchers in mathematics who are now not using this software and students in STEM courses.

Among these, the most promising group is the students who take undergraduate STEM courses. For a student who studies electronics engineering, purchase of a computation tool like MATLAB is not that feasible. Here comes the relevance of an open source alternative like SageMath.

Moreover, open source tools allow access to the source code, which is invaluable when it comes to the learning experience.

Last, but not the least, in classrooms, you need not worry about state-of-art performance that the industry demands. Summing it all up, the shift in focus to cater to the academia more will be the game changer in favour of SageMath in the near future. **EFY**

The author is assistant professor, department of ECE at SETCEM, Thrissur

SIGNAL PROCESSING IN C++

Using Aquila 3.0

JAI SACHITH PAUL

When it comes to modern information engineering, communication and signal processing are birds of a feather. Whether it is broadcast and communication, audio and video recording, RADAR engineering, remote sensing, biomedical engineering or seismic data processing, a communication engineer has to deal with many signals.

In this issue, we introduce you to Aquila, an open source, cross-platform C++ library that helps the user perform all major digital signal processing (DSP) functions including finding various transformations, filtering operations, spectrogram computations and much more. The library, actively developed by Zbigniew Siciarz, is in its third stage of development.

What Aquila is capable of

If you would like to calculate the spectra of a signal using Fast Fourier Transforms (FFTs), compare two signals or extract features from a speech signal, this DSP library could be the appropriate solution for you.

Accepting the input. Aquila allows the user to input the signal in various data formats. It could be in the form of a text file or a .wav file. It supports the input in the form of an array or a vector in C++. The user can even input data in the form of a raw pulse code modulated data.

Signal and noise generators.

The signals commonly used in DSP like sine wave, rectangular or square wave, triangular wave or saw tooth could easily be generated.

The library also contains com-

```
#include "aquila/global.h"
#include "aquila/source/generator/SineGenerator.h"
#include "aquila/transform/FftFactory.h"
#include "aquila/tools/TextPlot.h"
#include <algorithm>
#include <functional>
#include <memory>

int main()
{
    // input signal parameters
    const std::size_t SIZE = 64;
    const Aquila::FrequencyType sampleFreq = 2000;
    const Aquila::FrequencyType f1 = 96, f2 = 813;
    const Aquila::FrequencyType f_lp = 500;

    Aquila::SineGenerator sineGenerator1(sampleFreq);
    sineGenerator1.setAmplitude(32).setFrequency(f1).generate(SIZE);
    Aquila::SineGenerator sineGenerator2(sampleFreq);
    sineGenerator2.setAmplitude(8).setFrequency(f2).setPhase(0.75).generate(SIZE);
    auto sum = sineGenerator1 + sineGenerator2;

    Aquila::TextPlot plt("Signal waveform before filtration");
    plt.plot(sum);
}
```

Fig. 1: A sample code using Aquila

The story behind Aquila

The project was initially started in 2007 as an academic computer project, capable of recognising the songs of birds. In due course of development, the software was thoroughly redesigned and expanded in order to incorporate more general DSP tools. In Aquila 2, complexity of the code was greatly reduced by separating the code for signal processing from the graphical interface. The latest version of the software, Aquila 3.0, is intended to be more generic in handling data.

mon noise generators that include a white-noise generator and a pink-noise generator.

White noise is a random signal with constant power spectral density, whereas for pink noise the power spectral density is inversely proportional to the signal frequency.

Windowing functions. Windowing functions find applications in spectral analysis and beam-forming filter designing. When we deal with the windows in signal processing, these are zero valued outside chosen intervals. Various window functions such as rectangular window, Ham-

ming and Hanning windows, Barlett and Blackman could be easily implemented using this library.

Fast Fourier Transform. FFT has made signal processing in frequency domain as computationally feasible as in temporal or spatial domain. The user can find both the forward and the inverse FFT using the tool. He or she can have a visualisation of the frequency spectrum of sound or any other signal, with respect to time or other variables with the help of a spectrogram.

Filters. Application of filters on a signal essentially changes the shape



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Compatibility

- The software uses some features from C++11 standard. These are integer types, smart pointers and lambda functions, among others.
- A modern compiler is required for building the library successfully. A GCC compiler of version 4.6 or later, MS Visual Studio 2010 or later, a Clang compiler of version 3.1 or later will be sufficient.



Fig. 2: Sample output after coding using the library

of the spectrum of the signal. In frequency domain, spectrum of the signal is multiplied with the filter for modifying it. As per the documentation given on the website of the software (www.aquila-dsp.org), Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters are yet to be implemented.

Feature extraction. The feature extraction of the signal allows the user to reduce the signal into easily comparable forms. This is very useful in speaker-identification or speech-recognition processes.

Besides extracting power or energy of the signal, the software allows the usage of Mel Frequency Cepstral Coefficients (MFCC). Although MFCC is considered as one of the standard methods for feature extraction, its sensitivity to noise due to its dependence on the spectral form is a clear disadvantage.

In order to overcome this problem, methods that use information in the periodicity of a speech signal are used. The algorithm for finding Human Factor Cepstral Coefficients (HFCC) for feature extraction is yet to be ported from the previous to the latest version of the software.

Dynamic time warping.

Dynamic Time Warping (DTW) algorithm was originally developed for speech recognition.

Two sequences of feature vectors are time-warped and aligned.

The process

continues until a perfect match between the features occurs, based on certain matrices.

Who should use the tool

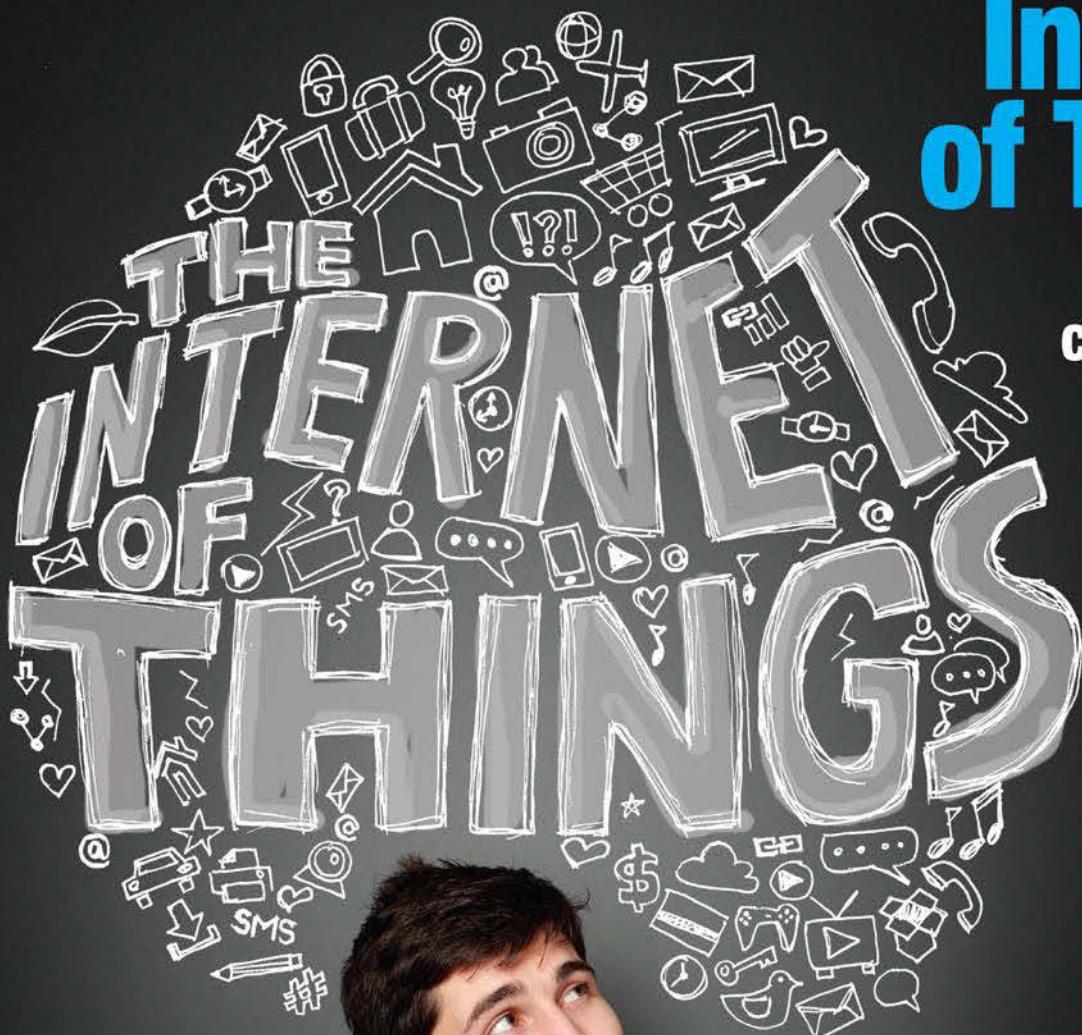
We had a quick overview over the various functionalities of the tool. The software is in a stage of continuous development, and a stable release of Aquila 3 that packs all algorithms in the previous versions ported is expected soon.

If you are a beginner trying to learn the basics of signal processing, Aquila could be an ideal tool for you. However, the library lacks advanced topics in signal processing such as wavelets and polyphase filters.

As a user at www.experts-exchange.com points out, another open source software called Signal Processing Using C++ (SPUC) provides features like digital-modulation schemes, which we do not find in Aquila. So the best solution in this regard will be to use both libraries through a wrapper to combine these. **EFY**

The author is assistant professor, department of ECE at SETCEM, Thrissur

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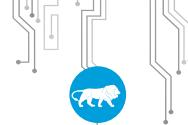
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INDUSTRY NEWS

MAKE IN INDIA

India to be major producer of electronic goods by 2020

India wants to be the major producer of electronic goods under its Vision 2020 plan, according to Omkar Rai, DG of Software Technology Parks of India (STPI). Until now India was seen as an outsourcing nation in the past.

Rai said, "Now that idea has

changed as India has gradually transformed into a producing nation and is consistently moving up the value chain." He added, "Many start-ups are now being set up in the IT sector."

Consumption value of electronic goods in the country is likely to

reach US\$ 400 billion by 2020, while internal production would be around US\$ 100 billion only by then. Going by the projections, India would face challenges in manufacturing to meet the demand-supply gap, but has the potential to create additional jobs", he said.

Guidelines for production-linked subsidy for electronics manufacturers to be finalised

According to a statement issued by IT and Communications ministry, the government's Department of Electronics and Information Technology (DeitY) is in the process of finalising guidelines for production-linked subsidies for companies willing to manufacture electronic items like microprocessors, semiconductors and others within India.

Ajay Kumar, additional secretary in DeitY, has said that, "The production subsidy is very substantive and a huge differentiator with ten per cent of the

turnover for ten years, and it is meant for projects that are capital-intensive and possibly do not look attractive by themselves."

He has also said that the government is working on chip design policy. And, with the objective to push demand for PCs and other IT infrastructure, the government is formulating a project that would be launched during the course of the next three months to provide fundamental facilities of education, health, skilling and others to every connected village.

IESA, ASTSA sign MoU to strengthen Indo-Japan ESDM industry collaborations

India Electronics and Semiconductor Association (IESA), the premier trade body representing the Indian electronic system design and manufacturing (ESDM) industry, has signed a memorandum of understanding (MoU) with Asia Semiconductor Trading Support Association (ASTSA) with an objective to promote ESDM industry co-operation between the two countries.

The MoU is part of the delegation that visited Japan to explore the possibilities of doing business in Japan and promote collaborations for the Indo-Japan ESDM industry.

The delegation led by IESA includes

leaders and potential investors who would like to expand their businesses in Japan as well as seek similar interest to expand mutual businesses through collaboration between Japan and India.

It would enable the two parties to promote ESDM ecosystem in India and Japan, and strengthen business relationships among member companies of both.

It would also provide an opportunity to them to jointly work towards a mutually-beneficial activity in the ESDM landscape and empower knowledge exchange and sharing among each other.

On the Move

V. Raja joins Philips India as VC, MD

Philips India has appointed V. Raja as its new VC and MD with effect from December 2015. In this new role, he is responsible for driving and building Philips India's healthcare and consumer lifestyle businesses.

mCarbon appoints Sabri Amireh as SVP for MEA

Leading mobile technology solution innovator mCarbon has appointed Sabri Amireh as senior VP and market unit head for Middle East and Africa (MEA) region. Amireh has a proven track record of delivering solutions for GSM operators through inspiring leadership in MEA region.

Blue Star MD Satish Jamdar to retire

MD Satish Jamdar will retire from the company by the end of 2015-2016. He was appointed MD in 2009.

Google India head Lalitesh Katragadda quits

Google India head Lalitesh Katragadda has quit the giant to join background-verification firm BetterPlace as executive board member and investor. He is an IIT Bombay alumnus and holds a PhD in Robotics from Carnegie Mellon University, USA.

Calendar of Forthcoming Electronics Fairs/Exhibitions/Seminars/Events

Name, Date and Venue	Topics	Contact address for details
CES 2016 January 6-9, 2016 Las Vegas, Nevada, USA	World's gathering place for all who thrive on the business of consumer technologies	Consumer Electronics Association (CEA) Website: www.cesweb.org
Electromation India 2016 January 7-9, 2016 Akota Stadium, Vadodara, Gujarat	Gujrat's first-ever focussed exhibition on automation, instrumentation, electronics and electricals	Spark Media Email: info@electromationindia.com Website: www.electromationindia.com
2016 IEEE International Conference on Consumer Electronics (ICCE) January 9-11, 2016 Las Vegas, Nevada, USA	International conference on consumer electronics	IEEE International Conference on Consumer Electronics Website: www.icce.org
India Electronics Week January 11-13, 2016 Bengaluru	An Indian exhibition for the global electronics industry showcasing concurrently six events: Electronics For You Expo, Electronics Rocks, T&M India, LED Asia, Raksha India and IoT Show	EFY Enterprises Pvt Ltd Phone: +91-11-40596605 Email: growthmybiz@efy.in
WEARABLE EXPO January 13-15, 2016 Tokyo Big Sight, Tokyo	Wearable device and technology expo	WEARABLE EXPO Show Management Reed Exhibitions Japan Ltd Website: www.wearable-expo.jp/en
Demystifying EMC January 18, 2016 Royal Berkshire Conference Centre, UK	Themes include EMC fundamentals, updates on regulations and standards, basics of circuit design and component selection through more specific MIL and transportation topics	Demystifying EMC Websites: www.yorkemc.co.uk , www.rohde-schwarz.com
7th Edition Source India February 2-3, 2016 Hotel Green Park, Chennai	International buyer-seller meet and conference	Electronic Industries Association of India (ELCINA) Website: www.sourceindia-electronics.com
ELECRAMA 2016 February 13-17, 2016 BIEC, Bengaluru	Serves the business needs of utilities, government, EPC consultants, contractors, electrical equipment manufacturers and generation companies	ELECRAMA 2016 Email: anil.nagrani@ieema.org
China Information Technology Expo April 8-10, 2016 Shenzhen Convention and Exhibition Centre, China	Largest and most comprehensive exhibition of electronics and ICT industry in China	China Information Technology Expo Website: www.citexpo.org
National Electronics Weeks 2016 April 12-14, 2016 Birmingham, UK	UK's largest gathering of electronics and manufacturing professionals	National Electronics Weeks 2016 Website: www.new-expo.co.uk
Consumer Electronics China April 20-22, 2016 Shenzhen Convention and Exhibition Center, China	Platform that unites international exhibitors with Chinese retailers keen to bring new products to their customers	CE China Website: www.b2b.ifa-berlin.com/en/ Exhibitors/ApplicationCEChina2016
Industrial Automation 2016 April 25-29, 2016 Hannover, Germany	Manufacturers present solutions for manufacturing and process automation, robotics, image processing, efficient drive technology and more	Industrial Automation 2016 Website: www.hannovermesse.de/en/exhibition/trade-fair-line-up/industrial-automation/
Internet of Things Applications Europe April 27-28, 2016 Berlin, Germany	Addresses the opportunity for the Internet of Things (IoT)	IDTechEx Website: www.idtechex.com
Del Mar Electronics & Design Show May 4-5, 2016 San Diego, California, USA	Covers electronic components, fabrication, design and other aspects of electronics manufacturing	Del Mar Trade Shows Inc. Website: www.mfgshow.com
CommunicAsia2016 May 31-June 3, 2016 Marina Bay Sands, Singapore	International communications and information technology exhibition and conference	CommunicAsia2016 Website: www.communicasia.com
CWST-Expo2015 June 9-11, 2016 Bombay Exhibition Centre, Mumbai	Presentation platform for coil winding, insulation, stamping, transformer manufacturers, coil winding machines and allied industry	Brandscope Exhibitions Phone: +91- 9699807207, 9899107207 Website: www.cwstexpo.com
8th Future of Wireless International Conference June 21-22, 2016 London, UK	A leading conference for discovering the latest in cutting-edge wireless technology	Cambridge Wireless Website: www.cambridgewireless.co.uk/futureofwireless
NIWeek August 1-4, 2016 Austin Texas, USA	Annual global conference for graphical system design organised by National Instruments	National Instruments Website: www.ni.com/niweek
IFA Berlin September 2-7, 2016 Berlin, Germany	Leading trade show for consumer electronics and home appliances	IFA Berlin Website: AboutIFA">www.b2b.ifa-berlin.com/en/IFA>AboutIFA

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.

Government keen to set up R&D centre for telecom products

The government is keen on setting up an R&D centre for testing of standards, methods and certifications. The move is in line with an effort to be updated with the latest technology and products in the telecommunications sector.

Recently, telecom and IT minister, Ravi Shankar Prasad, emphasised the need to establish an R&D centre to stay abreast in this fast-changing industry and address the multiple challenges in the form of security, health and environment. The centre will be called National Accreditation Board for Telecom (NABT) with a management body consisting of telecom experts.

By setting up NABT, the government would do away with the present testing labs that are under National Accreditation Board for Testing and Calibration Laboratories (NABL) for telecom products (under the aegis of Department of Science & Technology).

Tata Power commissions world's largest rooftop solar

India's largest integrated solar player, Tata Power Solar, has successfully commissioned a 12MW solar rooftop project for R.S.S.B. Educational & Environmental Society (RSSB-EES) in Punjab, which is a charitable organisation based at Dera Baba Jaimal Singh.

Built across eight sheltered venues in a single premise at Radha Soami Satsang Beas - Dera Baba Jaimal Singh in Amritsar, the project is the largest solar rooftop plant in the world, set up in a single phase.

The plant will produce more than 15 million units of power annually and offset over 19,000 tonnes of carbon emissions every year.

The rooftop project is set up under Punjab government's grid-connected rooftop solar projects scheme, wherein power from the plant will be fed to the grid. In April 2014, the organisation had set up a similar 7.524MW solar plant on a single rooftop.

Philips, Cisco form global alliance

Philips and Cisco have formed a global strategic alliance in a bid to create new value in energy savings, building efficiency and employee productivity, made possible by the Internet of Things (IoT) in modern offices. The alliance brings together Philips' LED based connected lighting system with Cisco's IT network to address a global office market estimated to be worth € 1 billion.

MediaTek Labs announces open source development platform

MediaTek Labs has announced MediaTek LinkIt Smart 7688, an open source development platform for a more connected world. The new platform runs OpenWrt Linux, offers a variety of programming options and enables rapid development of advanced Wi-Fi based devices like IP cameras, surveillance devices, smart appliances and Wi-Fi gateways that make use of cloud services.

Coal India to set up solar plants

State-run Coal India Ltd (CIL) plans to double its production capacity to a billion tonnes in the next five years. Additionally, it has committed to set up at least 1000MW of solar-power-generation plants in various states to compensate for greenhouse effects.

CIL has tied up with Indian Council of Forest Research and Education as well as National Energy Research Institute to find ways and means of producing coal through measures that would be beyond the mandatory environment norms. Central Mine Planning & Design Institute will work with the two institutions to ensure that coal production happens in the most eco-friendly manner.

Apart from this, via its subsidiary, South Eastern Coalfields, the company has invited tenders for setting up 200MW of solar-power-generation plants. It envisages setting up solar-power-generation plants of the said capacity in each tranche adding up to about 1000MW.

Government to distribute more than 60 million LED bulbs

The government is planning to distribute more than 60 million LED bulbs through State-run Energy Efficiency Services Ltd (EESL) in a span of one year. It has already distributed about 38 million LED bulbs through power-distribution companies under Domestic Efficient Lighting Programme (DELPH).

ON Semiconductor acquires Fairchild Semiconductor

ON Semiconductor Corp. has acquired Fairchild Semiconductor International Inc. for US\$ 20 per share in an all-cash transaction valued at approximately US\$ 2.4 billion. The acquisition creates a leader in the power semiconductor market with combined revenue of approximately US\$ 5 billion, diversified across multiple markets with a strategic focus on automotive, industrial and smartphone end markets.

India lights up villages using LED lamps

More than 800 villages in Uttar Pradesh will be lit with 76,000 solar streetlighting units as part of a government initiative to drive sustainable electrification in rural areas in the country.

The project will provide electricity across 40 districts in the state. It has been developed by Philips Lighting in partnership with Uttar Pradesh New and Renewable Energy Development Agency.

Krishnan Pallassana, Climate Group, India director, comments, "This project shows the good things that happen when companies, people and the government work together. Importance of LED streetlights in terms of safety, emissions savings and money savings is clear, and The Climate Group is thrilled to see our partner, Philips Lighting, working to improve safety and quality of life for villagers in Uttar Pradesh."

The Climate Group has long advocated the benefits of LED streetlighting around the world and, in

2014, began a global consultation programme in partnership with Philips Lighting to address the remaining barriers to scaling up LED adoption. In India, it aims to improve the living conditions of rural communities by connecting them to clean energy as part of its core project, Bijli - Clean Energy for All.

Shenzen govt to invest US\$ 200 million in Gujarat

Shenzen city, which comes under the central government of China, is planning to invest US\$ 200 million in ZTEsoft's smartcity projects in Gujarat. Shenzen government had signed two MoUs during Prime Minister Narendra Modi's visit in May 2015.

ZTEsoft is a subsidiary of ZTE Corp., the largest public telecom equipment manufacturer in China. It will offer financial assistance to develop and implement various facilities for smartcities in the state.

Samsung enters auto industry

Samsung Electronics has made an announcement that it will begin manufacturing electronics parts for the automotive industry, with specific focus on autonomous vehicles. The company revealed its plan during its annual structural reorganisation in order to pre-emptively respond to business uncertainties.

Initially, Samsung's automotive components team will focus on building electronics for infotainment and autonomous driving vehicles. The operation will be headed by EVP Jonghwan Park and overseen by VC and CEO Oh-Hyun Kwon.

The company's smartphone business has seen declining in terms of sales of late, so it has established a new automotive components team to target and pursue new business initiatives to prepare for future growth.

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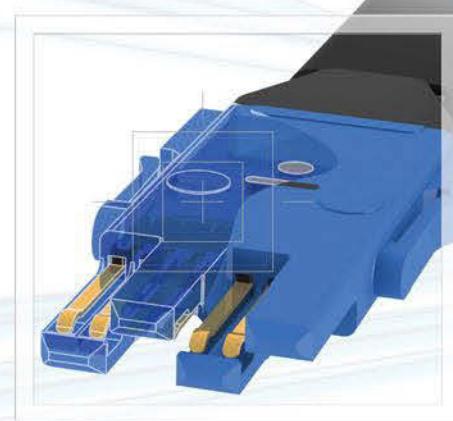
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Market Survey:

3Cs Drive CONNECTOR GROWTH



Sudeshna Das is senior executive editor at EFY

Rapid technological development has increased the demand for compact and reliable electronic devices. Compact-size products with improved connectivity, coupled with high speed will likely emerge winners. Connectors are an integral part of such devices. Key drivers of the connector industry are growing 3C applications (computing, communication and consumer electronics), miniaturisation of electronic devices and increasing electronics content in devices.

The growing market in Asia-Pacific

According to Bishop & Associates Inc., a market research firm specialising in the global electronic connector market, connector sales grew 8.2 per cent in 2014 to US\$ 55,402 million.

Lucintel, a management consulting firm, further predicts that the connector market will reach a value of US\$ 65.7 billion by 2019. However, connector sales figures in 2015 do not live up to its expectation.

A Bishop & Associates report shows an overall year-on-year (YOY) decline in sales by 5.6 per cent (Table I) across the world. Only the Asia-Pacific region is expected to round up the year with YOY growth of around 1.3 per cent. This indicates the emergence of a new

CONNECTOR INDUSTRY SALES PERFORMANCE BY REGION

Region	2013 (US\$ million)	2014 (US\$ million)	YOY change	2015F (US\$ million)	YOY change
North America	10,763	11,598	7.8%	11,410	-1.6%
Europe	11,108	11,803	6.3%	10,297	-12.8%
Japan	5375	5604	4.3%	4849	-13.5%
China	13,062	14,950	14.5%	14,734	-1.4%
Asia-Pacific	8022	8584	7.0%	8694	1.3%
ROW	2853	2863	0.4%	2306	-19.5%
Total world	51,183	55,402	8.2%	52,291	-5.6%

market for connectors in the Asia-pacific region, backed by strong demand from growing economies including India.

Less numbers, more functionality

As technological innovations float up each passing day, the number of connectors used per device is on a decline, while functionality continues to rise. With the development of downstream industries like computer and peripheral, automobile, industrial, communication, aerospace/military and medical treatment, connector characteristics have matured in the direction of miniaturisation, high density, high-speed transmission and high frequency.

The Lucintel report also predicts that, of all sectors, connectors for consumer electronics and industrial sectors will show the strongest growth. Increasing Internet traffic, development of high-density and micro-miniature technologies are all major driving factors for these segments. As weight and cost savings have become essential for high-reliability products, connector manufacturers have started to focus on developing smaller, lighter and higher-power connectors.

Increased demand for miniaturisation, intelligentisation, high speed, wireless and environmental protection of 3C products implies that the connectors used in those products need to adopt advanced technologies such as miniaturisation, wireless transmission, high-frequency high-speed transmission, environ-



Top five existing application fields

- Automobile
- Computer and peripherals
- Communication
- Industrial equipment
- Aerospace and defence

Top five growing application fields

- Consumer electronics
- Traffic electronics
- Medical electronics
- Communication electronics
- Computer and peripherals

mental protection and others.

These technologies have the following implications:

1. Miniaturisation technology requires smaller PIN space (space between connector terminals) and lower height.
2. High-frequency high-speed trans-

Technological evolution: Six main directions

1. FEC and IC packaging miniaturisation: density is less than 200mmH
2. High-speed transmission interfaces: connector must be matched with high-bandwidth and high-speed circuit, realising high speed
3. Reliability and stability of peak current mode: making full use of cooling air and providing better long-term stability
4. Response to the trend of electronics environmental protection: lead-free, halogen-free and nanometer environmental protection materials to be widely adopted
5. Processing: standardised assembly will become increasingly common
6. Adoption of more new IC design electronics automation tools for speeding up design quantity

mission technology means it can transmit higher bandwidth and has good electromagnetic compatible and shielding capabilities, which can effectively solve electronic equipment signal-transmission-interference issue, simultaneously transmitting uncompressed high-resolution video, multi-channel voice data and related control signals, and satisfy people's pursuit of HD videos and audios.

3. Wireless transmission technology can realise wireless signal send-

ing and receiving function and satisfy the demand for mobility.

4. Environmental protection (explained in the box on next page). However, demand for miniaturised and reliable interconnects will not just stem from the consumer electronics sector, it will also be driven by high-reliability segments such as medical, military and industrial that also require the connectors to be highly robust to meet their tough environmental requirements.

In addition to reducing the size of end devices, miniaturised connec-

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The advertisement features a grid of images showcasing various LED components and products. At the top left, there is a red circle with the text "NEW Launch". To the right, there are four main product categories with images: "LED Flood Light Fixtures" (10W/20W/50W/100W/150W/180W), "LED High Bay Light Fixtures" (50W/120W/150W/180W), "PHILIPS DRIVER" (9W, 10W, 12W, 20W), and "1 year Warranty". Below these are two rows of twelve smaller images each, displaying various LED components, modules, and finished products like street lights and tube lights.

- LEDs: High watt, SMD etc.
- LED BULBS-MR16, B22, GU10, E27.
- LED Downlighters / Fixtures.
- LED Modules, Rigid Strip, Strip Light.
- Modules for Street Lights & Bulbs.
- LED Street Lights/Bay Lights & Flood Light Fixtures.
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Phone: 011-28361005

Industry view

In a freewheeling conversation with EFY, Rajesh Arakkal, general manager, FCI India, shares his views on the connector industry in India

What is your view on the growth prospects of the connector industry in India?

The connector industry in India is highly diversified and each segment has its own growth pattern. Connectors are required in every industry, from consumer electronics and automotive to industrial production and military and aerospace. Since Make in India, electronic manufacturing clusters and MSIPS are holistic approaches, we expect the demand to rise from all sorts of electronic applications. India is going to become the manufacturing hub of electronic goods in the future, many mobile phone companies are planning to start production facilities in India. Automotive segment is going for an extensive localisation. All these developments add to the growth of the connector industry.

The telecom industry is one of the major contributors and growth drivers for many connectors companies in India through 3G/4G roll-outs. But that does not come overnight. An entire framework comprising spectrum auctions, allocations, partnering with the right technology provider and so on is needed. So, if high-speed technologies like 4G/LTE are picking up the base faster, it will surely be an advantage for the connector industry.

There is a good growth potential for industrial connectors, mainly in the field of automation, power, energy and defence. There will also be potential from the mobile phone manufacturers in India. Domestic demand for industrial connectors in India is expected to grow at least seven per cent to ten per cent in the coming years.

What are the unique advantages that influence the growth of this sector?

India with over 980 million mobile connections and only nine per cent 3G coverage shows high growth potential.

Growth of telecom connectors depends on the growing 3G/4G roll-outs. This also depends on the decision of telecom equipment manufacturers to make in India at the printed circuit board assembly level.

Increasing demand for fibre-optic connectors, fibre-management systems and cable assembly will be driven by growing data centres, the Internet of Things (IoT) and fibre-to-the-home (FTTH) applications.

The industrial connector demand will be driven by increased



Rajesh Arakkal, general manager, FCI India

consumption in power, energy, automotive and automation industries, ATMs, elevators, process automation and so on.

Government procurement for defence, railways, e-governance, etc will generate direct demand for connectors, while government initiatives like Make in India for consumer electronics, mobile phones and more will create demand for domestic component supply chains like connectors.

What are the hindrances that impact the growth of this sector?

Domestic production of electronics is nowhere close to meeting the increasing demand from India. That is why electronics imports in India exceeded those of precious metals in the first half of 2015. We need to cautiously develop an ecosystem to improve the domestic electronic system design and manufacturing (ESDM) industry.

There is an inverted tax structure in the connector manufacturing that hinders its growth. There is zero duty on import of connectors and terminals, whereas there is five per cent basic duty on raw materials. The government should take immediate actions to stop these irregularities in tax policies.

Which kind of quality parameters and standards are important for this segment?

Quality expectation of all customers/segments is rising. The customer is driving a zero-defects culture with equal focus on the cosmetic aspect, which, at one time, was focused on only by Japanese customers. Different segments have different quality standards and certifications.

What is your take on the investment climate in this segment with respect to workforce, investment stability, legal framework, logistics infrastructure and tax conditions?

Investment climate is favourable with the optimism in the market and reduction in the bank rate by RBI. With active implementation of MSIPS, capital investments will happen at a faster rate, which will help the electronic component industry growth.

On the tax side, delay in implementation of GST acts as a hurdle to the smooth flow of material and accumulation of tax credits.

tors can also help reduce weight. As weight and cost savings have become essential for high-reliability products, connector manufacturers are focusing on developing smaller, lighter and higher-power connectors.

Smaller, tougher ones for wearables

Wearable electronics, whether these are smartwatches, smartglasses, personal health monitors or electronics embedded in clothing, continue to be one of the biggest sectors driving demand for miniature connec-

tors that are able to withstand the rigours of a wide range of environment. These include connectors that can tolerate extremes of temperature, humidity and moisture, while providing tiny form factors that are able to reside within cleverly-packed electronic devices.

The sector includes devices such as glasses, jewellery, headgear, belts, arm wear, leg wear, skin patches, exoskeletons and e-textiles, with healthcare as the dominant sector for these products, merging medical, fitness and wellness.

The boom in wearable connectors has benefitted the makers of micro-USB connectors, board-to-board connectors, board-to-flexible printed circuit connectors, card connectors, battery connectors and custom cables.

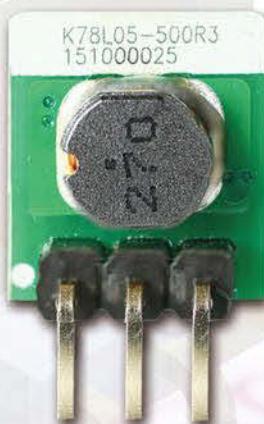
In future, continued emergence of small textiles and e-textiles will challenge connector suppliers as the requirement for washability will increase. Emergence of thin, printable battery technologies may drive the need for a new type of low-profile connector. **EFY**

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NEW PRODUCTS

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COMPONENTS

Power MOSFETs

STMicroelectronics has introduced a new family of high-voltage n-channel power MOSFETs for automotive applications.



