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- Developer Boards: DIY And Hobbyist Applications

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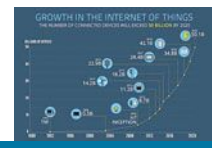

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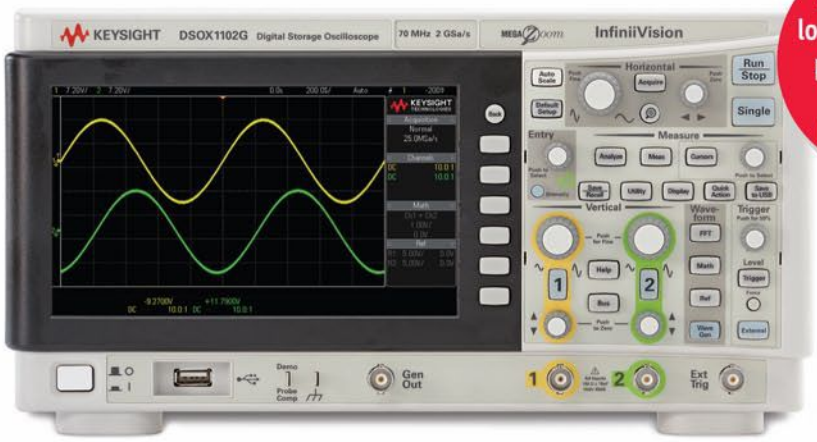

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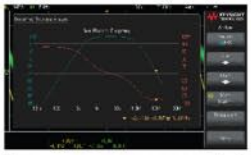
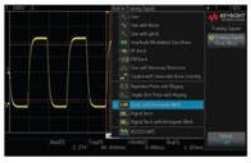


Frequency response analysis Bode plot



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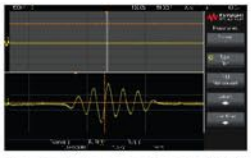
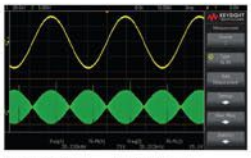


Zoom in to see signal detail



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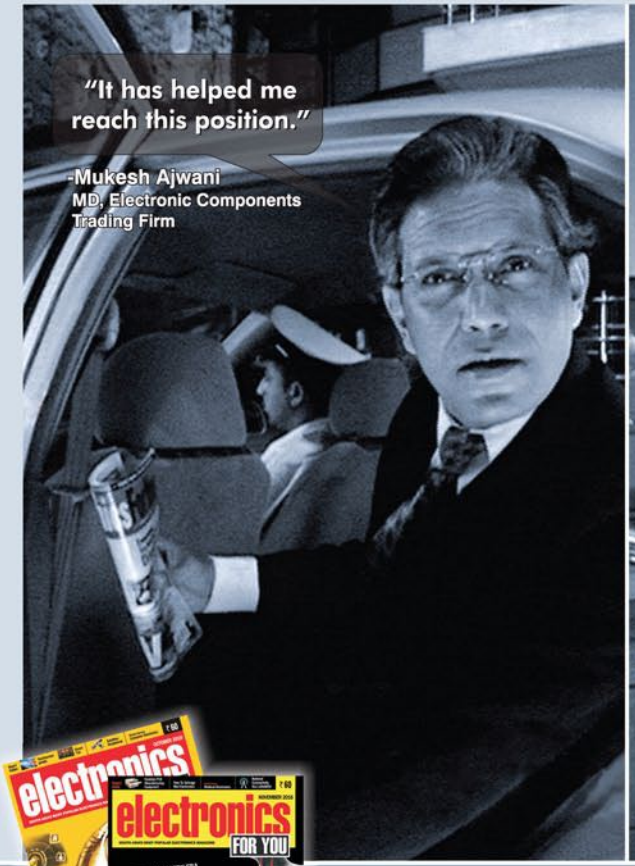

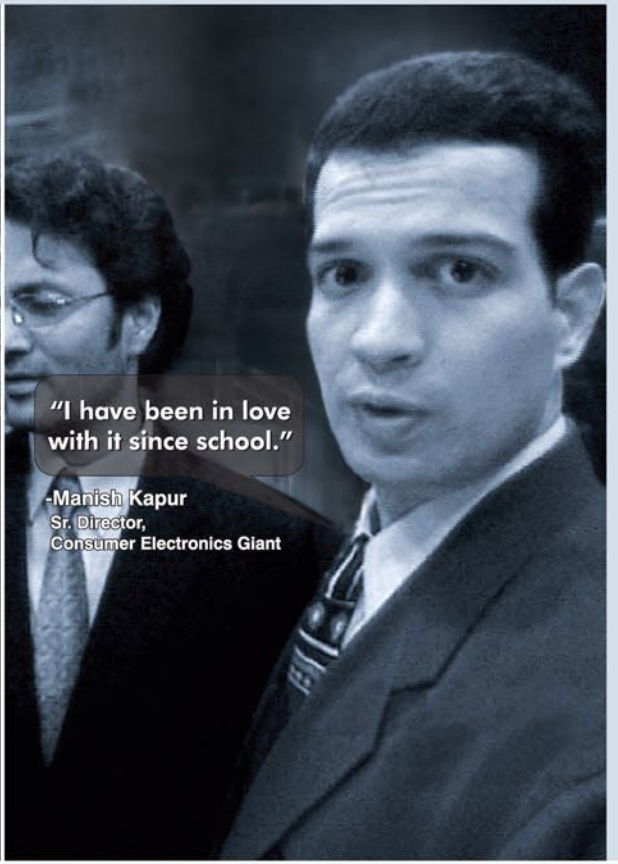

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FEEDBACK

YOUR SUGGESTIONS

ELECTRONIC NOSE

Please explain Cyranose 320, covered in 'How Electronic Nose Is Better Than Ours' article, published in January 2016 issue.

Swati Sawant
Through email

The author Akul Sabharwal replies: Cyranose 320 is a rugged, efficient and affordable tool to quickly perform on-site analysis. It is a trademark of Sensigent. Novel thin-film sensors are available on plug-and-play modules. The custom NoseChip sensor provides enhanced sensitivity and selectivity for gas and vapour detection.

The extended analysis software package (CDAnalysis) provides more classification algorithms, data analysis options and so on. It is used for more challenging sensing applications.

NoseChip is the name of the sensor module and PCNose is the software.

Multiple applications are programmed and stored as individual methods. Non-expert users can simply select the appropriate method by name and take measurements. Results are stored in the database for easy access.

DUAL-WAY AMPLIFIER

Regarding 'Simple Dual-Way Amplifier For Microphone and Guitars' DIY article published in January issue, I have the following queries:

1. If TDA2030/40 ICs are used instead of LM1875, will it require any change in the values of associated components in the circuit?

2. If TDA2030, LM1875 and similar ICs are operated on a single supply instead of dual (±), will it affect the total power output?

Anirvan Kule
Through email

From electronicsforu.com

Electronics Projects

'Low-Cost LPG Leakage Detector' DIY article published in January 2016 is excellent for students.
Samid Patel

I want to make 'Low-Cost LPG Leakage Detector.' What is the name of the spray bottle used in the prototype?
Savikhya
EFY. The author, Pamarthi Kanakaraja, says, "The spray bottle is Pro Flame portable gas cartridge from Godrej. I bought this product from Vijayawada Besant Road, Andhra Pradesh."

I want to assemble 'Time-Lapsed Photography' project published in December 2016 issue. Where can I get the complete kit of this project?
K. Majumder
EFY. You may please contact Kits'n'Spares to get the kit, or visit their website *www.kitsnspares.com*

Is 'Electronic Eye Security System' project published in January issue working well? What is the advantage of the same, and what does it cost?
Priya
EFY. Yes, the circuit is working perfectly well. The advantage is that it can be used as an inexpensive security device. Whenever light falls on sensor LDR1 in the circuit, an alarm sounds to alert the owner. This circuit costs less than ₹ 1000.

The author Petre Tzv. Petrov replies: Thanks for the questions. Here are the replies:

1. You should change the gain in order to obtain minimum gain of TDA2030/40 (value of closed-loop gain must be higher than 24dB; for example, 22k/680-ohm,). Also, you may need to change the RC network between output and ground according to the data sheet (for example, 4.7-ohm/100nF). And, you should not go beyond the maximum power supply range of the ICs.

2. Output power does not depend on the single/dual power supply. For example, at ±15V and (0V, +30V), you have practically the same output power in the same load resistance.

Corrections

In 'Vibration Sensor' DIY circuit published in February issue, diode D1 should be connected between resistor R5 and positive terminal of BATT.1, so that LED2 glows only when the battery is charging.

A. Samiuddhin
Through email

EFY. Thanks for pointing out the mistake!

In Industry News section of February issue, under the headline 'Odisha jails to be fortified with 4G Jammers,' the fifth line 'the state of Bhubaneshwar' should be read as 'the state of Odisha including the capital city of Bhubaneswar.' The spellings of Bhubaneswar were also wrong.

Abadan Mohapatra
Through email

EFY. Thanks for pointing out the mistakes!

HOME AUTOMATION USING ANDROID

I have assembled 'Home Automation Using Android' project exactly as given in the article published in August 2016 issue. Everything is fine but when I tried to turn on the light from my Android mobile, the corresponding load did not work. Please help.

Naidu
Through email

EFY. Upload the source code of this project into your Arduino board. Pair Android Bluetooth with the Bluetooth connected in the circuit. Next, turn on or off Light1 button on your Android. If the light is still not turning on/off, check the corresponding relay connection.

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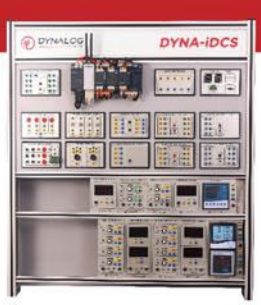

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Q&A

THINGS YOU WANTED TO KNOW!

Ques. HOW IS ELECTRICITY GENERATED, AND HOW DO WE USE IT AT HOMES?

Ujjawal R.

Ans. Straight from the generators, electricity is produced in thousands of volts. This is much more powerful than what we need for everyday use. Even at home, voltage from a wall plug is many times more than most household electronics need or can tolerate. Besides, different components require different voltages and amperages—higher or lower than the current flowing through most of the circuitry. Let us see how we can control this.

At a power station, steam generated from burning coal or heat from a nuclear plant turns a shaft within an electric dynamo. The shaft is attached to a rotor covered with thousands of wires. The rotor turns inside two permanent stator magnets whose fields generate high-voltage electricity in the bushings. This is transmitted as alternating current on the public power grid to homes and businesses.

Before electricity reaches electronic devices, it passes through a step-down transformer, which has a common magnetic core, usually iron, around which two wires are wrapped. Alternating current—electricity that flows first in one direction and then the other—moves through the primary coil—the wire that has more wrappings around the core.

Each time the current switches direction, its magnetic field expands or collapses, which is the same as the field moving, and induces an electric current in the coil. The current passes through the part of the core around which the secondary coil is wrapped.

The field creates a current in the secondary coil, but because the secondary coil has fewer wrappings, current created in the second coil has a smaller voltage, making this a step-down transformer.

Before any electronic appliance like a personal computer can use household current, current passes through another step-down transformer or voltage-reducing circuit.

Resistors are used to decrease the flow of electricity; much like a valve is used to limit the level of water that flows through a pipe. The material and its size changes the amount resistance the component offers. It is measured in ohms.

Variable resistors such as rheostat are also used in situations that call for resistance to be changed manually, on-the-fly. Another example of variable resistor is the potentiometer for controlling volume on a radio receiver.

Q2. PLEASE EXPLAIN THE CONCEPT OF BARCODES AND MATRIX CODES?

Hafsa Rafiqi

A2. ***Bar codes.*** The first six numbers encoded in a bar code identify a company that has paid a fee to acquire the rights to a unique manufacturer identification number. The manufacturer uses the number as the first part of a different 12-digit universal product code (UPC) for each product it makes. The manufacturer's six-digit code stays the same for all its products.

The next five digits signify the item number, or product code. The company's UPC coordinator assigns an item number, not just to every product but to every model or variation of that product.

The last number in the code is a check digit. Its value must match a number obtained by running the other numbers through an algorithm.

In a retail store, when a UPC passes under a laser connected to a register, it does not matter if the right or left side is read first. The bars on the left side are black with white separating these. On the right side, it is reversed—white bars separated by black. This lets the register know where the code begins.

If the register's computer determines that the check digit does not match the algorithm, the scanner beeps to tell the person at the register to re-scan the UPC.

When a scan is successful, the register sends the number to a computer server. The server checks on the store's current price for that item and sends that price back to the checkout, where it is added to the customer's receipt. For inventory, the server may also update the number of products sold.

Matrix codes. The UPC is good enough if all you need to do is record and read 12 digits. For a verbose code, you need the capacity of a 2D bar code, also called a matrix code or QR code (for quick response). The codes are generally about 645.16mmsq (1-inch-square) in size, but can represent 7000 digits or 4000 characters of text—on average, a little less than 700 words. Using free apps, the codes are read by most smartphones and onscreen by desktops or laptops not equipped with scanners. Not all variety of 2D codes work the same way, though.

Every QR code contains a finder pattern, an arrangement of squares that help the scanner determine the dimensions of the code, the top side and the angle at which the code is being scanned.

A pattern of squares forms an alignment pattern that tells the scanner if the code is distorted.

Along two sides of the code, the scanner reading the code superimposes rows of timing squares, which you do not see. The scanner uses the timing squares to judge how quickly the code is passing through its reading beam.

By calculating the ratio between the light and dark areas in the code, the scanner learns what areas serve to keep everything lined up and which contain data.

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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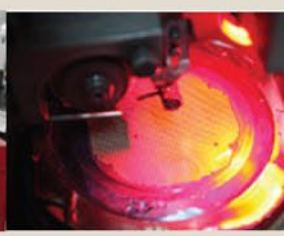

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Google X's balloon Internet takes a step closer to reality

Project Loon, which was launched in 2013 as part of Google X (now just X), has made a major breakthrough. According to Astro Teller, X's captain of moonshots, navigational systems that control the balloons have drastically improved beyond the wildest expectations of the project's engineers—something Teller admits happened by accident.

Loon's first pilot test in New Zealand in 2013; Google X (now just X), has been sending smart balloons up into the stratosphere for four years now with the aim of creating a floating, balloon-powered LTE network (Image courtesy: https://blog.x.company)

At first, Loon launched its balloons throwing caution to the wind, and controlling the devices just enough to catch the right air currents to take these on their way. After the team's navigation algorithms improved, flightpaths could be charted more accurately to plan return loops around oceans or continents after the balloons drifted away from their original targets, but it was still a tall task to keep these in one place.

But early last year, the Loon team noticed that some balloons lingered in one area instead of drifting away on the winds. The team identified three areas of development that helped the balloons' navigation system improve so rapidly.

One, the altitude control system was much more efficient after updating and streamlining its solar panels and air pumps, which allowed for more manoeuvres during each flight.

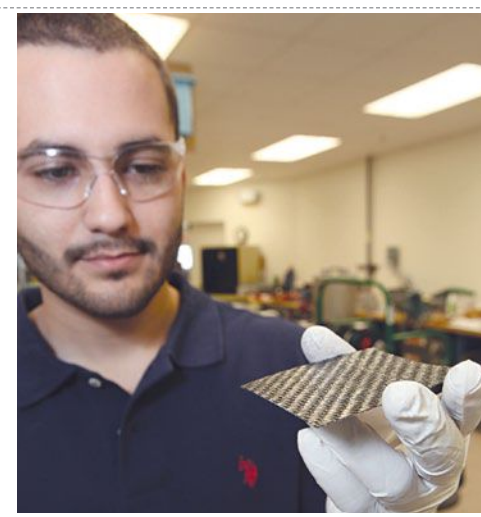
Second, since the balloons' algorithms depend on a lot of data to develop, reaching a point where simulated flights were just as good as real ones to refine those algorithms was a big step forward, too.

Finally, using a machine learning system to pilot the balloons was key for traversing the unpredictable conditions of the stratosphere.

Batteries that could provide power to microsatellites, cubesats

Dr Luke Roberson, senior principal investigator for Flight Research within Exploration Research and Technology Directorate at NASA's Kennedy Space Center in Florida, USA, is collaborating on research of a new solid-state battery prototype with Dr Ryan Karkkainen, a composite material expert at University of Miami, USA. The battery composition was developed by Xiangyang Zhou, PhD, associate professor of mechanical and aerospace engineering. Three students from the university are currently working on the prototype with Dr Roberson.

The battery is made by heat-treating vacuum-compressed several layers of small carbon-fibre squares and placing the solid-state battery layer between these. Composite reinforcement and mechanical/electrical testing will be performed at Kennedy Space Centre in the near future. The battery is only 2mm to 3mm thick, and is suitable for use in microsatellites, including CubeSats.



The size of the battery is so small that it could be a prime candidate for use in microsatellites, including CubeSats (Image courtesy: www.nasa.gov)

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A CubeSat (u-class spacecraft) is a type of miniaturised satellite for Space research that is made up of multiples of 10cm × 10cm × 11.35cm cubic units. It is no bigger than a large toaster, but batteries occupy considerable space in it. Placing a normal battery in an experiment at NASA takes up 20 to 35 per cent of the available volume. With this development, the battery can now be placed with the payload structure, providing more space to the scientists.

This technology could be used on satellite structural trusses, on International Space Station or to power habitat structures established on another planet. Commercial applications could include automobile frames or tabletop battery rechargers. The batteries can be made to be impact-, moisture- and flame-resistant with proper reinforcement, further increasing their scope of utilisation.

Sticky insect-sized drones to pollinate crops

Japanese scientists have developed tiny insect-sized drones coated with horse hair and a sticky gel that may help pollinate crops in future and offset the costly decline of bee populations worldwide.

The bio-inspired flying robotic artificial pollinator (Image courtesy: www.sciencedirect.com)

Undersides of these artificial pollinators are coated with horse hair and an ionic gel that is sticky enough to pick up pollen from one flower and deposit it onto another. The researchers are hopeful that their invention could someday help carry the burden that modern agricultural demand has put on colonies and, in turn, benefit farmers.

"The findings, which will have applications for agriculture and robotics, could lead to the development of artificial pollinators and help counter the problems caused by declining honeybee populations," says Eijiro Miyako, chemist at National Institute of Advanced Industrial Science and Technology (AIST) Nanomaterial Research Institute in Japan.

To determine whether the gel could grasp onto pollen, Miyako collected ants, put the ionic goop droplet on their bodies and left them to roam free in a box of tulips. Ants with the test material on their back gathered much more pollens than those without gel.

In separate experiments using houseflies, the gel was also found to have a camouflage effect—changing colour in response to different sources of light—which could help artificial pollinators avoid predation.