These AEC-Q101-qualified devices are built using ST's MDmesh DM2 super-junction technology with fast recovery diode. The devices feature a breakdown voltage over 400V-650V range and are housed in D2PAK, TO-220 and TO-247 packages.

*STMicroelectronics
www.st.com*

Insulated wires

Key features of the triple-insulated wires are:

- Has three layers of insulation, completely isolating primary from secondary winding of transformers



- Reduces size and weight of transformers
- Thermal resistance class B (130°C) and class F (155°C) available

- Self-bonding type has a self-bonding layer that covers the outer surface
- Litz wire type has high-frequency resistance that can sharply reduce power losses caused by skin and proximity effect
- Conforms to isolation requirement of safety standard UL1950/UL2353/EN60950

*Sagar Switch Gears Ltd
sales.ssglindia@gmail.com*

System on chip

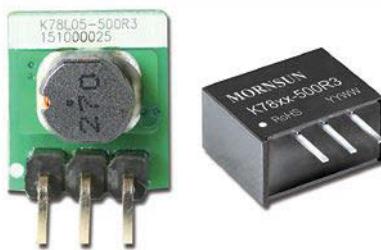
Renesas has unveiled its third-generation R-Car, an automotive computing platform solution for driving safety support systems and in-vehicle entertainment systems.

The new R-Car H3 system on chip delivers CPU performance, image-recognition processing, ISO 26262 (ASIL-B) compliance and a system in package with external memory to enable a wide range of automotive applications.

*Renesas Electronics Corp.
www.renesas.com*

DC/DC switching regulators

These regulators feature high efficiency (up to 94 per cent), low standby power consumption (low



to 54mW), wide input voltage range (6.5V DC ~ 36V DC) and an operating temperature range of -40°C to +85°C.

These also provide short-circuit and thermal protection, and do not require a heat-sink while operating. These are compatible with LM78XX series and have UL60950 and EN60950 approvals.

*Mornsun Guangzhou Science & Technology Co. Ltd
www.mornsun-power.com*

T&M

Clamp meter

The FLIR CM174 imaging 600A AC/DC clamp meter with IGM is equipped with a built-in thermal imager that can quickly lead to problems one cannot see with a standard clamp meter.

Featuring infrared guided measurement technology, the CM174 visually guides you to the precise location of a potential electrical problem, identifying dangerous and unknown problem areas safely. The narrow jaw enables greater accessibility, and its compact form-factor fits easily into a pocket.

*FLIR Systems India Pvt Ltd
www.flir.com*

Digital LUX meter

MECO digital LUX meter (model: 930P) is used for measuring luminance and intensity of light with user-selectable units of lux and foot-candle over range of 0 to 200,000 lux and 0 to 20,000 foot-candle with special functions like maximum, minimum,



backlight and auto power off.

MECO Instruments Pvt Ltd
www.mecoinst.com

OTDR modules

Anritsu has announced OTDR modules for its next generation Network Master Pro MT1000A all-in-one tester.



These modules can operate stand-alone or be simultaneously installed with available multi-rate transport module to create a rugged, handheld solution that field technicians can use to ensure performance of all network types, namely, mobile, metro, access or long-haul.

Anritsu India Pvt Ltd
www.amritsu.com

Oscilloscope

The SDS1000X series super phosphor oscilloscope is available with a maximum bandwidth of 200MHz, 1GSa/s sampling rate and 14Mpts memory depth.

The SDS1000X family utilises SIGLENT's new-generation SPO technology, which means high-waveform capture rate, 256-level intensity grading and colour temperature display, digital triggering and long memory depth.

SIGLENT Technologies
www.siglent.com

LEDs

Low-cost LEDs

Kwality Photonics has released high-performance medium-power LED KLSL2835W 150mA LEDs in 65 lu-

mens/70 lumens output that deliver exceptional brightness owing to the specially-designed lead-frame profile and improved heat dissipation of the device.

Kwality Photonics Pvt Ltd
www.kwalityphotonics.com

High-intensity LED light

The GAU-LTL-600W-LED-480V light fixture produces 60,000 lumens of high-intensity light while drawing only 500 watts from a 480-volt electrical system.



Forty-eight CREE high-output LEDs producing 963 lumens each are arranged in rows and paired with PMMA high-purity optics to produce a well-focused 24° wide-spot beam, which is ideal for providing far-reaching concentrated illumination while still covering a substantial amount of area.

This fixture is available in an optional 10° spot, 34° narrow-flood, 60° flood and 90° wide-flood beam spreads.

Larson Electronics
www.larsonelectronics.com

MISCELLANEOUS

Transponder

The RF430CL330H-Q1 transponder enables simple, secure pairing using out-of-band association model for Bluetooth, Bluetooth Smart and Wi-Fi between NFC-enabled smartphones or tablets and an automotive infotainment system. Pair and connect or execute NFC-enabled Wi-Fi-protected

setup with one tap to configure specific driver settings when entering the car, eliminating complicated manual procedures.

Texas Instruments
www.ti.com

Mattermatic 3D printer

The Mattermatic Jupiter Delta 3D printer features many innovations over open source delta designs like Kossel and Ros-toc. Featuring an all-metal chassis and an original unibody base, the design reduces assembly time while increasing the sturdiness of the 3D printer, making it stable even while printing tall.



Mattermatic
info@mattermatic.in

Q300 3D printer

The Q300 features a build volume of 255mm x 205mm x 205mm (10-inch x 8-inch x 8-inch). It is equipped with HEPA filter to remove airborne contaminants and fumes, and well-



engineered with an internal steel chassis and 100-micron resolution. With fully-automatic platform levelling and height sensing, no human interaction is required with the Q300.

Quant 3D, a brand of OK International Inc.
www.quant3d.com

ADVERTORIAL

DESIGN YOUR WAY TO VICTORY WITH MOUSER

Are you a hard-core designer, always willing to experiment? Is your room a junkyard of metals and circuits? Does the term the IoT excite you? Then this is the contest for you!

December 22, 2015, saw the launch of Mouser IoT Design Contest for India. With the motto 'Enabling your creativity Through Us,' this contest is all about thinking different, about innovating. Whether you are a design engineer, professional, academia, budding scientist or hobbyist, all you need is the thirst for designing an embedded system for the Internet of Things (IoT).

The challenge in a nutshell

Mouser, along with partners Murata and Broadcom, are giving you a list of seven components, seven small entities to make your system with. Choose one or more from the list, but make sure your design has at least one of these components.

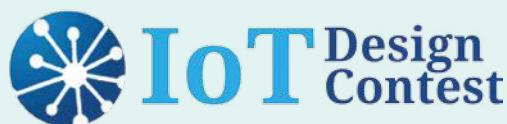
Not too difficult, right? Just get your ideas together, choose the apt components, put these together in an abstract and send it to us by 12th February 2016. Do not forget to register with us first!

Sounds interesting? Willing to put your wits to test? Then, given below is the list of components for you to choose from. If your abstract is selected, you will get to lay your hands on these latest and exciting components. We have added a small description for each, to help you get started quickly.

PKGS Shock Sensors from Murata

These vibration sensors are part of Murata PKGS series and are small, bi-terminal acceleration sensors that detect acceleration and shock as electrical signals.

Bimorph piezo elements clamped at one end (cantilever construction)



PRIZES UP FOR GRABS!

- First prize: INR 80,000
- Second prize: INR 60,000
- Third prize: INR 40,000
- 5 prizes for first 5 project submissions: power banks or portable hard drives
- Weekly prizes for quiz contests for the remaining abstract submitters: power banks or portable hard drives

with original polarisation technology are used to produce high-sensitivity and excellent durability. These are of re-flow solderable surface-mount device type and boast of high resonant frequency and wide-bandwidth operation.

Sample application idea. Write-protect your hard disk data, when it is under shock from the outside; enable pick-up control for disk-type storage in digital cameras and camcorders; detect minute vibrations of machinery; detect rapid acceleration (automotive); detect vibrations due to destructive acts (commercial windows, vending machines, etc)

Board-Mount Barometric Pressure Sensors from Murata

Murata ZPA series micro-electro-mechanical systems (MEMS) barometric pressure sensor is a capacitive-type sensor offering low current consumption and stable temperature drift.

ZPA series' capacitive MEMS technology is suitable for applications that require high accuracy and continuous data extraction. Compared to the existing piezo resistive type, low noise performance and low current consumption can be achieved simultaneously with the barometric pressure sensor.

Users can select output data rate from 1Hz, 5Hz, 11Hz to 23Hz. Change in pressure value will be reflected if the height is changed, the breath is blown in or the door is opened under closed environment conditions.

Sample application idea. Why not embed it in your mobile navigation device before your next trek?

UMAC Series Small Energy Device from Murata

A part of the UMAC series, the small energy device is a secondary battery, with features similar to that of a capacitor. Designed to be maintenance-free, it has a maximum charging/discharging rate of 10C (30mA) and an extended service cycle life with a

charging recovery rate of over 80 per cent, even after 1.5K cycles. It is a safe device as no thermal runaway occurs because of its low capacity and chemically-stable materials.

Sample application idea. Ideal for a small power equipment like an electric pen, a solar battery charger equipment and sensor node with wireless sensor network in combination with an energy-harvesting system

Type YD-Certified Wi-Fi Module from Murata

This Wi-Fi module is an embedded network controller solution providing simple serial-to-Wi-Fi Internet connectivity. It is type-YD-certified, which gives it the ability to IP-enable any device with a UART or SPI interface, integrating STM32 ARM Cortex-M3 microcontroller with additional interfaces.

The network controller module provides device manufacturers with an easy-to-design solution for data acquisition, device management and industrial control applications.

Sample application idea. Put together a sensor device application using ADC and GPIO interfaces and send data to the cloud via Wi-Fi connectivity

Bluetooth Smart Sensor Development Kit from Broadcom

Broadcom's WICED Sense Bluetooth smart sensor development kit is a kit for WICED SMART product family based on BCM20737S SIP module, featuring Bluetooth Smart technology. With six MEMS sensors on board, customers can quickly ramp up a demo/prototype specific to their needs. The over-the-air download feature provides the ability to update the tag's firmware from a central device like a smartphone, tablet or PC.

Sample application idea. With a development kit at your disposal that includes an associated smartphone app, why not develop a Bluetooth Smart app/demo

Bluetooth Smart Low Energy Module from Broadcom

Broadcom BCM20737S WICED Smart Bluetooth Low Energy module allows manufacturers to seamlessly connect peripheral devices like heart rate monitors, pedometers, door locks, lighting, proximity alarms and more. Designed for simple integration into coin-cell batteries, ARM Cortex M3 based BCM20737S will inspire a new range of connectivity for previously-unconnected devices.

Sample application idea. How about connecting to a headless device without a means of interactive configuration

Bluetooth Smart SoC by Broadcom

Broadcom's BCM20736 WICED SMART Bluetooth system on chip (SoC) provides a flexible solution that can be incorporated into a wider variety of devices to drive new use cases. The chip includes built-in wireless charging support for Alliance for Wireless Power (A4WP) standard.

Additionally, the highly-integrated design and smaller size of BCM20736 reduces power consumption to extend the battery life for wearables.

Sample application idea. Let us leave you to figure this one out. Maybe you could use a combination of modules

Enable your creativity today!

And, so we are done. Challenging enough? Get on to it then. You can work individually or in a team of up to four members. Registration is free. Top-100 projects get through to the next round.

All you need to do now is form your team, register, cook up your idea, send in your abstract and wait. For any other details, log on to <http://mouser.electronicsforu.com>

Do not forget, you just have till the 12th February 2016, to submit your abstract.



DIGITAL IC TESTER

With Embedded Truth Table

BHASKR JYOTI BORAH & RAJIB BISWAS

Different ICs come with different specifications. Thus, it becomes imperative to apply different hardware configurations and feed all possible inputs for checking different ICs. We need some easy and useful techniques to check the functionality of different kinds of ICs.

This article represents a prototype IC tester that is highly capable, highly reliable as well as cost-effective. Here, we develop a program with different functions for checking different ICs. We systematically analyse and test the prototype for several ICs, accessing each individual pin with all possible inputs. We also investigate truth tables associated with different ICs over a display channel. Author's prototype is

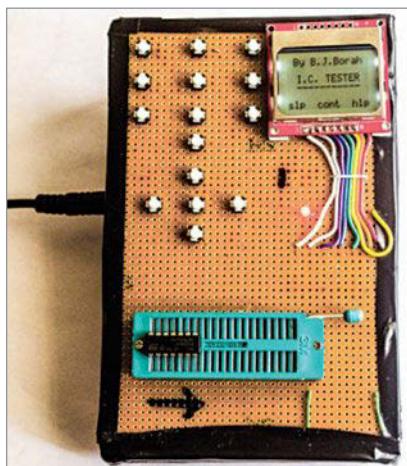


Fig. 1: Author's prototype

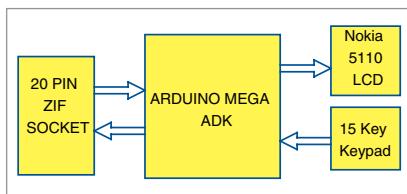


Fig. 2: Block diagram of the IC tester

shown in Fig. 1 and block diagram of the IC tester is shown in Fig. 2.

Circuit and working

Circuit diagram of the digital IC tester is shown in Fig. 3. It is built around Arduino Mega ADK board (BOARD1) based on ATmega2560 microcontroller (MCU), Nokia 5110 LCD connected at CON1, 5 × 3 matrix keypad (S1 to S15), ZIF socket (ZIF1), 12V/1-amp adaptor and a few other components.

ATmega2560 in Arduino Mega is equipped with a bootloader which enables new codes to be uploaded into the MCU without using an external hardware programmer.

The LCD screen used in this prototype has 48 × 84 pixels. It uses a low-power CMOS LCD controller (PCD8544) with a moderate power requirement of 3.3V. This can be adjusted to MCU power requirements with suitable resistors. For controlling the LCD, a simple library named lcd with some basic functions has been designed.

The purpose of using keypad matrix principle is to reduce the

required number of input/output (I/O) pins for controlling the keys. While taking an input, only one column is read at a time. The column to be read is connected to logical 0V.

Now, while checking the state of rows, it is possible to detect which key is pressed from that particular column. After reading one column, the MCU immediately goes for the next one by connecting the new column to logical 0V. It is very important that only that particular column (under checking) is connected to logical 0V. Otherwise, it will not be possible to detect proper input. In this manner, all columns are read one by one to obtain one complete cycle of the matrix scan.

With a clock speed of 16MHz, ATmega2560 is capable of scanning the whole matrix thousands of times per second. Note that diodes are added along all switches in order to eliminate unexpected results due to simultaneous multiple pressing of keys. For controlling the keypad, another library named keypad enables the user to feed different inputs to the MCU.

In the circuit, each I/O pin (associated with ZIF socket) is connected to 1-mega-ohm pull-down resistor. These resistors (R1 to R20) prevent the floating condition of input pins when these are not connected to any state (high/low). For the code designed for this IC tester to work perfectly, it is recommended that all connections to Arduino pins are made exactly as in the circuit diagram. If anything in the circuit diagram is changed, one must modify the code for the same.

Author's prototype was used to

PARTS LIST

Semiconductors:	
Board1	- Arduino Mega ADK
D1-D15	- 1N4148
LED1	- 5mm LED
Resistors (all 1/4-watt, ±5% carbon, unless stated otherwise):	
R1-R20	- 1-mega-ohm
R21, R26	- 470-ohm
R22	- 330-ohm
R23-R25	- 10-kilo-ohm
R27	- 100-kilo-ohm
Miscellaneous:	
S1-S15	- Tactile switch
CON1	- 8-pin connector
CON2	- Nokia 5110 LCD
ZIF1	- 2-pin connector
	- 20-pin ZIF socket
	- 12V/1-amp adaptor

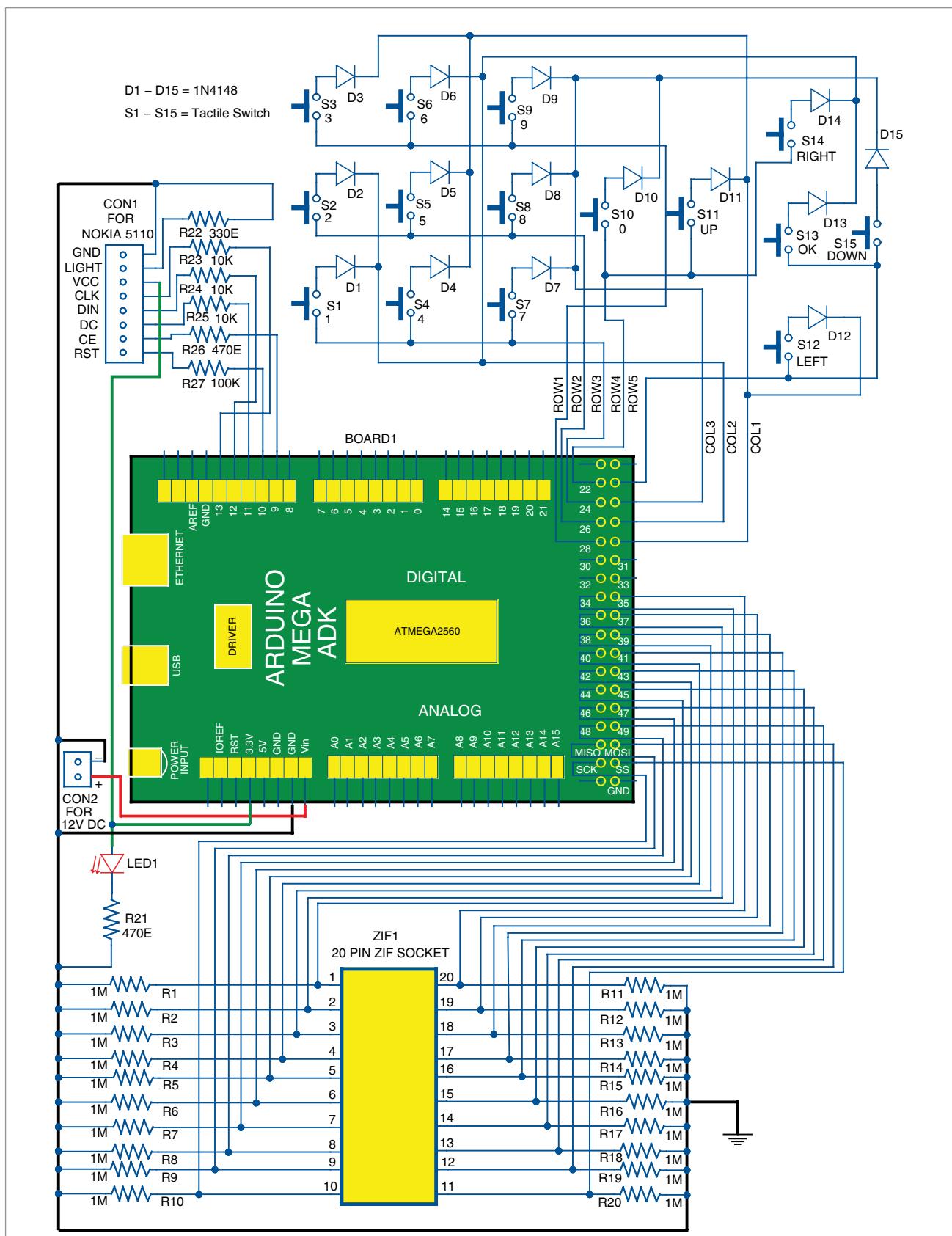


Fig. 3: Circuit diagram of the digital IC tester

test the following ICs successfully: 4000, 4001, 4002, 4011, 4012, 4023, 4025, 4029, 4030, 4049, 4050, 4068, 4069, 4070, 4071, 4072, 4073, 4075, 4077, 4081, 4082, 4093, 5408, 5409, 5411, 5421, 5479, 7266, 7400, 7401, 7402, 7403, 7404, 7405, 7408, 7409, 7410, 7411, 7412, 7414, 7420, 7421, 7427, 7430, 7432, 7473, 7474, 7476, 7478, 7479, 7486, 74132 and 74393.

ICs 4011, 4023, 4029, 4030, 4069, 4093, 7402, 7404, 7414, 7476 and 74393 were tested in EFY lab.

The number of supported ICs can be enhanced with the incorporation of new functions and libraries to the program. As ATmega2560 MCU has 256kB of flash memory, a program for very large number of ICs can be uploaded.

Unlike a typical IC tester, this device provides many useful features to its user. Nokia 5110 display panel and a 15-key keypad were used in this device for designing a suitable user interface, which enables the truth table exhibition possible.

Users can find help on the testing procedure. While entering the inputs (for example, IC number and time interval), they can clear the digits if entered incorrectly and re-enter the correct ones. Truth tables for each individual gate can be paused for better observation and can be skipped for saving time. There is feasibility of reproducing the previous stage (for re-entering the data) without resetting the device.

16MHz of processing speed makes the time response of this IC tester pretty good. No time-lag is observed while accepting data from the keypad and displaying information over the LCD panel. In case of auto-search, this prototype takes about 0.5 seconds on an average to detect the IC. All these features make this device powerful and user-friendly. A comparison of its features and specifications with two other branded IC testers (DICT-02 (Brand: Kitek) and Leaper-1A

TABLE I
COMPARISON WITH TWO OTHER IC TESTERS

Features and specifications	DICT-02 (Brand: Kitek)	Leaper-1A (Brand: Leap)	Author's prototype
Operating voltage	230V AC, 50Hz	9V	7V-12V
Dimensions	26.5cm × 18cm × 6cm	16cm × 11cm × 4.5cm	16cm × 10cm × 2.5cm
USB port	No	No	Yes
Provision for re-programming	No	No	Yes
Maximum pin number	40	24	20 (can be upgraded to 40)
Display unit	9-digit 7-segment display	16×1 LCD	Nokia 5110 LCD (48×84 pixels)
Input method	Alphanumeric keypad	No numeric keypad	5×3 matrix keypad (15 keys) Keys: 0-9, up, down, left, right, ok
Auto-search	Yes	Yes	Yes
Truth table observation	No	No	Shows for all gates
Counting process observation	No	No	Available for counter ICs
Analogue IC checking	Yes	No	Can be upgraded for analogue ICs up to 14 pins

TABLE II
GLOBAL VARIABLES

Variables	Basic operations
int good_gate=0, bad_gate=0;	For holding the information of the working condition of each gate
int i=0, x=1, ret=1;	Used in some loop conditions
char key;	Holds the character entered through the keypad
char str[5]; char str1[5] = "---"; char str2[5] = "---";	Holds some strings for display purposes
nokia_lcd my(9,10,11,12,13);	Specifies the pins connecting the LCD panel
matrix_keypad inp(28,26,24,22,23,29,27,25);	Specifies the rows and columns connecting the keypad

(Brand: Leap)) is shown in Table I.

Software. A brief note on the coding is shown in Table II with different uses of variables and in Table III with uses of important functions.

Construction and testing

An actual-size, single-side PCB of the transmitter unit is shown in Fig. 4 and its component layout in Fig. 5. One can use this PCB as Arduino shield with Arduino Mega ADK board using 12V power supply at CON2. Otherwise, Arduino Mega ADK board can be interfaced with the PCB using cable con-

nectors and power supply from 12V/1-amp adaptor.

As shown in block diagram (Fig. 2), the MCU is interfaced through an LCD, a keypad and an IC ZIF socket. The flow chart corresponding to the basic working process is shown in Fig. 6. As shown in the flow chart, this prototype is equipped with two methods for checking a particular IC. Both of these are elaborated below.

As different ICs come with their own specifications, checking process for each may vary. Here, we take an example of a common NAND gate

IC 4011, whose truth table is shown in Table IV.

Auto-search method. In this

process, the number of pins of the IC to be checked is entered first. The device then starts manifesting all

possible input signals to the IC and takes back its response for each possible input. If a response matches the output of a particular IC in its database, then it declares that IC as good (Figs 7 and 8).

Manual-checking method.

In this method, the IC number is entered first (for example, 4011 as shown in Fig. 9). On continuation, basic detail of that IC is displayed (Fig. 10). At the start of the checking process, an option for truth table is provided for the user (Fig. 11). For viewing the truth tables, this option must be selected. At the next stage, the MCU initialises the signal-processing task.

In case of this specific NAND gate IC 4011, the MCU provides 5V supply to pin 14 and 0V to pin 7. As this IC has four NAND gates, each of these is checked one by one. The MCU provides the necessary combination of inputs to each gate as per the truth table (Table IV) and takes back outputs from the IC (4011) as its input.

Then, by comparing these observed results with expected results as per IC specifications, the MCU yields its conclusion on that particu-

**TABLE III
DIFFERENT FUNCTIONS**

Functions	Basic operations
void loop()	Executes again and again
void auto_manual()	For selecting the mode of testing (automatic/manual)
int auto_search()	For automatic searching of the IC and giving its working status
int welcome()	For displaying a simple welcome screen
int help()	For displaying some important instructions
int test()	For accepting IC number and calling the exact function for the specific IC
long int accpt(char ch)	For accepting different inputs (for example, IC number, time intervals and binary numbers etc)
int ic_quad_2(int num)	For checking those ICs that have four 2-input gates (for example, 4011)
int ic_triple_3(int num)	For checking those ICs that have three 3-input gates (for example, 4073)
int ic_74_quad_2(long int num)	For checking some 74 series ICs that have four 2-input gates (for example, 7400)
int ic_hex_inv(int num)	For checking an IC with six inverting gates
int ic_4029()	For checking counter IC 4029
int ic_dual_4(int num)	For checking those ICs that have two 4-input gates (for example, 4082)
int ic_oct_1(int num)	For checking an IC with an 8-input gate
int ic_74393()	For checking counter IC 74393
int ic_hex_16pin(int num)	For checking some hex-buffers and hex inverters (for example, 4050 and 4049)
int ic_4000()	For checking a dual 3-input NOR gate (for example, 4000)
int ic_d_flip(int num)	For checking a dual D flip-flop (for example, 7474, 7479)
int ic_jk_flip(int num)	For checking a dual JK flip-flop (for example, 7476 and 7473)
int dec2bin(int n)	For converting numbers from decimal to binary

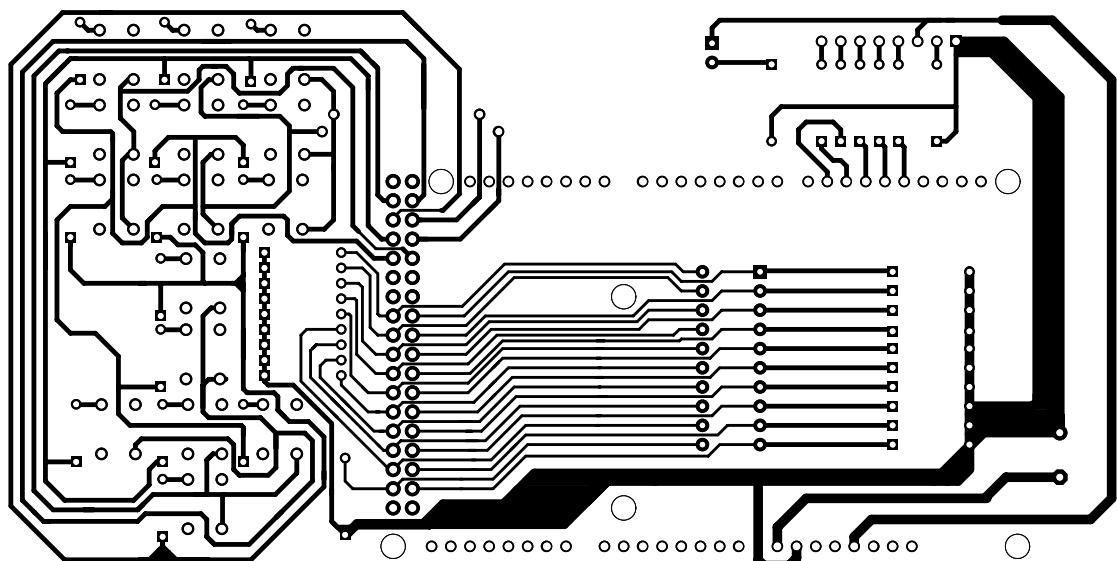


Fig. 4: Actual-size PCB pattern of the digital IC tester

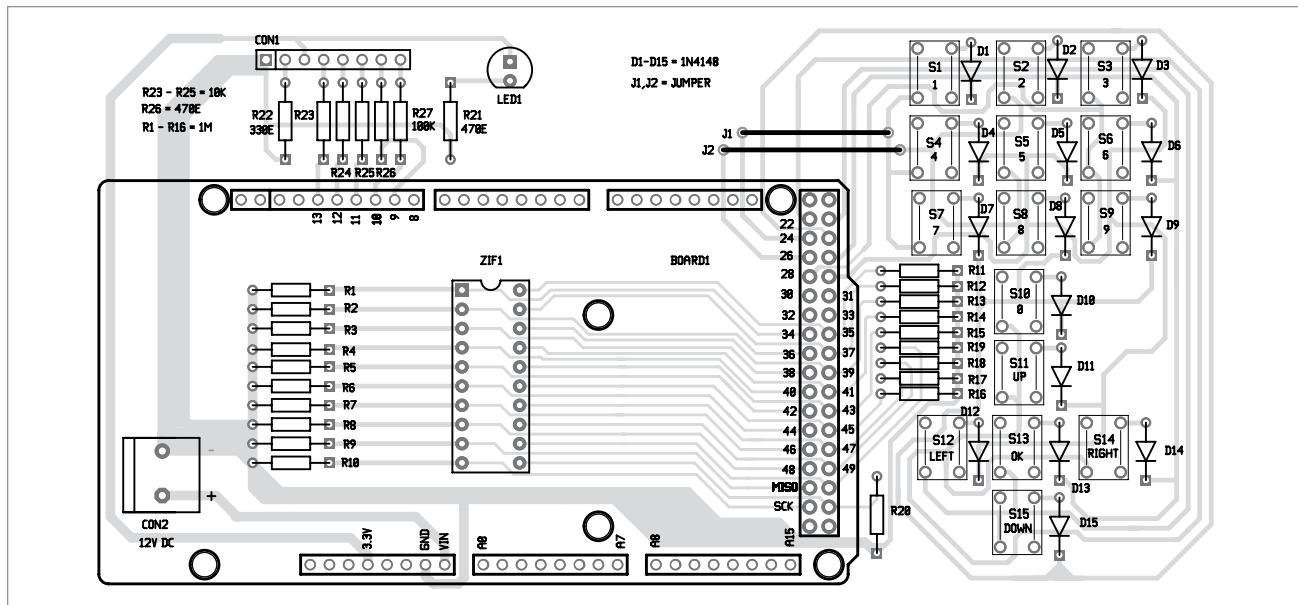


Fig. 5: Component layout of the PCB

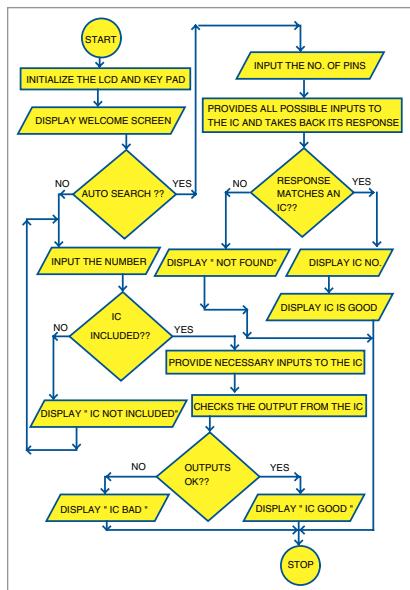


Fig. 6: Flow chart explaining the basic working process

Auto-search
No. of pins:
14
ext ok clr

RESULT
IC is:
4011/4093
IC is GOOD
exit

Fig. 7: Entering the number of pins in auto-search method

Fig. 8: Displaying the result in auto-search method

Enter IC no.
4011
ext ok clr

PLACE THE IC
4011
QUAD-2-INPUT
NAND GATE
ext chk bck

Fig. 9: Entering IC number

Fig. 10: Basic information about the IC

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

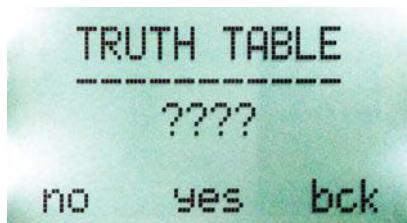


Fig. 11: Option for truth tables

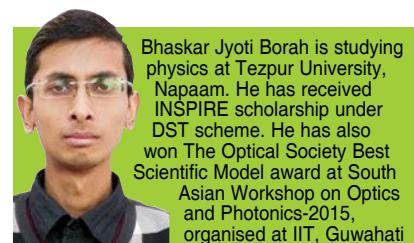
IN	IN	OUT	GATE
0	0	1	1
0	1	1	OK
1	0	0	skp
Pse			

Fig. 12: Observed truth table for the first NAND gate

TABLE IV
TRUTH TABLE FOR NAND GATE

Input A	Input B	Output
0	0	1
0	1	1
1	0	1
1	1	0

lar gate (Fig. 12 shows the result for the first gate along with the corresponding truth table). Finally, the number of good and bad gates is displayed, in addition to the overall condition of the IC (Fig. 13). EFY



Bhaskar Jyoti Borah is studying physics at Tezpur University, Napaam. He has received INSPIRE scholarship under DST scheme. He has also won The Optical Society Best Scientific Model award at South Asian Workshop on Optics and Photonics-2015, organised at IIT, Guwahati

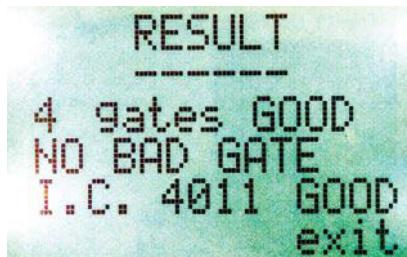
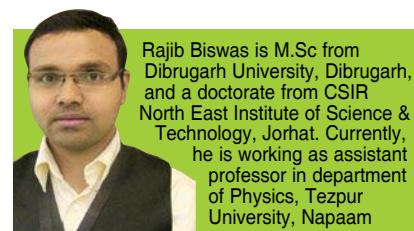


Fig. 13: Result of manual-checking method



Rajib Biswas is M.Sc from Dibrugarh University, Dibrugarh, and a doctorate from CSIR North East Institute of Science & Technology, Jorhat. Currently, he is working as assistant professor in department of Physics, Tezpur University, Napaam



EARTHQUAKE INDICATOR

Using Arduino

RONIE ADHIRAJ GHOSH

An earthquake is an unavoidable and unpredictable natural phenomenon that often causes damage to lives and property. We cannot fight it but we can stay alert and aware using technology that can protect us and the industry. Here a simple earthquake indicator for

home and industry using an Arduino and a highly-sensitive ADXL335 (Fig. 1) accelerometer is presented that can indicate vibrations.

This project can be modified and used as a knock-and-shake detector for ATMs, vehicles or door-break alarms. But its main aim is to detect earthquakes and other seismic activities.

We know that accelerometers like ADXL335 are highly sensitive to knocks and vibrations in any of the three physical axes. ADXL335 gives analogue voltage equivalent

to imposed acceleration. It has three outputs, one each for X-, Y- and Z-axes. The three analogue outputs are wired to Arduino Uno ADC pins. Any acceleration caused due to movement in any of the axes is detected by the accelerometer and hence by Arduino ADC.

If motion is violent enough during an earthquake and crosses a certain threshold, a local alarm light (LED) glows, a buzzer sounds as well as a relay energises. While the buzzer and light is for home purpose, relay output is for industrial

purpose; it can be wired to a PLC for safety interlocking of any moving machine part and furnace control for shutting these down in case of an earthquake. The threshold adjustment buttons are there for carrying out this task. An LCD has been provided for viewing threshold adjustments and for making the system user-friendly.

Circuit and working

The circuit (Fig. 2) uses Arduino Uno board wired to ADXL335 accelerometer module (connected across CON2) with its ADC inputs, namely, X-axis to A0, Y-axis to A1 and Z-axis to A2. Two pushbuttons through supply of 5V are wired to Arduino Uno interrupt pins 2 and 3 that are pulled down to ground via resistors R2 and R1. These buttons are used for incrementing and decrementing the threshold of vibration detection. A 16x2

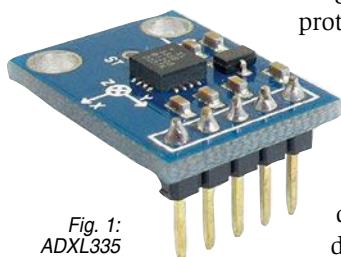


Fig. 1:
ADXL335

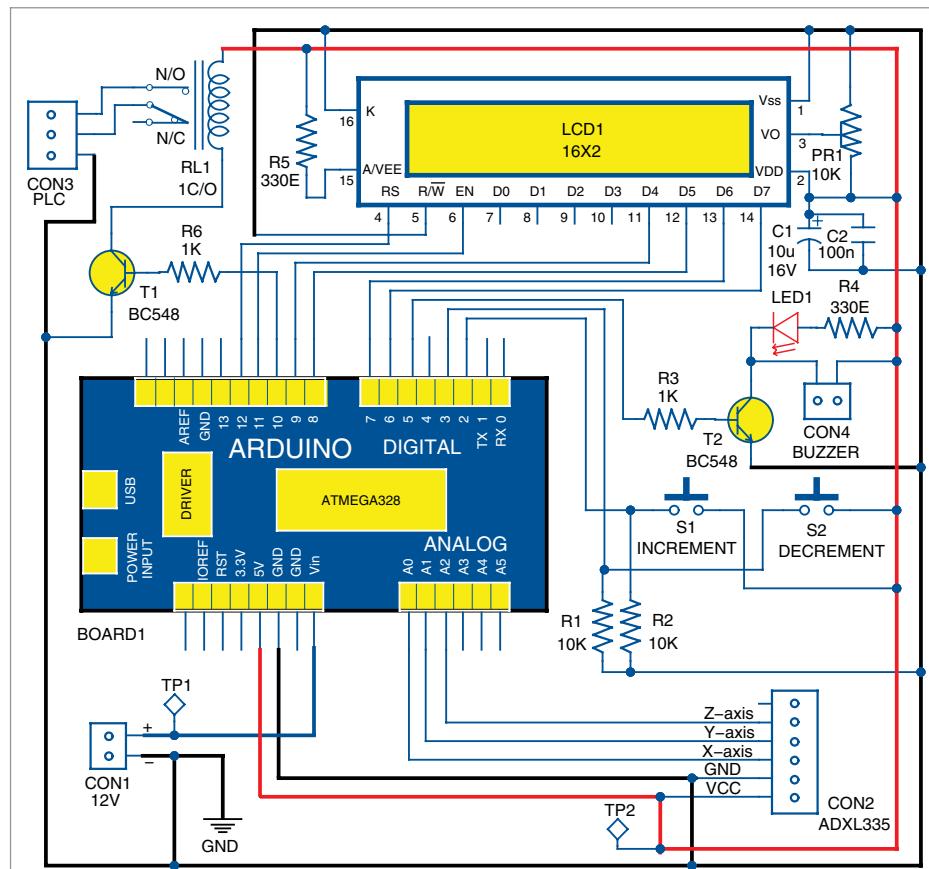


Fig. 2: Circuit diagram of the earthquake indicator

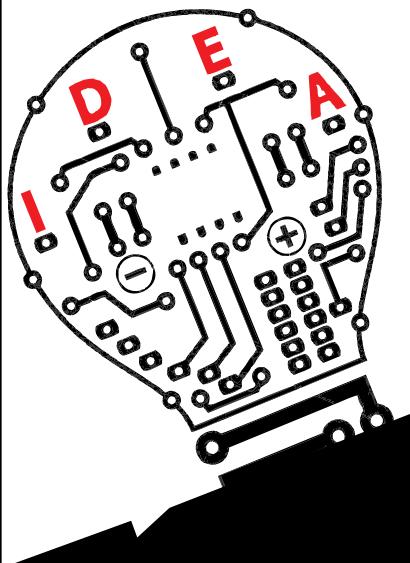
EFY Note

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](http://efymag.com)

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from designers and
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LCD (LCD1) is wired in 4-wire mode with Arduino pins contrast control and backlight enabled.

BC548 transistor (T2) is connected to pin 5 of Arduino for switching on the local alarm LED (LED1) and a buzzer connected across CON4. Another BC548 (T1) is connected to pin 10 for de-energising a relay (RL1) in case the alarm is triggered for industrial PLC interfacing for safety interlocks. Pins 11, 12, 9, 8, 7 and 6 are used for LCD control and data lines. When the setup is powered, and while it is still, it reads



Fig. 3: Initialising mode



Fig. 4: Monitoring mode



Fig. 5: Indicating mode

and stores current accelerometer values in Arduino internal EEPROM regardless of its orientation.

Since the ADC is 10-bit, special header file `<EEPROMAnything.h>` has been provided with the code. A five-second delay has been provided for all voltages and for the system to be stable before any initial value is read. Arduino's microcontroller reads all three axes data from the accelerometer and stores in the EEPROM. It also stores the default threshold value of 25 in the EEPROM.

Some conventional indications on the LCD (Fig. 3, Fig. 4 and Fig. 5) are shown here for different working modes. In initialising mode (Fig. 3), system parameters are

initialised. In monitoring mode (Fig. 4), the system enters into monitoring mode with current threshold value displayed on the second line of the LCD.

In indicating mode (Fig. 5), the system reads accelerometer values continuously and compares these with previous steady values of the accelerometer, stored in the EEPROM while initialising. If current value differs, that is, if stored value is either more than threshold value in positive side or less than threshold value in negative side, the alarm sounds and the relay is de-energised. This design and coding supports positive as well as negative values in all three axes.

Pushbuttons connected to pins 2 and 3 of Arduino serve as interrupts for incrementing and decrementing threshold values for sensitivity adjustments. For earthquakes, a threshold of 10 to 15 is good. The sensor can also be used to detect knocks and vibrations if the threshold is set to 5 to 8.

The entire setup can be wired and enclosed in a hard enclosure and mounted anywhere in industry or home. Users can also calculate resultant acceleration by using formulae of square root of $X^2 + Y^2 + Z^2$, where X, Y and Z are outputs from ADXL335, and then compare the result with the threshold to raise an alarm. Modifications can be done by the user on the same platform, if required.

Software comprises earthQuake.ino with some header files of Arduino. **EFY**

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FINGERPRINT DOOR UNLOCK SYSTEM Using Arduino

DINU D. AND CINLA K. PAPPACHAN

This simple fingerprint sensor project using Arduino can be very useful for door security, forensics, crime investigation, personal identification, attendance system and much more. In the future, there could be many more applications like fingerprint based driving licenses, bank accounts operation and so on. The whole system works under a simple algorithm called matching algorithm, which is used to compare previously-stored templates of fingerprints against users' fingerprints for authentication purposes.

A key is normally used for traditional door opening, but it provides

very poor security. In this project, only when an authorised person places a finger on the sensor, the door unlocks and the LCD displays a welcome message along with that person's name.

Circuit and working

The circuit shown in Fig. 1 operates using a 12V power supply. An Arduino microcontroller (MCU) requires only 5V but the solenoid electric lock requires 12V. As Arduino Uno has an inbuilt 5V voltage regulator, a common 12V supply can be used for the whole system.

The brain of the circuit is Ar-

duino Uno MCU board (BOARD1). It is based on ATmega328/ATmega328P and has 14 digital input/output (I/O) pins, six analogue inputs, 32k flash memory, 16MHz crystal oscillator, a USB connection, power jack, ICSP header and reset button, among others. It can be programmed using Arduino IDE software.

Fingerprint sensor module R305 (connected across CON2) has UART interface with direct connections to the MCU or to the PC through max232/USB serial adaptor. The user can store fingerprint data in the

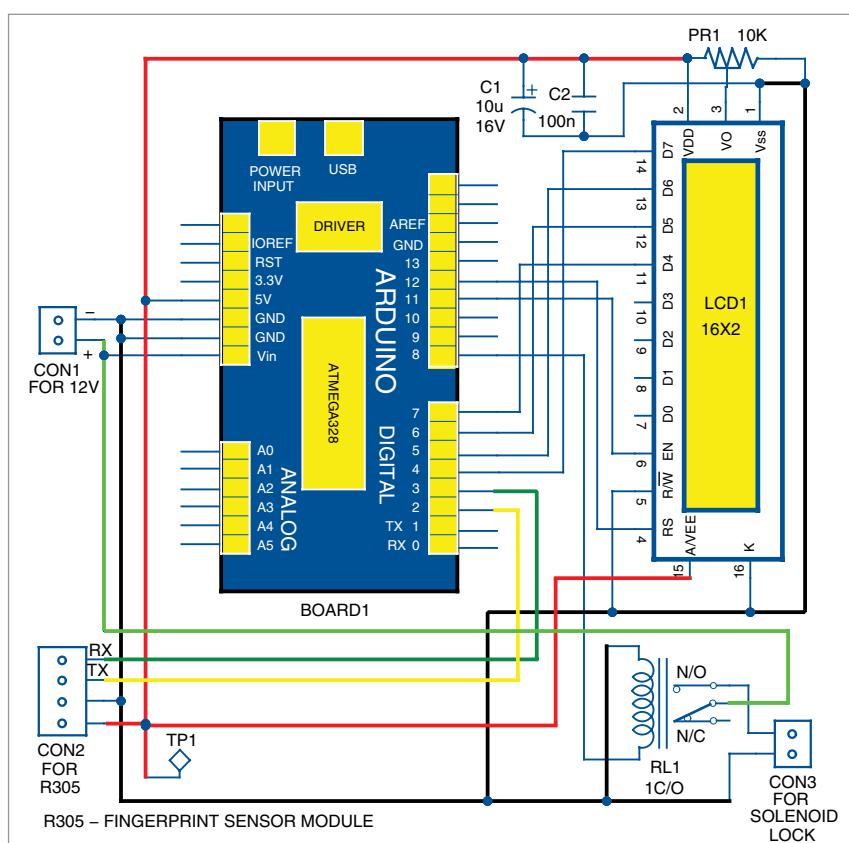


Fig. 1: Circuit diagram of the fingerprint door unlock system

Test Points

Test point	Details
TP1	5V (Voltage measure w.r.t. GND)

PARTS LIST

Semiconductors:	
BOARD1	- Arduino Uno
Resistors (all 1/4-watt, ±5% carbon):	- 10-kilo-ohm preset
Capacitors:	
C1	- 10μF, 16V electrolytic
C2	- 100nF, ceramic disk
Miscellaneous:	
RL1	- 5V, 1C/O relay
LCD1	- 16x2 alphanumeric display
CON1	- 2-pin connector
CON2	- DC supply
CON3	- 4-pin connector
	- R305
	- 2-pin connector
	- Solenoid lock



Fig. 2: Initial state



Fig. 3: Valid finger



Fig. 4: Invalid finger

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](http://efymag.com)

DO-IT-YOURSELF

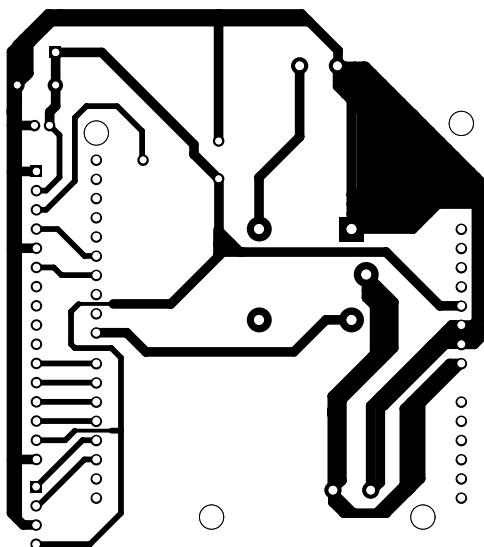


Fig. 5: Actual-size PCB pattern of the fingerprint door unlock system

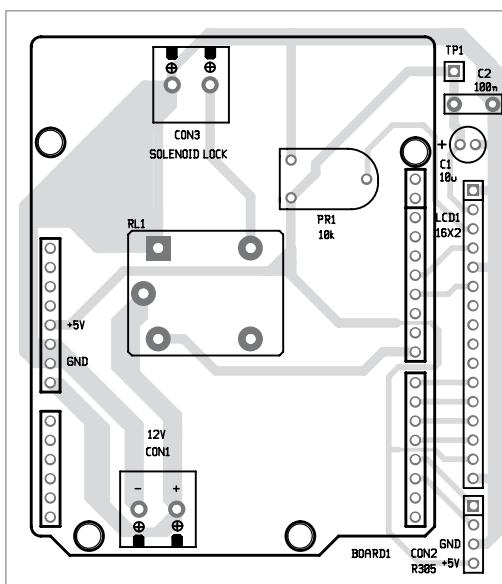


Fig. 6: Component layout of the PCB

the serial monitor window to 38400. Choose Newline option from the same place. Then, follow the instructions on the serial monitor. Place the finger on the fingerprint module. Type any whole number as the ID number. Press Send tab to send the ID number from the serial monitor to Arduino. This fingerprint gets converted into digital data and gets stored inside R305 module database.

More than 200 fingerprints can be stored on this system. Make sure

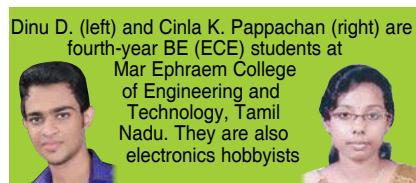
that each fingerprint has a unique ID number. This ID number will be used in the next program to identify the authenticated person's name. The serial monitor will guide the user as to when he or she should place the finger and when to remove it.

For debugging without an LCD display, make the same settings for the serial monitor after uploading Fingerprint program. This is used to compare the fingerprint in the sensor with stored prints. The serial monitor guides here also. The fingerprint program should be edited to change the name and ID numbers according to how users want.

Construction and testing

An actual-size, single-side PCB for the fingerprint door unlock system is shown in Fig. 5 and its component layout in Fig. 6. For convenience, we have designed the PCB as an Arduino shield. The users can modify the design as per requirement. Also, they can test PCB with Arduino board using a cable connector.

Make sure the baud rate given in the program is correct. Baud rate for the serial monitor can be anything but the baud rate for R305 sensor should match that given in its datasheet. Baud rate may vary with different versions of the sensor. It is given in the program like Serial.begin(38400) [baud rate for serial monitor]; finger.begin(57600) [baud rate for sensor]. Reset Arduino board before validation of the fingerprint. **EFY**



module and configure it in 1:1 or 1:N mode for identification. Pins TX and RX of R305 sensor are connected to Arduino digital pins 2 and 3, which are used for serial communication.

The LCD display (LCD1) is used to display messages during action. Here, a 16x2 display is used; each character is made of 5x7 dot-matrix. Pins 3, 4, 5 and 6 of the LCD are the control lines connected to preset (PR1) output, pin 12 (Arduino), GND and pin 11 (Arduino). Pins 11, 12, 13 and 14 are data pins of the LCD that are connected to pins 7, 6, 5 and 4 of Arduino, respectively. Preset PR1 is used to adjust the contrast of the LCD display.

An electronic door-lock solenoid (connected across connector CON3) is basically an electromagnet made of a big coil of copper wire with an armature (slug of metal) in the middle. When the coil is energised, the slug is pulled into the centre of the coil. This allows the solenoid to move to one end.

The solenoid lock requires more current than what Arduino can provide. Therefore to operate the lock, a 5V relay (RL1) is used. CON3 is connected between normally open (N/O) contacts of RL1 and GND. The sequence of messages on the LCD from author's prototype are shown in Figs 2, 3 and 4.

Software

Programs named enroll and fingerprint use different functions like getFingerprintEnroll(int,id), Adafruit_Fingerprint(&mySerial) and getFingerprintEnroll(id). These functions are defined inside the library and pass arguments when called.

After uploading enroll in the Arduino, open serial monitor from Arduino IDE from Tools→Serial monitor options. Change baud rate below



Low-Cost DUSK-DAWN CONTROLLER

BIKASH RAI

Solar streetlights can be easily integrated with a dusk-dawn controller by simply employing a pnp transistor and a few resistors where the solar panel itself works as the sensor. But what about other lighting sources that do not employ solar panels such as automatic lighting systems in small wind turbines, automatic lighting in cars or battery based systems where automatic lighting is necessary?

A simple, low-cost, yet an effective solution for the dusk-dawn controller circuit is described here. Author's prototype is shown in Fig. 1.

Circuit and working

Circuit diagram of the dusk-

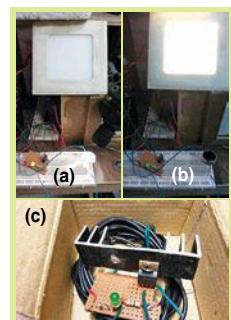


Fig. 1: Author's prototype: (a) dawn mode, (b) dusk mode and (c) prototype

dawn controller is shown in Fig. 2. It is built around a light-dependent resistor (LDR1), n-channel MOSFET IRF640 (T1), 12V LED light or a small inverter (100W) and a few other components.

PARTS LIST

Semiconductors:

- LED1 - 5mm LED
T1 - IRF640, n-channel MOSFET

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

- R1 - 1.2-kilo-ohm
R2 - 22-ohm

Miscellaneous:

- LDR1 - Epoxy-coated, moisture-resistant 25mm/12mm diameter, light-dependent resistor
S1-S2 - On/off switch
BATT.1 - 12V, 7Ah battery
CON1-CON3 - 2-pin connector terminal
- 12V DC, 5W LED lights
- 100W small inverter

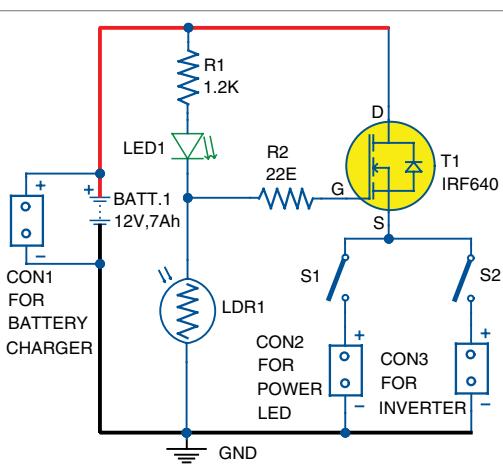


Fig. 2: Circuit diagram of the dusk-dawn controller

is, for power LED/small inverter circuit. Resistors R1 and R2 are used as a voltage divider and a current limiter in the circuit, respectively. LED1 is used as circuit de-activation indicator. LDR1 is the main com-

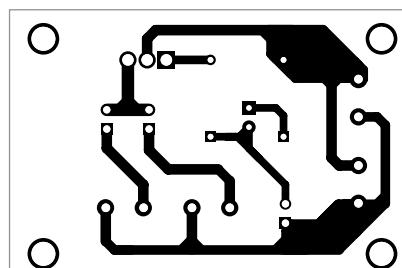


Fig. 3: Actual-size PCB pattern of the dusk-dawn controller

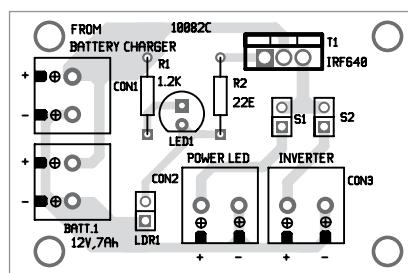


Fig. 4: Component layout of the PCB

The 12V battery-operated circuit is designed such that the common battery supply is used for operating the circuit as well as for load, that

ponent for actuation of the dusk-to-dawn sensing. The n-channel MOSFET IRF640 is for the switching action of the LED light or the small inverter connected to the system through switches S1 and S2, respectively.

With daylight falling on LDR1 (dawn mode), resistance of LDR1 becomes low, a small current flows through LED1 and it glows. At the same time, due to low voltage across LDR1, MOSFET IRF640 does not trigger. So load (LED light/inverter) remains off.

But when the surrounding area of LDR1 (dusk mode) is dark (at night), resistance of LDR1 becomes very high, no current flows through LED1 and it does not glow. At the same time, due to higher voltage across LDR1, IRF640 triggers. So load light (power LED light/inverter) comes on, provided switch S1 or S2 is on.

IRF640 can handle a maximum current of approximately 18A, but you can limit its application to approximately 8A-9A only, based on which the heat-sink is attached to the MOSFET.

Construction and testing

An actual-size, single-side PCB for the dusk-dawn controller is shown in Fig. 3 and its component layout in Fig. 4.

After assembling the circuit, enclose it in a suitable box. The unit should be fixed on the pillar in such a way that the daylight falls directly on LDR1. **EFY**



Bikash Rai is assistant engineer in Energy & Power Department, government of Sikkim. He is also a part-time research scholar at Sikkim Manipal Institute of Technology, Sikkim



DEVICE FOR CHARGING Three 12V Batteries

PETRE TZV PETROV

12V rechargeable batteries are used in cars, electronics projects, systems with emergency lights, electronic toys and so on. These batteries need to be kept charged to avoid damage due to self-discharge.

Circuit and working

Circuit diagram of the device for charging up to three 12V batteries is shown in Fig. 1. It is built around step-down transformer X1, two 1N5404 diodes (D1 and D2), nine 1N4007 diodes (D3 through D11), three 15V, 7815 regulators (IC1 through IC3) and a few other components.

Output voltage of a 7815 regulator can be modified with one or more

1N4007 or similar diodes to obtain the maximum voltage allowed for charging the 12V rechargeable batteries. Schottky diodes like 1N5819 (1A/40V) and 1N5822 (3A/40V) can be used instead of 1N5404 and 1N4007 diodes, respectively.

Jumpers J1 to J6 are kept closed

Test Points

Test point	Details
TP0	0V (GND)
TP1	Around 20V
TP2	15V
TP3	15V
TP4	15V

or open to obtain the maximum output voltage to charge batteries BATT.1 through BATT.3. You can replace these jumpers with appropriate on/off switches of at least 2A rating.

Maximum charging current for the batteries is limited by 7815 regulators along with resistors R2, R3 and R4. Connectors CON2, CON3 and CON4 are for connecting voltmeters to measure the voltage drop across resistors R2, R3 and R4, respectively, and to calculate the charging current of the batteries.

Connect the batteries BATT.1 through BATT.3 to be charged as shown in Fig. 1. The 7815 voltage regulators can be mounted on a

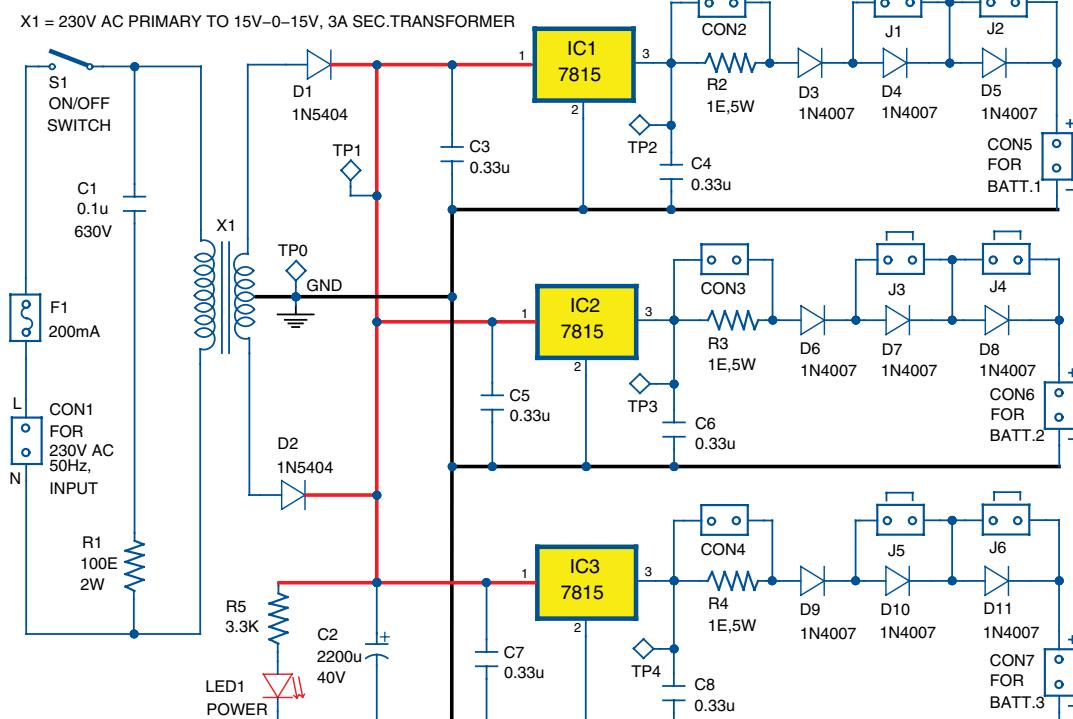


Fig. 1: Circuit diagram for the device for charging three 12V batteries

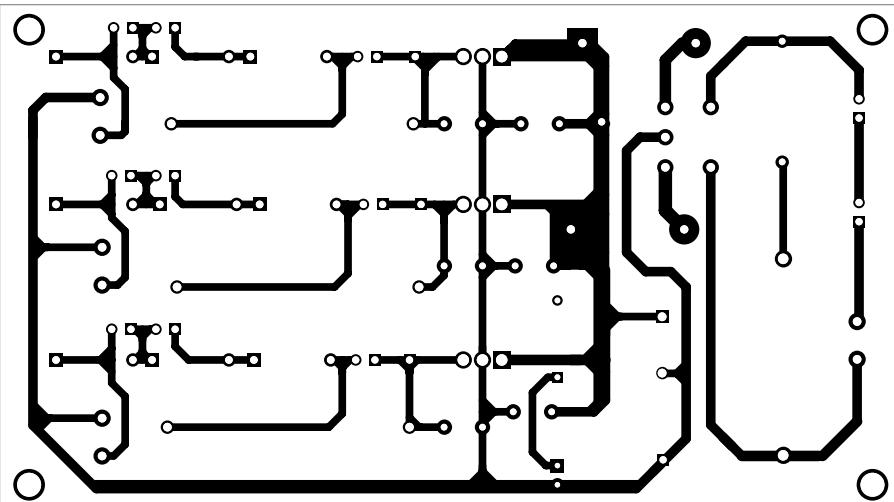


Fig. 2: Actual-size PCB of the device for charging three batteries

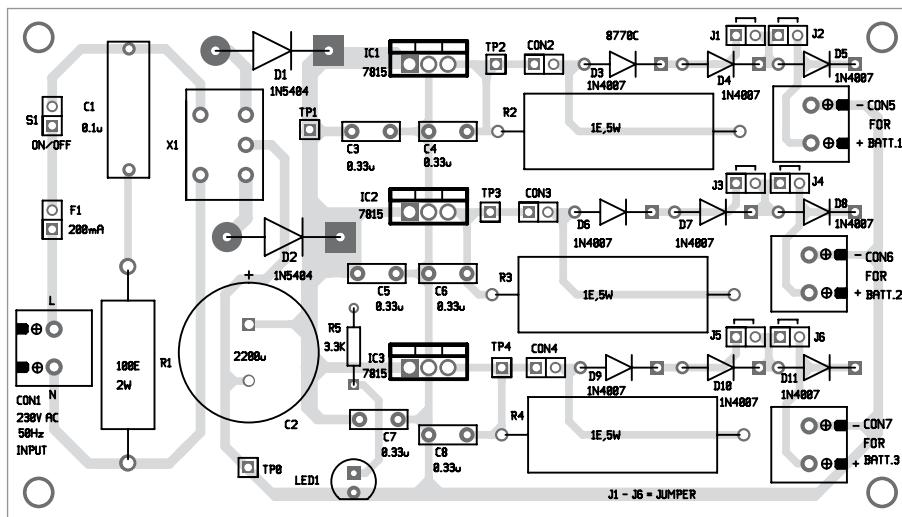


Fig. 3: Component layout of the PCB

common heat-sink having thermal resistance below $4^{\circ}\text{C}/\text{W}$. LED1 is used as a power on/off indicator.

Most 12V, 7Ah batteries can be connected for a long time but should be kept in charged state. The only adjustment that needs to be made to the device is to open or close jumpers J1 to J6 according to charging voltage requirement.

When jumper J1 and J2 are opened, charging voltage for battery (BATT.1) will be around $15\text{V}-0.7\text{V} = 14.3\text{V}$. If J1 is opened and J2 is closed, charging voltage for battery (BATT.1) will be $(15\text{V}-0.7\text{V}) \times 2 = 13.6\text{V}$. Similarly, if both jumpers J1 and J2 are closed, charging voltage for battery BATT.1 will be $(15\text{V}-0.7\text{V}) \times 3 = 12.9\text{V}$.

PARTS LIST	
<i>Semiconductors:</i>	
IC1-IC3	- 7815, 15V voltage regulator with heat-sink
D1, D2	- 1N5404 rectifier diode
D3-D11	- 1N4007 rectifier diode
LED1	- 5mm LED
<i>Resistors (all 1/4-watt, $\pm 5\%$ carbon, unless stated otherwise):</i>	
R1	- 100-ohm, 2W
R2-R4	- 1-ohm, 5W
R5	- 3.3-kilo-ohm
<i>Capacitors:</i>	
C1	- 0.1E, 630V polyester
C2	- 2200F, 40V electrolytic
C3-C8	- 0.33 μF ceramic disk
<i>Miscellaneous:</i>	
BATT.1-BATT.3	- 12V, 7Ah battery for charging with connector terminals
S1	- On/off switch
F1	- 200mA fuse with holder
CON1	- 2-pin connector terminal
CON2-CON4	- 2-pin connector
CON5-CON7	- 2-pin connector terminal
X1	- 230V AC primary to 15V-0-15V, 3A secondary transformer
J1-J6	- 2-pin jumper connector

The same will be applicable for other jumper such as J3, J4 and J5, J6 for BATT.2 and BATT.3, respectively.

Construction and testing

An actual-size, single-side PCB of the device for charging 12V batteries is shown in Fig. 2 and its component layout in Fig. 3. Enclose the PCB in a small box such that 230V AC mains can be connected easily.

Also, fix three terminals on the rear side of the cabinet for connecting the batteries.