Smart needle that makes brain surgery safer

University of Adelaide scientists have developed a smart needle with a tiny camera that allows surgeons to view at-risk blood vessels and avoid injuring these—an advance that may make brain surgery safer. The tiny imaging probe, encased within a brain biopsy needle, allows surgeons to see blood vessels as they insert the needle, allowing them to avoid causing bleeds that can potentially be fatal.

Robert McLaughlin, professor at University of Adelaide, says, "We call it a smart needle. It contains a tiny fibre-optic camera, the size of a human hair, shining infrared light to see the vessels before the needle can damage these." "And what is really exciting is the computer smarts behind this so that the computer itself recognises the blood vessel and alerts the surgeon," he adds.

"To have a tool that can see blood vessels as we proceed through the brain would revolutionise neurosurgery. It will open the way for safer surgery, allowing us to do things we have not been able to do before," said Christopher Lind, consultant neurosurgeon at Sir Charles Gairdner Hospital and University of Western Australia.

Over the past six months, the smart needle has been used in a pilot trial with 12 patients undergoing neurosurgery at Sir Charles Gairdner Hospital in Western Australia.

Ingestible devices that draw power from stomach acid

Researchers from Brigham and Women's Hospital and Massachusetts Institute of Technology have developed a set of ingestible devices that use stomach acid for long-term power. They have demonstrated a small voltaic cell that is sustained by the acidic fluids in the stomach. The system

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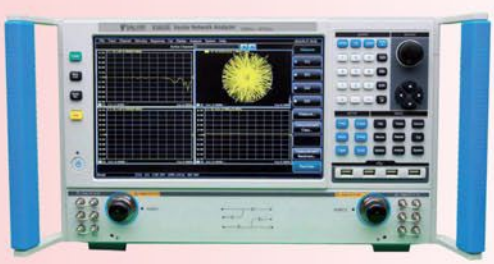

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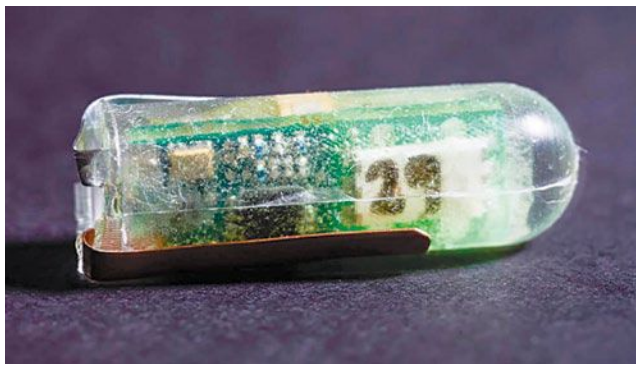

Ingestible power capsule (Image courtesy: Massachusetts Institute of Technology)

can generate enough power to run small sensors or drug-delivery devices that can reside in the gastrointestinal tract for extended periods of time.

Acids, like those in the gastrointestinal tract, are known to carry electric currents. The researchers built a prototype device 40 millimetres (1.6 inches) in length and 12 millimetres (0.5 inch) in diameter. Attached to the surface of the device are electrodes made from zinc and copper foil. Inside the cylinder are a commercial temperature sensor and low-power wireless transmitter circuits.

This type of power could offer a safer and lower-cost alternative to the batteries currently used to power such devices, as per the researchers.

Solar-powered bicycle to combat air pollution

In an effort to reduce air pollution due to vehicular emissions in India, scientists have designed a solar-assisted bicycle that is pegged as a low-cost, eco-friendly alternative to two-wheeler motor vehicles. The bicycle can switch between the solar-energy-powered motor and pedals.

Major air pollutants emitted from vehicles are carbon monoxide (CO), nitrogen oxide (NOx) and particulate matter (PM). Increasing air pollution not only affects the environment, it also has adverse health effects like lung cancer and cardiovascular mortality, which may lead to death.

"To overcome this problem, an effort is being made for developing an eco-friendly vehicle to reduce pollution in India," says S.A. Puviyarasu from Dr N G P Institute of Technology, Anna University in Tamil Nadu. "If we use a solar-assisted bicycle, we can reduce 60 per cent of all vehicular pollution in the country," Puviyarasu adds.

The design consists of a brushless DC motor mounted on the front wheel of the bicycle, an electric throttle for varying the speed of the bicycle and a lead-acid battery that stores solar energy. A solar panel (of any specification) is mounted on the bicycle carrier. Depending upon the specification of the solar panel, energy is produced.

When the power supply is given to the hub motor from the solar panel unit, the bicycle wheels rotate to move. The rider can choose between the motor and the pedals, or use both at the same time.

Device that turns air pollution into printing ink

Graviky Labs is an MIT Media Lab spin-off based in India, and it has come up with an ingenious solution to air pollution problems in Asia—convert polluted air into high-quality printing ink.

It takes 45 minutes worth of vehicular emissions captured by KAALINK to produce 29.6 millilitres (1 fluid ounce) of ink (Image courtesy: www.livescience.com)

While cheaper carbon black inks are manufactured through the deliberate burning of fossil fuels, Graviky Labs uses their proprietary device, KAALINK, to capture soot that is already being emitted from vehicles. KAALINK is retrofitted to the exhaust pipe of vehicles/generators to capture outgoing pollutants.

The collected soot undergoes various proprietary processes to remove heavy metals and carcinogens. The end product is a purified carbon-rich pigment. The carbon is then used to make different types of inks and paints.

World's first self-driving Tesla taxis to hit the roads in Dubai

The government of United Arab Emirates has purchased 200 Tesla vehicles to add to the fleet of Dubai Taxi Corp. fleet. Though the combination of Model S sedans and Model X SUVs will initially be used in autopilot mode, which requires a human driver, these will come equipped with the hardware needed for complete self-driving capability. The Roads and Transport Authority (RTA) in Dubai plans to do a test run in the autonomous driving mode, with the goal of making Dubai the smartest city by 2020.

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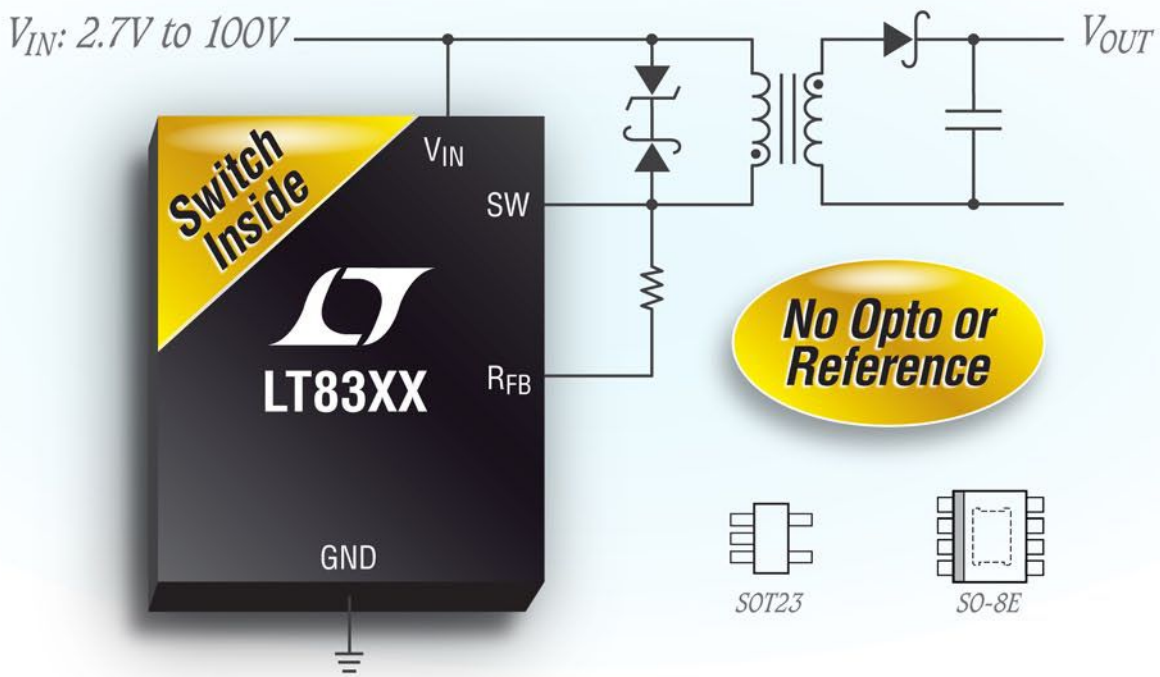

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Towards TRANSIENT ELECTRONICS And The Need For It

Dr S.S. Verma
is a professor at Department of Physics, Sant Longowal Institute of Engineering and Technology, Sangrur, Punjab

Electronic devices are built to last. But now their lifespans can be controlled, courtesy burgeoning research into transient electronics, or devices that are meant to serve a specific function before completely dissolving into their environment over a predetermined span of weeks, months or even years. Moreover, with a degrading environment where electronic waste also plays a major role, the need for such electronic devices that can be disposed of when we want increases.

The generation of heaps of electronic waste around us is compelling scientists to look towards the development of devices that will dissolve either on command or with time.

The technology that can break electronics down using a specific environmental trigger would allow metals and other non-biodegradable elements to dissolve down to their molecular elements for recycling. Self-destructing electronic devices is a step towards greatly reducing electronic waste and boosting sustainability in the use of electronic devices in our daily lives.

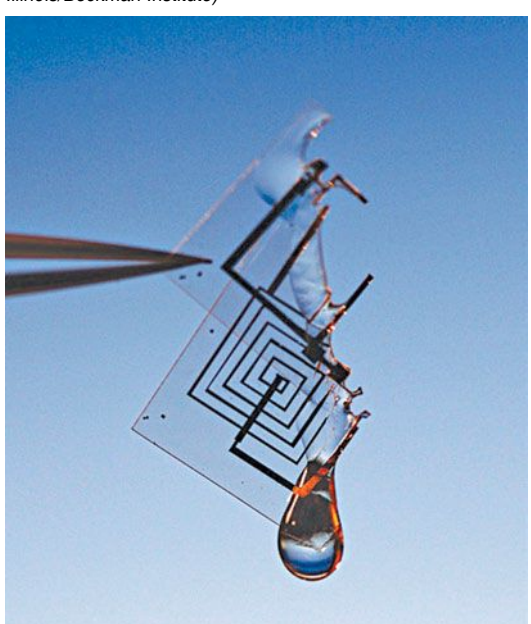

Fig. 1: Transient electronics can dissolve entirely in water or other liquids over a period of time ranging from minutes to weeks, a capability that offers a wide range of medical, environmental and other uses (Image courtesy: University of Illinois/Beckman Institute)

Potential of transient electronics

From medicine to military, transient electronics has many potential applications, specially where sensitive data is used. Applications include military electronic equipment, credit cards, passports and any application in which the electronic device is to be used for a defined period of time, for example, bioelectronics, implantable electronics, environmental monitoring applications and so on.

Millions of patients have benefited from the innovative development of medical electronic devices such as pacemakers or medicine-dispensing agents implanted in the body for either diagnostic or therapeutic benefits. While many such devices have revolutionised modern medicine, these often outlive their purpose in the body and require surgical removal to avoid complication.

But rather than surgery, what if these could simply disappear? That is the concept behind transient electronics. Transient electronics offers robust performance compared to current devices but fully resorbs into the environment after appropriate time—ranging from minutes to years, depending on the application.

To explore these possibilities, scientists have been working with an array of natural materials to test how well these perform in electronic devices and whether these would cause side effects or damage when implanted. One day it may transform the consumer electronics industry, but researchers are currently more interested in the devices' potential for medical care through implantable sensors or drug dispensers, as well as military exploits and environmental monitoring. Research into such devices has made rapid progress; preliminary versions of vanishing electronics might be available within the next few years.

Applications

Medical implants that are only needed for a few weeks could just disappear thereafter, without requiring extra surgery to remove these from the body. And, no one would have to retrieve dozens of transient water-quality sensors from a river undergoing water-quality monitoring. The electronics would dissolve

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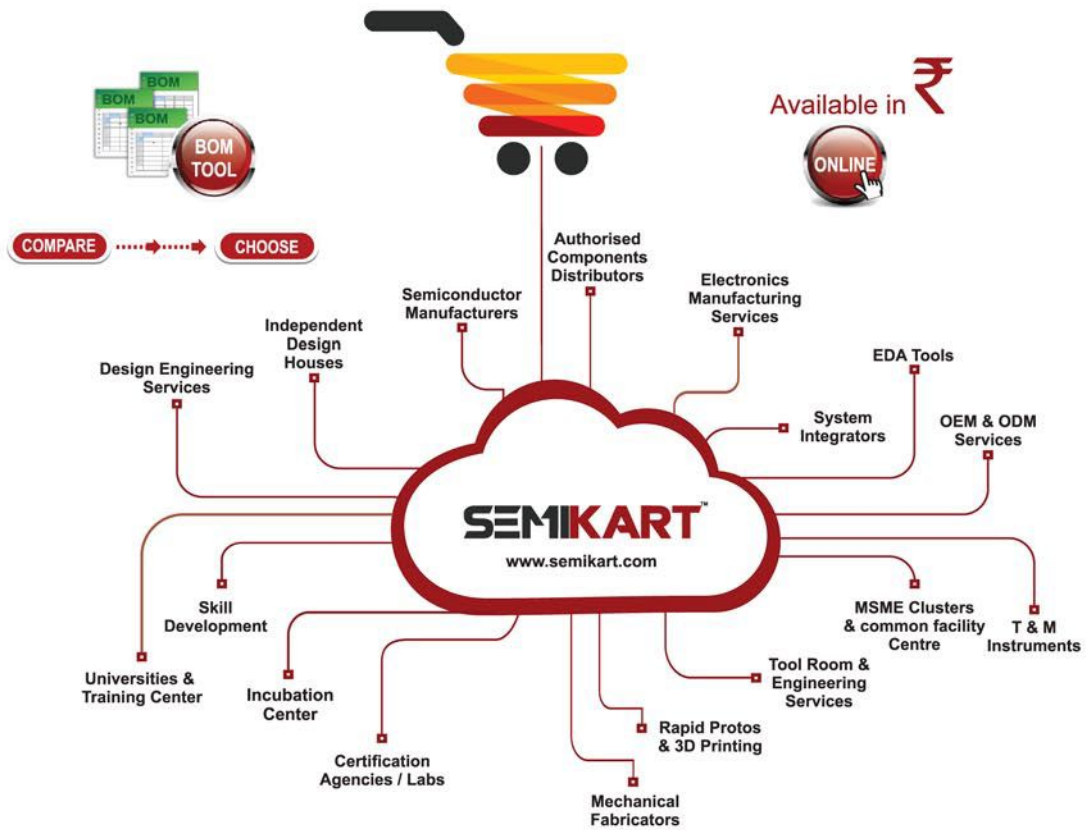

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without a trace and without harm to the environment.

Scientists have already designed transient electronics in the form of temperature sensors, solar cells and miniature digital cameras, for instance. However, earlier versions of bio-resorbable devices were made of materials that only partially dissolved, leaving behind residues, and did not perform as well as current devices. Though this area is at present largely unexplored, researchers are emphasising on the potential applications of transient electronics in the commercial world. Given below are some exotic applications of transient electronics.

Scientists have made key advances towards practical uses of a new genre of tiny, biocompatible electronic devices that could be implanted into the body to relieve pain or battle infection for a specific period of time and then dissolve harmlessly. The medical device, once its job is done, could harmlessly melt away inside the body.

Researchers are conducting further studies, centred around degradable polymer based materials that would make suitable platforms for other electronic components, including work on transient LED transistor technology. They have produced a blue LED mounted on a polymer base with electrical leads embedded on it. When it comes into contact with a drop of water, the base and leads begin to dissolve and the light goes out.

A lost credit card could vanish from existence (but most likely still leave debt behind), a secret diary could be programmed to self-destruct, should it be removed from its hiding spot, and sensors stored with food could indicate when it has reached temperatures that would cause the food to spoil.

The real-world application for transient electronics is, perhaps, in the field of military espionage. Should a spy or informer carrying sensitive information be captured, injured or worse, the electronics could

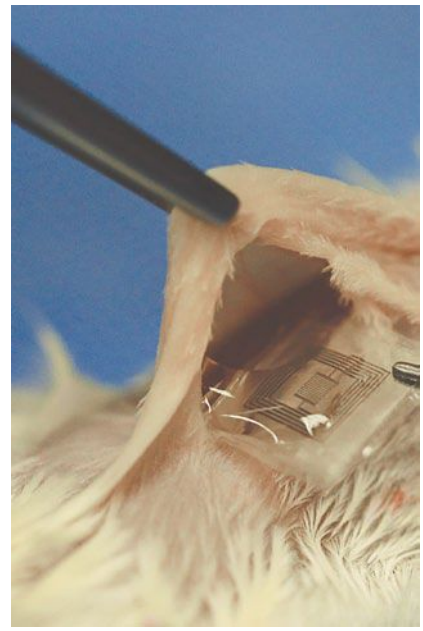

Fig. 2: This electronic implant can dissolve inside the body of a mouse (Image courtesy: http://rational-trader.blogspot.in)

be triggered to melt away before any classified information is gleaned by enemy forces.

A military device could collect and send data and then dissolve away, leaving no trace of an intelligence mission.

An environmental sensor could collect climate information and then wash away in the rain.

Electronic waste can also be controlled by designing integrated circuits out of materials that are biodegradable. Transient electronics, the new class of silk-silicon devices, promises a generation of medical implants that would never need surgical removal, as well as environmental monitors and consumer electronics that can become compost rather than trash.

Developmental status

Transient electronics can go as far and as complex as the demand and applications allow. Development of self-destructing devices came from a broad multi-disciplinary collaboration uniting researchers from all fields of science and technology. Multi-disciplinary research groups have tackled the problem of using other triggers to break down devices, including ultraviolet light, heat and mechanical stress. The goal is to find ways to disintegrate the devices so that manufacturers can recycle costly materials from used or obsolete devices, or so that devices could break down in a landfill.

Previous research in the area has explored the use of transient materials to create dissolvable devices such as transistors, resistors and diodes. Describing the research, researchers have mentioned that polymer composites consist of different ratios of gelatin or sucrose integrated with poly (vinyl alcohol) matrices. They have also demonstrated that dissolution and transiency of polymer composites could be retarded or enhanced by addition of gelatin or sucrose at different ratios, respectively.

Researchers are experimenting with a blend of programmable biodegradable and transient insulating polymer films. They have found that, by adding gelatin to the mix, dissolution can be slowed, while addition of sucrose speeds up the rate of transiency.

Using these special polymers, researchers were able to build and test an antenna that was capable of sending data and then completely dissolving when a trigger was activated. One constant in this experimentation with different composite structures is that the material maintains the appropriate physical properties to function as a substrate for electronics.