Verify the test points as per the table before using the circuit. **EFY**



Petre Tzy Petrov 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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SOLAR LIGHT For A Portable Toilet

T.K. HAREENDRAN

Despite being more expensive than standard permanent outdoor toilets, portable toilets (Fig. 1) have several significant benefits as these are self-contained and can be placed almost anywhere. These days portable toilets are frequently seen at outdoor areas like construction sites, farms, camp sites and even street-sides. Solar power provides an ideal solution for applications where lighting is required in portable



Fig. 1: Proposed toilet system

toilets that are located away from a mains supply grid, or the installation is expected to be on the site for a brief period.

Here is a circuit of a self-contained solar light for portable toilet lighting applications. The solar light housed within its own enclosure comprises a solar charger, rechargeable battery pack, white LED light source and PIR motion sensor as an occupancy sensor. The occupancy sensor (motion sensor) activates the light source and, after the booth has been vacated (or when there is no valid motion), the lighting switches off to save battery.

Circuit and working

Circuit diagram of the solar light

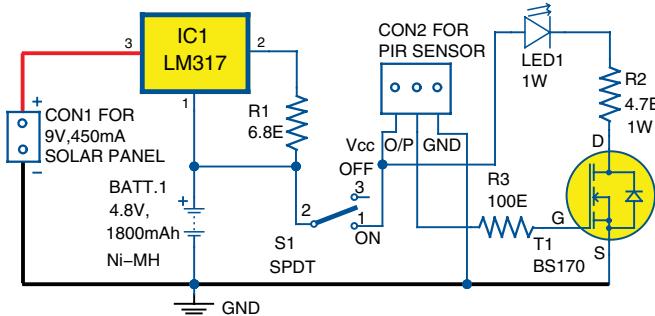


Fig. 2: Circuit diagram of the solar light for a portable toilet

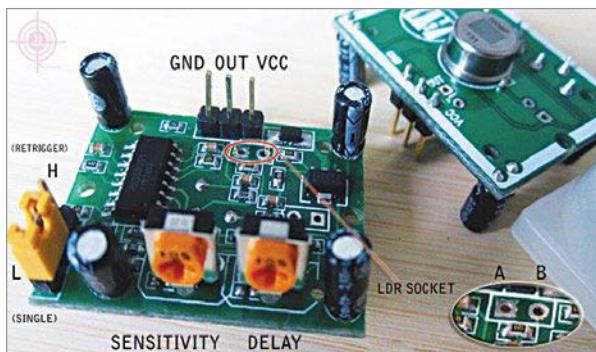


Fig. 3: Photo of the PIR sensor

for a portable toilet is shown in Fig. 2. It is built around a 9V, 450mA solar panel, voltage regulator LM317 (IC1), a PIR sensor, MOSFET BS170 (T1), a 1W white LED (LED1) and a few other components.

The circuit may

PARTS LIST

Semiconductors:

- IC1 - LM317 adjustable voltage regulator with heat-sink
 - T1 - BS170 MOSFET
 - LED1 - 3.6V, 1-watt white LED
- Resistors (all 1/4-watt, ±5% carbon, unless stated otherwise):
- R1 - 6.8-ohm
 - R2 - 4.7-ohm, 1-watt
 - R3 - 100-ohm

Miscellaneous:

- S1 - SPDT switch
- CON1 - 2-pin connector terminal
- CON2 - 3-pin connector
- CON3 - 2-pin connector for LED1
- BATT.1 - 2-pin connector terminal
- 4.8V, 1800mAh Ni-MH battery
- 9V, 450mA solar panel
- PIR sensor

be split into two sections: the charger and the sensing and control system. Power is supplied via the 9V, 450mA-rated polycrystalline solar panel, which is linked to CON1 and charges the 4.8V, 1800mAh battery pack, BATT.1, via the constant-current charger built around IC1. The 6.8-ohm resistor (R1) limits the charging current to near one-tenth rate of the battery, that is, 180mA.

The sensing and control circuitry is based on PIR motion detector module (Fig. 3), which is connected across CON2. When a valid motion is detected, output of the PIR sensor goes to around 3.3V and the light source LED1 (3.6V, 1W white LED) is switched on through medium-power MOSFET BS170 for a finite time. The 4.7-ohm, 1W resistor R2 limits the operating current of the white LED.

Construction and testing

An actual-size, single-side PCB for the solar light for a portable toilet is shown in Fig. 4 and its component layout in Fig. 5. Enclose the PCB in

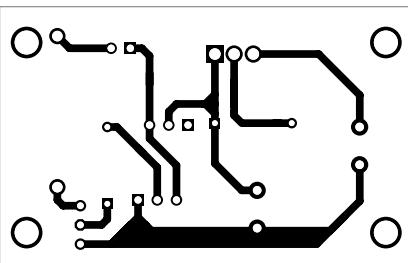


Fig. 4: Actual-size PCB of the solar light for a portable toilet

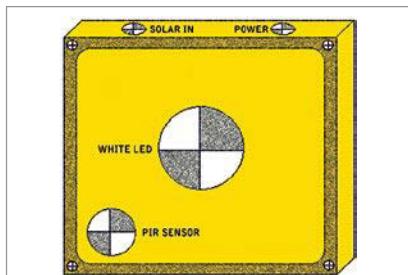


Fig. 6: Suggested enclosure

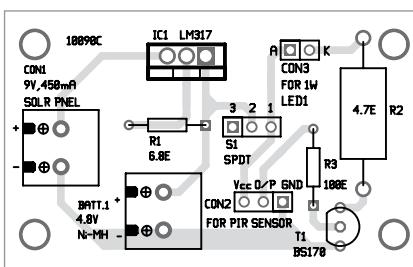


Fig. 5: Component layout of the PCB

a suitable small box in such a way that it can be fitted in the toilet.

After assembling the PCB board, connect the fully-charged battery

pack BATT.1 to the circuit and switch on S1. The PIR motion sensor detector requires an initialisation time of about 60 seconds (or even up to three minutes). Thereafter, it enters standby mode, ready for detection.

You can adjust the delay potentiometer in PIR sensor clockwise to increase the time delay from three seconds to up to 300 seconds. Similarly, turning the sensitivity pot in PIR sensor clockwise increases the detection sensitivity from three

to six metres. In some PIR sensor potmeters, the LDR socket option is not provided.

The solar panel (not fitted within the enclosure) can be mounted at an appropriate location. Battery pack BATT.1 is best linked to the circuit via two flexible, well-insulated multi-strand wires. Then, a heat-sink should be added to IC LM317.

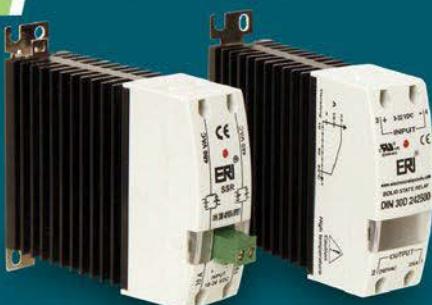
Finally, house the assembled PCB in a small plastic case with holes drilled for the connectors for linking the solar panel, switch S1, LED1 and PIR motion sensor. The suggested enclosure is shown in Fig. 6.

EFY note. Connect LED1 externally, with a proper heat-sink, to CON3 in the PCB. **EFY**



T.K. Hareendran is an electronics hobbyist, freelance technical writer and circuit designer

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Low-Cost LPG LEAKAGE DETECTOR

PAMARTHI KANAKARAJA

The circuit for an LPG leakage detector is readily available in the market, but it is extremely expensive and usually based on a microcontroller (MCU). Presented here is a low-cost circuit for an LPG detector that you can build easily.

The main objective of the circuit is to detect LPG leakage anywhere. Fig. 1 shows the author's prototype.

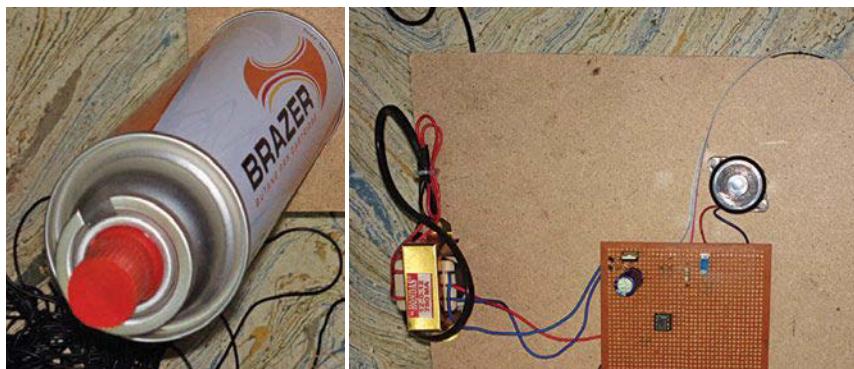


Fig. 1: Author's prototype

Circuit and Working

Circuit diagram of the low-cost LPG detector is shown in Fig. 2. It is built around step-down transformer X1, two rectifier diodes 1N4007 (D1 and D2), a 1000 μ F capacitor (C1), 7805 voltage regulator (IC1), MQ-6 LPG gas sensor (GS1), dual comparator LM393 (IC2), darlington transistor TIP122 (T2), 12V high-gain

Test Points	
Test point	Details
TP0	GND
TP1	Around 16V DC
TP2	5V DC
TP3	High during gas leakage

PARTS LIST	
Semiconductors:	
IC1	- 7805, 5V voltage regulator
IC2	- LM393 dual comparator
D1, D2	- 1N4007 rectifier diode
T1	- TIP122 npn darlington transistor
Resistors (all 1/4-watt, $\pm 5\%$ carbon, unless stated otherwise):	
R1, R3	- 1-kilo-ohm
R2	- 15-ohm, 0.5W
VR1, VR2	- 10-kilo-ohm potmeter
Capacitor:	
C1	- 1000F, 25V electrolytic
Miscellaneous:	
CON1	- 2-pin connector terminal
X1	- 230V AC primary to 12V-0-12V, 750mA secondary transformer
PZ1	- 12V high-gain siren/buzzer
GS1	- MQ-6 LPG sensor

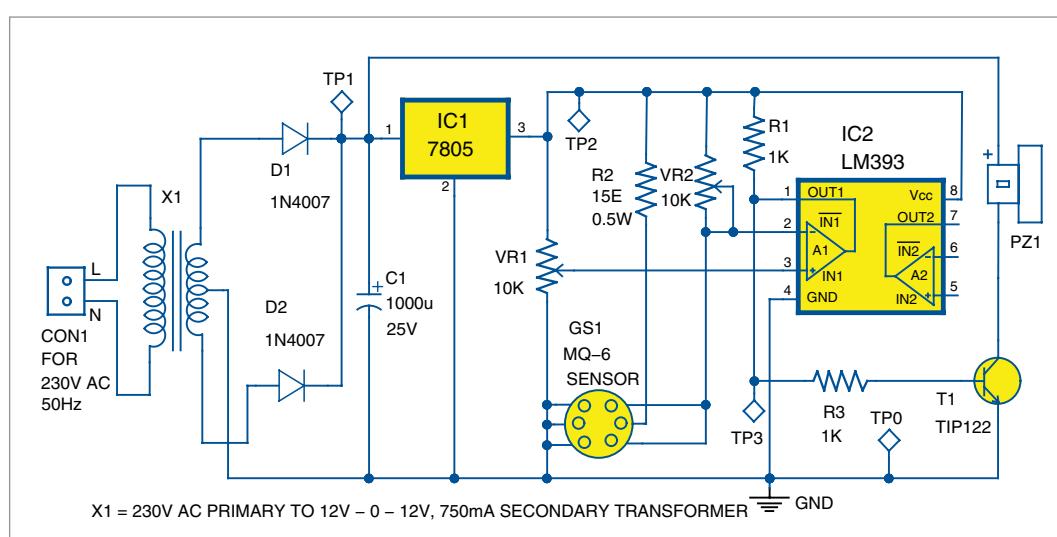


Fig. 2: Circuit diagram of the LPG detector

siren/buzzer (PZ1) and a few other components.

The mains supply is stepped down by transformer X1, rectified by a full-wave rectifier comprising diodes D1 and D2, filtered by capacitor C1 and fed to regulator 7805 (IC1) to maintain constant 5V DC output, which is fed to the circuit.

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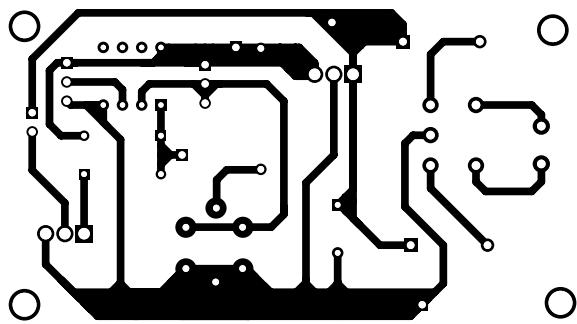


Fig. 3: Actual-size PCB pattern of the LPG detector

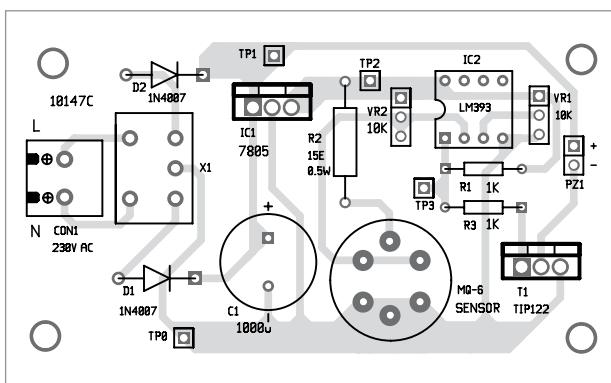


Fig. 4: Component layout of the PCB

the circuit is dual comparator IC LM393 (IC2). It is used to compare two different voltages, namely, reference voltage and MQ-6 gas sensor output voltage.

Reference voltage at non-inverting pin 3 of IC2 is set using potmeter VR1 to adjust voltage levels based on sensitivity requirements. LPG sensor (MQ-6) output voltage is fed to inverting pin 2 of IC2.

If reference voltage (pin 3 of IC2) is less than sensor voltage (pin 2 of IC2), output goes low, which means there is no LPG leakage. With low output, T1 remains cut-off and there is no current flow through the buzzer; it does not sound and remains in silence mode.

If reference voltage is greater than sensor voltage, output goes high, which means there is LPG leakage. The high output switches on transistor T1 and the buzzer rings loudly to alert the

people around.

It is very easy to find gas leakages with this circuit, which uses low-cost components and an interactive way to adjust different sensitivity levels, based on customer needs, with the help of potmeter VR1.

Construction and testing

An actual-size PCB pattern of the LPG detector is shown in Fig. 3 and its component layout in Fig. 4.

After assembling the circuit on a PCB, enclose it in a box with an opening for the

gas to enter. Place the unit near the LPG cylinder or gas stove, within a distance of one metre. Vary preset VR1 to adjust sensitivity of the sensor.

Verify the voltages are as per test points table before using the circuit. Now, spray the gas from the bottle (as shown on the left side of author's prototype) towards MQ-6 gas sensor and measure voltage at TP3; it should be high.

If you do not have a gas-filled bottle, place the unit near the gas stove burner and turn it on for a few seconds without igniting. Then, turn the burner off and adjust VR1 until buzzer sounds. **EFY**



Pamarthi Kanakaraja is associate professor (R&D cell) in Usharama College of Engineering and Technology, Andhra Pradesh. He has been working in the field of embedded designing and programming concepts for the last six years

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JavaScript Canvas Based PAINTING INTERFACE

SRIDHAR BUKYA

JavaScript is a versatile language for programming the Web's back-end. It powers HTML elements' behaviour based on the functions that are defined in the program.

The current program in JavaScript deals with canvas element (HTML5) that is used to paint graphical things on a webpage. It is similar to Vector Markup Language (VML) but initially was a bit complicated to program or understand. With the advent of new browsers, graphical quality, colour rendition and reproduction have been enhanced.

This program is also known as Temporary Paint Interface, as the drawn paint/object cannot be saved to a hard disk as it is. To save it, we need to hit Print Screen key, which copies the drawing on to the clipboard.

Program interface

TPI.html (Fig. 1) is coded in JavaScript and is easy to understand, as the code is self-explanatory. This is used to create drawings such as freehand lines, rectangles and even arcs.

Freehand tool can be used to draw or scribble free-flowing shapes that can include any kind of graphic object, namely, a curve, line, circle or an arc, just based on the way we hold down the primary button and move the mouse pointer in the canvas area.

The canvas element of HTML5 is used to make the diagrams as per

our requirement. We need to define the canvas as a 2D object in the code to place the required object in the desired space.

We can also change the radius of the circle and the thickness of a stroke; both vary on a scale of 1 to 30. And if needed, we can change the same in the code, up to a maximum of 100.

The code is written in an easy-

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*

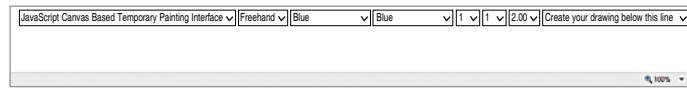


Fig. 1: Temporary Paint Interface (TPI.html) at startup

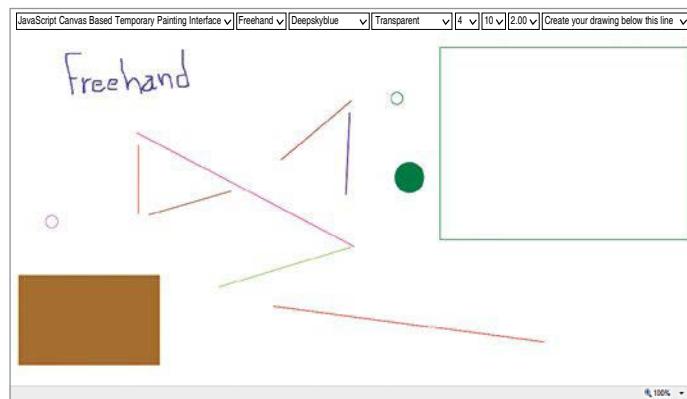


Fig. 2: Various shapes that can be created

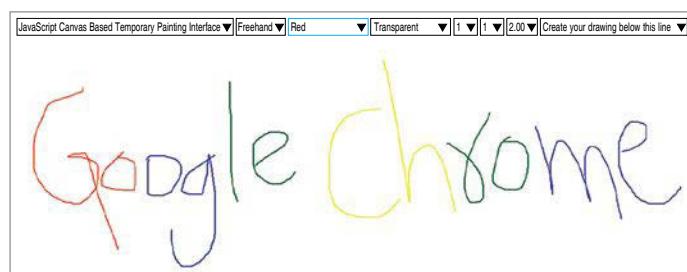


Fig. 3: Interface running on Google Chrome v 43.0.2357.65

to-understand language. In this project we define different kinds of shapes, including free-hand drawings/sketches, lines, rectangles, squares and circles. There is no direct reference to circles on a canvas, so we use Arc element from the canvas library and define its extent in radians, since JavaScript math library understands angles in radians only.

This program generates volatile drawings. The interface has been tested on Windows 8 operating system (OS) (Windows 7 OS in EFY lab) in Chrome browser. The interface does not run properly on touch based systems, as it is difficult to draw using fingers on this interface. But you can draw figures using a mouse or touchpad.

The interface also supports the whole gamut of colours with much ease. Colour names have been defined in a combo box rather than radio buttons, as combo box can be easily used to select one among various colours, and also saves space for other on-screen elements.

Copy the code in a notepad and save the file with .html extension in a definite path. Open the .html file to see the interface as depicted in Fig. 1. **EFY**



Sridhar Bukya is B.Tech in electronics and communications engineering. He enjoys coding in JavaScript, spatial technology (satellite communications) and mobile communications

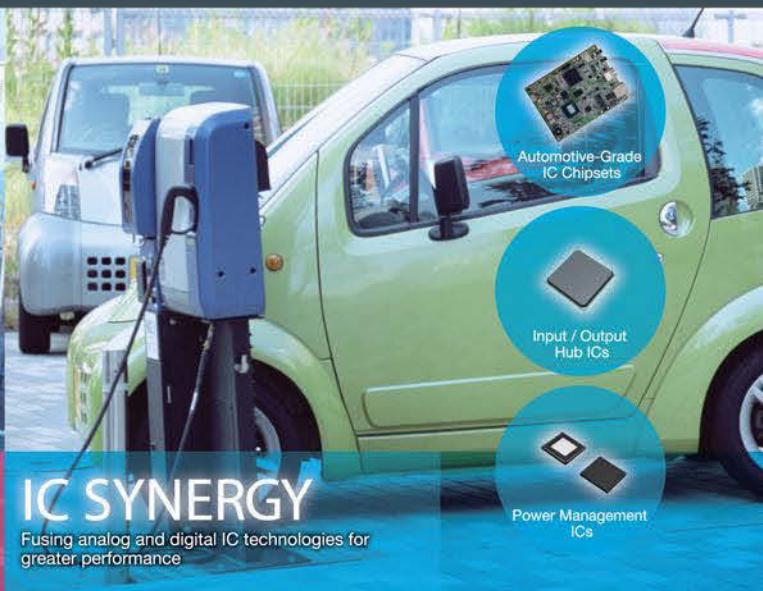
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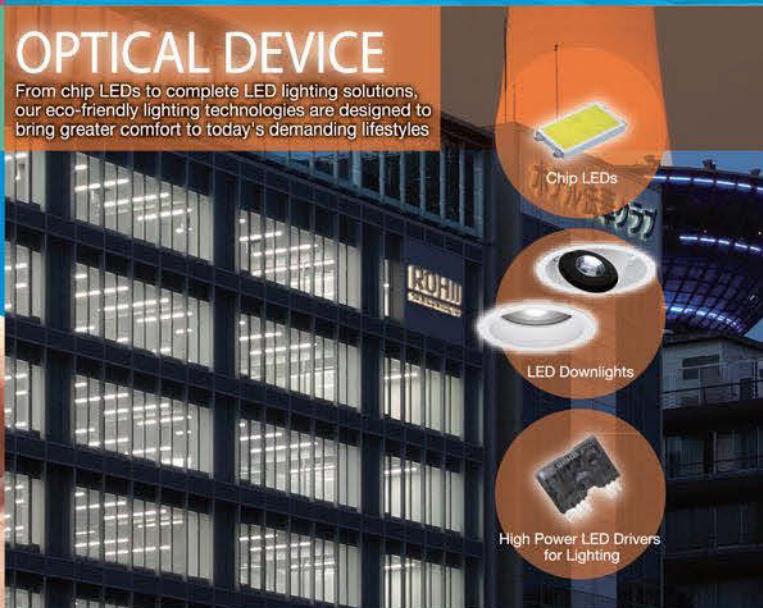
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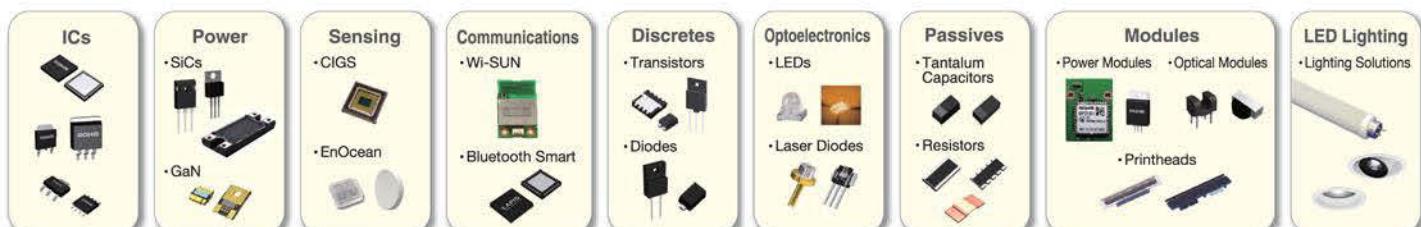
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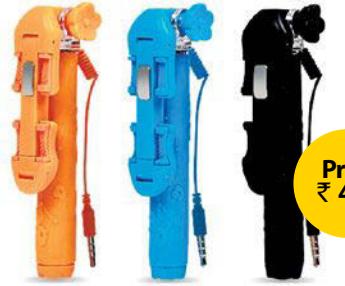


LG launches portable speakers

For creating the perfect music environment for all your moods

LG's latest portable X Boom Cube, OM4560, comes with a powerful amplifier that includes a 2500W PMPO output. It encompasses both wired and wireless options for powerful sound expandability, thus aiding users to connect two units to play music together. Using LG Music Flow app, they can centrally manage their entire music library and control all Music Flow units in their homes.

Sound Sync feature allows users to link their LG audio product with a compatible LG HDTV wirelessly via Bluetooth, reducing the cable clutter. The speakers also connect with a DTH set-up box through an auxiliary cable. Auto DJ, Bass Blast, Gesture Control and Auto Music are some more features of the product.



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The mini selfie stick requires no batteries and works everywhere. It has a simple wire connection that plugs into your smartphone's headphone jack to replicate the volume control shutter-release feature on both iOS and Android devices. Its solid grip feature makes it easy and comfortable to hold and with a sprung phone bracket, it can accommodate any mobile phone that measures between 5cm and 8.5cm in width; even the heaviest of these will be held firmly in place by its strong grip. The bracket is fully adjustable and can rotate a full 360° and tilt up to 180°. For watching videos, the stick can be used as a stand and it can be adjusted at any angle. It comes in black, blue and orange colours.

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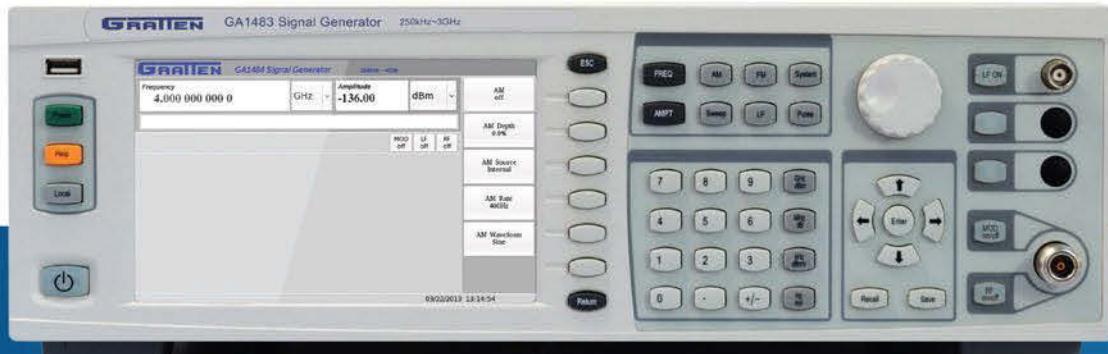
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The new dual-SIM Windows phone from Microsoft comes with 13.2cm (5.2-inch) quad-HD AMOLED screen, Qualcomm Snapdragon 808 1.8GHz hexa-core processor, 20MP rear camera, 5MP front camera, 32GB mass memory, built-in wireless and 3340mAh/USB-C fast charging and Bluetooth 4.1, among other features.

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- <-115dBc/Hz @ 20kHz (Carrier wave 1GHz) : GA1483
- -127 ~ +13dBm amplitude output range with 0.01 dB resolution
- Extensive Analog modulation: AM, FM, Phase and Pulse Modulation
- Hard keys on the front panel and soft keys on the unit's screen, provide fast and intuitive user experience

Model Spec	GA1483	GA1484B	GA1484C	GA1484A
Frequency range	250kHz~3GHz		250kHz~4GHz	
Resolution		0.1Hz		
Power range	-127 + 13dBm (Avaklakbe to -136dBm)		-15dBm ~ +17dBm	-110 + 13dBm
Resolution		0.01dB		
SSB phase noise		<-115dBc/Hz		<-105dBc/Hz
Harmonics		<-30dBc		

The screenshot shows the software interface for the GA1483. The main window displays 'Frequency 4,000,000,000.0 GHz' and 'Amplitude 0.000 dBm'. Below this, 'Modulation Status Information' is listed with parameters like Modulation Type, Depth/Delay, Source, Rate, and Waveform for AM, FM, Phase, and Pulse. At the bottom, it shows 'LF Out Freq' set to 100.000000 Hz.

Audio Function Source LF OUT

The screenshot shows the software interface for the GA1483. The main window displays 'Frequency 4,000,000,000.0 GHz' and 'Amplitude 0.000 dBm'. Below this, 'Modulation Status Information' is listed with parameters for FM and AM. At the bottom, it shows 'AM Depth' set to 30.0% and 'AM Wave' set to 4000L.

FM/AM Combined Modulation

The screenshot shows the software interface for the GA1483. The main window displays 'Frequency 4,000,000,000.0 GHz' and 'Amplitude -136.00 dBm'. Below this, 'List Mode Values' are listed with values 1 through 16. At the bottom, it shows 'Start' set to 1, 'Stop' set to 16, and 'Step' set to 1.

Combined List SWEEP Output

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The Nighthawk X8 AC5300 smart Wi-Fi router is the next wave in Wi-Fi. Tri-band Wi-Fi and quad-stream performance boosts X8's combined wireless speeds to up to 5.3Gbps. Four external active antennae plus four internal antennae amplify Wi-Fi range. 6Gb Ethernet ports allow even more wired devices to connect, and with port aggregation, two ports can combine to double maximum wired speeds.

Other interesting features include Smart Connect that intelligently selects the fastest Wi-Fi band for every device, dynamic QoS that prioritises network traffic by application and device, ReadyCLOUD USB access for personal and secure cloud access to USB storage anytime, anywhere, and ReadySHARE Vault, which is a PC software for automatic backup to USB hard drive connected to the router, among others.



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Price
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D7200 sets a new standard for image quality with its DX-format 24.2MP CMOS sensor and EXPEED 4 image-processing engine. Its advanced Multi-CAM 3500 II auto-focus sensor module with 51 precise focus points captures super-sharp images even in low-light conditions. You can film superior full-HD 1080/60p movies in 1.3x format, capturing distant subjects in a larger size. Improved noise reduction across a wide ISO range of 100 to 25600 allows you to capture moving or stationary images cleanly without additional lights.

GizMo ByTes

App to help the homeless in winter

Delhi government has launched a mobile based application to rescue homeless people during winter. Users can download the app and initiate a rescue operation over the phone by taking a picture and posting it on the app. Delhi Urban Shelter Improvement Board will then automatically detect the location of the person and the nearest rescue team will be informed and sent to the location. It will also give access to a list of shelters.

Pioneer ARC app for controlling in-car entertainment

Pioneer's ARC app will enable users to control and play various music sources and apps on their smartphones by operating Pioneer audio receiver or a smartphone. It will also enable them to manage contacts/calls and control selected third-party apps like Navigation to get turn-by-turn guidance through car speakers.

Tax-filing mobile app for chartered accountants

Online tax-filing company ClearTax.in is coming up with a tax-filing app for chartered accountants. The cloud based app will help them check the filing status of their clients at any time and from anywhere. It will come with features like automatic selection of the correct ITR form and import TDS, TCS and self-paid tax entries directly from form 26 AS, thereby eliminating any manual data entry. It also allows direct e-filing with digital signatures and easy revisions.

Swachh Delhi app by government

Swachh Delhi app enables residents to click pictures of garbage and apprise a centralised control room that will direct the concerned government body to attend to the complaint. Municipal corporations will be responsible for collecting the garbage and Delhi government's Public Works Department for the debris collection. The app can be downloaded by giving a missed call on the number 7666400400.



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BUYERS' GUIDE

ESTYLE

POCKET-FRIENDLY MICROWAVES



Kritika Pandey
is senior
correspondent at
EFY. For this article
she had inputs
from Satveer
Singh and Tanmay
Mishra

Microwaves have always established a special place in every kitchen. You cannot ignore the importance of a microwave. If you want to save time, save on gas or have a quick bite, a microwave is essentially an answer to all of these. In today's busy schedule, we are always looking for faster and easier ways of cooking. It does not make a difference if you are living a bachelor's life, are married or are elderly, you simply cannot ignore the significance of a microwave.

Factors like family size and food habits should also be kept in mind while buying a microwave. New-age microwave ovens are much faster and easier to use. Everyone can become a chef with a microwave costing less than ₹ 10,000.

Even though customers can find most of the required features under ₹ 10,000, these tend to lose out on some exclusive features that higher-end mod-

els provide. According to a sales manager at LG Electronics, "Our higher-end models provide features like fan at the back, charcoal heating, multi-cook *tawa*, longer warranty period and cooking classes by experts. Customers tend to lose out on these features when they go for sub-10,000 microwaves."

It is surprising that majority of people still use a microwave as a reheating equipment and shun traditional kitchen practices. Every microwave can be used for cooking, frying, baking and grilling. One can cook mouth-watering dishes like *murg tandoori*, *bharwan bhindi*, *naan*, *parathas* and even *kulchas*. You can fry *pakoras*, *vadas*, fish and chips using just a little oil. For health-conscious individuals, there is the option of making salads, sprouted lentils and much more.