Scientists have tested several biodegradable materials including DNA, proteins and metals for making transient electronics. Tiny electronic sensors and devices that can be implanted in the body and then dissolve almost without a trace are getting closer to reality.

Efforts are on to develop a transient memory resistor with dissolvable components. This electronic component, also called a memristor, is a new type of resistor that regulates the flow of electric current and

INCUBATION CENTRE IIT PATNA:
Paving Way for Innovation in Medical Electronics

Medical Electronics in India
India is a rapidly growing health care market. While the medical electronics device sector, which is a subsection of medical device industry is relatively small with its contribution at less than 6 percent it is growing at a steady and healthy pace. Estimated at USD 7 Bn by 2020, the Medical Electronics market in India is expected to be very attractive for Indian and international manufacturers alike.

Paving way of innovation
Government of India, under its **Make in India** initiative, is giving tremendous support to Indian companies in Medical Devices manufacturing sector. IIT Patna, with a mission to make Medical technology affordable and accessible to common people, has approached Ministry of Electronics and Information Technology with a proposal to establish a Technology Business Incubator having a special focus on Medical Electronics. With Matching funds from Government of Bihar also, Incubation Centre IIT Patna became a reality.

Incubation Centre IIT Patna
Incubation centre IIT Patna (IC IITP) is the Country's first government funded medical electronics incubator. The Foundation stone for this INR 47.10 Cr project was laid by Hon'ble PM Shri. Narendra Modi and Hon'ble CM of Bihar Shri. Nitish Kumar on 25th July 2015. The Incubation Centre is nestled within the pristine and sprawling 500-acre campus of IIT Patna, Bihar.

Incubation Centre IIT Patna aims to be the leading technology business incubator for development of products and intellectual property (IP) in Electronics System Design & Manufacturing (ESDM) and Medical Electronics. The IC IITP equipped with cutting edge technology that is particularly suitable for Medical Electronics start-ups.

Incubation Program
The two year Incubation programme at the IC IITP is designed to support start-ups for idea validation, product development, building and testing prototypes and early stage scaling of innovations. Business proposals for incubation can be sent to manager_ic@iitp.ac.in through the year which will undergo evaluation by a panel of experts for selection.

IC IITP will enable the incubated start-ups with fully furnished office space, conference rooms, internet and communication facilities. One of the major challenges faced by Startups in the area of Medical Electronics is the availability of advanced laboratories for design and prototyping. IC IIT Patna offers State of the art laboratories with end to end equipment for Electronic System Design and Prototyping, PCB Design and Prototyping, Testing and Measurement, Mechanical packaging and Product Prototyping. Incubation Centre is also in the process of setting up a micro-nano fabrication facility for MEMS fabrication.

For a Startup company, especially in healthcare, mentoring is of prime importance. IC IIT Patna will enable the incubated companies by getting them mentors from Industry, IIT and AIIMS Delhi faculty, Investors on business, technology, IPR and other aspects. IC management will work closely with the team to guide them on a regular basis.

A seed funding of upto 10 lakhs to the incubated company along with investor connect for additional funding needs and helps, to the incubated companies to start off their operations. Access to training materials on relevant topics and connect to various service providers such as legal and accounting firms are among other benefits an incubated company enjoys at Incubation Centre IIT Patna.

Have a vision to disrupt and transform Indian medical Electronics environment or electronics system design and manufacturing(ESDM)? Talk to the IC IIT Patna team or walk in to their office at IIT Patna Campus at Bihta, Patna.

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also remembers charges.

A flock of small, single-use drones capable of making precise deliveries or completing other military missions and then vapourising into thin air sounds suspiciously like science fiction, but such devices have already been developed and are being brought into the realm of reality. One intriguing example of these ephemeral materials is small polymer panels that sublimate directly from solid to gas.

So far, the disappearing antenna is the most impressive application of this technology. One minute, it is an antenna broadcasting important coordinates or whatever. Drop in a solution, though, and the next minute it is gone—nothing but a few flecks of metal remain.

Another device is a blue LED. It is bright and shiny, and then it is gone, almost without any trace.

Researchers hope to develop more sophisticated devices like a credit card that could dissolve when lost by just sending a signal from a smartphone to start the process.

A new technology can make computer chips self-destruct when remotely triggered. The new method uses silicon computer wafers attached to a piece of tempered glass that shatters into smithereens when heated in one spot. Heat can be turned on via a remote, which, in the future, could conceivably be triggered by anything using Wi-Fi to a radio frequency signal.

Methodology

Researchers have created electronics that will self-destruct on command, and the technology uses radio frequency, acid and a layer of wax on the circuit to let the devices melt with an application of heat or on receiving a signal from a remote device.

They have dissolved electronics in water, which could be used for biomedical implants using heat as the trigger. Heat-triggered devices use magnesium circuits printed on very thin, flexible materials. They have embedded a weak acid in a bit of wax on the circuit. When wax is heated, acid is released and dissolves the components. To remotely trigger the reaction, researchers have installed a heating coil that the radio signal turns on. That, in turn, melts the wax.

Researchers can control how fast the device degrades by tuning the thickness of wax, concentration of acid and temperature. They can now design a device to self-destruct within 20 seconds to a couple of minutes after heat is applied. Devices can also degrade in steps by encasing different parts in waxes with different melting temperatures.

This gives precise control over parts of a device that are operative, creating possibilities for sophisticated devices that can sense something in the environment and respond to it. To remotely trigger the reaction, researchers have embedded a radio frequency receiver and an inductive heating coil in the device. You can send a signal to cause the coil to heat up, which melts the wax and dissolves the device.

Conclusion

Transient electronics or self-destructing electronic systems work until these are no longer needed, at which point these dissolve completely—dissolution is triggered by even ordinary water in their operating environment. The most immediate application envisioned by developers is for medical devices that dissolve in the human body in a set period of time after being implanted.

Researchers have pulled off a disappearing act for electronic devices that could change the way we think of our gadgets, as well as introduce new capabilities for medical implants and spy gear. In the future, they envision more complex devices that could be adjustable in real time or responsive to changes in their environment such as chemistry, light or pressure. EFY

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RockBLOCK Mk2: Communication Beyond Limits

Adil khan is an electronics hobbyist, interested in satellite communication, cyber security and cyber forensics

Communication is a basic requirement. However, sometimes we are in an area where Wi-Fi, GSM and other forms of terrestrial communication are not available and so we are unable to communicate or send messages. And without any terrestrial connectivity we cannot install any project required for either one- or two-way connectivity. In this situation, a satellite communication device comes to the rescue, and helps us send or receive data using satellites for projects like oil pipelines, weather data collection, location tracking and emergency communication.

What RockBLOCK Mk2 is

RockBLOCK Mk2 is a satcom (short for satellite communication) device for communicating over Iridium global satellite network. It is manufactured by UK based Rock Seven that also manufactures Iridium based satellite-tracking and communication systems.

RockBLOCK Mk2 is a module for satcom that sends and receives short-burst data for location tracking and weather balloons. It can send and receive short messages from anywhere on Earth (land, sea and air) with a view of the sky, and work beyond the reach of Wi-Fi, GSM or 3G/4G. The device is compatible with Windows, Linux, Mac, Arduino and Raspberry Pi operating systems, and other platforms with serial and USB ports.

> The Iridium constellation consists of 66 cross-linked low-Earth orbit satellites plus several in-orbit spares, which means true global coverage and real mobility everywhere. The network is a meshed constellation of interconnected, cross-linked satellites, where each satellite can talk with the nearby satellite in adjacent orbits. Unique to Iridium, this architecture provides inherent advantages in performance and reliability over other mobile satellite services providers.
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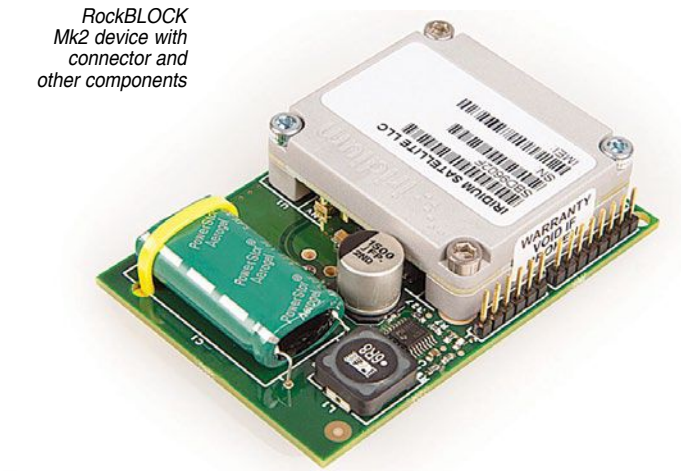


RockBLOCK Mk2 device with connector and other components

Features include:

- Integrated antenna and power conditioning
- Plug-and-play satellite communication
- Two-way communication system
- Global operation using Iridium satellite network
- Data arrives via e-mail or directly to Web service
- External antenna connector (optional)

Short-burst data is a bandwidth-limited messaging system, capable of transmitting/receiving packets of 340/270 bytes size. With a good view of the sky, it is possible to send/receive such data.

It is suitable for applications that need to regularly send or receive small amounts of data for tracking, telemetry, system control and monitoring applications. It is not suitable if very low latency is required (less than one minute), or if data to be transmitted is larger than a few thousand bytes. Also, it cannot be used

PRODUCT DETAILS	
Powered by	Direct header connector, or optional FTDI USB adaptor
Built-in antenna	Yes (optional SMA version for external antenna)
Transmit and receive using	Iridium satellite network
Weight	RockBLOCK Mk2 Naked: 76 grams
Size	RockBLOCK Mk2 Naked: 76mm×51.5mm×19mm
Waterproofing	RockBLOCK Mk2 Naked is not waterproof, whereas RockBLOCK+ is
Power required	5V DC,100mA minimum
Power consumption	Max 450mA (100mA minimum)

to send images and large files.

At the heart of RockBLOCK Mk2 is an Iridium 9602 modem. RockBLOCK Mk2 hosts the 9602 and provides it with an antenna and its power supply requirements. It exposes the modem's serial interface via a breakout connector using a USB/serial adaptor.

UART. Serial communication is provided by a full UART interface at 3.3V. This can be operated in three-wire mode (Rx/Tx/GND) with no detriment to functionality or performance. Signals are available on a 2.5mm (0.1-inch) header for easy connection.

USB compatible. A 2.5mm 6-pin header is provided for direct connection to FTDI TTL-232R-3V3 cable. It provides a virtual com port on a USB host.

What Iridium satellite network is

Iridium is the only satellite network that allows transmission of information from any point on Earth; other networks have no coverage in polar regions and have intermittent or no coverage in marine and land areas.

Iridium operates its satellites on L-band, which requires line-of-sight for operation.

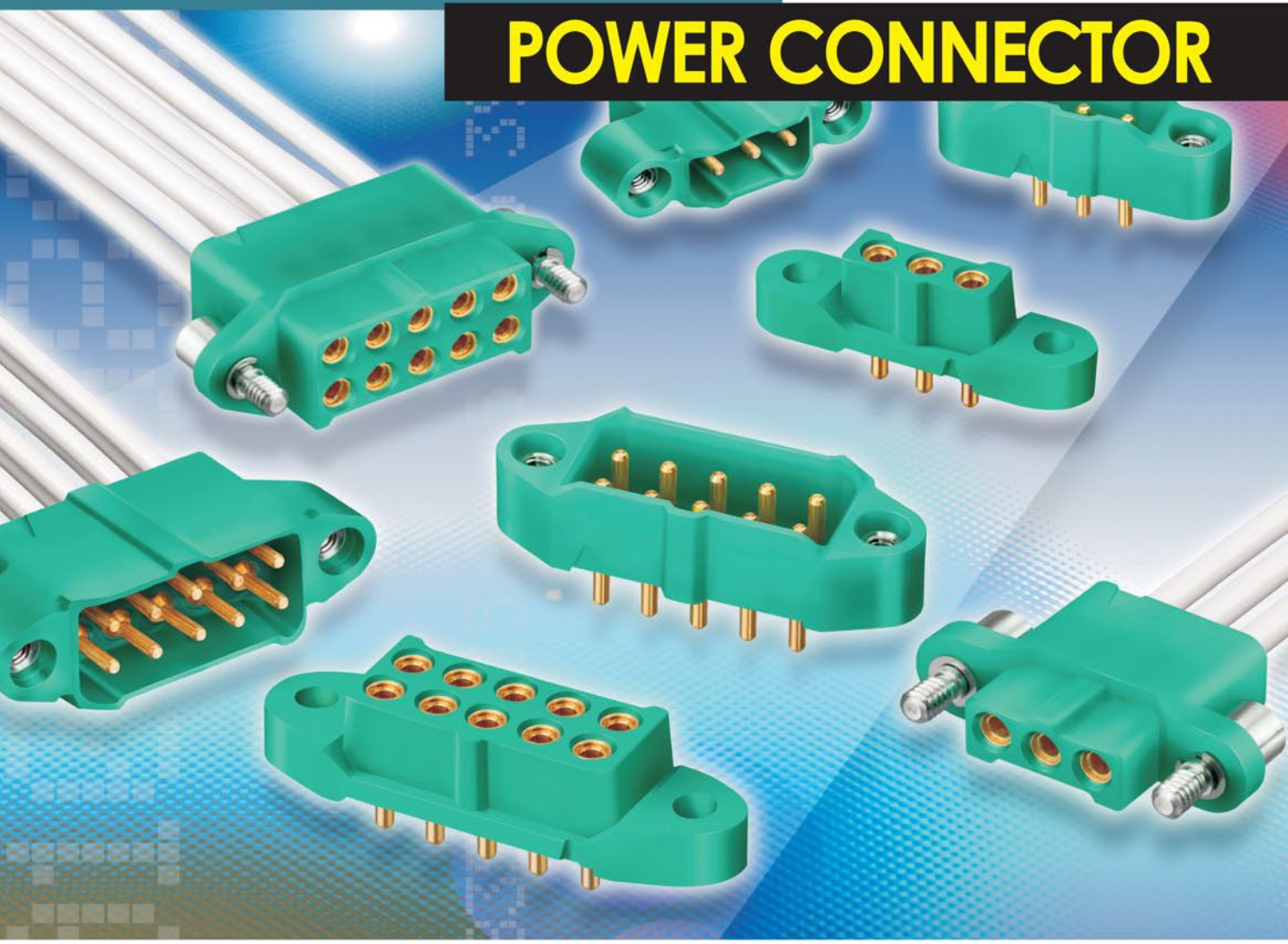
How RockBLOCK Mk2 works

When you send short-burst data from a device, it is received by low-Earth orbit Iridium satellite. Data then goes to Iridium ground station. When Iridium ground station downlinks this data, it sends it to Rock Seven server, which transfers the data to your e-mail or web service. EFY

HARWiN

Harwin M300 5 &10A

POWER CONNECTOR



High Reliability Connector for Power Application

Harwin's M300 series is a 3.00mm pitch, high reliability / high performance connector system suited to aerospace, defence, industrial and other harsh environments. M300 provides a dual and single row cable to board and board to board solution for application requiring up to 10A of power in a small space.

Available in 3-contact single row, 6- and 10-contact double row, M300 comes with extended rear potting wall for strain relief, the housing are clearly marked with "position 1" identifier. All M300 connector are RoHS compliance.

Features

- Small PCB Footprint
- 3mm pin spacing
- Up to 5 & 10 Amp
- 1000 mating operation
- Jackscrew security system
- Keyway Polarising position
- Extremes temperature -65°C to +175°C
- Four finger contact ensures connectivity in rugged condition

For more detail please visit our website www.harwin.com or contact us at sales@harwinasia.com

DIGITALISATION: An Imperative For New-Age India

Preethi Menon
is vice president - enterprise applications, Clover Infotech

Every once in a while, a new technology or innovative practice takes the world by storm, but soon the technology or practice becomes more of a fad than a way of life. It changes the pace and scope and disrupts for a while, after which another trend takes over. Digitalisation stands out because it has shown that it can be a real equaliser, a fast track to growth and development, and could solve problems hitherto not touched yet for want of even a semblance of an available solution.

For a country like India, which has 70 years of freedom behind it, digitalisation could be a real game-changer. Its extensive reach, seamless connectivity and mass digital literacy are aspects that can truly ring in the dawn of a digitalised India. With the Internet of Things (IoT) revolution and upward graph of economic growth, a truly digital India in the next five years is not an unreachable goal. The seed of a massive revolution that digitalisation holds within it has potentially opened up unlimited opportunities for businesses—to pioneer this transformation, to achieve increased profitability in the process and to enable businesses achieve customer delight.

A few critical aspects that all businesses, startups or proven industry leaders need to lay emphasis on in order to attain their digital best and help the nation's goal post of a digital India are discussed in this article.

With transparency we will see value

The modern consumer, who has embraced e-Commerce, needs, expects and demands transparency. We have always had an uncaring attitude about the lack of transparency prevailing in most government services. However, the government has begun to take key steps to digitise its services for the public, because it sees the value in these services. Digitalisation can help in the transmission of government subsidies and benefits to the last mile, thereby reaching the remotest areas, and truly democratise. This opens up the possibilities of digitising all public services offered to the common man. The difference it would make to governance could be overwhelming.

While information and process clarity is visible across the Web and portals, these can be extended to mobile devices as well. Businesses are changing their strategies to get their services out through mobiles and to a heavily mobile-using audience. Also, digital channels and social media are leveraged to promote the existence of such government services and enhance its usage. Digital India is one such initiative that has gained traction through it.

The nine pillars of Digital India (Image courtesy: www.bharatniti.in)

The freshness of innovation

Everyday niche products and services are thought of and brought to the market, thanks to innovation, without which sustainability of businesses hangs by a thread. Benefits of efficiency in production and operations has given innovation that status. A simple thing like connecting rural and agrarian communities with the Internet is making a vast difference in the quality of lives of the people there. Mobile money and digital healthcare services are a few areas that are making inroads to help marginalised communities.

Innovation results in solutions that would transform the way businesses and government bodies communicate with the customer/stakeholder contextually and ubiquitously. This almost magical quality

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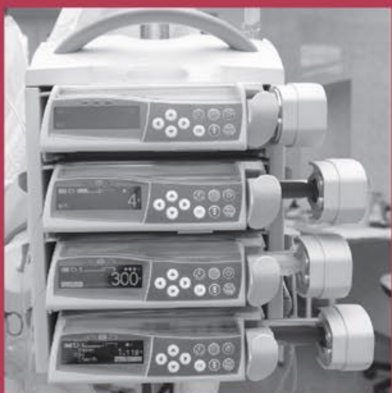


.Infusion Pump

Recommend:

Model : HBU25 / HBU40 / HBU50 / HBU100
Size : 2" x 3" 1" x 4" 1" x 4" 2" x 4"
Wattage : 25~100W

Medicall hospital needs expo

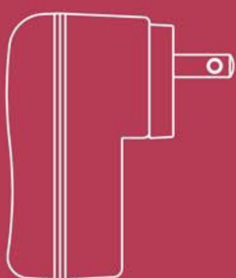
Medicall Chennai

Date:
2017/7/28~7/30

Booth No.:
TBD

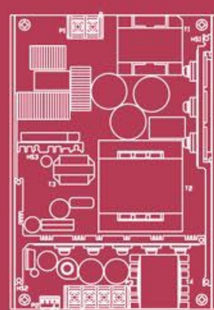
ADDR.:
Chennai Trade Centre, Chennai India

OPEN FRAME



WALL MOUNT

DESKTOP



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of omnipresence and omniscience is exactly what governments and businesses can achieve through a structured digitalisation strategy.

Empowering businesses and the government to transcend to the next level

While the India growth story has been providing good sources of funding for new-age businesses, they need to find their feet faster than their more established counterparts. Their longevity is subject to the vagaries of markets, the dynamic consumer psyche and the disruption caused by new technologies. An optimal digitalisation approach is the only solution that will spur the zesty startups to sustain and crossover to establishments that can make a mark in history.

As the way things evolve with services and businesses, enterprises seek the digital revolution as an opportunity to create new-age solutions and take the customer experience to the next level. This is being mobilised in order to address these evolving business requirements. Firms are introducing dedicated enterprise business applications and digital transformation practice, under which an attempt is being made to help customers gain a technological edge over competitors, by deploying essential business solutions and enhancing their business processes.

Digital transformation changes everything

Digital transformation has changed the way technology companies think. Today, we know that the heads of marketing, finance and even human resource seek digital services as much as the technology heads. Digitalisation has impacted the way organisations work, set their internal processes and interact with their employees, as much as how they interact with their customers.

Today, digitalisation is not an option or even a need, but an imperative. Adopting digital transformation practices in all aspects is what differentiates the best companies from the whole lot, irrespective of the sector these operate in. Digital transformation by itself is a paradigm shift in mindset, technology adoption, process and people alignment. It cannot happen overnight, but is ushered in through a series of steps—just like industrialisation in India took long, hard years. The only difference here is that digital transformation would take a lot less time and impact a lot more.

While talking about digitalisation, organisatons or, for that matter, governments need to ensure customer satisfaction and a delightful end-customer experience. If the solution or service does not create value for the customers or end users, it may end up being just a fad.

Automation of business processes across an organisation is demanding and requires a robust and well-connected application ecosystem. Whatever enterprise resource planning offering is used, it should seamlessly connect all business functions to facilitate the exchange of information and collaborative working.

Also important for organisations is to excel in creating a seamless online experience with their user interface and user experience capabilities to capture the interest of their target audience and keep it constantly engaged. Keeping it together would be integrated digital initiatives to help maximise resources and deliver better outputs.

The goal of Digital India, with focus on connectivity as a Wi-Fi symbol in its logo suggests, is not that far. With more investments and better services, we could be at a cusp of a true revolution here, because businesses in a nurturing ecosystem, powered by digitalisation, are creating the change that we hoped for this long. EFY

Importance Of QUALITY ENGINEERING In Consumer Electronics

Subhabrata Chatterjee is senior technical specialist at TP Vision India Pvt Ltd, Bengaluru

In a modern world, it is a big challenge for many industries in information technology or manufacturing to maintain quality without compromising on the costs of quality and non-quality. These two together make the total cost towards maintaining quality of a product, and are involved throughout the project's life cycle. The primary challenge here is to determine how to trim the overall costs of quality and non-quality.

There are many definitions of quality set by various gurus around the world, some of which are given below:

"Quality should be aimed at the needs of customers, present and future."

—Dr Edward Deming

"Quality is the degree of excellence at an acceptable price and control of variability at an acceptable cost."

—Robert A. Broh

"Quality is the loss (from function variation and harmful effects) a product causes to society after being shipped, other than any losses caused by its intrinsic functions."

—Dr Genichi Taguchi

Consumer electronic products have huge competition in today's market. Due to this, there is a thin cost margin with good character that draws consumers to buy the merchandise, along with quick and quality after-sales service.

Examples from open source that speak about the impact of cost of non-quality

- German car maker, Volkswagen, recalled all 5561 e-golf battery-electric cars sold in the USA between May 21, 2014 and March 1, 2016 because of faulty battery software that could cause the cars to stall and crash, according to the company's safety recall report filed with National Highway Traffic Safety Administration.
- Customers returning electronics products had cost the USA consumer electronics retailers and manufacturers nearly US$ 17 billion in 2016, an increase of 21 per cent since 2007, according to Accenture research report. These costs include receiving, assessing, repairing, reboxing, restocking and reselling returned products.

There are many factors that may affect costs of quality and non-quality. A few of these are mentioned below.

Cost of quality is the cost of conformance incurred from costs of prevention and appraisal. These include:

- Cost of contract
- Cost of employee training and education
- Cost of auditing
- Cost of maintenance
- Cost of resolving an impediment
- Cost of maintaining company assets like test equipment
- Cost due to field trials
- Cost of employee wages
- Cost of prototype and reviews
- Cost of continuous improvement
- Cost to make infrastructure for logistics and packing (focus on packing technologies)

Cost of non-quality is the cost of non-conformance incurred due to internal and external failures. These include:

- Cost of rework
- Cost of frequent design change
- Cost of requirement change
- Cost of material waste
- Cost of delay in release due to internal failure or regressions
- Cost due to non-conformance in manufacturing process
- Cost due to non-conformance in raw materials like electronic and electrical components
- Cost due to non-conformance in assembly of components
- Cost due to warranty claims
- Cost incurred from customer complaints
- Cost due to return of product
- Cost due to service
- Cost due to lack of service (losing customers)
- Cost due to legal and government rules, when certain regulations are not fol-

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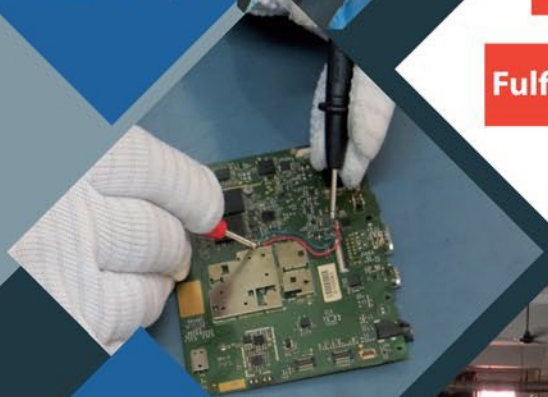
Testing Capability



Precision Soldering Techniques

Manufacturing Facility

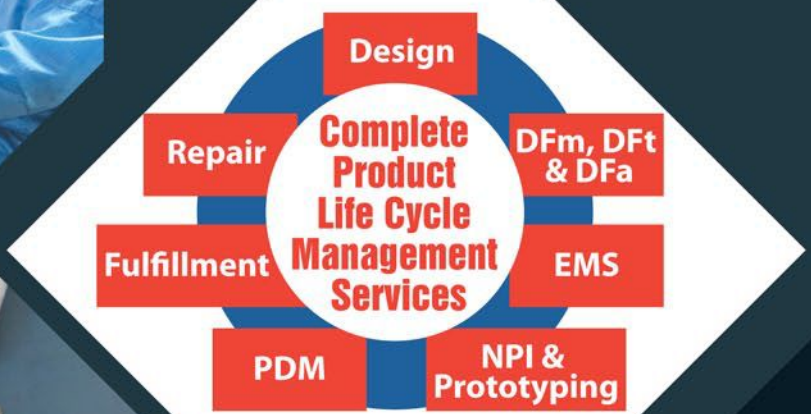


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TABLE I
NITTO DENKO CORP.—MANUFACTURING LINE FOR ADHESIVE TAPES FOR ELECTRONICS

Cost classification	Material	Energy	System	Waste management	Total
Product	¥2,499,944 (68.29%)	¥57,354 (68.29%)	¥480,200 (68.29%)	—	¥3,037,498 (67.17%)
Material loss	¥1,160,830 (31.71%)	¥26,632 (31.71%)	¥222,978 (31.71%)	¥74,030 (100%)	¥1,484,470 (32.83%)
Total	¥3,660,774 (100%)	¥83,986 (100%)	¥703,178 (100%)	¥74,030 (100%)	¥4,521,968 (100%)

TABLE II
SUMIRON CO. LTD—SMALL-TO-MEDIUM BUSINESS AND MASS PRODUCTION

Cost classification	Material cost	Energy cost	System cost	Waste management cost	Total
Product	40,300,000 (53.3%)	2,700,000 (3.6%)	8,900,000 (11.8%)	—	51,900,000 (68.7%)
Material loss	16,600,000 (22.0%)	1,600,000 (2.1%)	5,400,000 (7.1%)	—	23,600,000 (31.2%)
Disposed of/recycled	—	—	—	90,000 (0.1%)	90,000 (0.1%)
Sub-total	56,900,000 (75.3%)	4,300,000 (5.7%)	14,300,000 (18.9%)	90,000 (0.1%)	75,590,000 (100.0%)

lowed in product designing and implementation

The development, quality assurance and quality control team is mostly responsible for reducing the costs of quality and non-quality. Research says that most recurrences from the field that get consumers unhappy are technical issues, including ones due to behaviour of a product with other connected devices, reliability, stability, performance and so on. This requires skilled employees (both proof and evolution) who can identify issues related to design, protocol or codification.

Owing to the immense pressure to establish the product early in the market, organisations focus more on getting the work done, bypassing many quality-related processes (which increase the software deliverable process time), which may also impact the fast pace of field returns. By this point, it is too late to contain the cost of non-quality.

The challenge is to manage this state of affairs, so that industries can optimise the overall monetary value without compromising the quality of products. Below are a few factors that may allow organisations to achieve such goals.

Of the many reasons for the cost of non-quality, a few important ones are explained below.

Cost of rework. Repeated tasks to achieve a certain goal is called rework. This may happen if engineers have not performed error-free work at the first try. Rework is the most common problem that many organisations face in their day-to-day project lifecycle. Consequently, situations of schedule constraints create extreme pressure for the development team, which may result in the lack of involvement in the testing phase.

Below are some probable points due to which rework may occur:

- Faults not solved correctly, non-conforming with regards to coding standards or logic
- Very frequent change in requirements, design, etc, during development and testing stages
- Incomplete coverage in code implementation or hardware implementation during design implementation phase
- Test executions or design implementations not measured or evaluated; hence, incomplete coverage
- Incorrect test plan and test strategy creation
- Frequent regressions
- Negligence by developers or test engineers

Cost of frequent design/requirement change. Design changes in software are very common during the software development lifecycle. Generally, design changes come in when projects are in the middle of software development lifecycle, which contribute to a lot of rework. Below are a few points that indicate the impact of design changes:

- Design changes in one component often impact other components, which often encourages software changes in other components as well and, finally, rework in one or more software elements
- Increasing overall development cost
- High chance of delay in the market
- High rate of regressions
- May need to develop additional components and, hence, boost efforts with respect to planned efforts

To avoid these issues, it may be useful for organisations to ask a few questions during conception phase and create a secure database that may provide optimal information to recover the shock of design changes.

Some such questions that should

> "A five per cent reduction in defect rate can increase profits by five to 95 per cent."
>
> ***—Bain & Company***

Next Generation Test Sourcing Solutions

Rental of test equipment is finally starting to become a part of Indian technology culture, as a growing number of companies learn about the array of benefits it has compared to direct purchase. The fast moving nature of the India market, with new technology standards being adopted all the time, means that key test requirements continue to evolve at a dramatic pace. Consequently there are serious risks that purchased equipment could quickly become outdated and the investment made in it might not be recouped. Also budgetary constraints are now dictating that test hardware should be obtained without having to make heavy upfront payments.

Test equipment sourcing specialist Livingston first established an Indian operation in 2010. The company has, since then, witnessed substantial growth in its market share and expanded its client base considerably. Headquartered in Gurgaon, **Livingston India** offers an extensive range of test equipment from leading manufacturers like Keysight, Rohde & Schwarz, Anritsu, JDSU, Yokogawa, EXFO, Kaelus, Fluke, Tektronix, Fujikura and Sumitomo. Its comprehensive portfolio includes OTDRs, fibre splicers, OSAs, PIM testers, cable antenna testers, network analysers, power meters, oscilloscopes, signal generators, spectrum analysers, etc. This is backed up by in-depth engineering and application advice from its highly skilled locally based staff.

Livingston India presents the Indian market with wide array of equipment sourcing options - allowing customers to find the perfect match for their particular needs. In addition to short/medium term rental plans, the company offers long term leasing and rent-to-buy services. It also provides companies with highly effective asset management services.

Clearly test equipments require periodic servicing, maintenance and recalibrations at relatively frequent intervals. It is crucial to have mechanisms in place to safeguard against downtime during such activities - otherwise costs will be accrued. Furthermore, if rented equipment is 5 or 6 years old then its performance must be brought into question. Aware of all these issues **Livingston India** offers substitute units for those being serviced or recalibrated. Furthermore, the company only employs the newest equipment, replacing it every 3 years.

To complement its test equipment rental and leasing offerings, **Livingston India** presents its customers with industry-leading asset management services. Livingston has developed its own proprietary software packages for hire management, asset management and calibration management purposes. Through these services and by utilising our sophisticated on-line tools, equipment utilisation can be increased dramatically (by as much as 70% in some cases) and last minute purchases to cover any unforeseen shortfalls can be avoided. Equipment that is redundant in one location can made use of elsewhere in the organisation, or alternatively it can be sold off so as to generate extra cash for reinvestment back into the business.

Livingston India differentiates itself from other rental firms within the Indian market in terms of the scope of products it offers and the high degree of quality these products attain. As part of the Microlease group it can draw the support of a global network with longstanding expertise in test equipment rental and asset management with products suitable for the telecom and semiconductor sectors. By working with **Livingston India**, customers can implement far better strategies when it comes to the sourcing and managing of test equipment. They are able to mitigate the financial penalties associated with underutilisation of equipment, equipment failure, inadequate downtime cover, or poor organisation of test assets.

Livingston India

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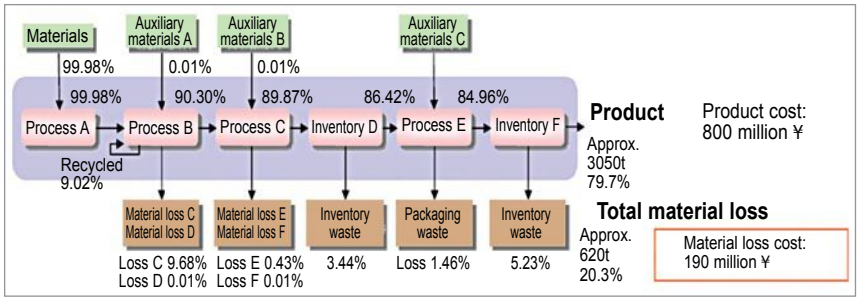

Fig. 1: Sekisui Chemical Co. Ltd - production characteristics: company-wide MFCA implementation for 34 sites with individually-different production characteristics

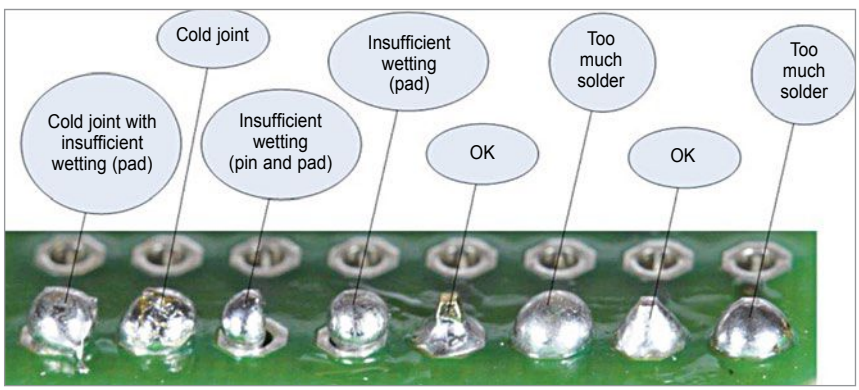

Fig. 2: An example of poor soldering

be answered and documented during design phases are:

- What is the anticipated number of plan modifications that may happen during the development stage?
- How many elements should be involved during plan modification?
- How much rework effort is required for plan modification?
- Which component requires optimal rework effort?
- Which ingredients should be prepared early to minimise shock due to design modifications?

Database structure that may be useful to analyse and foresee design change efforts is given below:

- Unique design change number
- Description of design change
- Name of module or component where design change needs to be made
- Type of change
- Time spent to carry out the change
- Name(s) of person(s) who made the change
- Date on which design change is made

Cost of material waste. Any material/tool that is unavailable due to defect, mishandling or being scrapped is material waste. In every organisation, during execution of its process there is always some loss incurred. Material loss margin varies from company to company, depending on how they are checking it. A few material losses can be manipulated effectively, whereas others cannot.

Especially in the research and development sector, loss due to bad workmanship such as test equipment error, development/test setup issue, choosing right vendors for quality service and materials, and the like can be curbed by training, whereas material losses during the making of prototypes are inevitable.

By preventing material waste, costs can be spared in any kind of establishment. A few examples where industries took in huge costs towards material waste are given in Tables I and II, and Fig. 1.

> "For every customer complaint there are 26 other unhappy customers who have remained silent."
>
> ***—Lee Resource***

Waste material can be imaged in consumer electronics based industries in the following ways:

- When defective tools, equipment or raw materials (like spare parts and consumables) are purchased
- Test equipment errors due to lack in regular calibrations
- Mishandling of equipment/poor workmanship
- Bad-quality materials
- Wrong settings or calibrations
- Poor inspection
- Lack of environmental controls
- Poor supervision of workmen

Cost due to non-conformance in manufacturing process. Non-conformance in the manufacturing process is an event that deviates from certain manufacturing protocols and criteria. Usually, manufacturing process management experts are keen to curb these losses. Non-conformance management solutions enable identification and documentation of these quality events, apply standard risk criteria to triage, route events appropriately and enforce structured failure analysis, root cause identification, quarantine and final disposition.

There are various factors in the manufacturing process that may incur as contribution to manufacturing defects. Some factors that are observed as part of the manufacturing process are mentioned below:

- Lack in availability or usage of electrostatic discharge (ESD) devices like ESD wristbands, ESD tables, ESD clothes and the like
- Human hair that may fall on PCBs/components in assembly lines and cause damage to the board due to ESD generated from hair
- Thermal balance
- PCB cracked or broken dur-

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- Environment Friendly. Non Corrosive. Non Conductive.