Parameters to look out for

Some key points you could look out for are:

TOP 5 MICROWAVE OVEN MODELS UNDER ₹ 10,000

	LG MC2149BPB	IFB 25SC3	Haier HIL2590EGC	Godrej GMX 25CA2 FIZ	Whirlpool Magicook 20G 1-2-3 Microwave
Price	₹ 9999	₹ 9990	₹ 9490	₹ 8599	₹ 8499
Features worth looking at	An impressive floral pattern, 76 Auto Cook Menu includes 48 Indian dishes at the touch of a button. It has a stainless-steel cavity, promising uniformity of heating for better cooking, fan at the back and multi-cook <i>Tawa</i> .	With a capacity of 25 litres, this microwave comes with a pre-heat facility, steam-clean feature, automatic multi-stage cooking, express cooking function to decrease cooking time and deodoriser to remove odours.	This is a 25-litre unit specially designed to clean anti-bacterial stainless-steel cavity. Combi-cooking options like Grill + Convection, Micro + Grill and Micro + Convection are available. It is enabled with Quartz grill for uniform grilling of food, which is user-friendly. There are five different power levels, auto-defrost plus Indian auto-cook menu.	The 25-litre unit by Godrej has 40 instant-cook Indian menus. Other features include multi-stage cooking, express cooking, auto reminder, child lock, deodorizer, stainless-steel cavity, ceramic enamel cavity and 36 auto menus. It also comes with a recipe book by Tarla Dalal.	This microwave griller is designed with precision and comes at reasonable price with a long-term warranty. It has a unique taste-binding technology that will keep the taste and freshness of the food at its best. Its sleek design makes it a favourite of every kitchen.

The prices mentioned here are from various e-commerce portals and are subject to change.

Automatic sensors. An automatic sensor or a humidity sensor determines the steam requirement to cook something. This sensor fixes the cooking time for a meal and also prevents over-cooking.

Power rating. If you are cooking a meal for two or more, opt for a microwave with higher power. Higher wattage means lesser cooking time. Small ovens are usually rated between 600W and 900W, while medium-range ovens are rated 900W to 1200W; big ones used in bakeries and hotels can exceed 1650W.

Control panel. Prefer mechanical controls with dials as these are easier to repair. The best part about this is that you can change the settings while the food is still being cooked.

Multi-stage cooking. This is one of the most useful features in a microwave as it enables one to cook at different stages of cooking without interrupting the process. It helps in automatically changing it to specified levels after specified time.

Shortcut keys. Most microwaves have automatic settings for cooking specific food items, known as auto menus. You can choose a predefined setting and cooking is done automatically.

Auto-defrost and steam cooking. Auto defrost saves a lot of time. You just need to select the type of food and enter its weight, and the microwave will select the time and power level to defrost.

New features

Most companies are eager to come out with features that are better than the competition. Here are some features that will help you choose the right microwave for your kitchen:

Steam cooking. All you need to do is put a water bowl in the microwave. As the water evaporates, steam heats the food and moisture is added to it.

Child-safety lock. If you have children at home, you will need this

Key market players

- LG Electronics
- Samsung
- Panasonic Corp.
- Whirlpool Corp.
- Sharp Corp.

feature. It is a lock that does not let them accidentally use the system.

Speed-cook/combination mode.

This mode uses microwave energy in addition to other heating sources (convection or halogen bulbs) that allows the food to cook faster than traditional ovens.

Bi-level cooking. Some microwave ovens come with racks that offer cooking space for two items. It also improves baking by allowing heat under the dish.

Online versus offline

While talking to users, we found that working individuals, who are choked on time, usually prefer buying things online, whereas housewives and elderly still go by older methods of shopping. According to Nalini Bakshi, "I have a nine-hour shift and by the time I am home, markets shut down. So if I want to buy anything from clothes and accessories to electronics, I buy it online." She added that, good schemes and offers are also great when it comes to online shopping.

However, it has been observed that consumer behaviour and sales pattern vary from region to region. A sales manager at Croma in Delhi points out, "It is true that people are increasingly getting lured by the offers e-commerce portals are offering, but Indian customers always love to see and feel the product for real."

According to industry estimates, 2014 saw a sale of one million microwave ovens in India. It was said that sales were affected by factors like emergence of alternative cooking appliances like air fryers and cook-tops, or due to economic slowdown that did not allow people to splurge. **EFY**

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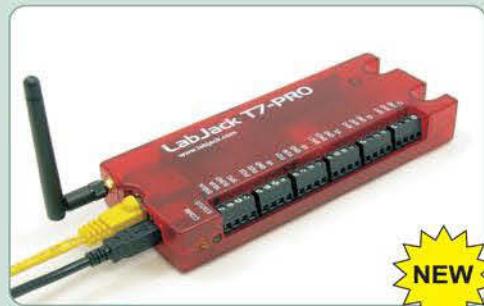


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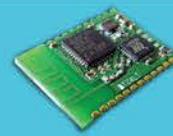
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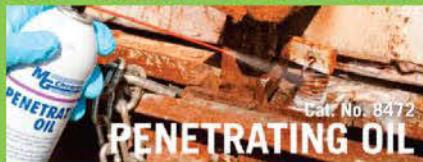
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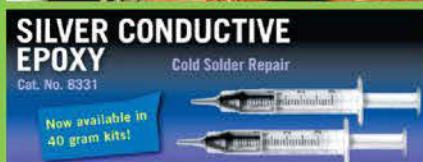


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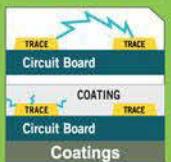


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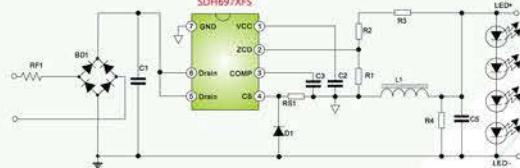
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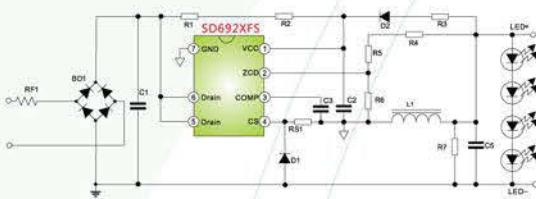
SD692XF

Silan Solution For India LED Tube Application

Key Features

- ◎ Non-isolated buck topology
- ◎ Line and load regulation: ±2%
- ◎ High power factor, PF>0.9, THD<15%
- ◎ Efficiency>87%
- ◎ Vcc over-voltage protection and UVLO
- ◎ Output open/short circuit protection
- ◎ 600V MOSFET integrated

Typical Application Circuit



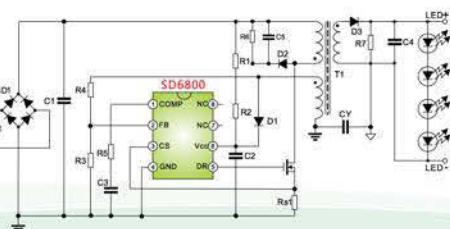
SD680X

Silan Solution For India LED Downlight/Streetlight Application

Key Features

- ◎ Boundary conduction mode
- ◎ Primary side regulation
- ◎ PF>0.95, THD<10%
- ◎ Output open/short circuit protection
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- ◎ Maximum power<80W
- ◎ Designed for downlight/streetlight

Typical Application Circuit



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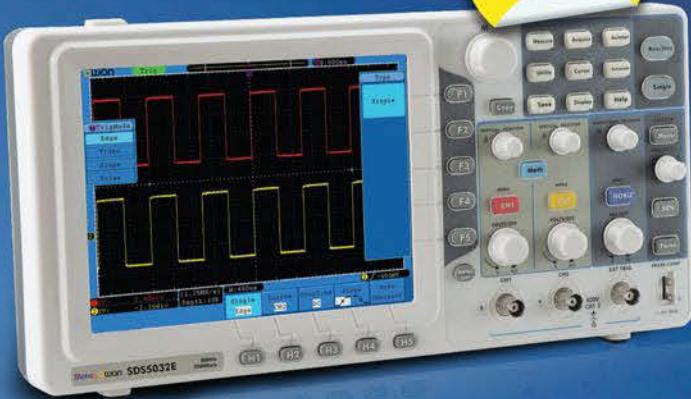
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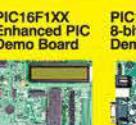
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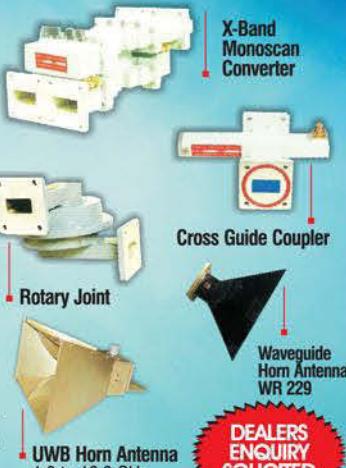


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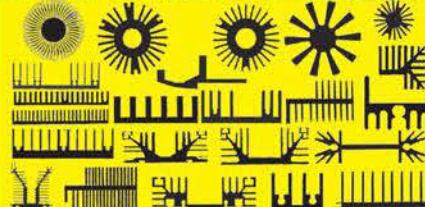
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February	Drones	Security and Surveillance	Desktop Power Supplies	126cm (50-inch) Flat-Panel Televisions
March	Intuitive Gesture Control	Test and Measurement Equipment	Noise Meters	Blood-Pressure Monitors
April	Latest Display Technologies	Solar Industry	Digital Multimeters	Wireless Printers for Homes
May	Solid-State Storage	3D Printers	3D Printers Under ₹ 100,000	Fitness Wristbands
June	Affordable Virtual Reality	The Internet of Things	Wi-Fi and Radio Frequency Modules	Earphones
July	Connected Homes and Appliances	Home Automation	Budget-Friendly Oscilloscopes	Wireless Routers for Homes
August	Self-Driving Cars	LED Lighting	LED Chips and Bulbs	Low-Priced Tablets
September	Solar Cells to Inverters: What's New	Strategic Electronics	Soldering/Desoldering Stations	3G/4G Dongles
October	Sensors	Consumer Electronics	LCD and OLED Display Modules	Smart Televisions
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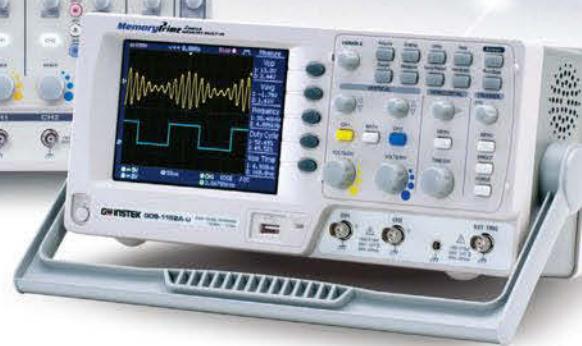
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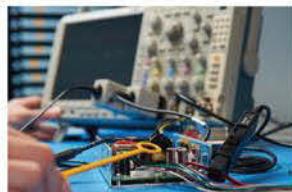


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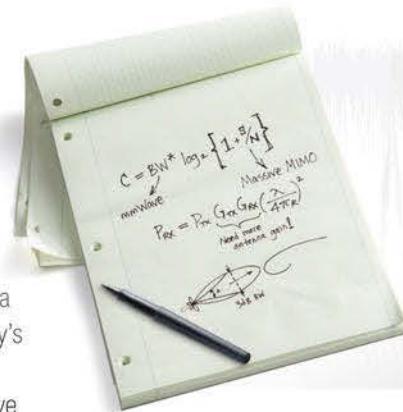
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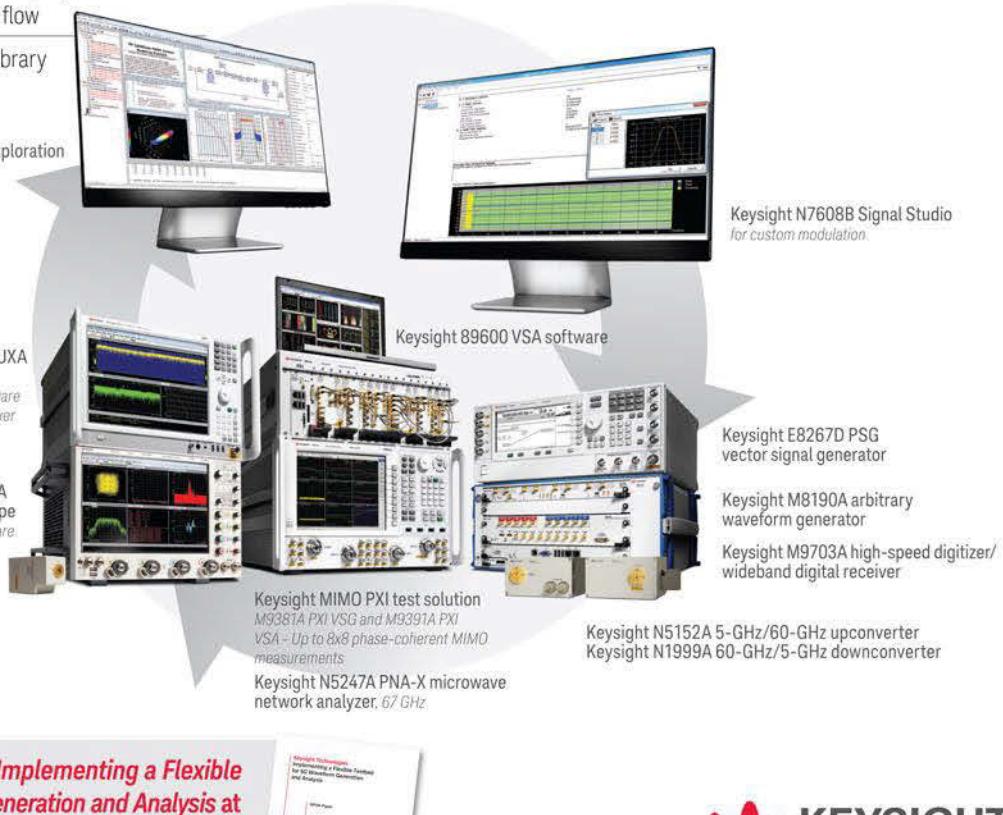
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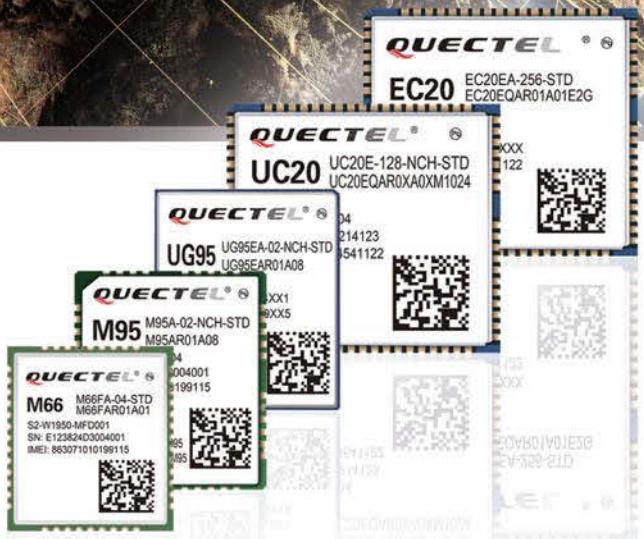


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Time has come for the Indian electronics industry to exhibit its manufacturing and designing capabilities and potential. The growing import of electronics and IT products is putting pressure on the nation's forex reserves and Balance of Trade. If we continue on this path, it will create a precarious situation for the country. Acknowledging this, the government is actively promoting indigenous products through its 'Make in India' initiative. However, it is easier said than done. To attract investments in setting up plant in India, the government is providing subsidies under M-SIPS while Preferential Market Access Policy (PMA) is generating the demand.

However, it is important to build an eco-system that is suitable for manufacturing of electronics products. This will require concerted efforts from all the stakeholders including the manufacturers of electronic products, components or the equipments. To realise the dream of turning India into a manufacturing hub would require not only a brazen overtaking of hairpin bends, but also navigational acumen to derive the desired results.

Realising this, EFY is taking the initiative to bring the entire ESDM fraternity under the banner of India Electronics Week (IEW) which will have six co-located shows covering all the major aspects of electronics industry. This week-long celebration will be triggered with small events being held in key cities across India, culminating in the main industry (B2B) event being held at Bangalore International Exhibition Convention Centre (BIEC), Bengaluru from 11th to 13th January, 2016.

This year, besides our flagship event Electronics For You (EFY) Expo and two other important events Electronics Rocks and Test & Measurement India, we are also introducing three more co-located shows LEDasia.in, IoTshow.in and Raksha India to broaden the scope of the event to include LED lighting, Internet of Things and strate-

gic electronics. Projects like smart cities and a focus on shifting to energy-efficient lighting will trigger the LED lighting and IoT industry to grow manifold in the coming years. While the change in Defence Procurement Policy to promote use of indigenous products will boost the domestic strategic electronics industry. So this is the right time to start thinking of their manufacture in India in larger numbers.

Of course, all the previous features of the EFY Expo are being retained, like a section devoted to test and measurement equipment; the fourth edition of 'eRocks' with a special demo showcase pavilion; and the ELCINA CEO Summit and Buyer-Seller Meets. Additionally, ELCOMA, the apex body of lighting manufacturers in India, has joined hands with EFY for the LEDAsia.in event. IPC India, the industry association for printed circuit board and electronics manufacturing service companies and Surface Mount Technology Association (SMTA) have decided to conduct their workshops during the event.

On behalf of the entire EFY Group, I want to take this opportunity to thank all those who have supported us in this initiative, including Department of Electronics & Information Technology (DeitY), our other partners, sponsors, participants and well-wishers. With the collective effort, our vision of having an Indian electronics exhibition that we can all be proud of seems to be taking shape, slowly but steadily. Of course, a lot more needs to be done, which we would definitely like to do with your continued support. IEW being an indigenous initiative, we are sure you would like to make it your first choice in India.

Thanking you once again, and with best wishes to all of you,

Ramesh Chopra
Executive Chairman, EFY Group



I am delighted to witness the growth and progress of the 'ELECTRONICS FOR YOU (EFY) EXPO' and keenly look forward to the 6th edition which opens on January 11th -13th 2016 at BIEC, Bengaluru.

As a partner of EFY and co-promoter of the event, ELCINA is committed to developing EFY Expo into a high value interactive platform for Indian and international players from ESDM sector. ELCINA is confident that the 6th EFY Expo will be a grand success and welcomes all participants.

The Expo focuses on the complete electronics value chain including electronic components, assemblies, EMS and capital equipment for electronics manufacturing. In addition to special 'zones' for Innovators, Designers, Manufacturers and Engineers, EFY-Expo will also feature ELCINA's CEO Summit and Buyer-Seller Meet to support creation of a strong domestic value chain. Some special features this year include Test & Measurement India, IoTshow.in and LEDasia.in providing opportunities in these rapidly growing domains.

ELCINA through its initiative of developing EMC Clusters is committed to establishing a strong eco-system to catalyse growth of high value added electronics manufacturing in the country. EFY Expo is equally focussed on supporting the two key national initiatives of "Make in India" and "Digital India" and ELCINA invites all stakeholders from ESDM industry to participate and benefit from the activities during the show.

I wish great success to all participants and industry colleagues for achieving their objectives.

Rajoo Goel
Secretary General
ELCINA



I am happy that ELCINA a knowledge & Exhibition Partner for EFY Expo, of which the 6th edition is being organised at BIEC, Bengaluru during January 11th – 13th 2016.

The government is determined to make India self-reliant in electronic hardware manufacturing. The vision is to replicate India's success in software and the government recently launched "Digital India" and "Make in India" campaigns as a step in that direction.

ELCINA, through its initiative to develop EMC Clusters, is committed to establishing India's own dedicated manufacturing platform which will support and help create an eco-system to catalyse growth of high value added electronics manufacturing in the country.

The Electronics For You Expo India 2015, an international exhibition organised by the EFY Group and promotes the 'Make in India' agenda by providing an ideal platform for innovators, designers, manufacturers and sellers in the industry to showcase the latest in electronics.

The Expo features participation by manufacturers and distributors of electronic components, raw materials, assemblies, and capital equipment and EMS providers. This will brings together, the Business and Technology aspects of electronics on one platform for the benefit of all participants for the entire ESDM value chain.

I wish EFY Expo 2016 great success and am sure that it will continue to grow and achieve its objective of bridging the gap between manufacturing and consumption in the country.

Vikram Desai
President
ELCINA



It gives me a great pleasure to announce that ELCOMA and EFY are jointly going to organize LEDasia.in under India Electronics Week 2016, 11-13 January, 2016.

LEDasia.in exhibition is one of its kind which will bring together exhibitors from India and around the world for displaying LED lighting products which are latest in technology and most energy efficient in performance. It will be our endeavour to make this exhibition more meaningful and informative. We shall try to hold this exhibition every year and we promise that we shall make it ever larger and interesting than before.

Besides exhibition, we are also going to organize various other events like one day conference, networking sessions etc.

We will be very thankful to ELCOMA members for participating in this exhibition. We are also thankful to EFY for providing ELCOMA a platform to reach its message of energy efficient lighting to the stakeholders.

We wish the organizers and participants all success.

Shyam Sujan
Secretary General
ELCOMA

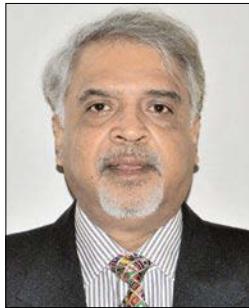


I am pleased to note that LEDasia.in which is going to be held during India Electronics Week 2016, will facilitate knowledge sharing for stake holders of the Industry.

LED is a significant game changer for the industry and an unprecedented opportunity for manufacturers and other stake holders. The Industry is gearing up to build up manufacturing capacity replicating the programs initiated for CFLs for LED as well. It is estimated that by year 2020, by changing most of the street lights and domestic sockets with LED lighting, the power consumption for lighting will come down from 18% at present to less than 13%.

I, on behalf of ELCOMA and the lighting Industry, would like to thank EFY for inviting us and providing a new platform to showcase our Industry.

Sunil Sikka
President
ELCOMA



IPC India congratulates Electronics For You team and is glad to be associated with India Electronics Week 2016 event.

With Government's push to Indian electronics industry through "Make in India" initiative supported by lucrative incentives, pro-active measures & industry friendly legislations & sops and with global MNCs' investments into joint ventures with Indian companies, we are sure this event offers a good platform to enthusiastic electronics fraternity and brings bright opportunities to one and all associated with the event.

IPC India supports the event as an associate partner offering Professional Workshop, IPC Standards Review Meet and IPC Hand Soldering Competition during the course of the event.

We wish the very best to the event organizers, sponsors, exhibitors, delegates, participants and above all - the visitors.

Akshinthala Vijayendra

Managing Director
IPC India

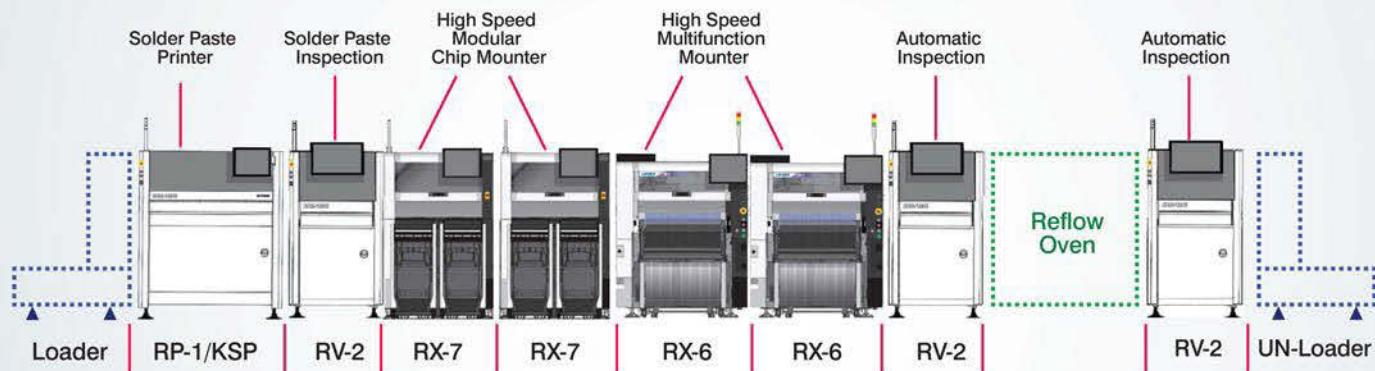
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Stick, Tray



JX-350 Mounter

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- Comp. Range: 0603-33.5mm
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- Feeders: Option MAX 160,
Electrical Double
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INDIA ELECTRONICS WEEK 2016

A GLOBAL ELECTRONICS INDUSTRY MEET-UP IN INDIA

The inaugural edition of India Electronics Week will be held in Bengaluru, and will comprise six co-located shows to cover the entire electronics ecosystem



The EFY Group is organising the inaugural edition of India Electronics Week (IEW) to promote India's electronics industry. This week-long celebration will feature small events being held in key cities across India and will culminate in the main industry (B2B) event at Bangalore International Exhibition Convention Centre (BIEC), Bengaluru from January, 11 – 13, 2016. The theme for this mega show for the 2016 edition is 'Invest in India'.

What makes this event different?

What will make this event stand out is the fact that it will be an amalgamation of six major events covering various

facets of the electronics industry. The flagship event from EFY Group, the *Electronics For You Expo*, which is into its sixth edition, will be back as a part of IEW. As in previous editions, EFY Expo will continue to focus on the entire electronics value chain, including components, parts, materials, manufacturing services and equipment. The other major events that will again be back as part of IEW are *Electronics Rocks* (fourth edition) and *Test & Measurement India* (fifth edition). While *Electronics Rocks* is a leading conference on electronics design and embedded systems, *Test & Measurement India* is a show that exclusively focuses on the T&M equipment industry.

INDIA ELECTRONICS WEEK 2016 IS SUPPORTED BY STATE GOVERNMENTS

Andhra Pradesh Government extended its support for IEW 2016 as an Associate State Partner through Department of Information Technology, Electronics and Communications

Karnataka Government extended its support for IEW 2016 as an Associate State Partner through Department of IT, BT and S&T

Even more interesting is the fact that IEW will also witness the launch of three new shows, namely, LEDAsia.in, IoTshow.in and Raksha India. The present government's focus on energy-saving solutions is providing the much needed thrust to the Indian LED industry – LED lighting in particular. The LEDAsia.in show aims to promote the electronics that powers LED lighting. On the other hand, IoTshow.in will focus on the Internet of Things industry, which is gaining prominence with the government's Smart City initiative. Raksha India aims at showcasing the latest trends, technologies and what's in demand in strategic electronics, catering to the defence, aerospace and home-land security sectors.

With these shows, IEW aims to promote the entire electronics value chain while engaging all the stakeholders—be it the manufacturers, OEMs, distributors/channel partners, volume buyers or the decision makers from the various government agencies. What's unique about this mega event is that even while providing visitors and participants with a bigger canvas and wider audience, it still maintains a strong focus on each of the specific areas of the ecosystem.

KEY FACTS

Dates: January 11 - 13, 2016

Venue: Bangalore International Exhibition Centre (BIEC), Tumkur Road, Bengaluru

Business visitors: Entry on all 3 days

Students: All 3 days

SHOW TIMINGS

January 11 (Monday): 10 am to 6 pm

January 12 (Tuesday): 10 am to 6 pm

January 13 (Wednesday): 10 am to 4 pm

HIGHLIGHTS

Business Summits



How to make money in IoT? Who can make? What are the business opportunities in the LED Lighting sector? Who can get subsidies from Indian government on their investments in electronics manufacturing, and how? These are some of the questions that will be answered at Summits being conducted at IEW. Listen and network with the who's who of Indian Electronics industry.

Spot Light: Start-ups



Through initiatives such as 'Get Funded' and 'Innovation Zone', IEW is putting the spotlight on Start-ups. Get Funded helps them connect with VCs and get funding. Innovation Zone enables them to show-case their solution to customers and partners.

Rapid Prototyping Zone



It's become easier to create prototypes now. >From 3D Printers to desktop SMT manufacturing equipment—innovative rapid prototyping equipment are getting launched globally. IEW brings many of these innovative offerings for you at the Rapid Prototyping Zone.

Technical Conferences & Workshops



4 technical tracks, 10 workshops, 70-plus experts from India and abroad. It cannot get better than this. Internet of Things, LED Lighting, Defence Electronics, Smart Automobile, Smart Homes & Cities, Smart Industry and Smart Humans—are some of the themes driving IEW's technical events.

Invest in India – the theme for IEW 2016



The theme for IEW 2016 is 'Invest in India' as the event aims to drive investments in manufacturing and the design of electronic products in India. This theme will be reflected in the various activities happening at the IEW. This will also be the theme for the ELCINA CEO Summit, which will be held on the first day of the show (January 11).

You can visit www.indiaelectronicsweek.com for more details.

Queue-less entry for IEW visitors: Print badges at home and walk straight in

EFY Group's vision statement is 'Technology Drives Us'. And this statement is best reflected in the digital badge creation and printing technology deployed by EFY for all the shows co-located at *India Electronics Week 2016*. All visitors who register online before the event will get a pre-printable badge as a PDF file, which they can print and bring to the venue. At the venue, lanyards will be available, in which the badges can be inserted and visitors can walk straight in. No queues at all!

To register, go to <http://register.indiaelectronicsweek.com>

ELCOMA partners with EFY for LEDAsia.in

ELCOMA, the apex body of lighting manufacturers in India, has partnered with EFY to drive the co-located show LEDAsia.in. Besides promoting visitor footfalls and encouraging its members to exhibit, ELCOMA is organising a day-long summit where thought leaders

from the industry, the government and large institutional buyers will come together and discuss the roadmap ahead.

For more details on the *ELCOMA LED Lighting Summit*, go to: <http://ledasia.in/schedule/>

India's first tech conference on designing better LED lights

For the first time in India, a technical conference is being organised to update circuit design engineers on how to design better for LED lighting applications. The role of electronics in lighting has increased drastically, and both the power efficiency and life of the light is influenced by its electronics. At this technical conference, Indian engineers will be updated on the latest technologies, components and best practices in the field of LED lighting. This technical conference will be held on January 12, 2016.

A detailed agenda of this conference will be released shortly on www.LEDasia.in

Get Funded: A first to connect electronics start-ups with VCs (*IEW, IoTshow.in, Electronics Rocks*)

Start-ups in electronics hardware will get to meet VCs and get funding through the 'Get Funded' initiative. Organised in partnership with FHS (First Hundred Sales), the 'Get Funded' initiative is an attempt to provide a platform for the recognition of and funding for start-ups working in the electronics hardware space.

To register as a start-up for 'Get Funded', go to: <http://iew.fhsidelab.com/home>

The top 10 start-ups to get free booths: As part of the 'Get Funded' challenge, the top 10 start-ups are to get free demo booths at the 'Innovation Zone' on the expo floor. At the expo, these start-ups will be able to demonstrate their innovations to the media, potential customers, channel partners and systems integrators. Plus, they can motivate others to join the 'Start-up India' campaign launched by our prime minister.

When you register as a start-up for the 'Get Funded' challenge, our partners, First Hundred Sales, will then interact with you to decide on whether your start-up qualifies in the Top 10.

Live: PCB Design Consultancy (IEW)

Got a problem with your PCB design? Want to check if it's production-friendly? Seeking tips from experts to improve the design? PCBpower.com is setting up a special facility, where its PCB design experts will be able to review your Gerber files and share tips on how to improve them. Again, you can seek 30-minute appoint-

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	Smart AC/Solar street Lights : <ul style="list-style-type: none"> Highly economical and rugged wireless solutions for Smart Cities & Smart Infrastructures Periodic update of AC lamp parameters like voltage, current & brightness to remote server. Periodic update of Solar lamp parameters like battery voltage, solar voltage & brightness to remote server. Remote ON/OFF/Dimming the lamp from Web Portal. GIS details of Lamps. Fault update and remote analysis of fault.
	Smart Data Concentrator Units : <ul style="list-style-type: none"> Control group of AC & Solar lamps along with Energy Meters in the network. Designed to provide 6 hours back up available with both 1phase and 3phase supply.
	LED Lightings <ul style="list-style-type: none"> Complete OEM branding for Bulbs, Tube lights, Down Lights, Flood Lights, Bay Lights, Street Lights, High Mast Lights available. High Performance & cost effective Solutions with CPRI approvals.
	Solar PWM & MPPT Charge Controllers: <ul style="list-style-type: none"> Auto dusk-to-dawn operation with timerbased dimming from 10% to 100%. Optional MPPT algorithm for high efficient charging of the battery PWM Solar Charge Controllers with built in Drivers from 10W to 40W RF Smart Control ready
	LED Drivers : <ul style="list-style-type: none"> Complete Solutions for wide range of High performance LED Drivers from 3W to 300W.
	SMPS Adaptors : <ul style="list-style-type: none"> Wide range of Wall Mounted & Bench Top SMPS Adaptors from 5W to 50W available. Over 350 Models of different ratings for applications like Point Of Sales Machines, Printers, Ticketing Machines, IT Equipments, Telecom Equipments, Setop Box, CCTV etc.
	SMPS & DC-to-DC Converters : <ul style="list-style-type: none"> Wide range from 10W to 1KW, open Frames or Enclosed, With or without PFC, ZVS Power Supplies, Single Phase & 3 Phase SMPS.
	Battery Chargers : <ul style="list-style-type: none"> 60W Battery chargers: 6V, 12V, 24V, 48V. 120/250W Battery charger: 12V, 24V, 36V, 48V, 72V. 1000W, 48V Rack mounting FCBC Power supply for Telecom Base stations

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ments through our Web based system.