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ing assembly of QA/QC activities due to which component failure may occur
- Soldering problems

To cover the fabrication/assembly process and to measure the quality of manufacturing, there are some testing measures that need to be followed, a few of which are mentioned below:

- PCB analysis test
- Zero-value analysis
- Soldering evaluation and corrective action

A few examples of the type of quality non-conformance and damages that may occur in the manufacturing process and in the field are shown in Figs 2 through 6.

There are many dependencies in the manufacturing of consumer electronics products. Examples of dependencies are given below:

- Dependencies with system-on-chip manufacturer and vendor
- Dependencies with raw materials like small electronic and electrical components
- Dependencies with packaging vendors
- Dependencies with product body manufacturing vendors
- Dependencies with PCB vendors
- Dependencies with PCB layout vendors
- Dependencies with logistics vendors

Despite these dependencies, it is a great challenge for manufacturing industries to sync with various vendors and maintain manufacturing process quality. Following are some possible impacts if challenges are not met appropriately:

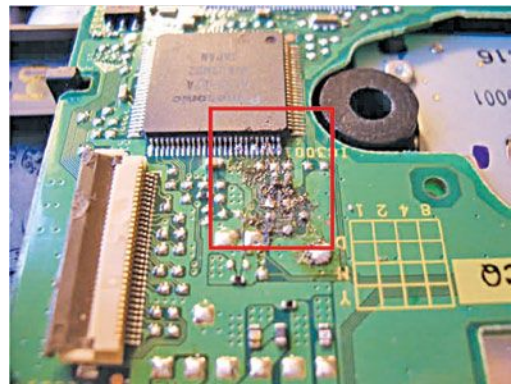

Fig. 3: Shorts between components and pins

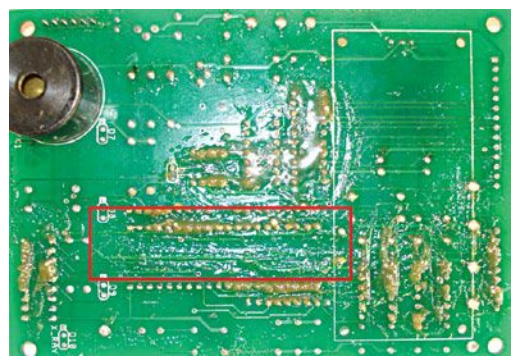

Fig. 4: Dust on PCB after soldering

Fig. 5: Ant on PCBA surface

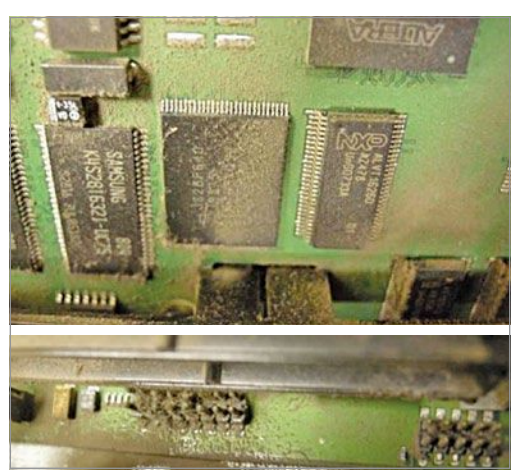

Fig. 6: Dust and debris in memory ICs

- Increase in field call returns
- Increase in rework
- Increase in warranty cost
- Increase in scrap
- Increase in low performance in overall productivity

To address the above points, non-conformance management systems should ask the following questions during the manufacturing process:

- How long does it take to find, analyse and resolve manufacturing issues?
- Are you sure you have really solved the issue?
- Is the issue recurring?
- How do you implement and enforce preventive measures?
- Do you really have the data required to identify non-conformances?

Non-conformance management systems teams usually work on the following mindsets:

- To identify any deviations in processes
- To identify quality assurance test results on product, packaging and product body
- To initiate appropriate actions to overcome the above two points
- To initiate field call returns analysis and take appropriate actions depending on analysis reports

Cost due to non-conformance in raw materials. To make consumer electronics products, we need many raw materials in the form of electronic, electrical, mechanical and packaging materials. These call for the involvement of multiple vendors to supply those raw materials. Hence, manufacturers need to evaluate the caliber of new materials that various vendors are offering. Examples given below show the problems that may occur due to non-compliance of raw materials:

- Failure of electronic/electrical components
- Damage of products during transportation due to inferior packaging quality

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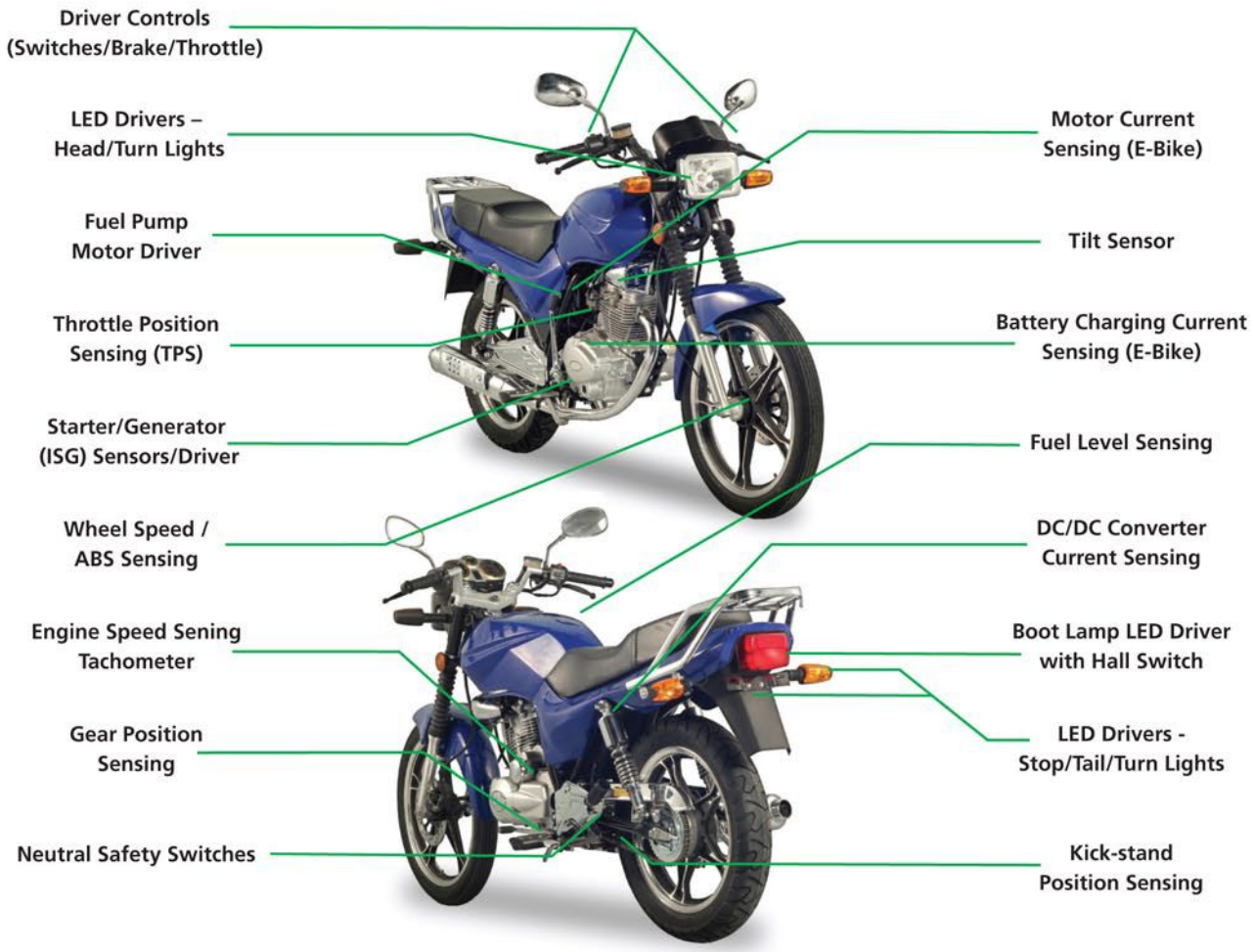

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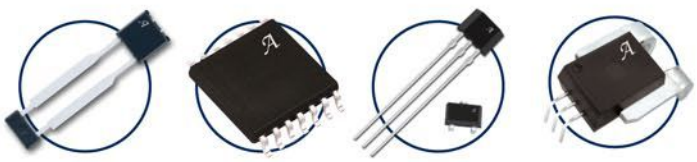

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- Burning out of product
- Product malfunction due to environmental temperatures and other reasons

Hence, every industry should deliberate the following:

- Validate datasheet for raw materials that different vendors are offering; whether the datasheet meets product design principles
- Rate of failure of samples calculated per 100 samples
- Reliability of those samples
- Tolerance range
- Mechanical characteristics
- Packaging characteristics

Valuation of the above points may help decide which vendor to choose. It can also help boil down the field call return in the form of component damage, damage due to transportation, mechanical reliability and more. Meanwhile, it is also necessary to track and control, so that things are in place.

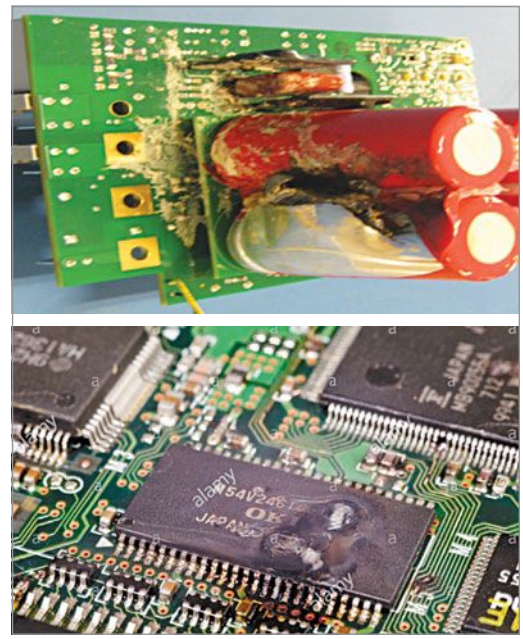

Fig. 7: Examples of component damages

The above-explained cost of non-quality increases customer complaints and more returns, hence, higher warranty cost. This leads to the company using earnings for maintenance and customer satisfaction. Sometimes, cost of non-quality is so high that it brings down profit margins substantially.

Cost due to lack of service. Like manufacturing, supply chain management, design and development, customer serviceability is also important. Outstanding customer serviceability makes consumers become brand focused, and it also helps with word-of-mouth marketing due to customer-oriented service. EFY

SECURITY CHALLENGES For The INDUSTRIAL IoT

Suhel Dhanani is senior principal MTS, industrial strategy, Maxim Integrated, San Jose, CA, USA

The Industrial Internet of Things (IIoT), a subset of the IoT evolution, is quite the rage within automation companies as they seek to add a high-margin software component to their traditional businesses. Since Maxim Integrated chips are used to build these automation systems, they get a unique perspective on how automation system design has to evolve or, in some cases, change as companies attempt to put their automation systems online to take advantage of the IIoT. This article briefly introduces the IIoT and focuses on the security challenges that must be solved to implement secure IIoT-capable end systems.

The IIoT in manufacturing

Manufacturing can get the most leverage from the IIoT because of the sheer amount of data it can capture and process; data is the underpinning of the IIoT since it can be analysed and visualised to help optimise operations and costs. Within manufacturing, security solutions provided by intelligent sensors, distributed control and complex, secure software are the glue for this new revolution.

To realise the promise of the IIoT, chip vendors have to put a lot of their systems, including legacy systems, up in the Cloud. This has profound security implications since security implementation for industrial control systems has not kept pace at best and, in some cases, is non-existent. This will change as actors (malicious or otherwise) realise that a factory or a plant is effectively online, and exploit different attack opportunities.

Security will have to be a combination of software as well as embedded hardware to protect critical control systems from a variety of attacks. Three key challenges are: hardware authentication with secure keys, secure communications using TLS and secure boot. Since connectivity (the thing that enables the IIoT) completely exposes all of their security shortcomings, security cannot be an afterthought if they are to realise the benefits of the IIoT.

Benefits of the IIoT at work

A good example of the IIoT at work is General Electric's newest US$ 170 million plant in upstate New York. It opened about a year ago to produce advanced sodium-nickel batteries used to power mobile phone towers. The factory has more than 10,000 sensors spread across 16,722.5 square metres (180,000-square-feet) of manufacturing space, all connected to a high-speed internal Ethernet. They monitor activities such as which batches of powder form the battery ceramics, how high a temperature is needed to bake these, how much energy is required to make each battery and what local air pressure is being applied. On the plant floor, employees with tablets can pull up all data from Wi-Fi nodes set up around the factory.

Another good manufacturing example is Siemens Amberg electronics plant that manufactures Simatic programmable logic controllers (PLCs). Production is largely automated, and machines and computers handle 75 per cent of the value chain on their own—the rest of the work is done by people. Only at the beginning of the manufacturing process is anything touched by human hands, when an employee places the initial component (a bare circuit board) on a production line. From that point on, everything runs automatically. What is notable here is that Simatic units control the production of Simatic units. About

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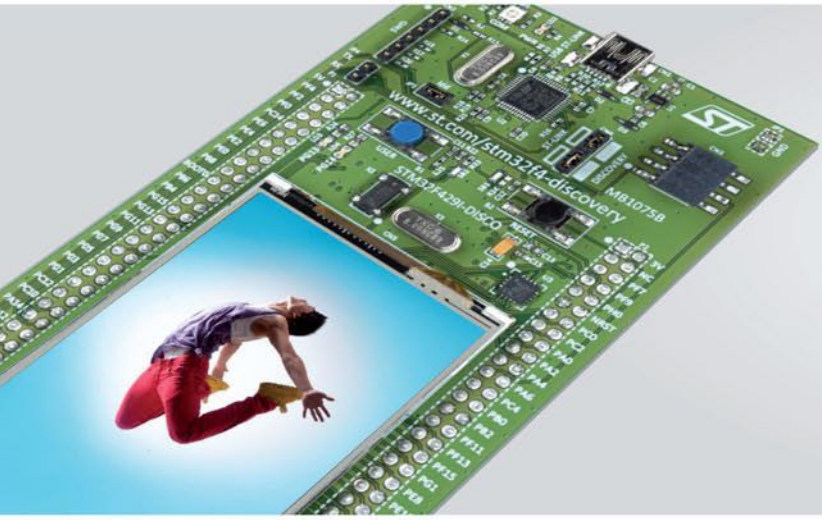

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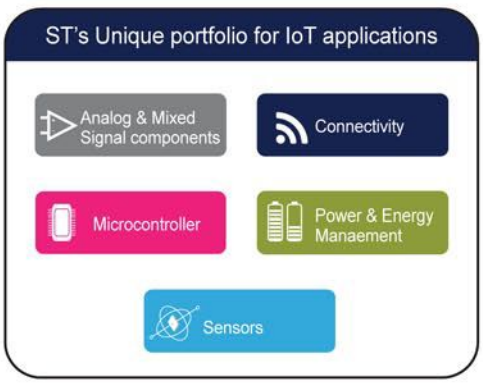

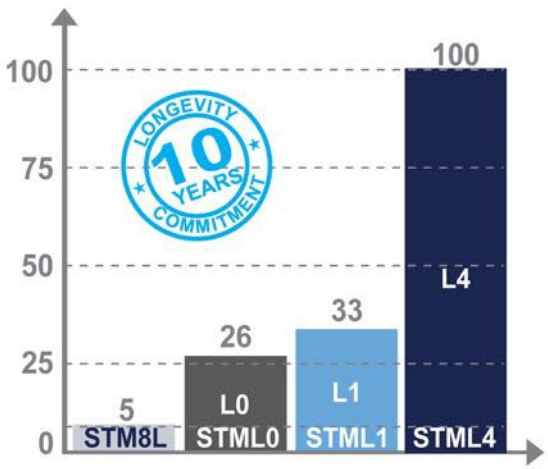

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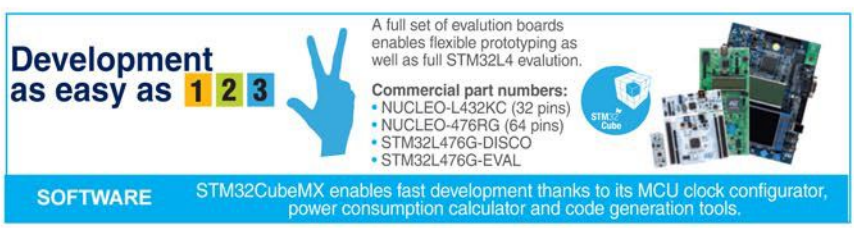

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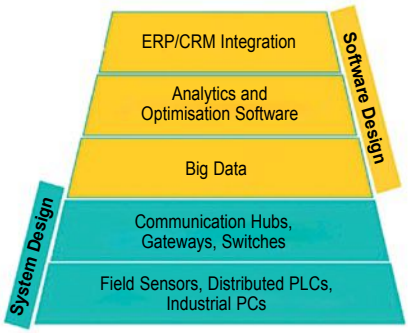

Fig. 1: The IIoT stack from an automation perspective

1000 such controls are used during production, from the beginning of the manufacturing process to the point of dispatch.

The IIoT harnesses sensor data, machine-to-machine (M2M) communication and automation technologies. Smart machines are better than humans at accurately and consistently capturing and communicating data used to fix inefficiencies and solve problems in terms of up-time, scheduled maintenance, power efficiency and more efficient utilisation, sooner.

Maxim Integrated has broken down the IIoT in terms of a stack as shown in Fig. 1. At the very bottom of the IIoT stack, they have the devices (systems) on the factory or process floor. These can be field sensors, controllers, industrial PCs and so on. All of these are hardware systems and can include aspects of hardware security. These end devices must have useful data to communicate and are generally hooked up to communication hubs, gateways and switches so that data can be put in the Cloud (or an intranet) as Big Data.

But that is not all. The promise of the IIoT is that this data can be integrated within the ERP and CRM software of the firm to not only efficiently plan and cost out a manufacturing process, but also to use customer/market information to change assembly lines and process parameters.