To avail this facility, you will need to register first, and then use the Online Appointment Scheduler facility to fix your meeting time with the PCBPower.com team. To register, go to: <http://register.efyexpo.com>

Live: IoT Labs

Start-ups can gain access to highly expensive T&M equipment for free. A live lab will be set up at the Expo floor in partnership with a global leader in T&M equipment. Through a Web based system, you can book a 30-minute appointment with the lab, and if you get an approval, you can test your IoT products with the help of the top test engineers at zero cost!

To avail this facility, you will need to register first, and then use the Online Appointment Scheduler facility to fix your meeting time with the PCBPower.com team. To register, go to: <http://register.efyexpo.com>

Demo package for start-ups, SMEs and educational institutions

Start-ups have limited resources. But they need to market their products and services, too, in order to connect with customers and channel partners. To enable start-ups to

TECHNICAL Events

Designing IoT Hardware
12th-13th Jan 2016

Designing IoT Solutions
12th-13th Jan 2016

Designing LED Lights
12th Jan

Designing Defence Electronics H/W
11th Jan

T&M Showcase
11th Jan

Tech Workshops
11th to 13th Jan

BUSINESS Events

Expo

11th Jan to 13th Jan

Inaugural

11th Jan 2016 (10 am)

Keynotes of Industry Leaders

12th & 13th Jan

ELCINA CEO Summit

11th Jan 2016

ELCOMA LED Lighting Summit

12th Jan 2016

IET: Who Earns Money in IoT? How?

12th Jan 2016

Get Funded Challenge

13th Jan

ELCINA Buyer Seller Meet

11th-13th Jan 2016

MAKERS & DIYERS' Events

Makers of India Meet
13th Jan

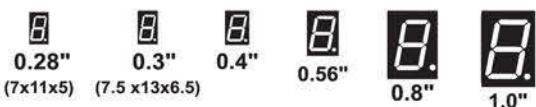
SMTA Workshop
13th Jan

IPC Hand-soldering Competition

For more information visit our website: www.indiaelectronicsweek.com.

Vision ~ Innovation ~ Solution ~ Value Addition

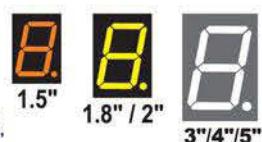
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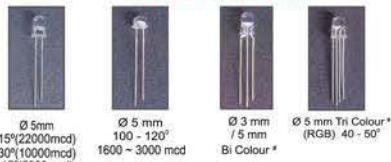


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3 DIGIT

0.25" (15x8x4)
0.26" (17.8x8.8x4)

4 DIGIT

0.56" (37x19x7)
0.56" (37x19x7)

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2 DIGIT

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0.3" (15.5x15x7)
0.36" (15x14x7)
0.39" (20x13x7)
0.4" (20x16x7)
0.43" (24x19x6.5)
0.56" (25x19x8)
0.8" (36x26x10)

3 DIGIT

8.8.8
0.25" (15x8x4)
0.26" (18x8.8x4)
0.28" (22.5x10x6)
0.3" (30.4x13.2x7)
0.39" (30.5x14x7)
0.4" (30x16x7)
0.48" (25x19x8)
0.56" (37.5x19x8)
0.8" (54x26x8.5)
0.8" (60x28x8.5)

4 DIGIT

8.8.8.8
0.25" (24x10x5.1)
0.28" (30.2x10x6)
0.28" (32x10x6)
0.3" (30.4x13.2x7)
8.8.8.8
0.24" (23x10x5)
0.32" (28x11x5)
0.36" (30x14x7)
0.39" (40x12.6x7)
0.4" (34x15x7)

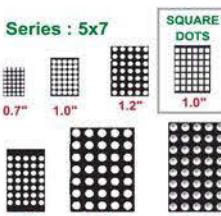
5 DIGIT

8.8.8.8.8
0.25" (38.6x10.2x8)
0.31" (35x12.5x6.5)
0.36" (36.5x14x8)
0.56" (63x19x8)

6 DIGIT

8.8.8.8.8.8
0.30" (41.0x11x5.8)
0.36" (43.5x14x7)
0.5" (73.8x24.9x7)

Series : 5x7



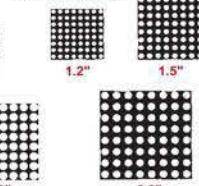
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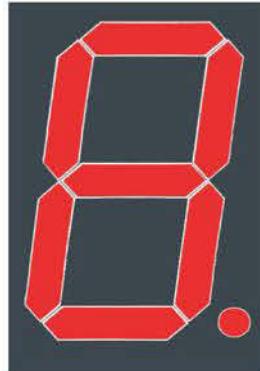
Series : 8x8



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101 BAR GRAPH

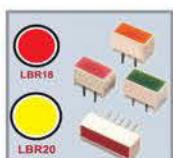


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LB720 LB15x15
LB1020 LB27x27
LB2040 LB32x32

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1.2", 1.5", 2.0", 2.3"

ARROWS



Size : 0.7", 1.0",
1.5", 2.0", 3.0" & 4.0"

Size : 5.0", 6.0", 8.0",
10.0", 12.0", 16.0" & 20.0"



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TWILIGHT

THE 6TH EDITION EFY EXPO 2016 GETS BIGGER AND BETTER!

Being held in Bengaluru for the first time along with five other co-located shows, the sixth edition of Electronics For You (EFY) Expo aims at promoting investments in India

With the India Electronics Week, the flagship event from EFY Group – the EFY Expo, will be back. In sync with the overall theme of the IEW, the EFY Expo will also focus on 'Invest in India'. This sixth edition of the show—EFY Expo India 2016 aims to bring together the entire electronics industry under one roof.

As in earlier editions, the EFY Expo will exclusively focus on the entire electronics value chain, including components, parts, materials, manufacturing services and equipment. The Expo is a comprehensive and ideal platform for the electronics industry, where exhibitors comprise innovators, designers, manufacturers and sellers. It attracts visitors from across various functional branches and verticals of the electronics industry, including buyers, production managers as well as engineers (from R&D and design) and innovators.

The previous editions of the Expo witnessed the introduction of a number of new initiatives like the Buyer-Seller Meet, the live SMT line, conferences, etc, to promote the industry. The EFY Expo India 2016 too will offer an exciting array of new and exciting initiatives.

What it aims to achieve

1. To serve as a platform where OEMs meet suppliers of products and services, including suppliers of components, manufacturing equipment, consumables, test & measurement equipment, contract manufacturers, design houses, certification agencies, infrastructure providers, etc.
2. To create one common platform for the entire electronics industry where innovators, design engineers and implementation engineers can meet manufacturers, traders and institutional buyers.
3. To lay a strong emphasis on creating appealing content (in terms of conferences, workshops, seminars, etc) to attract the right audience. Thus, the event is studded with a series of conferences, seminars and technical workshops.



KEY FACTS

Dates: January 11 - 13, 2016

Venue: Bangalore International Exhibition Centre (BIEC), Tumkur Road, Bengaluru

Business visitors: Entry on all 3 days

Students: All 3 days



Department of Electronics & IT supports EFY Expo 2016

Department of Electronics & IT has, yet again, extended its support to EFY Expo 2016. DeitY's support is in recognisaiton of the fact that EFY Expo is turnning out to be a measure platform for government departments and industry associations to interact with the Indian Electronics Industry.



“ EFY Expo India is in sync with our objective of taking the Indian electronics industry forward. We have been supporting the Expo for the past four years as it provides an ideal platform to accelerate the growth of the electronics industry. This platform has helped in creating awareness in the electronics industry about the goals and targets of the various government initiatives. I wish the event all the best this year and I am hopeful that it will be able to further contribute to the growth of the industry.

—Dr Ajay Kumar, additional secretary, Department of Electronics and Information Technology

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Special attractions

ELCINA CEO Summit:

Each year, decision makers and important members of the electronics ecosystem assemble at this Expo to discuss and debate the latest topics and trends in the market, possible partnerships, tie-ups, joint ventures, etc. This year, too, the Expo is focused on facilitating communication between members of the ESDM ecosystem through various programmes.

The ELCINA CEO Summit, in sync with the overall theme of the Expo, which is 'Invest in India', will help organisations identify investment opportunities, avenues, ramifications and subsidies to be availed under various government schemes.

Buyer-Seller Zone:

This is a special platform created for large buyers to have face-to-face interactions with leading suppliers of electronics, components and manufacturing equipment. The 2015 edition of the Expo witnessed participation from 17 major buyers including those from the LED lighting and automotive industries. This year, the event aims to increase the number to 30. This year, telecom manufacturing will be an additional focus area.

Vendor Development Talks:

This provides a platform wherein buyers can specify their sourcing requirements as well as vendor-selection parameters. What differentiates these talks from the Buyer-Seller Meet is that unlike the latter, which provides a one-on-one platform, the vendor development talks provide a platform to interact with a much larger number of sellers – even those not exhibiting at the Expo.

Other major attractions include participation from international exhibitors which will highlight the latest global trends. Additionally, this could also potentially lead to strategic business deals like joint ventures or distributorships between foreign firms and their Indian counterparts. The event also provides facilities like the VIP Lounge to facilitate such decision making and for signing other business deals.

Innovator's Zone:

This is a special zone at the Expo where innovators from all parts of the country will showcase their innovations. This is a must-visit for design engineers and senior decision makers at OEM firms to see innovative products that they can manufacture and sell.



R.S. Sharma, secretary, DeitY, Government of India, at the inauguration of the ELCINA CEO Summit at EFY Expo India, 2015



Taiwan's ambassador to India Chung Kuwang Tier, inaugurating the ELCINA CEO Summit at EFY Expo India, 2015



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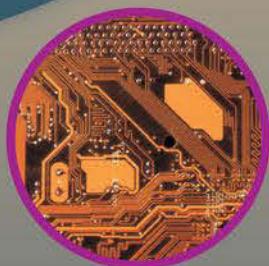
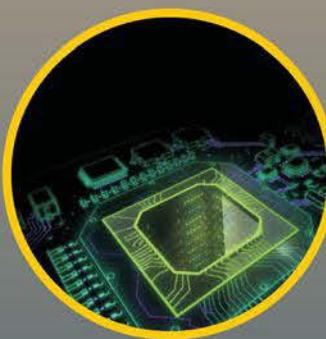
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A glimpse of EFY EXPO 2015

Buyers' Feedback

We visit EFY Expo India for electronics procurement, and this time we see a larger number of Indian manufacturers showcasing their products. This shows that the Indian market is growing, with a stronger push from Make in India.

**Tushar Patil, manager - sourcing,
Anchor Electricals Pvt Ltd**

A very good initiative. It is like Auto Expo, but is more informative and gives better chance for one-to-one interactions.

Mohit Gupta, DGM, VE Commercial Vehicles Ltd

The expo has been very good in bringing different manufacturers and suppliers under one roof.

**Narendra Dogra, DGM – materials and purchase,
Intex Industries**

A very good forum that helped us interact with both small and big vendors. Overall, a good experience!

Yuvaraj A.R., additional general manager (CMS division), Bharat Electronics Ltd (BEL)

The show was well organised. It had an excellent choice of exhibitors and arrangements. The buyer-seller meet was very helpful. I met close to 17 sellers at the meet, which was very relevant with good time slots. Moreover, I found online appointments made in advance with sellers very useful.

Nandha Gopala Krishnan R., global supply management Asia - RM, Electronics & Fasteners Commodity-India, Stanley Black & Decker India Ltd

LARGE BUYERS AT EFY EXPO 2015 BUYER-SELLER MEET

1. ANCHOR BY PANASONIC
2. BHARAT ELECTRONICS LIMITED (BEL)
3. EMERSON NETWORK POWER INDIA PVT LTD
4. FIAT INDIA AUTOMOBILES PVT LTD
5. FLEXTRONICS TECHNOLOGIES INDIA PVT LTD
6. GE LIGHTING
7. INTEX INDUSTRIES
8. MAGNETI MARELLI INDIA PVT LTD
9. MARUTI SUZUKI LTD
10. MOSER BAER LTD
11. NTL ELECTRONICS INDIA LTD
12. PRICOL LTD
13. RENAULT NISSAN
14. STANLEY BLACK AND DECKER INC
15. SU-KAM POWER SYSTEMS
16. TJ STRATSOURCE LLP
17. VE COMMERCIAL VEHICLES

Exhibitors' Feedback

Since the government's Make in India initiative and important standards are going to be enforced very soon, we put up some dedicated products that can comply with the standards. We were able to meet some good prospects and get good enquiries in this expo.

**Suvrat Verma, assistant manager,
business development, Rohde & Schwarz India Pvt Ltd**

The primary objective to participate in this show was branding and showcasing our test and measurement solutions. The overall theme of EFY Expo was very good—to bring all major T&M companies under one roof. We were able to meet some serious visitors.

**Madhukar Tripathi, senior manager -
marketing and sales, Anritsu India Pvt Ltd**

I found this event interesting and informative with respect to Make in India campaign.

David Liu, global sales director, B. B. Battery

We have been associated with EFY Expo since its inception in 2011 and closely monitor its improvement on year-to-year basis. This year the best part was the proactive role of the organiser in arranging the buyer-seller meet. It helped exhibitors to get in touch with their right customers.

Sumit Sharma, marketing manager - India, Good Will Instruments Co. Ltd

The quality of EFY Expo is quite encouraging for us.
Sanjay Malla, CEO, Toradex Systems India Pvt Ltd

We have participated in many international and national expos, but the quality of visitors at EFY Expo was superb. Most visitors spent 15 minutes on an average in our stall and showed genuine interest.

Haren Shah, chairman, Peach Technivations Pvt Ltd

We had a very good experience at EFY Expo. On the second day, we signed an MoU with our Taiwanese partner, Infomax, for the production of industrial mobiles in India.
Varun Manwani, director, Sahasra Electronics

It was a good show. We got good leads through this Expo. The overall quality of visitors was really good.
Mukesh Sharma, regional sales manager, Flir Systems

This year the Expo was a big success since there were three shows happening in parallel, so we had common visitors that led to increased footfall and focus. Many of our customers including prominent players in EMS and LED manufacturing used EFY as a platform to meet and discuss new requirements along with their product samples.

**Padmanabha Shakthivelu, sales
manager - India, Electrolube India**

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THE 1ST EDITION LED ASIA.IN

INDIA'S FIRST EVENT TO FOCUS ON THE LATEST TECHNOLOGIES IN LED

Being held as a part of IEW, the inaugural edition of LEDAsia.in will showcase the latest products and technologies in LED lighting while acting as a common platform for manufacturers to reach out to B2B and B2G decision makers

LEDAsia.in is a dedicated show being organised for the first time. It will seek to promote LED lighting and its various components like chips, drivers, heat sinks, modules, etc. From components to consumables, manufacturing equipment to T&M equipment – all aspects of electronics that go into LED lighting will be showcased here.

The show aims at attracting visitors from various branches of LED lighting including technical and purchase decision makers, component manufacturers, channel partners and entrepreneurs seeking to invest in the sector.

Thus, the platform provides an opportunity to the LED lighting product manufacturers to reach out to B2B and B2G decision makers. This show will also serve as a platform for forging alliances amongst manufacturers, component suppliers and channel partners in southern and western India. Additionally, a special package titled 'Make in India' has been announced for exhibitors in this category.



Knowledge &
Exhibition Partner



LEDASIA.in

KEY FACTS

Dates: January 11 - 13, 2016

Venue: Bangalore International Exhibition Centre (BIEC), Tumkur Road, Bengaluru

Business visitors: Entry on all 3 days

Students: All 3 days

Special attractions

ELCOMA LED Lighting Summit

Supported by ELCOMA, which is the apex body for lighting manufacturers in India and liaisons between government agencies as it represents the interests of the industry, the event will witness a gala summit on LED lighting. This summit will bring together players from the entire LED ecosystem, including industry and government bodies.

In sync with the main theme of IEW, which is 'Invest in India', this summit will focus on identifying investment and manufacturing opportunities in LED lighting while discussing infrastructure, government policies w.r.t. procurement, standardisation and various subsidies that can be availed.

Technical Conference on LEDs

For the first time in India, a technical conference dedicated to the electronics design aspects of LEDs will be organised.



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- Bipolar Transistors for CFL (Energy Savings Lamps)
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- CBB60 / CBB61 / CBB65 (Start / Fan capacitor for AC)
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THE 4TH EDITION

**electronics
Rocks**

GET READY TO WELCOME **ELECTRONICS ROCKS** FOR THE FOURTH TIME

The most awaited electronics event of the year is finally here, bigger and better. Having run successfully for three years now, the fourth edition of eRocks is going to leave you asking for more

The much-awaited event for electronics enthusiasts, the EFY Group and design engineers, is back again for the fourth time in a row, and it promises to be a spectacular show. To be held at the Bangalore International Exhibition Centre on January 11 to 13, 2016,

KEY FACTS

Dates: January 11 - 13, 2016

Venue: Bangalore International Exhibition Centre (BIEC), Tumkur Road, Bengaluru

Business visitors: Entry on all 3 days

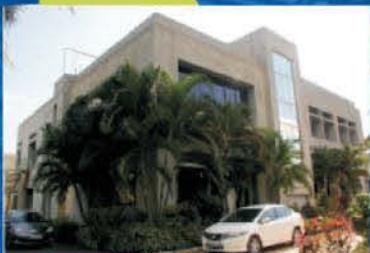
Students: All 3 days



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Ravi Sharma (CEO) | +91-9970053301 | ravi.sharma@epitomeindia.com

Electronics Rocks is in with a new theme this year—the hardware behind the Internet of Things.

This is the arena for electronics engineers, the designers and developers, the entrepreneurs, the brains behind the hardware, and the hands behind systems integration. The stage is set and the show is ready to begin. With a focus on the hardware that makes the IoT possible, the event is set to rock and unearth all that goes into creating IoT hardware designs.

The previous years saw 'The Great Indian Jugaad' happening flawlessly, much to the satisfaction of the OEMs and the start-ups. This is where speakers demonstrated their latest products and shared how they ensured a successful market entry. Expect this time to be no different with a promising showcase lined up.

Why visit?

Here are three reasons why you should not miss this mega event.

Learn the tricks of interdisciplinary electronics: With electronics no more being just components and boards put together to make a circuit, eRocks is here to highlight the tricks of the trade in the papers presented by the decision makers and creators of the industry.

Carry back skills that will give you the edge: The workshop sessions offer a spread of core electronics in a never-seen-before fashion. Right from putting stuff together, understanding the outputs, interfacing different sections into one, right till developing the code—eRocks is not just going to tell you how it is done but teach you how to do it yourself.

Four exciting tracks that cover the major happenings: Smart Industry, Smart Homes, Smart Automotive and Smart Humans (consumer and medical), the four tracks at this year's eRocks promise to uncover the mystery behind what went through the minds of the innovators in these unique and emerging sub-sectors. With the latest trends to be discussed in detail, this is a congregation of ideas aplenty and might even give you a peek into what's up and running, and what's up next.

What's special at this year's eRocks?

The major offerings this year are for the design houses and the do-it-yourself enthusiasts.

Get funded 2016: Along with getting inspired by the founders of the latest start-ups, about 30 to 40 start-ups will get to meet with VCs and mentors in one-on-one sessions at the first electronics hardware start-up meet-up. This offers the ideal platform for start-ups to pitch

Organisations represented by speakers include:

- IISc
- Tech Mahindra
- Continental Automotive
- ThroughTek
- Diabeto
- Mercedes-Benz
- Ethernet Powerlink Standardisation Group
- Magna Electronics, Germany
- Imagination Technologies, and...
- 20 others

to investors, seek mentorship from industry experts and get a chance to have their product crowdfunded.

Makers in India: A conference to be addressed by the Makers Asylum, this is where hundreds of hackers and makers are going to converge. You will get to see things in a new light, understand them differently and apply them in situations unheard of so far.

eRocks 2016: A glimpse

- Get enlightened at a session on 'Hardware is hard! How to solve Indian manufacturing challenges' by Shreekant Pawar, co-founder and CMO, Diabeto.
- Feel mesmerised listening to a speech on 'Nanotech Sensors For Human Body Health Monitoring' by Dr Vijay Mishra, CTO, IISc, CeNSE.
- Lose yourselves in a discussion on 'The mistakes I've made building ADAS, and how you can learn from them' by Plato Pathrose, systems engineering lead, Magna Electronics Company.

Other co-located shows...

Electronics Rocks is set to happen as part of the India Electronics Week that targets design engineers and electronics enthusiasts. Alongside the show, there are a host of other events to nurture electronics minds. Electronics Rocks is set to pull in hardware design engineers for its fourth edition. IoTshow.in is the destination for software minds obsessed by the IoT paradigm. EFY Expo is back again for its sixth edition, targeting the entire electronics ecosystem, as always. Raksha India is the new defence and aerospace destination. LEDasia.in is set to take you on a ride with its mind boggling line-up of design engineers, buyers and sellers. For T&M equipment, products and services, Test and Measurement India is back again for its fifth edition.

ChipMax Proudly Introduces the 4th Generation SMT Desktop Pick and Place machine from Neoden, with Highly Intelligent flying Vision System, and first of its kind.



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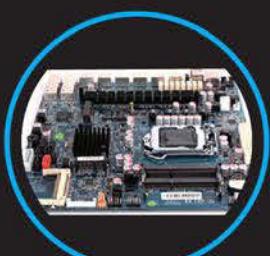


High Speed Flying Vision Camera System:

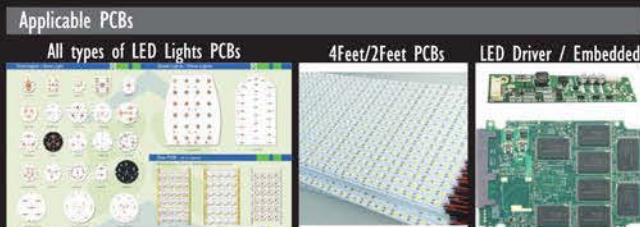


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SMT Pick & Place Machine



SMT Reflow Oven

THE 1ST EDITION

iotshow.in

BRACE YOURSELVES FOR THE INTERNET OF THINGS EXTRAVAGANZA OF 2016!

Just another IoT get-together? If that's what you think, join us to find out why this event is different!

The EFY Group has always been known to delve into the latest in electronics and make it their forte. In keeping with this trend, the year 2016 will flag off the first edition of the IoTshow.in. This is an expo-cum-conference that will track this biggest trend that's set to take the electronics industry by storm. The event is scheduled to be held between January 11 to 13, 2016, at the Bangalore International Exhibition Centre.

From integrating IoT hardware into your platform and connecting your device to the cloud, to controlling your applications smartly, IoTshow.in will guide you on making an impact in the connected space. IoTshow.in is a platform designed to raise the bar of IoT design in India by giving you insights into the most popular IoT components, solutions and technologies.

What's in store?

Conferences by thought leaders from across the world:

The event will host about 40+ speakers, taking 1500 delegates through the latest technologies and trends. These sessions are being modelled to teach from experience and offer an opportunity to learn from the mistakes made by the current market rulers.

Workshops showcasing niche skills: Workshops dealing with topics covering the what, how to, as well as the where and when to use queries, promise to impart the most necessary skills.

Exhibits that will leave you wondering: With demonstrations of innovations from industry leaders, high-value engineers and founder-innovators, who're all driven by a passion for technology and engineering, the Expo will be an enriching and exciting event.

What's in it for you?

The event is set to happen along four tracks this year — tracks that are creating breakthroughs and dictating trends.

- **Smart Automotive** – Discover what's driving infotainment and on-board diagnostics!

- **Smart Home** – Learn how to create your own ideal world, a king's palace, a life of comfort and luxury!
- **Smart Industry** – The Industry 4.0 revolution is at your doorstep! Learn more about it.
- **Smart Humans** – If there's anything new in consumer or medical electronics, it will be here!

What are you going to find?

- A session on '*How ecosystem principles can help us build smarter homes*' by Yuping Tseng, CTO at ThroughTek and Ting Zhou, systems director at Omnipinion Technologies.
- Listen to Vinay Chaddha, CEO, GVC Systems, take you through '*Building industrial IoT devices that sell — learning from experience*'.
- Srinivas Mandavalli, country manager, Imagination Technologies will tell you about '*Building secure and flexible IoT platforms*'.

KEY FACTS

Dates: January 11 - 13, 2016

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Students: All 3 days



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EFY Expo, Bangalore**

THE 1ST EDITION LAUNCHING RAKSHA INDIA

A one-of-a-kind event for the aerospace and defence sector is set to roll out on January, 2016, at the Bangalore International Exhibition Centre

KEY FACTS

Dates: January 11 - 13, 2016

Venue: Bangalore International Exhibition Centre (BIEC), Tumkur Road, Bengaluru

Business visitors: Entry on all 3 days

Students: All 3 days

Raksha India is not just a congregation of people who work in the aerospace and defence sectors. It is where ideas are born, where thoughts take shape, where action begins, where you find what you seek and your work finds sponsors. It's where you find your partners. This is the destination where those with common goals meet, where history is created, and where the future is carved.

Raksha India is India's first event to connect business and technical decision makers in organisations that use electronics in strategic sectors including defence, aerospace and home-land security. The event brings together a B2B exposition, a Buyer Seller Meet and a Technical Conference, to expose you to the best and the latest of both industries combined.

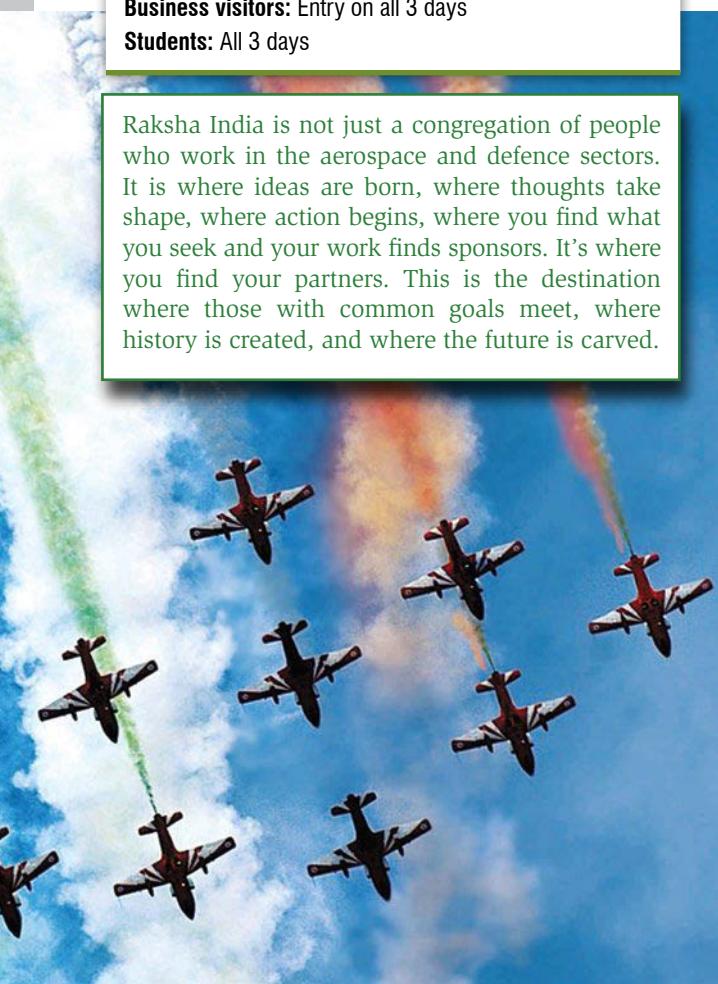
Taking its first steps, Raksha India is the ideal podium for you to sense the pulse of what's happening in the tools, technologies and customer requirements domain. The conference will enable you to network with thousands of new and potential customers, vendors and professionals in the electronics industry.

The opportunities...

Discuss new technologies, tools and processes with advice from the best in the industry: Eight dedicated conferences will bring together the best minds and practitioners from the aerospace and defence industries, offering visitors the best opportunity to hear about first-hand experiences and views.

Rekindle the spark in your team: This is an ideal chance for your teams to expose themselves to extreme learning, to knit themselves together more tightly to form superbly efficient groups. This is where you get to hear of ideas you weren't even aware about, carry them back and apply them in your company to improve your products, performance and results.

Meet with business leaders: Where there are business leaders, decision makers and business creators will follow. Raksha India offers a congregation of the biggest businesses in the industry today, throwing open exciting networking opportunities for the established, the just-started and the soon-to-start players.



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L121



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L131C



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THE 5TH EDITION KNOW WHAT'S THE LATEST IN THE **TEST & MEASUREMENT SPACE**

The only dedicated show in India for test and measurement products and services

Test & Measurement (T&M) India is Asia's leading exposition of T&M products and services. Launched in 2012 as a co-located show along with Electronics For You Expo, it has established itself as the must-attend event for users of T&M equipment, and a must-exhibit event for suppliers of T&M products and services.

In 2015, T&M India added an important element by launching the T&M Showcase—a platform for showcasing the latest T&M products and technologies. Despite being a first-of-its-kind event in India, the T&M Showcase was well received by the audience and the exhibitors.

Being held as part of India Electronics Week 2016, it is the first time that this event will be held in Bengaluru

along with EFY Expo, Electronics Rocks, LEDasia.in, IoT-show.in and Raksha India. T&M India 2016 will feature T&M Showcase too, where new products will be demonstrated LIVE to the audience.

KEY FACTS

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Students: All 3 days

A glimpse of T&M Showcase 2015



- 1 Vishal Gupta, senior application consultant, Keysight Technologies
- 2 Subhasis Bera, engineering manager and education product marketing, Tektronix India Pvt Ltd
- 3 Naveen Kataria, senior application engineer, Anritsu India Pvt Ltd
- 4 Arindam Mandal, business manager-consumer technology, UL India Pvt Ltd
- 5 Suvrat Verma, assistant manager, Rohde & Schwarz India

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TAI-CHING is an ISO9001:2008 and ISO14001:2004 certified company specialising in cable and wire harness assembly. It covers industries such as commercial, consumer, data com, gaming, medical, automotive, industrial machinery, audio/video, surveillance system, GPS and RFID. Quality manufacturing, competitive and reasonable pricing, and strong technical engineering support have helped the company to develop a wide range of customers globally.

Contact details: Ph: +91 989911788, +8862 8647 3598, sales@tai-ching.com, www.tai-ching.com

ADTECH SYSTEMS LIMITED

Adtech Systems Limited is a company in integrated electronic security systems. It was started in the year 1992. Adtech is an ISO9001:2008 certified public limited company with its registered office at Chennai and branch offices/support centres in all major cities across India. It partners with leading global security companies like Mobotix, Germany for high resolution video systems; with Tyco, USA for fire protection and intrusion detection systems; Software House, USA for access control systems; with Lonix, Finland for building connectivity/intelligent green building systems; with ATEIS, Netherlands for public address systems and Nico Technology, Taiwan for intelligent lighting solutions.

Contact details: Mobile: 09380270224, www.adtechindia.com

ADVANCE TECH SERVICES (P) LTD

Advance Tech Services (P) Ltd was started in 1996 with the aim of bringing world class solutions to the Indian electrical, electronics, automobile and pharma industries, apart from other commercial applications. The company has a wide base of satisfied customers, primarily because it considers quality products as life's assets.

Contact details: Ph: +91 11 47002024-27, info@advancetechonline.in

AJANTA MANUFACTURING LTD

Ajanta Manufacturing Ltd (Oreva Group) is the name of the company behind the leading brand Oreva. Be it lighting products, electrical products, vitrified tiles or e-bikes, Oreva has mesmerised the market with its presence. The Oreva Group has consciously always ventured into the market for world class and value-for-money products that reach across the country. Oreva CFL has broken all sales barriers and has truly become the power saver to the nation. Manufacturing millions of CFL lamps every year helps in contributing to the nation's prosperity by saving huge amounts of electricity.

Contact details: Ph: +91 79 3015 7999, Fax: +91 78 7803 6465, www.oreva.com

ALFA ELECTRONIC COMPONENTS

Alfa Electronic Components was established in 1993 and the company provides a comprehensive and widest range of LEDs and LED products around India. Instead of limiting ourselves just as a 'distributor' or 'shopkeeper', we stretch our strength an inch extra in all directions! Our technical know-how helps us to have updated information of the international market. Our awareness about various emerging industrial applications has made us gain a strong foothold in almost every segment of the LED field. We have been serving all types of electronic industry across every corner of India with LED products.

Contact details: Ph: (91)-(22)-26840075, 26837807, Email: info@alfaopto.com / alfaopto@gmail.com

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Anand Enterprises was established in 1987 to manufacture a wide range of PCB mounting hardware for the electronics and electrical industries. These parts are moulded in Nylon6, HDPE and ABS plastics. The products are injection moulded on automatic/semi-automatic moulding machines by a specially trained workforce that follows strict quality norms. These components are very useful in many applications such as PCB mounting, heat sink mounting, transformer mounting, fuse link mounting, bus bar mounting etc.