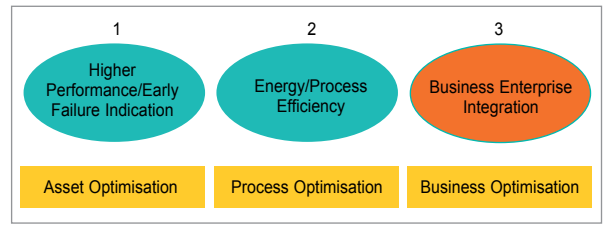

Fig. 2: Potential IIoT benefits

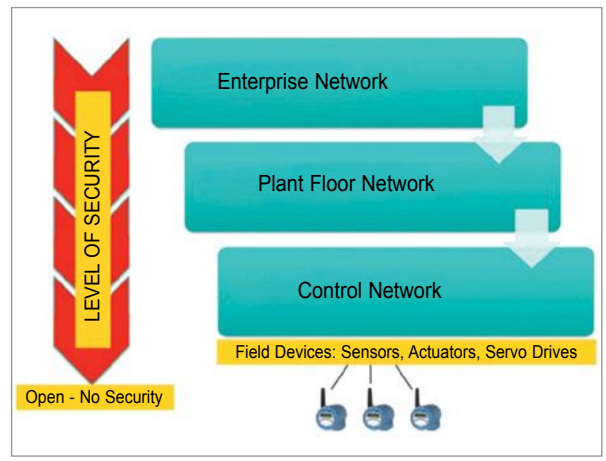

Fig. 3: Mapping security by plant network levels

The top of the stack impacts software development and integration, whereas the bottom impacts the system design perspective.

Primarily, the benefits of IIoT can be broken down into three groups (Fig. 2): asset, process and enterprise optimisation. It is easier to optimise a motor than it is to optimise a drilling operation, which, in turn, is easier to optimise than the manufacturing lines of a large enterprise. But optimising at every level is the dream of the IIoT.

The first level of analysis and interaction occurs at the edge—data is collected from a sensor (for example, a wind turbine sensor, a motor encoder or a vibration signature). This is processed locally to help understand how to tweak parameters that would give the highest efficiency or provide an early indicator of a potential failure.

The next level of analysis is done at the control room or plant level where sensor data from multiple end devices and even multiple assembly lines is aggregated to make decisions that would increase the efficiency of the factory or a process; for example, a control room making idling or sleep decisions of various end devices to reduce the overall power profile of the process.

The first two aspects of using data to positively impact operations is what you are familiar with and use in some way, shape or form. However, what the IIoT envisions is not just an increase in data collection and analysis at the first two stages, but integrating process data with enterprise data to make really interesting decisions that so far have not been made before.

Consider a company enjoying a market explosion. The assembly line can be programmed to manufacture higher volumes of the product, or completely bypass subassemblies adding features not valued by the market. Now, combine both the operating and financial data to provide more insight to the chief financial officer. The agility of the company and its ability to pivot, change and continue to grow can be exponential. Indeed, it is an attractive proposition, and many are eager to move forward, quickly. So quickly that security has not been keeping up with the new IIoT systems.

The IIoT exposes system vulnerabilities

There are a few ways that IIoT systems are vulnerable to attacks. Among the two most prominent are Cloud storage and network architecture.

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Putting data on the Cloud (public or private) is an integral component of the IIoT. But this comes with huge security implications. Traditionally, industrial control system (ICS) vendors have maintained that their systems have a built-in air gap. This is no longer true when these systems have a direct or indirect connection to the Internet. The IIoT is going to drive the understanding that ICSes need to have embedded authentication and security features.

Let us now look at the network architecture that enables the IIoT. Fig. 3 provides a top-level view of how field devices in a factory or a manufacturing process are ultimately connected to the network.

There has always been a control network, a host of field sensors, actuators or servo drives (and other such devices) connected to PLCs or distributed control systems. Typically, this control network is a bunch of isolated networks. But increasingly, control networks that manage different sections of a factory or process are connected together, creating the plant network.

A plant network lets supervisors see the entire plant operation and deduce how the different sections of a plant interact with each other. Information at this level allows for optimisation of the entire plant or an oil field. Ultimately, this plant network information is integrated with the enterprise/business network to enable the real promise of the IIoT.

Each level of operation within the control network needs to have its security needs assessed—security is different at each level. If you start at the top, the domain of IT, you have secure switches and servers that are (hopefully) updated with the latest software and patches as explained below.

• At the plant level, security is not up to date. However, IT still has some control.

• At the control network layer, PLC architectures are decades old. Generally, updates are rare, and frequent patches cannot be applied to systems that are responsible for 100 per cent factory uptime. Security is generally weak here.

• At the field level, which is generally never discussed, security is virtually nonexistent. Field devices are open, trusted and cannot really have any encryption implemented because interoperability is paramount. If you look at field slave devices, such as sensors and actuators, these systems have zero security

features (for the most part) and work on protocols developed almost 30 years ago during the 1970s through the 1990s.

Addressing risks in ICSes at the field level

When you look at the field level in more depth, two primary points that present risk to the ICS are remote field sensors and I/O modules. At stake are uptime, predictable maintenance and overall industry efficiency—the cornerstones of the IIoT.

Risks with remote field sensors. Physical security of all sensors may not always be possible, especially when the sensors are very remote like those used to monitor oil and natural gas fields. Inaccessibility further makes these vulnerable to physical attacks, so it is essential to authenticate all sensors before their data is accepted. However, in most cases, field sensors, even those used in critical infrastructure systems, are both open and trusted. This vulnerability of the field sensors has not gone unnoticed.

In 2014, the well-known Black Hat conference featured a paper by Russian researchers who concluded that attacking an enterprise system directly is too much trouble. Instead, they concocted and described a 'Man in the Middle' attack by spoofing and replacing an open and trusted HART modem based field sensor. They have described the process in detail and even made the software libraries available for download.

Focus on secure systems for the IIoT must begin with a trusted sensor that is sending data to the Cloud or the PLC. Implications of a security breach on these remote devices can be profound.

Risks with I/O modules. Another way to get access to an open trusted system is by using cloned I/O modules to deliver malware. Factory owners are used to replacing I/O modules within their PLCs. There have been cases in Asia where cloned I/O modules (with a fake corporate logo of some of the top automation vendors) are available in the market. Again, since this is a trusted system with traditionally little to no embedded security, it can be an effective vehicle for delivering malware to the main PLC CPU. Physical security (making sure that PLC system updates are limited to a select set of people) can deter this, but keep in mind that this does not need to be a malicious act. You might not even know whether this is a cloned or a fake I/O module.

Implementing hardware authentication with a field sensor. A systems solution for the potential risks described can be simple. If you are going to trust the data from a slave sub-system, the data

must be authenticated. There is a simple embedded hardware approach to keeping these kinds of trusted systems secure. An authentication scheme was instituted many years ago for medical and consumer products such as printer cartridges. These systems traditionally employ a standards based authentication process, using a custom secure device.

This authentication scheme is based on the challenge-response exchange between the host and the slave device (Fig. 4). The host system sends a challenge used by the slave system to compute a response. This response is validated by the host system to make sure the slave system is not cloned or counterfeited. Only after validation does the host communicate with the slave system.

A simple conceptual block diagram of a hardware based authentication scheme similar to the symmetric SHA-256 algorithm is shown in Fig. 5. The SHA-256 protocol, based on a challenge-and-response exchange between authorised devices, authenticates the sensor before its data is accepted and read. SHA-256 authentication makes it almost impossible for an attacker to connect to a network, to pretend to be a sensor or to replace the sensor system with a compromised system, unless the hacker has an identical authentication device with the same programmed-in private key.

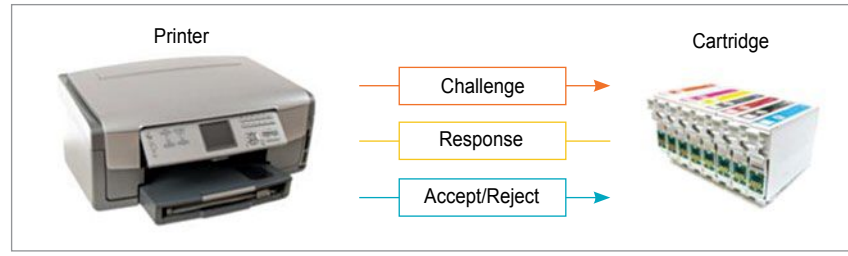

Fig. 4: Authenticating the slave module—can be used with both a field sensor and an I/O module

Vendors provide the key programming service at an American facility and then ship a programmed authentication device to you. This device has a unique key that is known only to you. Devices that store the key are tamper-proof with a range of active and passive tamper protections built-in.

Risks with PLCs, CPUs and solutions

What controls your plant or process is the PLC and the main CPU that is running all control algorithms. But these systems are never designed to withstand security attacks and breaches. Hence, once these systems are connected online, there are many ways to compromise the main CPU of the PLC. Some of the attack surfaces can be applications software, operating systems or hardware, but the most vulnerable surface is firmware. If the firmware can be modified or infected, any change due to malware is not only hard to detect but also, if found, is very difficult to ascertain the intention or purpose behind it.

Most PLCs lack source and data authentication on firmware uploads. Some PLCs even lack checksums for validating the correct transfer of the firmware. If the attacker can modify the PLC firmware, he or she can:

- Take complete control over the infected system
- Learn about the production process
- Selectively sabotage the manufacturing operation (aka Stuxnet)
- Propagate to the enterprise from a trusted manufacturing system

Not everyone wants to take control of your system to destroy your plant. The risks can be more subtle. There is a lot of intellectual property embedded in a manufacturing setup, and sometimes the intent is merely to get this intellectual property. This kind of malware will not manifest itself by creating problems in your manufacturing setup.

Automation World once reported, "The interesting thing about Dragonfly is that it targeted ICS information not for the purpose of causing downtime, but for the purpose of intellectual property theft. Potential damage could include the theft of proprietary recipes and production batch sequence steps, as well as network and device information that indicate manufacturing plant volumes and capabilities."

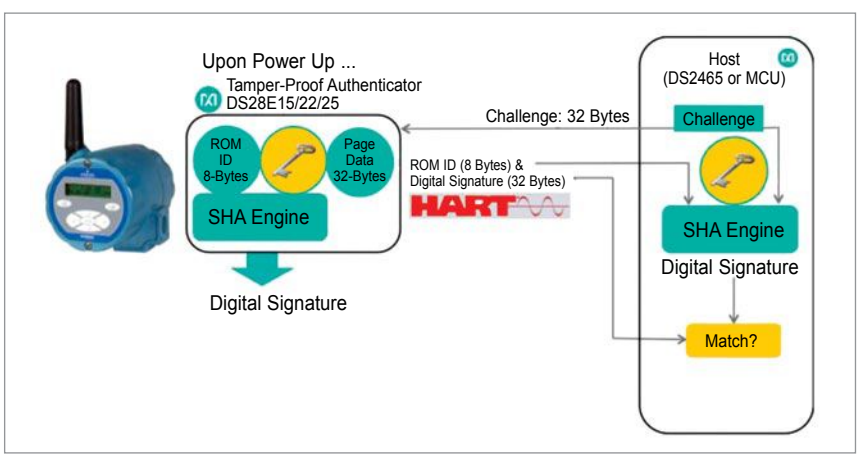

Fig. 5: Sensor authentication with SHA-256 (private key)

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The system solution to mitigating something like this is to implement secure boot for the main PLC CPU. This is a way of authenticating the firmware and only accepting software that has a valid digital signature. Depending on the requirements, you could also encrypt the firmware.

Security processing demands can easily overwhelm the MIPS of a traditional PLC CPU or even create latency issues. This is best done by off-loading the security functions to a low-cost, off-the-shelf secure microprocessor that is built for these functions, as shown in Fig. 6. The system shown here uses an external secure microprocessor to validate the firmware's digital signature.

All the above examples use keys to enable authentication, but this raises the question of key protection. Physical security of an encryption key is of prime consideration in many applications, since there is no security once the key is compromised.

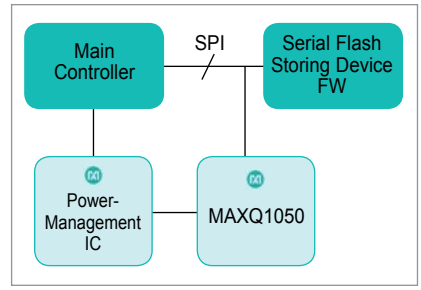

Fig. 6: Secure boot of the main PLC CPU

To properly address physical security, several issues must be considered. These include a physical mechanism for generating random keys, a physical design that prevents covert electronic interception of a key that is being communicated between authorised agents, and a secure method of storing a key that protects against clandestine physical and mechanical probing.

Various secure key-storage devices provide system designers a host of features that range from package design to external-sensor interfaces and internal circuit architectures. These requirements were developed by American military in the form of FIPS 140 standard, and many chip vendors provide very comprehensive tamper-proof capabilities that can be used in ICSes.

The future of the IoT security

There may be other approaches to security as well, and as you begin to realise how important security is in a connected factories environment, you will eventually coalesce around a few approaches.

The IIoT in manufacturing is in high demand, and is a growing trend. Security will also eventually grow to cover vulnerabilities, but the need is already here. EFY

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The TOP 5 IoT HACKS

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The Internet of Things (IoT) automates your lives by connecting everything around you from your cars to your homes to even your bodies.

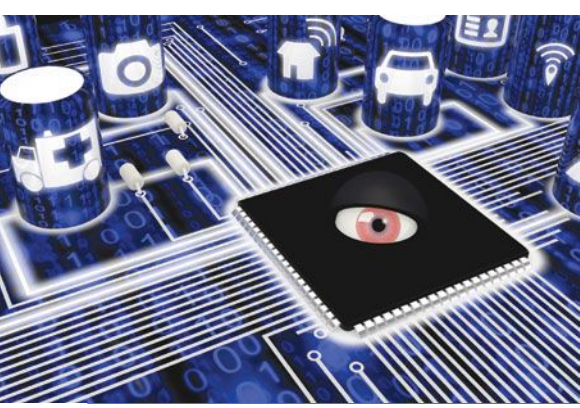
On the other side of the spectrum is the concern for the safety and security of your data. All data is interconnected, which reduces the efforts needed by hackers to hack the entire system.

A large number of Internet-connected devices lack even the most basic cyber security protocols, making these hackable in minutes. And even though most secure and trusted machines give hackers a tough time, one tiny loophole is sufficient for them to steal your data. In fact, Intel's prediction for threats in 2017 includes IoT malware that will open backdoors into the connected home that could go undetected for years!

To add to the fear, there are a lot of such IoT hacks that have been reported in the recent past. Let us take a look at five of these.

You are on the driving seat, but it is not you who is driving

Charlie Miller and Chris Valasek, automotive cyber security researchers, have proved that hacking Jeeps is child's play for them, especially because all carmakers are doing their best to turn an automobile into a smartphone. Uconnect, an Internet-connected computer feature in hundreds of thousands of Fiat Chrysler cars, sport utility vehicles (SUVs) and trucks, controls the vehicles' entertainment and navigation, enables phone calls and offers Wi-Fi hot spots. Uconnect's mobile connection lets anyone who knows the car's Internet Protocol (IP) address gain access from anywhere in the world.



In 2015, the duo attacked a Jeep over the Internet, from a distance of around 15 kilometres. They toyed with the air-conditioning, radio and windshield wipers, disabled brakes at low speeds and managed to paralyse the vehicle. This made Chrysler announce for a recall of 1.4 million vehicles and fix the vulnerabilities. But now these researchers have come out with better hacking tricks.

By sending carefully-crafted messages on the vehicle's internal network known as a controller area network (CAN) bus, they can pull off even more dangerous, unprecedented tricks like causing unintended acceleration and slamming on the car's brakes, or turning the vehicle's steering wheel at any speed. Unlike last year, instead of cutting the transmission on the highway, they can turn the wheel 180 degrees.

One major relief is that this hack can be performed only with a laptop that is directly plugged into the Jeep's CAN network via a port under its dashboard. But they promise this would get wireless soon.

Instead of merely compromising one of the electronic control units (ECUs) on a target car's CAN network and using it to spoof messages to the car's steering or brakes, they attacked the ECU that sends legitimate commands to those components that would otherwise contradict their malicious commands and prevent attacks.

By putting the second ECU into bootrom mode—the first step in updating the ECU's firmware that a mechanic might use to fix a bug—hackers were able to paralyse that innocent ECU and send malicious commands to the target component without interference.

Adventures of Barnaby Jack

Barnaby Jack, a hacker programmer and computer security expert, has managed to hack multiple devices including automatic teller machines (ATMs), pacemakers, ear implants and insulin pumps. At Black Hat conference in 2010, he gave a presentation on jackpotting, or exploiting ATMs to make these dispense cash without using a bank's debit or credit card. Jack gave demonstrations about different kinds of attacks involving physical access to the machines and completely automated remote attacks. In both cases, malware was injected into

the operating system of the machines, causing these to fraudulently dispense currency on the attacker's command.

During the remote attack, malware was installed on the target system via exploited vulnerabilities in the remote management system, most notably the use of default passwords and remote management transmission control protocol (TCP) ports. The attacker then executed the malware, causing the target ATM to dispense a given amount of currency.

Jack has also developed software that allows him to remotely send an electric shock to anyone wearing a pacemaker within a 15 metres radius.

Jack has also come up with a system that scans for insulin pumps that communicate wirelessly within a 91 metres radius, allows hackers to hack into these without needing to know the identification numbers and then sets these to dish out more or less insulin than necessary, sending patients into hypoglycaemic shock or ketoacidosis.

With more such hackers who can find out the vulnerabilities in various medical devices, hacking the human body is becoming pretty easy.

World's first digital weapon

Stuxnet, a highly sophisticated computer worm was discovered in 2010 and was essentially termed the world's first digital weapon. It was developed by American and Israeli governments, and was used to wreak havoc on an Iranian nuclear facility called Natanz. It targets industrial control systems that are used to monitor and control large-scale industrial facilities like power plants, dams, waste-processing systems and similar operations. It allows attackers to take control of these systems without the operators knowing.

Attack using Stuxnet was the first one that allowed hackers to manipulate real-world equipment, thereby making it very dangerous. It was the first computer virus to be able to wreak havoc in the physical world. It was sophisticated, well-funded and there were not many groups that could pull off this kind of threat.

It was also the first cyber attack that specifically targeted industrial control systems. It targeted the computer system of machines used to enrich uranium, known as centrifuges, and instructed these to spin the machines out of control. Eventually, the forces broke the centrifuges.

At the same time, Stuxnet reported to the control room that nothing was amiss. Over a period of few years, about 20 per cent of Iran's centrifuges spun out of control and were destroyed. Iran's nuclear scientists had no idea why so many centrifuges were busted. It indeed turned out to be a brilliantly sophisticated attack.

A kindle of devices attacked at once

A massive Distributed Denial of Service (DDoS) attack against Dyn, a major domain name system (DNS) provider, broke large portions of the Internet in October 2016, causing significant outage to a ton of websites and services, including Twitter, GitHub, PayPal, Amazon, Reddit, Netflix and Spotify. According to security intelligence firm Flashpoint, Mirai bots were detected driving much, but not necessarily all, of the traffic in the DDoS attacks against DynDNS.

Mirai is a piece of malware that targets IoT devices such as routers, security cameras and DVRs, and enslaves vast numbers of these compromised devices into a botnet, which is then used to conduct DDoS attacks. Since the source code of Mirai botnet has already been made available to the public, anyone can wield these attacks against targets.

This time hackers did not target an individual site, rather, they attacked Dyn that many sites and services were using as their upstream DNS provider for turning IP addresses into human-readable websites.

This type of attack is notable and concerning because it largely consists of unsecured IoT devices, which are growing exponentially with time. These devices are implemented in a way that these cannot easily be updated and, thus, are nearly impossible to secure.

Manufacturers majorly focus on performance and usability of IoT devices but ignore security measures and encryption mechanisms, which is why these are routinely being hacked and widely becoming part of DDoS botnets used as weapons in cyber attacks.

An online tracker of Mirai botnet suggests that there are more than 1.2 million Mirai-infected devices on the Internet, with over 166,000 devices active right now.

Not-so-smart refrigerator

White-hat hackers, or ethical computer hackers, at Pen-Test Partners were able to use fake security credentials to intercept communications between the fridge and Google Calendar.

Besides the fridge, the hackers also found 25 vulnerabilities in 14 allegedly smartdevices including scales, coffee makers, wireless cameras, locks, home automation hubs and fingerprint readers.

The hack was pulled off against RF28HMELBSR smartfridge, part of Samsung's line-up of Smart Home appliances that can be controlled via their Smart Home app. While the fridge implements SSL, it fails to validate SSL certificates; thereby, enabling man-in-the-middle attacks against most connections.

The Internet-connected device is designed to download Gmail Calendar information to an onscreen display. Security shortcomings mean that hackers who manage to jump on to the same network can potentially steal Google login credentials from their neighbours.

To sum it, the threats are real and our data is prone to attacks. Therefore while using IoT devices make sure that security is built on the foundation of the system and validity checks, authentication, data verification and encryption is carried out frequently. EFY

OPEN SOURCE And EMERGING PROTOCOLS Lead The Way For THE IoT

Saurabh Durgapal is working as technology journalist at EFY

Ever since the Internet of Things (IoT) came into the picture, it has caused one disruption after another. After all, the prospect of connecting anything non-computer to the Internet sounds exciting. But who knew that even after connecting your security system to the Internet to send out an alert to the authorities, you could still get robbed. Nevertheless, there is a lot of exciting stuff going on in the IoT spectrum.

T. Anand, principal architect, Knewron, says, "Newer communication protocols are helping in making wider-networked devices work together, without the need of heavy communication infrastructure." "These are more secure, consume less power and give a simplified interface to the Cloud and mobile phones," adds Akshay Aggarwal, co-founder, Mektrasys. Gartner, in its report about working areas in the coming two years, has highlighted low-power networks and security as important areas.

Focus areas in the IoT

Connectivity has seen a lot of focus over the past couple of years. Selecting a wireless network for an IoT device involves balancing multiple requirements including range, battery life, bandwidth, density, endpoint cost and operational cost. Multiple connectivity solutions like Long-Range Wide Area Network (LoRaWAN), Narrowband, Thread, Weightless or white space are some of the contenders. The long-term goal of an IoT network is to deliver data rates up to tens of kilobits per second (kbps) while consuming low power.

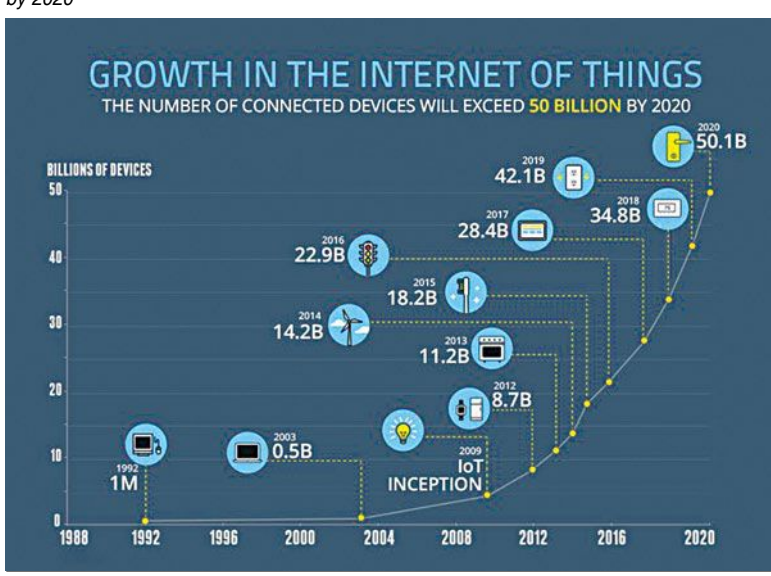


Fig. 1: The number of connected devices will exceed 50 billion by 2020

Low-power networks are on the rise. "Many new transmission protocols are addressing range issues by keeping data rates lower," says Anand. LoRaWAN has been popular over the past couple of years in low-power networks. As per a test run in Bern, Switzerland, a single access point could connect to a device 49km away. With that much capacity, you could connect an entire country with a handful of such access points. This network, however, is more suited towards machine-to-machine (M2M) communication, and manufacturing plants seem to have realised the importance.

"We are seeing automobile manufacturers collaborating for LoRa usage," says Rishabh Chauhan, global community manager, The Things Network. He explains, "The trick lies in controlling the duty cycle and allowing maximum number of devices to use the network."

Phani Varanasi, chief executive officer, Hanbit Automation Technologies Pvt Ltd, looks at innovative uses of LoRa. "We are looking at using a form of global positioning system (GPS) that uses LoRa instead of General-Packet Radio Service (GPRS)." The user device pings off multiple access points and allows information on the location of the beacon at any point of time. "This is helpful in place like a large shipyard where it gets difficult to track individual vehicles over a couple of

TABLE I
POPULAR OPERATING SYSTEMS AMONG THE IoT COMMUNITY

Operating system	Features
Contiki	• 10kB RAM and 30kB flash required • Extensive wireless networking support with an IPv6 stack • Touted for efficient memory allocation
RIOT OS	• 1.5kB RAM and 5kB flash required • Multi-threading, dynamic memory management, hardware abstraction, partial POSIX compliance and C++ support • Touted for efficient power usage
TinyOS	• Smallest operating system with the base less than 400 bytes • Most applications fit in 16kB
Raspbian	• Popular with Raspberry Pi DIYers • Supports Node-RED • Linux based
Brillo	• 32MB RAM and 128MB flash required • High adoption among hacker boards • Tied to Google's Weave communications protocol built on Android

kilometres," he explains. Post approval from WPC, this would be an interesting localised GPS to look out for.

Narrowband for the machines. Narrowband Long Term Evolution (NB-LTE), for example, can be fully integrated into existing LTE networks without the need of an overlay network. A version of LTE is being tested out for M2M communication as well. LTE machine-type communication (LTE-MTC), or LTE-M, also works within the normal constructs of LTE networks. However, it is more energy efficient in terms of its extended discontinuous repetition cycle, meaning that the endpoint can communicate with the access point on how often it listens for the downlink.

The advantages do not end here though. Applications are extremely simple as well. A mobile phone operator only has to upload new baseband software onto its base station, hence saving up heavily on added antenna costs.

It is also expected to be simpler because of the operation in the 1.4MHz band of the channel instead of the 20MHz in regular communication. This, however, has been further simplified into NB-LTE-M that dedicates existing resource blocks to the IoT traffic, by using further smaller channels. Instead of using 1.4MHz spectrum and six resource blocks, it works with only one LTE resource block, giving an effective throughput of about 200kbps for downlink and 144kbps for uplink.

Narrowband backed by mobile systems. Narrowband IoT (NB-IoT) networks are seeing a rapid rise since late 2015. The nudge was provided by the collaboration between Nokia, Ericsson and Intel Technologies to boost NB-LTE. Longer battery life and cheaper modules are the focus areas in the development of NB networks. Since it uses the backbone of the existing system, it provides for a better implementation on an economic scale.

This comes as a competing technology to Huawei's Narrowband Cellular IoT (NB-CIoT). Also known as NB-IoT, it looks to take over most of the smart city management, with applications ranging from smart water/gas metering, municipal light and waste management, livestock breeding to irrigation and environment monitoring. The biggest advantage of it is that its backing is based on mobile networks. This is, however, not based on LTE but instead on Direct Sequence Spread Spectrum (DSSS) modulation. It is expected to be simpler than NB-LTE-M with even cheaper chipsets.

The challenge with NB-IoT is that it does not fit in with LTE, hence, it calls for a separate side band with a different software setup, which could again increase deployment costs.

Lesser-known connectivity options. Sigfox is a viable alternative to LoRa, working in the same spectrum using binary phase-shift keying (BPSK). Even though it is

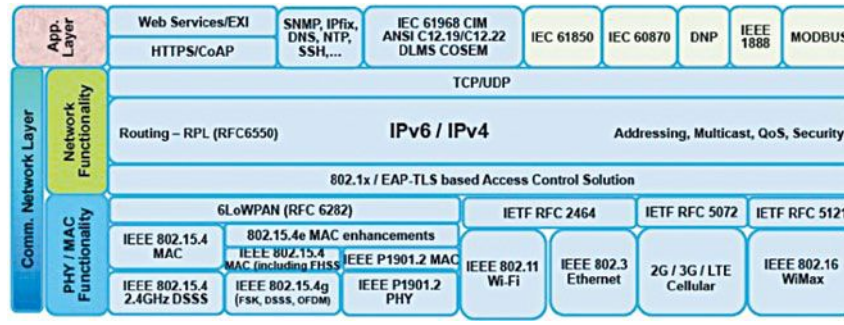


Fig. 2: IoT standards and protocols

bidirectional, communication via Sigfox tends to be better for uplink as compared to downlink. Downlink capacity is constrained due to limitations on receiving sensitivity at endpoint. This could well work for M2M communication, where we are concerned with the status of machines and status updates happen automatically.

Availability of Sigfox modules is not an issue anymore, as Sigfox is readily selling the endpoint technology to manufacturers. Availability of endpoints makes Sigfox extremely affordable. However, cost of a base station is high, making the system at par with LoRa network.

Thread is another technology that is being talked about. It targets to change the spotty and power-hungry nature of established connections. The mesh network created in a Thread connection looks to connect hundreds of devices around your home with minimum of batteries.

As per *threadgroup.org*, a simple AA battery could last for years. Aggarwal explains, "It spreads on the guarantee of an IP based work organising arrangement that is secure, solid, versatile and streamlined for low-power operation." Scalability of the network of up to 250+ devices and AES encryption to plug leaks in wireless connections add to the charm.

Weightless is a proposed wireless technology standard for exchanging data between a base station and thousands of machines around it using white space with high levels of security. White space refers to unused broadcasting frequencies in the wireless spectrum. This may not sound like much, but it becomes an important factor when you consider the capability to cover tens of kilometres in a single wireless hop. However, more realistic expectations from the system can be made after some solutions come to light.

Hardware and the open source community. There has been a lot of focus around the IoT with regards to open source hardware in the recent past. "The open source IoT framework allows you to utilise open-sourced implements to customise an IoT platform to suit your requirements," says Aggarwal. It provides a positive push for the initial start of product development.

Anand says, "However, due to mixed type of resource availability, product development is often left to be a subject of concern. We have a lot of IoT solutions, some of which are working towards making open source hardware applicable in real life."

A look at improved security in IoT systems

A lot of focus with the IoT is on Edge devices operating independently. Hence, we start with a secure booting process that verifies the authenticity and integrity of the software using cryptographically-generated digital signatures. Post setting up the device, access controls to remote users should be verified. If security is compromised, access control could ensure minimal control to unauthorised users—limited to entering access codes. Once the device connects to a network, it should verify itself with the network very much like Wi-Fi passwords. However, making it a non-cached system could be an improvement in this regard, in case any unauthorised entity gets this far.

The device also requires packet-inspection capability to control traffic for the device. This would be significantly different from the mainstream protocols that ensure no loss of data. And most important of all, security codes and hashes need to be updated regularly. This may be a huge task to undertake, but it could ensure ideal operation of the network.

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Increasing availability. Self-contained RF-certified module solutions that allow multiple protocols like TCP, UDP and IP on chip are flooding the market from various vendors. Built-in security features in these solutions help reduce certification times and allow the addition of communication to microcontroller based products. The ease of using these solutions is also increasing. Chauhan says, "The community approach allows you to take LoRa networks in your own hands. We have had successful implementations in about 100 cities with community participation."

Anand believes, "We need to move towards applied developments with open source hardware rather than just the hobby and fun part of it." Open source community has been helpful in supporting product development that could be made more useful with a focus towards product deployment and adoption, as it is finally critical for true success.

How secure are these systems

Security and analytics top the list of focus areas with IoT development. The IoT introduces a wide range of security risks and challenges to IoT devices, their platforms and operating systems, their communications and the systems to which these are connected. After all, experienced IoT security specialists are scarce, and security solutions are currently fragmented involving multiple vendors. As data volumes rise, newer analytic tools and algorithms are also needed, but as data volumes increase, traditional analytics are not enough to carry out the task.

At present, a very high number of IoT systems are open sourced and have open networks. This brings in the concern of security of these networks. These concerns are further fuelled by reports from Keeper Security, which highlight the state of passwords employed by users. Out of the one million passwords analysed by the group, a whopping 17 per cent went with the password 123456. Others in the list are no better. This brings in the question as to how secure the system can actually remain.

Improving the security. Security technologies required to protect IoT devices and platforms from information attacks and physical tampering must be improved significantly. Encrypting the communication and addressing innovative hacks and denial-of-sleep attacks that drain batteries must be looked at for the system to last longer. Security can also be made complicated by basic processors and simple operating systems used in edge devices that do not support complex security solutions.

Chauhan explains how they take care of security in their systems. "There are provisions for three levels of security in the systems. You need the network key that allows your device to connect with the network, the device key that allows you to access the device and the application key that allows you to access the particular data in the edge device." But if you set passwords like 123456, the system is going to have a tough time keeping intruders out.

Some ways to improve security can be implemented throughout the development cycle, starting with a threat model to consider the dangers and designing the system accordingly. Threat modelling helps the design team to consider vulnerable factors while designing the system, instead of post deployment. Security can then be implemented throughout the device lifecycle to keep those hackers on their toes.

Major contributors to this report

- **Akshay Aggarwal,** co-founder, Mektrasys
- **Phani Varanasi,** chief executive officer, Hanbit Automation Technologies Pvt Ltd
- **Rishabh Chauhan,** global community manager, The Things Network
- **T. Anand,** principal architect, Knewron

TABLE II
RECENTLY-LAUNCHED EDGE MODULES TARGETING THE IoT

Name	Supporting technology
RF-Lora from RF solutions	LoRa
CMWX1ZZABZ-078 from Murata	LoRa
MultiConnect xDot from Multi-Tech Systems	LoRa
ATA8520-EK from Microchip	Sigfox
Toby R2 series from U-blox	LTE
Monarch from Sequans Communications	LTE-M
Cinterion EMS31 from Gemalto	LTE-M
SARA-N2 from U-blox	NB-IoT
EYSHSNZWZ from TAIYO YUDEN	Bluetooth

What to expect in the future

Multiple ecosystems are expected to be the norm in the future, so interaction between different ecosystems is going to be another thing to look at. Areas such as smart homes, smart cities and healthcare call for robust systems with more reliability. Developers must regularly update the systems as more standards evolve in the future.

All things considered, multiple protocols could eventually help you out. There is Amazon Echo Dot competing with Google Home. Simply saying the words could get your prescription ordered or your air quality monitored. We have somehow managed to add connectivity in everything from televisions to tyres.

Considering a mix of image analytics and reactions on these by mechanical systems could be the next big thing. Adding image analytics to mechanical systems and tweaking some algorithms could lead to a much easier lifestyle. Which brings in the question, "Would that level of comfort be good for us and not turn us into lazy people sitting and typing everything away?" EFY

How THE INTERNET OF THINGS Can Take You Places

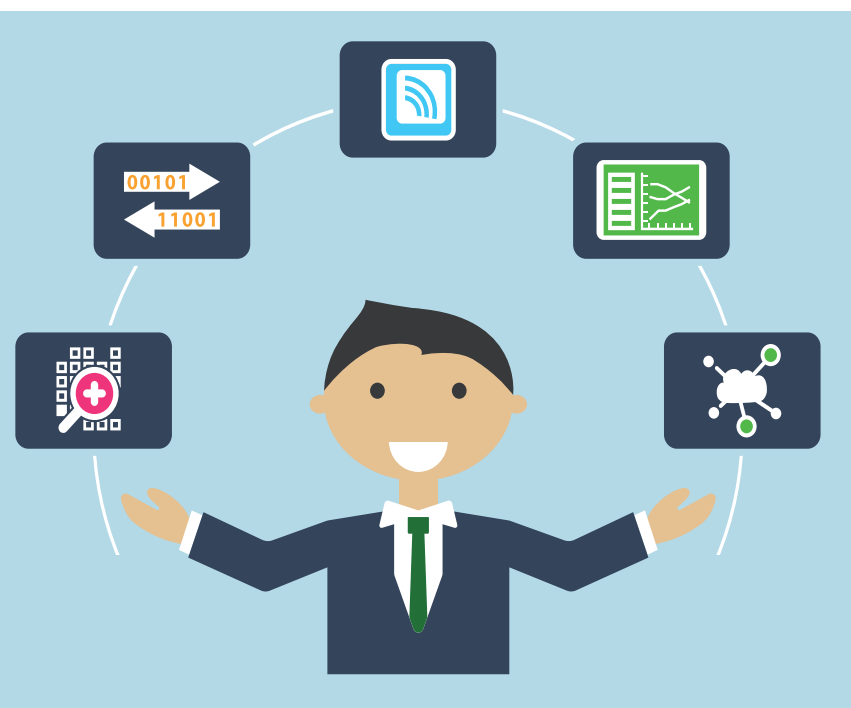
Saurabh Durgapal is working as technology journalist at EFY

We live in a fast-paced world. We wake up in the morning and are in a rush to get to office. From there we are in a rush to get home. We sleep less and focus all our energies into developing ourselves. We develop ourselves and hope that we are working in the right direction.

Developers hone their skills with the hopes of being successful in their field, without any assurance of the particular skill having a good scope in the next five to ten years. Let us take a look at the actual developing opportunities in the industry, so you have a better idea where to take your career next.

The IoT requirement

The Internet of Things (IoT) seems to be the keyword associated with data analytics. Anything that you can connect to the Internet is essentially the IoT. International access to the Internet at about 3.2 billion and counting increases career prospects. The IoT is a still developing field with additions being made on a regular basis.