Contact details: Ph: +91 9822354463, +91 9922818961, anandspacers@gmail.com, www.anandspacers.co.in, www.pcbspacers.com



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Mail: sales@pcbpower.com | Phone: +91 7600012414 / +91 7600012415

ANAND INDUSTRIAL COMPONENTS

Anand Industrial Components (AIC) is among the leading excise registered distributors of connectors and cables. It has an experience of over 24 years with a pan-India presence and a reputation for offering quality components at competitive prices. With 4,200 products displayed at its office at Lamington Road, Mumbai, and a state-of-the-art warehousing facility in Panvel, it has proven capabilities in satisfying the needs of its customers. It represents some of the well-known majors in the industry like Essen Deinki, Essen Connectors, Prime Components, Watts Electronics, Solid Electronics, Calonix, Xinya, etc.

Contact details: Ph: +91 9322231143, +91 22 23882783/23828207, anand@aici-india.com, www.aic-india.com

ANRITSU INDIA PVT LTD

Anritsu Corporation, headquartered in Japan, is a global provider of innovative communications test and measurement solutions for more than 115 years, providing solutions for existing and next-generation wired and wireless communication systems and operators. Anritsu products include wireless, optical, microwave/RF and digital instruments as well as operations support systems for R&D, manufacturing, installation and maintenance. Anritsu also provides precision microwave/RF components, optical devices and high-speed electrical devices for communication products and systems.

Contact details: Ph: +91 80 40581300, ACIN-Sales@anritsu.com

ANTRIX ASSOCIATES

Bengaluru based Antrix Associates has four branch offices at Gurgaon, Pune, Hyderabad and Chennai. It is a leading distributor for all types of electronics, PCB assembly solutions ranging from small tools to high-end machines through its principal companies in Korea, Japan, China, Singapore, Taiwan, Italy, Singapore and Malaysia. Its product range includes ESD/anti-static, soldering stations, solder material and electric screwdrivers. Besides automated soldering, dispensing and screwing systems, robotic systems and SMT lines. The highest range of its products includes inspection machines like X-ray, AOI and solder paste inspection systems.

Contact details: 080-32402279/41250132;
Email: antrixsales@gmail.com, sales@antrixonline.com

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Anvin Electronics Pvt Ltd has a team of experienced engineers who have over 25 years experience in the field of PCB assembly, test, repair and rework. It starts with suggesting the right kind of equipment and giving total solutions. We provide complete engineering services which ensure that the entire system hardware and software is able to perform all functions required by customer. Our team has the breadth and depth of experience necessary to evaluate and automate your test requirement and develop efficient test strategies.

Contact details: Ph: +91-80-22425514, Fax: +91-80-41203785,
e-mail: info@aeplsolutions.com, Website: <http://www.anvinelectronics.com>

APLAB LTD

Founded in 1962 by P. S. Deodhar, a widely acclaimed engineer and scientist, Aplab has witnessed a steady vertical growth since then and is today is among the most reputed brand in India for high technology electronic systems. Aplab has been catering to the global market for almost half a century and offers a wide range of electronic products that meet international standards for safety and reliability such as UL, VDE, etc. The company has multiple product divisions namely T&M instruments, power conversion and controls, UPS systems, solar power products, banking and retail automation, etc.

Contact details: Ph: +91-22-67395555, 25821861, Fax: +91-22-25823137, Email: response@aplab.com, www.aplab.com

APLUS INDIA / APLUS VOICE SOLUTIONS

The company specialises in customised voice solutions and voice ICs, modules, CoBs and voice melody/music solutions for customers in the automotive, telecom and security space. It also offers voice/melody solutions to makers of toys, greeting cards, fire alarm sirens, video greeting cards, token displays, elevators, voice controller LED flashers, car reverse horn ICs, etc. Other products in its portfolio include voice ICs, CoB programmer tools, re-recordable voice ICs, re-programmable voice ICs, low-cost one-time programmable voice ICs, remote IVRS, music on hold for EPABX systems, telecom voice, etc.

Contact details: Ph: +91 9833374818, +91 22 26182082/26173575, sales@aplusindia.net, sms003@sms003.com

APPLIED REALTECH SYSTEMS (ARTS) PVT LTD

Applied RealTech Systems (ARTS) Pvt Ltd, with its headquarters in Bengaluru, is a vibrant and dynamic organisation, providing a complete suite of innovative measurement solutions to its customers in the areas of digital embedded and RF design by partnering with the leaders in the respective fields. Its dedicated associates work in tandem to deliver test and monitoring solutions to exceed the expectations of every client. ARTS is the sole authorised distributor for Keysight Technologies in Karnataka and Goa.

Contact details: Ph: +91 80 23506121/22/23/24,
marketing@arts.net.in

ARGOSY RESEARCH INC

Argosy Research Inc is a research-centered company specializing in design and manufacture of storage and mobile technology products. Established in 1987, Argosy became public in 2004. Our innovative thoughts and our proactive approaches have propelled us to the forefront of the industry. Headquartered in Taiwan, Argosy has three subsidiaries in the USA, Europe, and China to provide solid regional support and efficient service. Our profound expertise, experienced engineering team and global logistic network has turned us to be a trustable partner to many world class companies.

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ARK COMMUNICATION

Based at Vadodara in Gujarat, ARK Communication has been in the field of developing LED light products since 2009. Currently, it is coming up with LED light fixtures like downlights, zoom lights, track lights, bay lights, etc, and is changing the basic concepts behind fixture designing. It offers slim light fixtures with uniform colour, slickness and aesthetics as well as technical soundness in the best form factor. Its products have excellent heat management because of the use of pressure die-caste aluminum supports, with a unique mounting concept. These come with an active cooling mechanism for effective heat dissipation.

Contact details: Ph: 09824073200, Kuldip Upadhyay, Email: info@rayrhythms.com

ARROW ELECTRONICS

Arrow Electronics is a global provider of products, services and solutions to industrial and commercial users of electronic components and enterprise computing solutions, with 2014 sales of \$22.8 billion. Arrow serves as a supply channel partner for over 100,000 original equipment manufacturers, contract manufacturers and commercial customers through a global network of more than 470 locations in 55 countries. Arrow provides specialized services and expertise across the product lifecycle. Arrow does this by connecting customers to the right technology at the right place at the right time and at the right price.

Contact details: Muralidharan .G, Email: muralidharan.g@arrowasia.com, Website: www.arrow.com

ARTIM ELECTRONICS

Artim Electronics (formerly Green India Electronics) is a reliable name amongst the buyers of electronic components. Ever since its inception in 2013, Artim Electronics has been an extended 'supply chain' partner for electronic design and manufacturing companies. Besides the supply of components, Artim also supports end-to-end high quality designs for companies facing time-to-market challenges. In the past, Artim had successfully delivered products in the field of home automation (IoT or Internet of Things) and power electronics.

Contact details: Ph: +91 7676500600, muthu@artimelectronics.com, www.artimelectronics.com

ASIAN ELECTRONICS

Established in 1996, Asian Electronics is a well-known specialised importer and distributor for the Galaxy brand in India for its range of LED products with Rosh and Im80 Certificated Quality such as –all type of SMD lead's, LED lance's, High power LEDs, through hole LEDs, all sized and coloured seven segment displays, LED dot-matrix displays, LED light bars, etc.

Contact details: Ph: 022-23826807/23883778; Email: sales2asian@gmail.com, asianelete@yahoo.com, www.asianelectronics.co.in, www.leddisplayindia.co.in

ATLAS COPCO

Established in 1960, Atlas Copco has leading positions in compressor technique, industrial technique, mining and rock excavation technique, construction technique, to related aftermarket and rental. With state-of-the-art manufacturing facilities today at Pune, Nashik and Hyderabad, the company has a national presence with over 2 500 highly skilled employees in 22 offices across India. Manufacturing plants in Pune and Nasik are ISO 9001 and ISO 14001 certified. In addition, the company has two engineering competency centers for compressors and construction and mining equipment.

Contact details: Website: www.atlascopco.in

B&B BATTERY (INDIA) CO. PTE LTD

The world renowned battery manufacturer, B&B Battery, was established in 1992 in China by its Taiwan headquartered parent company, which is known for its stringent quality practices. The company first launched a technically advanced VRLA (valve regulated lead acid) battery. Today, it offers the most reliable and valuable batteries in diversified markets. B&B's dedicated and par excellence infrastructure and technical prowess have formed a strong foundation for providing responsive technical service to every customer. Moreover, excellent R&D helps it to develop dedicated batteries for specific applications.

Contact details: Ph: +91 80 26496670, indisales@bb-battery.com, www.bb-battery.com

BEIJING SANTEL TECHNOLOGY & TRADING CORP.

Beijing Santel Technology & Trading was established in 1993. We are a state-owned enterprise mainly engaged in international trade and tendering agency, project management and consultation services. For many years, by giving play to its own advantages, we have successfully achieved the transformation of development patterns from domestic purposes to international fields. We take mechanical equipment and electronic information as our primary business, becoming the most competitive corporation specialized in communication system.

Contact details: Ph: (86 10) 68387010 Ext : 819, Website: <http://www.globalsources.com/bjsantel.co>

CADENCE DESIGN SYSTEMS INDIA PVT. LTD.

Cadence is a leading provider of electronic design automation (EDA) and semiconductor intellectual property (IP). Its custom/analogue tools help engineers design the transistors, standard cells, and IP blocks that make up Systems on Chip (SoC). Its digital tools automate the design and verification of Giga-scale, Gigahertz SoCs at the latest semiconductor processing nodes. Its IC packaging and PCB tools permit the design of complete boards and subsystems. Cadence also offers a growing portfolio of design IP and verification IP for memories, interface protocols, analogue/mixed-signal components, and specialised processors.

Contact details: Ph: 080-41841111, Email: communications_india@cadence.com, www.cadence.com



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CHINA ELECTRONIC APPLIANCE CORPORATION (CEAC)

Officially established in 1964, China Electronic Appliance Corporation (CEAC) is a subordinate body of China Electronics Corporation Group (CEC), and serves as one of the three largest trading enterprises in the electronic industry in China. With 13 subsidiary companies and 15 invested holding companies, CEAC possesses a powerful nationwide network. CEAC is mainly engaged in the business of electronic components distribution, telecommunication, imports and exports, and exhibition services.

Contact details: Ph: +10 59798101 839, jhwang@ceacfbt.com, www.ceac.com.cn

CHINA ELECTRONICS INTERNATIONAL EXHIBITION AND ADVERTISING CO LTD (CEIEC)

CEIEC was founded in April 1980. After years of operation, CEIEC has built co-operative relationships with more than 160 countries and regions, and has made contribution to the development of the Chinese electronics industry. CEIEC is honourably entitled to a number of A-grade certificates of world trade, international engineering, tendering, exhibition and advertisements. By the end of 2013, CEIEC's total assets and sales revenue had reached RMB 26.708 billion and RMB 38.68 billion respectively.

Contact details: Ph: +86 10 6829 6358, wgsheng@ceiec.com.cn, www.ceiec.com.cn

CHIPMAX DESIGNS PVT. LTD

Chipmax Designs Pvt Ltd Bengaluru, was established by electronics engineers with the idea of contributing valuable service to the Indian electronics industry. The company has support and sales offices across India. The company is into the customisation, supply, training, installation and after-sales service for SMD assembly machines for SMEs engaged in developing various products like LED lights, LED driver boards, solar inverters, UPS systems, electronic meters, security systems, GPS/GPRS navigation systems, embedded systems, membrane key boards, etc.

Contact details: Ph: 080-23656465, Email: info@chipmax.in

CIRCUIT SYSTEMS INDIA LTD / PCBPOWER

Circuit Systems India Ltd / PCBPOWER offers an arsenal of printed circuit board (PCB) products and is an electronics solutions provider. Its experience of 19 years in the industry helps it offer PCB solutions that best fit its customers' needs. As a leading online PCB solutions provider, its aim is to ensure the full realisation of the customer's ideas and designs. Its constant endeavor is to offer quality PCBs, ease of ordering and the industry's best on-time delivery performance and this has helped the company become a preferred choice in the industry as an online PCB specialist for prototypes and small volumes.

Contact details: Khushal Panchal (VP), Mobile: 7600012414, 7600012415, Email : sales@pcbpower.com

CLION ELECTRIC CO. LTD

Clion Electric Co. Ltd, which was established in 2003, is one of the leading relay manufacturers in China with more than 900 workers. It imported the most advanced production equipment and technology from around the world. Its product range includes electromagnetic relays, solid state relays, power semiconductor modules, relay sockets and bridge rectifiers, etc. Its annual output has reached 80 million pcs. Under the ISO9001;2000 International Quality Management System and the ISO14001;2004 system, Clion has obtained the 3C, CQC, CE, UL and TUV certifications for its products and they are also RoHS compliant.

Contact details: Ph: 86-577-57156992, Fax: 86-577-57572255, E-mail: tony.chen@clion.cn

COMKEY.IN

ComKey.in is an innovative idea developed by its parent company, Siricom Technology, a reputed distributor of SMD devices based in Bengaluru to cater to the needs of young engineers as well as R&D centres with its online eComponents store. ComKey.in is the first Indian online electronic components store to supply in rupee payments with a warehouse located in Bengaluru. ComKey.in brings together the latest products, services, and various electronic products as well as electro mechanical components manufactured by various Indian companies to offer one-stop solutions to the Indian electronics industry.

Contact details: Ph: 080-26592222, 26292221, Mobile: 9845199474, Email: rsp@siricomindia.com, www.siricomindia.com

COMPONIX INDIA

Established in 2004, Componix is the authorised distributor for reputed manufacturers of electronic components based in Taiwan, Korea, China, etc. Componix India is headquartered in Mumbai, with a sales network covering the metro cities like New Delhi, Bangalore and Pune. Componix is an approved vendor to leading OEMs/factories in India, with a focus on lighting, automotive electronics, power supplies, automation and industrial applications. It supplies components to reputed clients, ensuring their utmost satisfaction. Its customers are in the automotive, lighting and consumer electronics domains.

Contact details: Ph: +91 22 23827771/23827772, info@componixindia.com

CONINS PUNE

Conins is well established in the field of conformal coatings. Its Acrylcoat conformal coating is well accepted in the electronics industry, and enjoys an excellent reputation for its quality. Conins has a state-of-the-art manufacturing plant and a well-equipped R&D facility for developing and testing its products with totally indigenous technology. This is backed by highly qualified and well experienced engineers. 'Consistency in quality' is Conins' hallmark. As a Conins customer, one can rely on consistent quality and reliable supplies at economical rates. Acrylcoat is approved by C-DOT and conforms to MIL standard: MIL-I-46058C Type AR.

Contact details: Ph: + 91 20 25672299, + 91 9422003495, + 91 9545591323, +91 9545494422, coninspune@gmail.com



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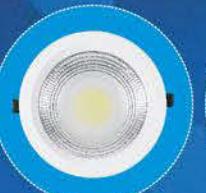
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COSMO FERRITES LIMITED

Cosmo Ferrite Limited was founded in 1986 and its operations started in 1987. The company has production capacity of 3600 MT for Soft Ferrite components. It is accredited by ISO 9001:2008 [QMS] & ISO 14001:2008 [EMS] certification. The company has UL94V-0 approval coating material. The research & development department is recognised by government of India's Department of Scientific & Industrial Research. It serves industries such as lighting, energy meter, solar, welding, induction heating, UPS/inverters, medical electronics, Railways etc.

Contact details: Ajit Saxena, Mobile: +91-8130390138, Email: ajit@cosmoferrites.com

CTC TECHNOLOGIES CO, LTD

The company's main office is in Tianjin, China. It also has offices in Shenzhen and Hong Kong. The company specialises in test equipments, such as spectrum analyzer, network analyzer, signal generator, WLAN tester, power meters, signal analyzer, power supply, RF/wireless communication test set, bluetooth tester, shielding box, oscilloscopes and so on which are made by Agilent, Anritsu, R&S, Advantest, TEK etc.

Contact details: 86-22-58895688-2000, Website :<http://www.phoenixelec.com>, <http://www.80613.tradebig.com>

DELTA MAGNETS LIMITED

Delta Magnets Limited (formerly known as G. P. Electronics Limited) was established in 1985 with technical know-how from TKS Japan. The company's manufacturing facility is located at Nashik - 180 Kms, North - East of Mumbai, India which is the nearest sea as well as airport. Delta Magnets Ltd is among the top manufacturers of hard ferrite magnets in India. Completing its third decade of service, the company is a trusted development partner for high growth industries such as automobiles, entertainment electronics, information & communication, power supply and medical appliances.

Contact details: Ph: 022-4079 4700, Email: sales@deltamagnets.com, Website: <http://www.deltamagnetsgroup.com>

DESAI ELECTRONICS PVT. LTD

Founded in 1981, by its Managing Director, Mr. Vikram M. Desai, Desai Electronics Pvt. Ltd. (DEC) is a leading manufacturer of Plastic Film Capacitors in India. In the 34 years since its inception, DEC has grown from producing 0.5 million capacitors to 400 million capacitors a year. DEC is the 1st Indian manufacturer to get UL certification for X2 capacitors. The Quality Management Systems are certified under ISO 9001:2008, all its capacitors conform to IEC 384 & are RoHS compliant. DEC has been an undisputed market leader, in the segment of fan regulator capacitors, for over 10 years now.

Contact details: Mobile: 9822438055, Email Id – phinduja@deccapacitors.net

DEVTECH M2M LTD

Devtech M2M constantly uses innovative technology to manufacture products, which are energy efficient. A team of technology experts backs it from Devtech M2M (USA), with over 400 man-years of R&D experience in the field of creating sustainable and energy-efficient solutions. Devtech M2M has experience of controlling traditional ballast like MH/HPS/CDM to current LED technology and it addresses all the control and communication systems. These products are meant for new/retrofit solutions and are backed by total operation and maintenance software support via remote monitoring of the all customer sites.

Contact details: Ph: +91 20 30516119, info@DevtechM2M.com, www.DevtechM2M.com

DONGGUAN TONGKE

Founded in 2007, Tongke Electronic Co Ltd, has more than 200 employees, among which there are 20 highly skilled technicians with more than 10 year experience. The company has now become a professional diodes manufacturer. High stability and high reliability make our products famous in our country and also internationally. We have automatic vacuum sintering furnace, clean assembly plant, precision placement machine, imported high-precision testing machine.

Contact details: <http://www.made-in-china.com/showroom/diodetk>

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DOU YEE ENTERPRISES

Dou Yee Enterprises is the premier total industrial solutions provider in the Asia Pacific region, serving with distinction the semiconductor, data storage, electronics and biomedical industry since 1982. We have 39 international branch offices strategically located around the world to give customers the fastest and most accessible products and services. Our manufacturing plants, located in Singapore, Malaysia (Seremban), China (Suzhou) and France are governed by consistent quality systems with ISO 9001:2008 and ISO 14001:2004 certifications.

Contact details: Tel: (65) 64442678, Fax: (65) 67437172,
Website: <http://www.douyee.com>

DRIVE TECHNOLOGIES

Drive Technologies has supplied world class equipment, materials and aids for the electronic industry in the field of circuit assembly, testing, cleaning and conformal coating. In the conformal coating space, the company ensures the right material at the right time with thorough technical backup. Based on these credentials, the company is trusted by numerous large and small scale companies in India. The conformal coating from HumiSeal is central to the company's future growth.

Contact details: Ph: +91 22 24250020, prasad@drivetech.in,
c.palin@chasecorp.com, www.drivetech.co.in

DS ELECTRONICS

DS Electronics was established in 1989, as a professional company engaged in marketing industrial components and allied products. The company has built a strong reputation among manufacturers and dealers all over India. With the eco-friendly movement gathering steam all over the world, the demand for energy-saving products for commercial LED lighting has grown, which led the firm to incorporate DS Lighting Technologies (a division of DS Electronics). The company succeeded in partnering with Taiwanese company, Prolight Opto Technology Corp, which offers LED products ranging from 0.2W to 200W.

Contact details: +91 22 66346525, 23882742,
chetanthakkar49@hotmail.com, ketanthakkar5@gmail.com

DSQ TECHNOLOGY CO LTD

DSQ was founded in the year of 1988, by the founder Mr. Johnny Tseng---CEO. Concerning high demand for stamping parts, terminal and connector, the founder made use of his own knowledge in engineering and devote himself to manufacturing process improving. At first, he designed the tooling with innovative method by relaying the material strip in an opposite position to save material. It is the creative method at that time. And we also use new method to wide-range applicable products, it drove us to cost down in high percentage.

Contact details: Ph: 886-2-2675-4451, Email info@dsq.com.tw, office@dsq.com.tw, Website: www.dsq.com.tw

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Contact details: Ph: +91 11 45603555, manpreet.kaur@flir.com.hk, www.flir.com

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Contact details: Rohit Parmar: Ph: 9773307110, Suresh Parmar: Ph: 7666663630, Jayesh Parmar: Ph: 9920190113; www.flozal.com

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Contact: details: Mobile: 099711 20972, Email: info@gaienergy.co.in, Website: http://www.gaienergy.co.in

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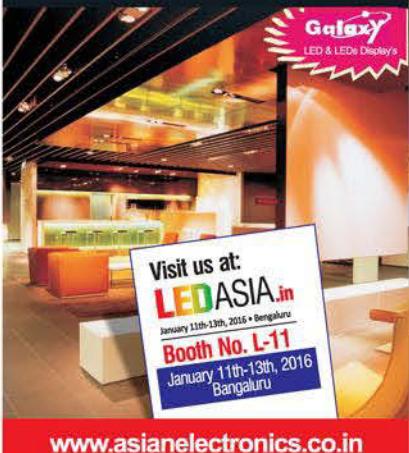
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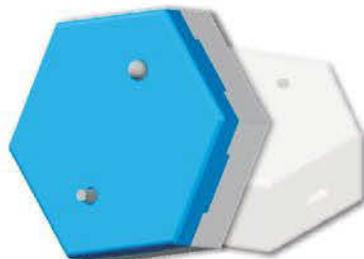
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Contact details: Ph: +91 9953557477, praveen.mahajan@keyoperation.in

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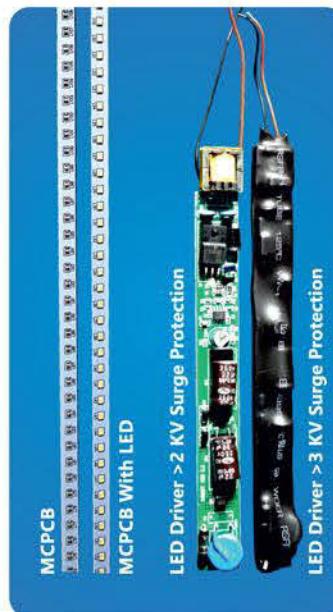
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Contact details: Ph: +91 9890198883, anand@knewron.co.in

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Contact details: 022-23863232, Mobile: 09323163232, Email: info@klsledindia.com, Website: <http://www.klsledindia.com>

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Kwality Photonics Pvt Ltd is India's largest producer of LEDs, LED displays and opto electronic products. Kwality is not only among the pioneers in the field, being the first Indian company to have successfully established LED production in India but also commands the highest market share in domestic sales. This could be attributed to the fact that the firm is led by noted scientist engineer and expert in LEDs—Vijay Kumar Gupta, the CEO who has been associated with LED manufacturing technology for over 30 Years with reputed institutions like IISc, BARC, TIFR and Central Electronics Ltd.

Contact details: Ph: +91 40 27123555, +91 9000081171, sales@kwalityindia.com, kwalitypolywa@gmail.com, www.kwalityphotronics.com

KYORITSU ELECTRIC INDIA PVT LTD

Kyoritsu Electric India Pvt Ltd is a Japanese company that was established in India in 2008. The company is involved in the sale, marketing and after sales service of PCB assembly and test equipment. It has a 100 per cent local manufacturing set-up for ICT and function test jigs with ATE and test-programs. It has a team of 18 experienced, well trained engineers and has branches in New Delhi, Bengaluru and Pune. The PCB assembly and test equipment offered by the company include in-circuit testers; Kyoritsu's FOCUS-2000 which is based on an uncommon, reliable and high performance solid state switching, etc.

Contact details: Ph: +91 250 2024668, kalpesh@kyoritsuelectric.com, www.kyoritsuelectric.com

LDRA TECHNOLOGY PVT LTD

For more than forty years, LDRA has developed and driven the market for software that automates code analysis and software testing for the safety, mission, security and business critical markets. Working with clients to achieve early error identification and full compliance with industry standards, LDRA traces requirements through static and dynamic analysis to unit testing and verification for a wide variety of hardware and software platforms. Boasting of a worldwide presence, LDRA is headquartered in the United Kingdom with subsidiaries in the United States and India, coupled with an extensive distributor network.

Contact details: Ph: +91 80 40808707, +91 9686190912, india@ldra.com, www.ldra.com

LIGHTSTYLE SOLUTIONS PRIVATE LIMITED

Lumens Technologies (www.lumenstech.in) is a distributor in the electronics and semiconductor segment and primarily caters to the Indian LED lighting manufacturing industry, supplying LEDs of various brands. Its motto is: 'All solutions and brands under one roof.' Lumens has been a reliable and trusted partner to leading LED brands like Seoul Semiconductor, Honglitronics, Refond Opto, LG Innotek, Lextar, Luminus, YLL and HHH LEDs. The Lumens team, which has specialised experience in the lighting industry, helps it to get associated with quality, renowned brands and bring the best parts to the Indian market at affordable prices.

Contact details: Kuldeep Gupta, Ph: 09833394060, Email: sgupta@lumenstech.in

LOGSUN SYSTEMS

Logsun Systems started its business activities in 2001-2002. Logsun Systems is a manufacturer, distributor, reseller and service provider for electronic products, catering to industries, corporates, defence institutes, technical educational institutes like engineering colleges, polytechnics and other vocational institutes, individual developers and hobbyists. The organisation has its setup in Pune and has inhouse development tools and the latest testing facilities.

Contact details: Ph: +91 20 24356456 24351400, Email: info@logsun.com info@logsunonline.com, www.logsunoonline.com www.logsun.com

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Office: 2097/22, Balaji Market, Chahindra, Bhagirath Place, Delhi-06

Ph.: 011-23867603, 23876170, Mob.: 09811205116, 9999124434,

9999124435, 9999124438, Email: maxel.solarpower@gmail.com

Web.: www.indiamart.com/maxelelectronicssystems / www.maxelelectronics.com

LUMENS TECHNOLOGIES PVT LTD

Established in 2013, Lumens Technologies is an India based semiconductor distributor specialising in lighting solutions like LEDs, drivers and optical solutions for the LED lighting industry in India. Lumens aims to be a leader in the LED lighting/ semiconductor industry by offering a vast selection of products, services, and solutions for a range of buyers and manufacturers. Lumens Tech has tied up with various LED manufacturers across the world to cater to all types of lighting and customer application requirements. It is an authorised all-India distributor for Seoul Semiconductor, Honglitronics, Lextar, Luminus and the Iijin brands.

Contact details: Ph: +91 8879482333, +91 22 25950265/2525, sgupta@lumenstech.in

MAXEL ELECTRONICS SYSTEMS PVT LTD

Maxel Electronics Systems Pvt Ltd was established by Pranay Aggarwal and Vinay Aggarwal in 2001. The company manufactures all types of LED lighting products (both industrial and domestic). It has been catering to all the lighting needs of its customers as well as LED light manufacturers. It also offers LED drivers for panel lights, streetlights, floodlights, etc. It has diverse power electronics products including digital home UPS cards, online UPS cards, DSP-based sine wave cards, microprocessor-based voltage stabiliser cards, SMPS power supplies, etc.

Contact details: Ph: +91 11 23867603, 23876170, maxel.solarpower@gmail.com, www.indiamart.com/maxeletelectronicssystems/ & www.maxelelectronics.com

MAXSEMI TECHNOLOGIES PRIVATE LIMITED

Maxsemi Technologies is a technology company that is focusing on innovations in: Consumer lighting products: Bluetooth based RGB bulbs and downlights with built-in speakers for music streaming and FM radio. Commercial lighting: Cloud based control for streetlights or downlights with remote on/off, fault management, etc. Smart cloud based utility meters

Contact details: Ph: +91 9972132555, www.maxsemi.in

MECO METERS PVT LTD

Meco Meters Pvt Ltd was established in 1962 by its CMD, Premchand Goliya. It manufactures test and measurement instruments in its state-of-art manufacturing facility in Mumbai. The company has contributed to the growth of the electronics industry and has proved to be an inspiration to many domestic manufacturers who made a mark in the industry by competing with MNCs. Meco's product range includes digital multimeters, digital clamp meters, insulation testers, transducers, panel meters, energy monitoring instruments, energy meters, battery meters, solar analysers, harmonics analysers, power quality meters, etc.

Contact details: Ph: 022-27673320, 27673300, Fax: 022-27673310, Email: sales@mecoinst.com, www.mecoinst.com

MECTRONICS MARKETING SERVICES

Mectronics Marketing Services is a leading name in the Indian electronics manufacturing industry for its high quality PCB assembly consumables and equipment. Since the last 21 years, the company has been serving the market with a team of experienced and qualified engineers. For smooth operation in each part of the country Mectronics has six offices in Delhi, Bengaluru, Chennai, Hyderabad and Pune. Its Noida-SEZ warehouse is for ex-stock, zero duty inventory and for exports.

Contact details: Ph: +91 9810335220, +91 11 42208256, manish@mectronics.in, pankaj@mectronics.in

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Contact details: Mobile: 9823181162, Email: vishnu@messungglobalconnect.com, Website: www.messungglobalconnect.com

METRO ELECTRONIC PRODUCTS

Metro Electronic Products is more than 50 years old, and deals in testing and soldering equipment. The company was started in 1960 by Prem Prakash Kwatra. The product range it deals in includes multimeters (digital and analog), soldering and desoldering stations, oscilloscopes (CRO and DSO), LED and environment testing equipment, function generators, power supplies, frequency counters and various other instruments. The company has a strong presence in test equipment, with a range of brands that have a high customer recall, i.e., Metro-Q, Mastech and Owon.

Contact details: Ph: +91 11 23868195, 47508195, 23875355, infometroQ@gmail.com, www.metroq.in

Head Office :

535, 2nd Floor, F.I.E.,
Patparganj Industrial Area,
New Delhi-110092 (India)
Tel: 01142208256/43041581

Email: mectronics@mectronics.in

Branch Offices :

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south@mectronics.in

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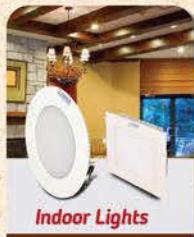
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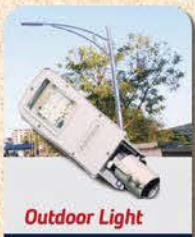


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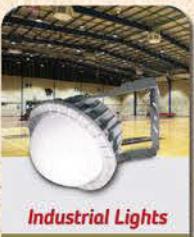
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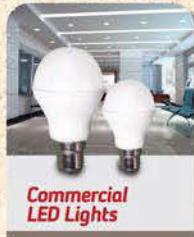
Indoor Lights



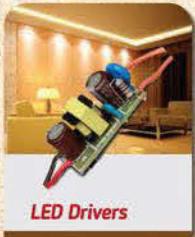
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Please Contact for Further Details :

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Contact details: Ph: +91 80 23485149, 23489971, sales@miracle.net.in, www.toroidal.com

MLS INDIA

MLS India is a completely owned subsidiary of MLS Co. Ltd, which is one of the largest manufacturers and suppliers of LM80 certified SMD & DIP LEDs. The wide choice of LM80 certified MLS LEDs are available in warm white, natural white and cool white. Lamp manufacturers using MLS LEDs can bid for all BEE, EESL, municipal corporation or any other government tenders & BIS based LED indents using our 2835 (0.5W, 0.2W, 0.1W), 5630 (0.5W) and 3014 (0.1W) LEDs, MLS also has a wide range of colour LEDs available in 3014, 2835 and 5050 packages.

Contact details: Ph: 011-41685700, Email: deepak.bohra@mlsindia.net, Website: www.mlsindia.net/www.forestled.com

MOUSER ELECTRONICS

Mouser Electronics, a subsidiary of TTI Inc, is part of Warren Buffett's Berkshire Hathaway family of companies. Mouser is an award-winning, authorized semiconductor and electronic component distributor, focused on the rapid introduction of new products and technologies to electronic design engineers and buyers. Mouser.com features more than 4 million products online from more than 500 manufacturers. Mouser publishes multiple catalogs per year providing designers with up-to-date data on the components. Mouser ships globally to over 500,000 customers in 170 countries.

Contact details: Manjula Girish, Email: india@mouser.com, Website: <http://www.mouser.com>

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Contact details: Ph: +91 80 41190053, +91 9916461742, Shirin.Bardia@ni.com, ni.india@ni.com, www.india.ni.com

OLIVE EXPORTS PVT LTD

Olive Exports Pvt Ltd (Olive LED) is a research, design, development, engineering, customisation and manufacturing company for power saving LED lighting products and accessories. The company has all the major recognition and credentials for its products, including BIS, MNRE, NSIC, BEE, RDSO, CE, ROHS, LM79, DGS&D, DEFERENCE and ESCO. Olive Exports has set up the complete production and laboratory infrastructure for manufacturing its lighting products.

Contact details: Ph: +91 9312400900, olivedlights@gmail.com

ONYX COMPONENTS & SYSTEMS PVT LTD

Established in 1992 by young technocrats with entrepreneurial spirit, Onyx is a leading stockist and distributor of electronic components in India. The company has its head office at Hyderabad, and regional offices in Delhi, Bengaluru, Chennai, Pune, Coimbatore and Ahmedabad. In tune with product dynamics, the company caters to various segments in telecom, power, industrial, automotive, medical, defence, consumer and EMS, thus covering the entire Indian market.

Contact details: Ph: +91 9704401236, Fax: +91 4066631800, swamy@onyxindia.com, harika@onyxindia.com, www.onyxindia.com

OPTICS & ALLIED ENGG. PVT. LTD

Optics & Allied Engg. Pvt. Ltd, Bengaluru is one of the leading manufacturers of lenses, optical filters, optical windows, prism light pipes, LCD/LED backlights, reflectors and diffusers for LED downlights, streetlights, stage lights, back lights, polymer optics, reflectors, light guide plates, back lights, LGPs, stereo zoom microscopes, VVMS, illuminated magnifiers, etc.

Contact details: D. Rajendra Kotaria, Email: info@opticsindia.com/marketing@opticsindia.com

OPTOTECH COMPONENTS

Optotech Components is a Mumbai based company and it deals in high power cob LED, LED drivers and other LED devices. The company wants to be one of the key players in the LED segment in the country.

Contact details: Mobile: 08046038808

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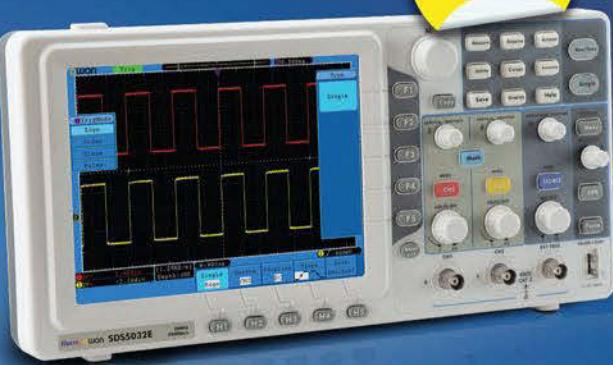
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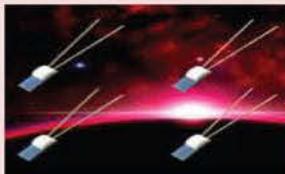


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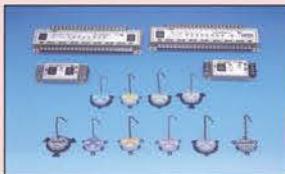
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International Sales : +91-9816032741, +91-1792-277236

For General Enquiry Ph: +91-1792-277231/32

PEACH TECHNOVATIONS PVT LTD

Peach Technovations Pvt Ltd aims to empower electronics manufacturers and traders with creative IT solutions for the management of sales, stores, purchase, production, preventive maintenance and repairs, product support, and other business operations. Several of its products are offered in the Software-as-a-Service form to ensure affordability for MSMEs. Peach's creations have won acclaim across and beyond India for their effectiveness in streamlining operations. In addition to solutions for business management, Peach also offers e-Governance systems for establishing transparency and efficiency in the government and NGOs.

Contact details: Ph: +91 9898250740, parth@peachcomp.com

PENTODE TECHNOLOGIES PVT LTD

Pentode Technologies is a company with the spirit of innovation. It is a high-tech company head-quartered in New Delhi, India, and is specialised in developing high quality wireless communication terminals (GSM, GSM/GPRS module, GPS modules), manufacturing, sales of vehicle trackers, RFID attendance machines, home and industrial automation systems and smart track light controls. As a leading provider of wireless communication products, the company focuses on the design of chain links, dedicated to wireless communication modules, GPRS/GPS modules and other intelligent terminals.

Contact details: Ph: +91 11 26343022, info@pentodetechnologies.co.in, www.pentode.in

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Phytec with its 30 years of hardware expertise, develops and produces world class high quality OEM products—SOM and SBCs. Its ARM based System-on-Modules phyCARD, phyCORE, phyFLEX and phyWAVE are delivered with industrial grade highly reliable BSP software. Phytec's OEM and ODM services cover spectrum of the product life cycle from concept to design through manufacturing and after-market services. Its engineering encompasses complex PCB design, operating systems, drivers, development environments and app-specific software support to reduce customer investments in the design stage.

Contact details: Email: vasu.b@phytec.in, rashmi.p@easyarm.com, Mobile: 9535504414, Ph: 40867046/49, www.phytec.in

PIE ELECTRONICS

Pie Electronics offers all kinds of LCD panels, LCD modules and LED backlights. Its main field of business is display products, which include LEDs, LED displays, LCDs, backlights, and EL based products. The company tagline "Your Display Partners" best describes what it does. As a professional company, Pie has successfully built strong relationships with its clients and suppliers, around the globe.

High quality products, delivered in time at a reasonable price, have earned it a reputation for providing reliable and professional service to its customers.

Contact details: + 91 11 27497255, sales@pieindia.co.in, www.pieindia.co.in

PRECIOUS ELECTRONICS PVT LTD

Precious Electronics Pvt Ltd was established in 1962 by professionals with experience of having worked in the electronics trade for many years. At that time, the electronic components industry was at its Infancy. It was in need of an efficient distributor and dealer network. Precious Electronics therefore decided to concentrate on dealing in components of good quality and thereby provide much needed marketing outlets to the growing industry. Gradually, over time, it made fruitful inroads into the industry, and established a reputation for itself.

Contact details: Ph: 022-2386 7459/9473/9478, Email: sales@preciouselectronics.com, paresh@preciouselectronics.com, www.preciouselectronics.com

PRECISION TECH ENTERPRISES

Precision Tech Enterprises is a reputed manufacturer in the field of automobiles, automotive electronics and consumer electronics. The company has a range of manufacturing capabilities including product design, injection mould manufacturing, plastic components and sheet metal components manufacturing. The company has its own brand for mobile phones—Nuvo, and for mobile accessories, it's Azure. The company has established its new dedicated assembly lines for the assembly of electronic devices like mobile phones and has state-of-art testing equipment.

Contact details: Ph: +91 8130694094, ankit@nuvo-info.com, sb-rakheja@pte-india.com

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Contact details: Ph: 080-25502773, Email: sales@procyontech.com, Website: http://www.procyontech.com

PYROTECH ELECTRONICS PVT. LTD

Pyrotech Electronics Pvt. Ltd is a leading manufacturing company in the field of LED lighting, occupancy sensor, CCTV system and is based out of Udaipur, India. The company employ more than 400 engineers & 2500 skilled technicians in its 13 different units. The turnover of group companies is around Rs 2,500 million. Pyrotech is manufacturing electronics instruments for last 35 years and has developed drivers for LED lights. The reliability and performance of these drivers are based on their electronics design and manufacturing experience.

Contact details: Mobile: 9352506417, 9509310101, Email: mktg@pyrotechlighting.com

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MLS INDIA is a completely owned subsidiary of MLS Co. Ltd., which is one of the largest manufacturers & supplier of LM80 certified SMD LEDs. The wide choice of LM80 certified MLS LEDs are available in Warm white, Natural white and Cool white.

Lamp manufacturers using MLS LEDs can bid for all BEE, EESL, Municipal Corporation or any other Government Tenders & BIS based LED indents using our 2835 (0.5W, 0.2W, 0.1W), 5630 (0.5W) and 3014 (0.1W) LEDs, MLS also has a wide range of Color LEDs available in 3014, 2835 and 5050 packages.



MLS INDIA, 1021-1022, DLF Tower-A, DDA District Centre, Jasola, New Delhi- 110025, T: +91-11-41685700 M: +91- 8800314447
Email: shobhit.bhasin@mlsindia.net, Website: www.mlsindia.net

QUECTEL

Quectel Wireless Solutions is a dedicated supplier of M2M wireless modules. As one of the leading providers of GSM/GPRS, UMTS/HSPA/LTE, GNSS modules with many years of extensive experience, Quectel is always looking to be at the forefront of technology and maintaining its customers' full satisfaction. A comprehensive product portfolio, strong R&D capabilities, matchless support services and a global presence have all established Quectel's leadership position in the M2M marketplace.

Contact details: www.quectel.com

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R. STAHL (P) Ltd is a 100 per cent subsidiary of R. STAHL AG, Germany, which has been a globally reckoned benchmark in the field of explosion protection for over 155 years, with a large basket of products designed, developed manufactured and marketed by it. These include a wide range of innovative, first-of-their-kind products in the electrical and instrumentation domains. Its QMS is ISO 9001:2008 certified and its facility is ATEX and IEC Ex approved.

Contact details: Sascha Ternes (GM, sales), Ashwini Bondale (senior manager, sales), G. Aishwarya (asst. manager, marketing), Email: sales@rstahl.net marketing@rstahl.net

RANK INFOTECH (TOYO CONNECTORS & CABLES)

Toyo Connectors and Cables has been in the business since 2001. In 2004, it started manufacturing wire harnesses and cable assemblies, and in 2014 it started a new unit for PVC wires, which in the next three to four months will also manufacture shielded and unshielded cables. Toyo PVC wires and wire harnesses are CE, RoHS approved. Toyo has over 6,000 products in the connectors and cables segment.

Contact details: Ph: 022-23896060/61/62, Email: rank@hathway.com / rankdata@vsnl.com, Website: www.rankinfotech.com

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Contact Details: Ph: 04422251434/35, Mobile: 8939869605, 8939862566, Email: info@readyled.in, anusuya@readyled.in, Website : www.readyled.in

RELYSYS

RelySys Technologies India Pvt. Ltd is engaged in developing embedded products in M2M (Machine to machine communication) and IoT (Internet of Things) space. Key products are IoT gateway platforms, 6LoWPAN based sensor and actuator nodes, power back up solutions, access control products and motion sensors. RelySys products find usage in enterprise/industrial grade remote monitoring, automation, security and surveillance applications across various industry verticals.

Contact details: Ph: 080-26851175, Mobile: 9611999887, Email: shreesha.nataraj@relysys.co.in

RESEARCH DESIGN LAB (ISOFT)

Research Design Lab (RDL) will be showcasing some innovative, cutting edge technology related products like home automation kits, DIY kits (robotics), Li Fi modules, embedded components/modules, development boards, interface boards, sensors, wireless and Bluetooth modules, for tech enthusiasts and hobbyists to explore further.

Contact details: 9845068037, 9886271407, Email: sandeep@researchdesignlab.com; raghav@goaltechnologies.org

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Contact details: Ph: +91 11 42535400, sales.rsindia@rohde-schwarz.com, Website: www.rohde-schwarz.co.in

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ROHM Co., Ltd is an international semiconductor company headquartered in Kyoto, Japan. Established in 1958, ROHM has more than 40 bases all over the world. The company mission, right since its establishment, has been 'Quality is our top priority'. Based on this mission, ROHM provides highly-reliable electronic components, ICs, discrete semiconductors, passive components and modules to a wide range of industries (such as consumer equipment, IT, automotive and industrial equipment) through its global networks.

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Elegance Technologies established in 2007 is a private Indian firm based in Bangalore the silicon valley of India. Elegance Technologies was formed for the purpose of offering software and hardware development services to the high technology industry. We provide cost effective and innovative embedded systems solutions to business, including both hardware design and software development, with expertise covering many processors/micro controllers and real time operating systems. The company relies heavily on innovation and cutting-edge technologies to provide a wide spectrum of reliable hardware solutions and applications.

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The Sahasra Group is India's first multi-vertical electronic product and services company with a footprint in four continents. Its manufacturing plants and sales offices are located in India, USA, Rwanda, Belgium and Canada. The Group serves the market and its customers through a wide array of services; it has interests in electronics manufacturing, clean technologies, electronics skills development and electronics product distribution businesses.

Contact details: Ph: +91 120 2462782, contact@sahasraelectronics.com, www.sahasraelectronics.com

SANSON SM TECHNOLOGIES

Sanson Technologies is a proprietor ship firm established on 2010 to cater the increasing needs of the SMT industry. We undertake tasks to reach out to a wide range of customer needs related to the SMT fields. We have team of experienced and qualified staffs in various levels like planning, installation, training etc. We have always maintained the best quality of work and punctuality.

Contact details: Ph: 080-23334467, Website: www.sansontechs.com

SARASWATI DYNAMICS PRIVATE LIMITED

Saraswati Dynamics Private Limited (SDYN) is the pioneer and market leader of environmental testing in India. We specialise in designing and manufacture complete range of electrodynamic vibration systems and environmental chambers to meet the testing requirements of diverse industries across the globe. SDYN has translated its designs into products that are at par with any equipment of its kind, worldwide. Our systems enable our clients to create real life environments for testing and validating the quality and reliability of their products.

Contact details: Mobile: 9997752000, Ph: 01332-262093/94 Email: sakshi.goel@sdyn.in, Website: www.sdyn.in

SECO

SECO is a world leader in electronic embedded solutions. Spanning 35+ years of experience, SECO has shown the ability to adapt its knowhow to new, challenging customers' needs, and to provide cutting-edge solutions to its partners. On the strength of its knowhow and in contrast with recent outsourcing trends, SECO has always set up the entire production cycle in Italy, from the development stage to mass distribution. Thanks to new solutions and R&D activities, together with partnerships with major scientific universities and world-leading companies, SECO is today a global market leader, providing solutions to modern challenges.

Contact details: Ph: +39 0575 26979, Fax: +39 0575 350210, marcom@seco.com, www.seco.com

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Based in the Sahibabad Industrial Area of Ghaziabad, Shakti Keypads is one of the leading organisations engaged in the manufacture and export of a range of membrane switches for various industrial applications. With up-to-date manufacturing facilities, the company has today positioned itself as a well-known supplier of membrane switches in the country. Established in 1990, Shakti Keypads is successfully serving a wide clientele in the domestic and global markets, and today enjoys a good market presence for its products.

Contact details: Ph: +91 120 4372005/06, info@shaktikeypads.com, shakti80@airtelmail.in, www.shaktikeypads.com

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Contact details: Ph: 886-2-2963-4247, Website: <http://www.singular.com.tw>

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SLN Technologies, an ISO 9001-2000 company based in Bangalore, with branches all over India. SLN is the leading player across the industry verticals like IT, embedded electronics, PCB manufacturing, RFID & OE, customized electronics system development and integration services and embedded software to defence, space and public sector companies in India. Today we offer the complete turnkey project solutions for PCB and embedded electronics. This has been possible through 22 years of on hands experience in the industry.

Contact details: Ph: 080-41718881, 41718882, E-mail: anil@slntechnologies.com, Website: <http://www.slntechnologies.com>

SOFTGRIP POWER PRODUCTS LLP

Softgrip Power Products LLP is a company based out of Pune and it deals in electronic components and energy meters. Some of the products of the company includes energy meters such as single phase multi function energy meter, trivector energy meter, prepaid energy meter etc. It also has electronic ballast, panel meter, CFL lamps, tubes and multi point display systems.

Contact details: Ph: 020-66307869, 66307861, 66307862, 66307863, +(91)-9373303399

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Span is an established software services company that was set up in 1994, offering comprehensive IT services. Its clients include Fortune 1000 companies, software firms (ISVs) and tech start-ups. Span's offshore development centers in India are certified for ISO 9001:2008 and ISO 27001:2005. They have also been appraised at CMMI Level 5 and PCMM Level 5. Span has a global footprint with offices in the U.S., Singapore, India and group offices in Europe. Span is wholly owned by the largest Nordic IT services major, EVRY (www.evry.com).

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Spectrum Lightings is one of the leading distribution companies primarily focused on LED lighting, polymers, plastic components, etc. It is managed by a group of professionals with sound business and technical competence. Spectrum Lightings Pvt Ltd, is a group company of Spectrum Tool Engineers Pvt Ltd. The Spectrum Group was started in the year 1990 by a technocrat with a background in the design and manufacture of injection mould tools, press tools, gauges, jigs and fixtures. Initially, the company was known as Spectrum Tool Engineers Pvt Ltd (STEPL).

Contact details: Ph: +91 80 23286814, +91 9900031963, customercare@spectrumtechvision.com, www.spectrumtechvision.com

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Sri City is an integrated business city, situated 55 km north of Chennai, in India. Strategically located along National Highway 5 with excellent access to sea, air and rail links, the city is spread over an area spanning 10,000 acres. The industrial zone encompasses a large Special Economic Zone with a Free Trade Warehousing Zone, an adjoining Domestic Tariff Zone, and an Electronics Manufacturing Cluster. Sri City is presently home to over 100 companies across varied sectors, including 60 multinationals from 26 countries across the globe. These include Isuzu, Pepsico, Colgate Palmolive, Foxconn, Alstom, Kellogg's, Cadbury's, and many others.

Contact details: Ph: +91 44 3940 2000, Mobile: +91 97909 40148, Email: hariprasad.r@sricity.in | www.sricity.in

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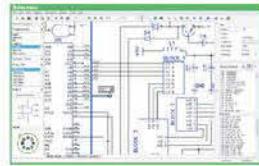
Superior Flux & Mfg. Co. was founded in USA in 1932. It was the first company to introduce an organic acid (OA) flux, No. 30. Today, Superior offers the complete line of products for the electronics and industrial domain. Superior products are exported worldwide. The range includes Solder pastes: No-clean/RMA/water-soluble, Tacky Fluxes: No-clean/RMA/water-soluble, BGA spheres, Repair and rework pastes and fluxes, Wave solder fluxes: VOC-free and alcohol-based; no-clean, water-soluble, Rosin RMA, No-Clean fluxes for select soldering, Saponifier, Dross remover, Descaler, Solderability testing fluxes for tin/lead and lead-free solders, etc.

Contact details: Mobile: 9886070793/910855250/702242203, Email: buyinflux@gmail.com, metalconnect@gmail.com

SUQIAN HUAHONG ELECTRONIC INDUSTRIAL CO. LTD

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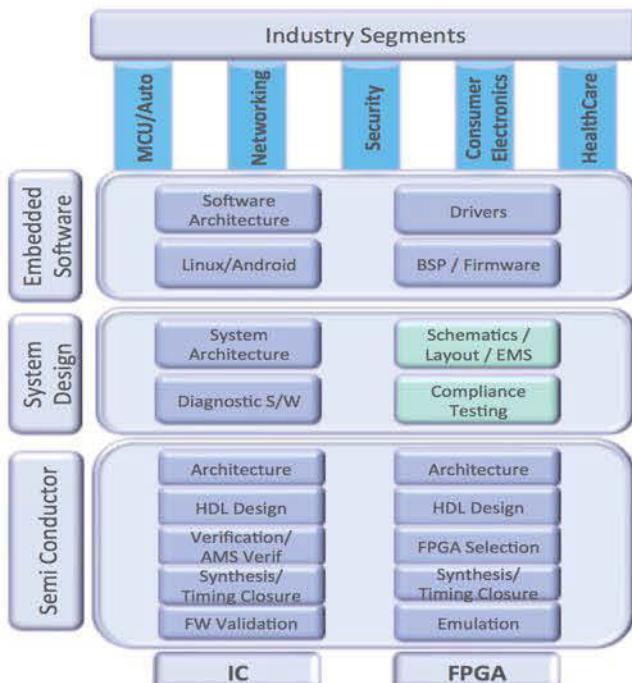
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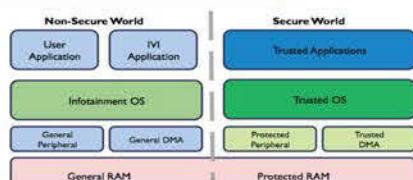
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Contact details: www.taitra.org.tw

TAIWAN ELECTRICAL AND ELECTRONIC MANUFACTURERS ASSOCIATION (TEEMA)

Established in 1948, TEEMA is the organisation representing manufacturers producing electrical and electronic products, ICT and components in Taiwan. The association represents 90 per cent of Taiwan's electrical and electronic manufacturers, and has 3,762 member companies.

Contact details: Ph: +886 2 7926666, julie@teema.org.tw, www.teema.org.tw

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Contact details: Ph: +91 80 40936722 / 40936922, sales@tangenttest.com, www.tangenttest.com

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Established in the year 1989, we "Taurus Electronics" are sincerely engaged in trading, and importing of LED Products. Our products are made, using superior quality raw material, which are availed by us from the renowned vendors. As we are in this field of business from past 20 years and after gaining long experience, we have gradually grown understanding the needs and demands of our clients in the changing scenario. Along with the provision of best quality products to our customers , we also provide our clients with best prizes which are worth paying for these products.

Contact details: Ph: 022-23898402, 23804995, Website: <http://www.tauruselectronics.in>

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Founded in 1946, Tektronix Inc. is an American company best known for manufacturing test and measurement devices such as oscilloscopes, logic analysers, and video and mobile test protocol equipment. Tektronix has over 60 years of experience designing test and measurement equipment. The company offers products for communications, computers, semiconductors, military/aerospace, consumer electronics, education and broadcast applications.

Contact details: Ph: +91 80 30792726/41, in.tek.com

TEMCO ELECTRICALS & ELECTRONIC INDUSTRIES

Temco Electricals & Electronic Industries is an MNRE channel partner and an ISO 9001 certified Indian company specialising in embedded system based hardware and software solutions, UPS/inverters and power back-up products. The company's experience and expertise has helped it to provide world class DSP based UPS/inverters and LED lighting solutions to its customers. Temco mainly focuses on bulk buyers and OEM suppliers.

Contact details: Ph: +91 9538742311, +91 7795552777, +91 80 32010525, temcoblr@gmail.com

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Contact details: Ashwini Kumar Patkur, Mobile: 9620755547, Ph: 080-6723 3553, Email: Ashwini.kr@ind.tuv.com

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Contact details: Ph: 080-25251111, Email: contact@tymtix.com, www.sensairy.com

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Uchi Embedded Solutions is into embedded system development tools, and provides tools and solutions for the design and testing, as well as the manufacture of embedded electronic products. The company makes a sincere effort to offer quality products at affordable prices. Buying from Uchi Embedded Solutions can be an entirely new experience for customers because the company acts like a consultant rather than a sales manager when interacting with them. Uchi suggests the right solutions through its pre-sales demo, pre-sales evaluation, payment credits, buy back policies, etc.

Contact details: Ph: +91 9986016902, sales@uchiembedded.co.in

UHLEDISPLAY INC

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Contact details: Ph: 09601026206, Email: tarun@ledisplay.in, www.ledisplay.in

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Contact details: Ph: +91 41384400, Fax: +91.28413759, Mobile: +91 9620459483, www.ul.com

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Unisem is an established independent distributor for electronic components as well as electro-mechanical parts, with a special focus on defence, power and telematics. The company represents the world renowned and US based capacitor manufacturer Cornell Dubilier. Unisem also represents the Simcom range of GSM/GPS modules catering to the growing telematics market in India. Additionally, it represents various other international manufacturers, brands and independent distributors across the globe with the support of its strategic partners in the UK, the US and Asia.

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WebNMS is a leading provider of scalable IoT platform and multi-vendor telecom network management solutions. The IoT platform is engineered to cater key enterprise concerns such as 'energy management, remote security and location tracking with on-board vehicle diagnostics'. Applications built on the platform's open APIs allow enterprises to increase the productivity of fixed and mobile, high-value assets while reducing their total operational expense (OPEX). Besides having a robust and highly customizable platform, WebNMS also holds several ready to deploy IoT applications: www.webnms.com/iot.

Contact details: Sangeeta Priyadarshini, Marketing Analyst, Mobile: 9176420297, Email: sangeeta.priyadarshini@zohocorp.com

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Xiamen PRT Technology Co. Ltd was founded in 2004. It is a professional printing solutions provider in China, specialising in the R&D, production and distribution of thermal printer mechanisms, thermal printer modules, and dot matrix printer mechanisms. The company has a professional and experienced R&D team which has more than 70 people. It employs hundreds of staff members and workers in the office and workshop. It has branch offices in Mainland China at Beijing, Shanghai, Guangzhou, Fuzhou and Kunshan, etc. to provide clients with direct and fast service.

Contact details: Ph: +86-(0)592-5993973, Fax: +86-(0)592-5930505, Email: so@prttech.com

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Xiamen Unicreed is a professional manufacturer of high and low frequency transformers. It offers a variety of product lines, including encapsulated transformers, toroidal transformers, power transformers, switching transformers and common mode chokes, etc. In addition to standard products, the company's experienced R&D team can either modify existing products or make complete custom designs according to specifications.

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Contact details: support@zealmfg.com, marketing@zealmfg.com, www.zealmfg.com

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Contact details: Qianshi Industrial Zone, Yongjia Wenzhou, Zhejiang, Ph: 0086 13868609000, Fax: 0086 577 89731256, E-mail:salesmanager@calonsw.com

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Contact details: Ph: +91 80 23370038/46, avinash.k@kwk-resistors.in

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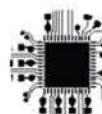
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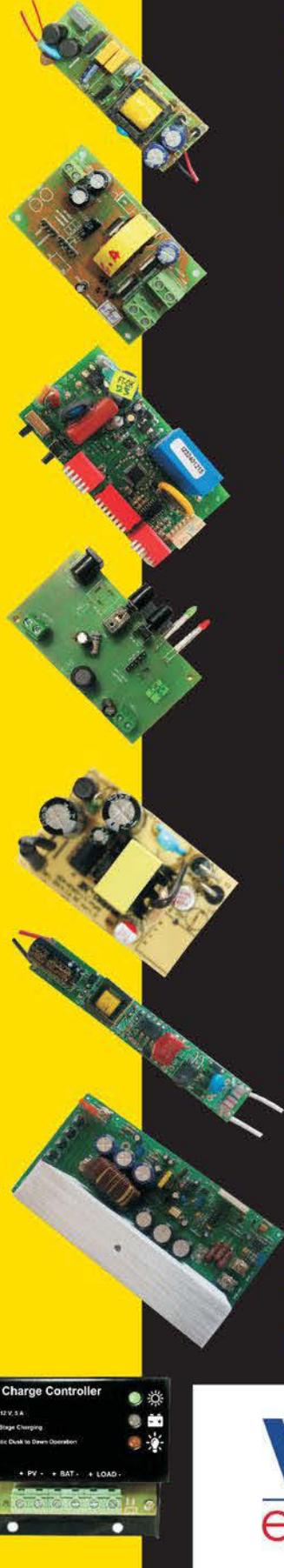
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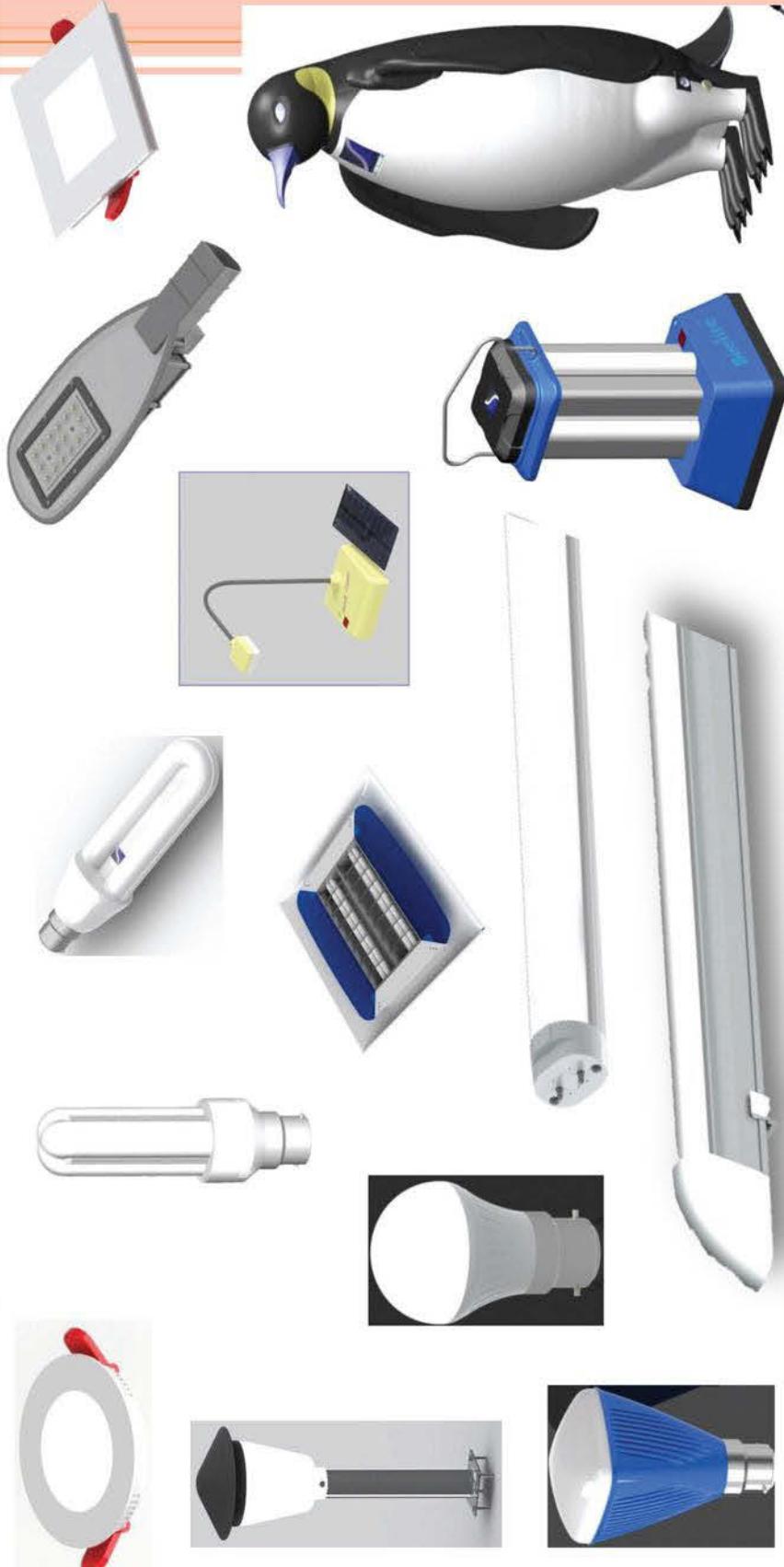


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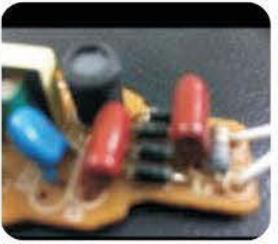
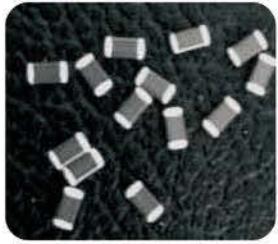
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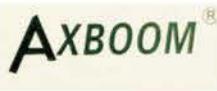


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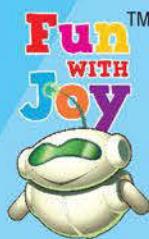
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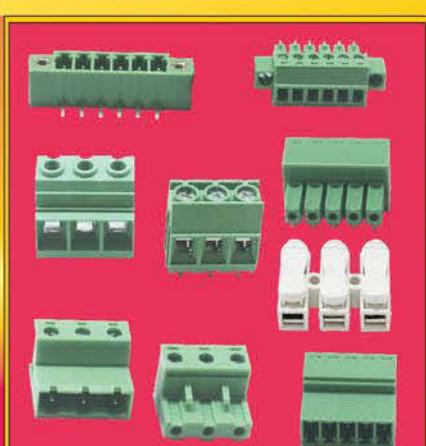
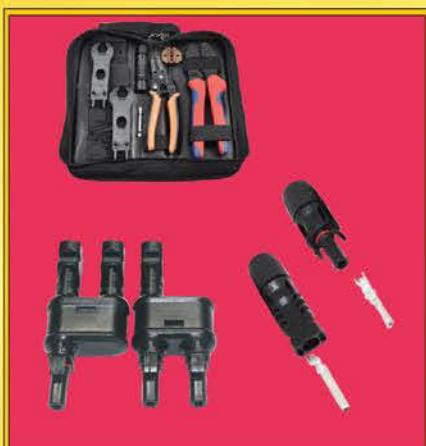
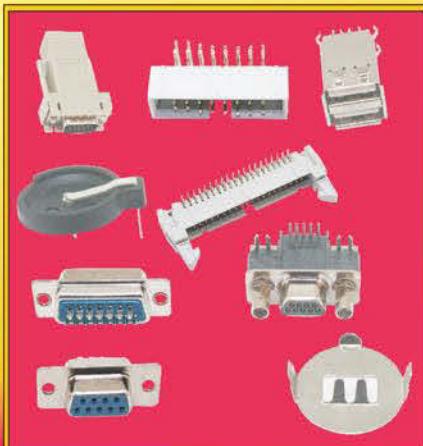
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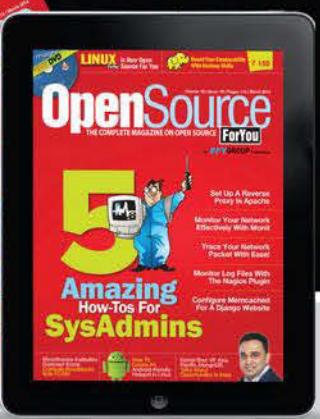


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