All data that you see on print or the digital world is being compiled and made meaningful by man-machine collaboration. This calls for specialisation in the field of digging through relevant data to compile a meaningful report. Hence, data analytics seems to be the field with a lot of scope, since people always require meaningful data to work with, in order to achieve something better and bigger.

The added advantage for the IoT is the integration of hardware and software skills. There is still a difference, but now a person working on software can develop working interest in hardware, and vice-versa. Until the IoT dust settles, there is going to be a lot of confusion, as people are likely to keep changing roles.

The current situation

According to an IoT report by VisionMobile, "Sixty one per cent of wearable developers work in relatively small companies of less than 50 employees." This comes as good news for people having doubts with regards to small organisations. Not just small organisations, "the number of developers working alone (20 per cent) is surprisingly high," as per the report. Being a part of this change is very easy, and as expected, the report suggests that the number of developers working on IoT applications is to increase five-fold over the next five years.

According to TechGig Code Gladiators, a coding contest organised by *techgig.com*, Java, C and C++ have come up as the preferred languages

for programmers. Most contestants came from Bengaluru, Pune, Hyderabad, Chennai, New Delhi and Mumbai.

Specifics for development

"Engineers with multi-disciplinary skills are in high demand," explains Dr Milind Kulkarni, director - engineering institutes, ITM group. According to the market, Big Data analytics and Cloud skills are important because IoT sensors tend to send large amounts of data in real time. But the most important skills developers need are proficiencies in Cloud, mobile and data analytics. Expertise on the trifecta would govern salary and status with time.

Since the IoT requires dedicated hardware, there is a large requirement for developers with the knowledge of embedded systems. Since embedded hardware as well as software has to be continually updated, efficient development is now prioritised. Development skills will get you started, but creativity would keep you going.

Considering the hardware

Manufacturing hardware adds a certain level of complexity, so as a developer, refining some of those skills in hardware is likely to add to your skill set.

The IoT relates to connecting every device to a network. A very large number of these connections require sensors and dedicated hardware development. Current sensors include, "vibration, radio frequency, temperature, humidity, pressure and more," lists Hrishikesh Kamat, chief executive officer, Shalaka Technologies Pvt Ltd. A dedicated hardware learns from every recorded activity. "The system can learn and update after every activity," adds Kamat.

Automation also covers a lot of opportunities in product- and service-oriented industries. According to Siddarth Bharwani, vice president, Jetking Infotrain Ltd, "Researchers, robotics system engineers, senior robotics specialists, analysts, trainers, robotics technicians, supervisors and assistant engineers in the design and application of robot systems comprise major opportunities."

A lot of confusion in software

Software development is an area that requires fine tuning. Once we have a higher number of devices, decision towards a particular technology can be made easily. According to some industry experts, C programming, JavaScript and PHP skills should be in demand. These comprise the most basic in development and, hence, would provide a better way to work the system.

JOB OPPORTUNITIES AT A GLANCE

By location	By technology	By programming language
Bengaluru	IoT hardware development	C
Pune	IoT software development	C++
New Delhi	Cyber security	Java
Hyderabad	Data scientist	Python
Chennai	Solutions architect	C #

Some other experts believe that the IoT development could see demand in Java, Android, CSS and JavaScript skills. TechGig corroborates this with respect to language options. This sector is, however, limited to website development and management.

Cyber security experts

In a connected world, another matter of concern is security. According to a study by HP Fortify, conducted in 2015, "Six out of ten devices that provide user interfaces were vulnerable to a range of issues such as persistent XSS and weak credentials." If we are to envision a fully-connected world with majority of the devices along with their Cloud and mobile components allowing passwords such as 1234 or 123456, security becomes a major concern.

Additionally, higher the number of connected devices, higher the opportunities to break the system. Last year saw a rise in the number of data attacks, which were more than a hundred thousand. Bharwani adds, "Enterprises have to protect themselves, their services and data from vulnerabilities." Hence, efficient security professionals would be in high demand. However, since most of the potential weak links are similar to mobile or Web applications, people currently working on security have an edge; after all, anybody would bet on an experienced horse.

Difference in development now

At first glance, it does not feel like much of a difference. People are working on development and have been for more than 20 years. The biggest defining factor with the IoT is the things themselves.

Since there is no fixed device and range of development is unlimited, coding for this broad range of devices will define IoT software development. For hardware, most automated devices are connected and sensor-oriented. Hence, incorporating sensors in every imaginable device would be the change in development. These devices range from a simple wearable to dynamic streetlights with warnings for over-speeding, and would require developers to be creative in finding solutions for specific scenarios.

Available opportunities

Metros and big cities are becoming target spots for job roles.

Major contributors to this report

- **Hrishikesh Kamat,** chief executive officer, Shalaka Technologies Pvt Ltd
- **Dr Milind Kulkarni,** director engineering institutes, ITM group
- **Siddarth Bharwani,** vice president, Jetking Infotrain Ltd

"Bengaluru and Pune are becoming hot locations for IT and R&D companies," says Dr Kulkarni. He bases this on the available talent in these places. He explains, "Mumbai, New Delhi, Hyderabad and Chennai are providing good opportunities in multiple sectors such as finance, IT and consulting." Pune, Chennai and Sanand (Gujarat) also have major opportunities related to auto manufacturing.

Opportunities will always be there in major cities as these cities provide better infrastructure along with governmental aid in businesses. Specifically talking about IoT opportunities, there is no fixed location that would provide opportunities. Hardware development, however, would change the dynamics somewhat.

You cannot have hardware development just about anywhere. Catering to content delivery, we have a number of data centres located in engineer-efficient locations. "A large number of engineers with knowledge in automation, networking and configuring servers would also be required for setting up, maintaining and troubleshooting at the data centres," adds Bharwani.

The size and precision in IoT devices require specific development facilities that would require setting up of heavy industries. Since such development makes more sense in commercial zones, these would be hotbeds for opportunities. The best-in-class opportunities can be found in places with a history of electronics manufacturing, like Silicon Valley, Hong Kong, Shenzhen, Taiwan and other similar places.

The next step

With software DIYs becoming popular, basic application development can be picked up by spending time in front of a computer on a regular basis. The IoT being the next big thing, with heavy focus on connectivity, it makes sense to update your networking skills as well. Some of the promising locations would include places with high concentration of people looking for work with mobile development skills. So I hope now you know what to do. EFY

IP CORES For FPGA Designs

S.R. Ravikiran is an electronics hobbyist and has 14 years of experience in FPGA

Intellectual property (IP) cores are standalone modules that can be used in any field programmable gate array (FPGA). These are developed using HDL languages like VHDL, Verilog and System Verilog, or HLS like C.

IP cores are part of the growing electronic design automation (EDA) industry. In this article, these will be discussed with respect to SRAM based FPGAs.

Let us take an example of universal asynchronous receiver-transmitter (UART) IP block, which is intended to be used in different applicatons. The developed UART IP core module should:

- Meet basic UART functionalities
- Be portable, so that it can be used in any vendor technologies; for example, Xilinx/Altera as plug and play
- Have user-configurable parameters (like baud rate)
- Have processor interface/generic parameter file to modify configurations as required
- Provide IP data sheet

Types of IP cores

IP cores can be categorised as hard IP core, firm IP (semi-hard IP) core and soft IP core.

Hard IP cores. These are part of the FPGA-independent modules; for example, PCIe or Ethernet IP modules available in Xilinx FPGA. You have to configure the location and provide interface connectivity with other modules, clocks and resets.

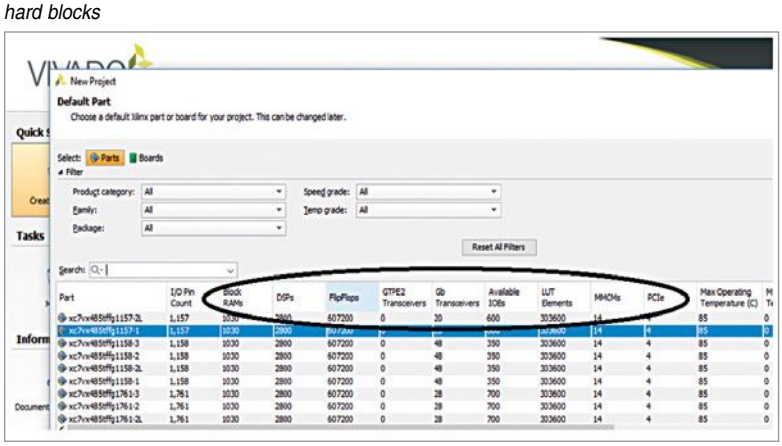


Fig. 1: Xilinx Vivado - FPGA selection overview includes hard blocks

Since these blocks are already part of the FPGA device, these will not be taken into account while calculating the utilisation of the slice logic report. In the utilisation summary, these will be counted as the number of PCIe/Ethernet blocks used. Because of a fixed location in the FPGA, these cores cannot be ported to other FPGAs. Neither can these be reused like HDL components, if already used in the FPGA.

Fig. 1 shows Xilinx Vivado tool - FPGA selection window for Virtex-7 FPGA with internal hard IP details for creating the project. The number of hard IPs may vary between different FPGA families.

Fig 2. shows the dedicated location of the hard IP in Virtex-7 FPGA.

Unmarked (not labelled) areas (between DSP slice and block RAM, or block RAM and PCIe, or PCIe and transceivers) in the FPGA (Fig. 2) contain large distribution of flip-flops, latches, multiplexers, LUTs, etc. Soft IP cores or custom logic are implemented in these areas.

Advantages include:

- Timing violations minimised
- No extra cost, that is, cost of the hard block is included in the FPGA; hence, can be considered as low-cost compared to other two types of IP cores
- No individual licence, except for compiler tool licence
- RTL code maintenance reduced
- No extra documentation required; for each IP level, documentation provided by vendor
- For slice/LUT summary, hard IP cores not considered
- Low dynamic and static power can be achieved if hard IP blocks are used in the designs
- Functionality and performance guaranteed
- Fully-tested and with known errors/limitations, if any, as per documents provided by vendor

Disadvantages include:

- Not portable; these are highly optimised and targeted at specific FPGAs

- Fixed implementation with pre-defined constraints
- Limited availability of number of hard IPs with respect to particular FPGAs

Firm IP cores. Firm IP cores are also known as semi-hard IP cores. These are a form of gate-level netlist, where you have the flexibility to place the module in the FPGA as per usage and with minimal user-programmable configurations.

For example, if a third-party IP is targeted at Xilinx FPGA, then the IP provided will be .ngc file. You can integrate this file with your project and instantiate it as a component in the top level to interconnect with other modules, and then proceed with synthesis.

To use a firm IP core, you should have proper FPGA resource planning and requirement specifications before procuring the IP for the project.

Xilinx Coregen-generated IP cores (like FIFO, shift registers and memory interface cores) can be grouped into the firm IP core category. You have to include .ngc/.xco in the project directory (for Xilinx), and specify the instantiation in the top file. Instantiated components can be moved around within the FPGA to meet performance and timing.

Advantages are:

- Modifications allowed to some extent
- Functionality and performance are measurable
- Resource utilisation considers firm IP logic area
- Completely tested
- Documentation may be available up to some level

Disadvantages are:

- Limited portability
- Modifications to source not possible
- May be licensed based on cost
- Source utilisation matters while considering the FPGA
- Timing/performance may have impact

Soft IP cores. These are completely flexible and do not depend on vendor technology. These can be ported across various FPGA platforms. The IPs are developed using HDL languages and you are provided with source codes, so the IPs can be modified according to your application and easily integrated with your modules. These are reusable and can be targeted at many variants of FPGAs.

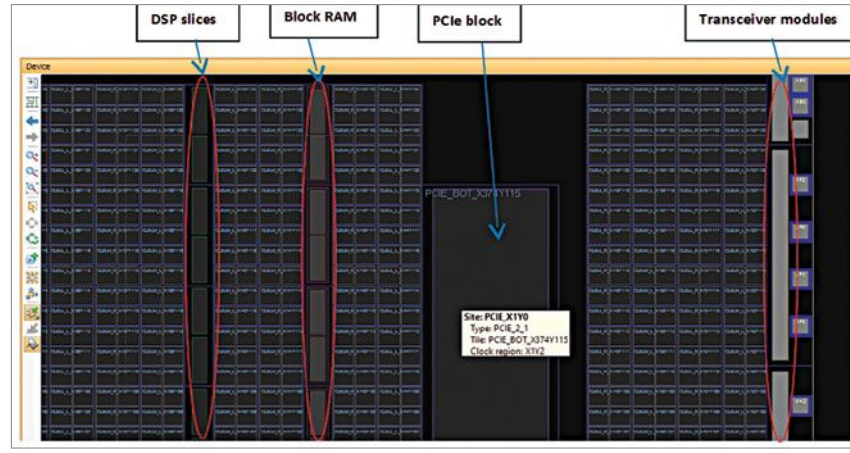


Fig. 2: Xilinx Vivado - Virtex-7 FPGA hard IP core locations

In Xilinx FPGAs, ARM, Zynq and PowerPC processors fall under hard IP category, whereas Microblaze falls in the soft IP group.

Similarly, in Altera, ARM, Intel ATOM processors come under hard IP core, and Nios-II processor under soft IP core.

Examples for other soft IP cores are 8051 microcontrollers IP, I2C controllers, SPI controllers, standard bus interfaces or any open core whose source can be modified.

These modules should be used as primitive instantiation in the custom RTL so that these get connected to user logic. In some cases, DDR2/3 cores are also specific to some banks of FPGAs.

Advantages are:

- Portable across FPGAs, independent of target technology/vendor
- Available as open source IP
- Easy to modify and implement as per custom applications
- Complete data sheet/documentation available for originally-targeted device/technology

Disadvantages are:

- IP cost may be high when compared to firm IP core since source code provided by third party
- Individual IP core licence may be required
- Performance/timing may vary with originally-targeted device/technology
- Documentation might be generic or specific to originally-targeted device/technology
- Support may not be available (or limited support available) for custom modifications
- Extra effort required while targeting custom technology/device
- In-depth understanding of design required before modifications can be made

Several factors must be considered while selecting the suitable IP such as cost of IP, effort required for customisation (for soft IP core), time to market, FPGA family, availability of simulation environment (unit and integrated levels) of IP, documentation, board-level evaluation of IP and support during development, among others. Nowadays, since most basic IP cores come with FPGA implementation tools for free, it makes time-to-market faster and results in lower costs.

In this article, we have taken Xilinx and Altera as examples. But you can find other vendors as per your FPGA designs. So depending on complexity, timeline and overall project cost, you can choose proper IP core type. EFY

Use BLOCKCHAIN TECHNOLOGY To Rout Risk Out Of Network Transactions

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

Ripple, a blockchain based technology startup, is sitting on a venture capital of US$ 93 million, sourced from an interesting mix of funders ranging from Google Ventures and Seagate Technology to a horde of banks like Standard Chartered. Ripple's network already has 15 global banks, and 10 more are waiting to board the train. Shanghai Huarui Bank, a privately-owned bank in China, is working with Ripple to implement a commercial cross-border payment service, so customers can transfer money internationally in real time. The bank feels it will help Chinese families to send money to their children studying abroad.

What is Ripple's offering that promises such confidence in the network? What is this technology, which interests not just banks but Web giants and the tech industry as well? In two words, the answer is blockchain technology.

Bank investment in blockchain technology is expected to reach US$ 400 million by 2019. This is because of the confidence that blockchain technology has the potential to ensure completely secure and tamper-proof transactions, in scenarios ranging from smart contracts and real-time international money transfer to contactless payments. Early blockchain systems had their share of problems like settlement lag and lack of privacy, but the current generation of startups is bent upon delivering enterprise-grade blockchain.

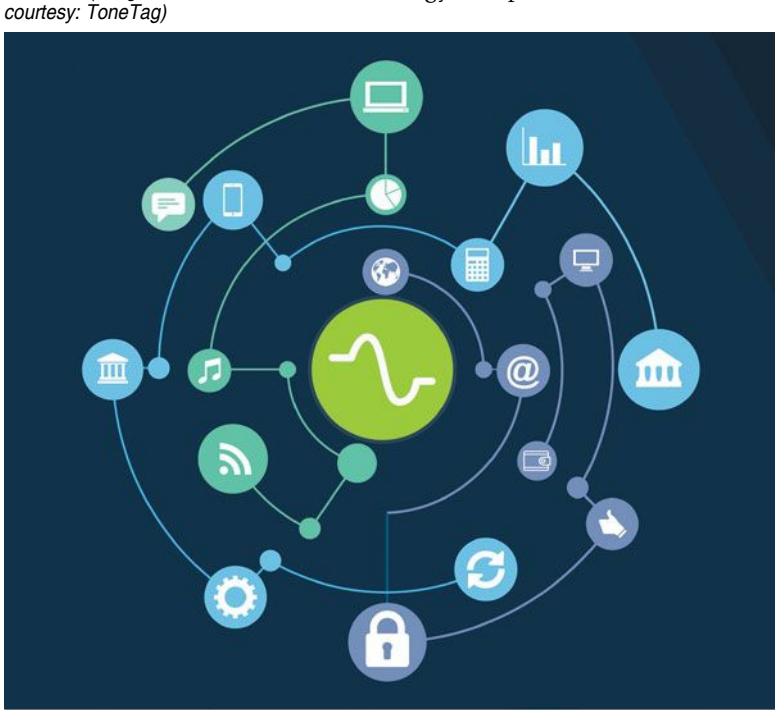


Fig. 1: Blockchain technology ensures completely secure and tamper-proof transactions in various scenarios (Image courtesy: ToneTag)

Demystifying the blockchain

You do not have to feel bad if you have already Googled for blockchain and not made head or tail of it. Even finance and tech experts take some time to understand this concept, and even more time to explain it confidently. As with most nascent technologies, it is difficult to differentiate the technology from its applications, and understand it for what it really is, what it is currently used for and what else it can do.

A blockchain is a decentralised, distributed public ledger that records, validates and secures transactions in a system. As is obvious from the name, a blockchain is made of several blocks. Each block contains encrypted data pertaining to a transaction, along with a hash that draws upon the previous block in the chain.

This way of connecting each cryptographically-hashed block with the previous one ensures that all data in the chain remains secure and unchanged. There is no single owner of any transaction—each transaction is authorised and backed by thousands of computers (called miners)—and so there is no single point that can be attacked or hacked.

That is what makes blockchain based transactions secure and tamper-proof. Using blockchain technology, it is possible to

carry out peer-to-peer transactions over the Internet, without requiring middlemen like payment gateways to authorise transactions.

"The block records some or all of the current transactions, and once it is completed, the block is time-stamped and hashed into the permanent database or blockchain.

"The blocks are linked to each other in a linear, chronological order where each new block contains the hashed details of the previous block. This creates a chain of transactional information, so that every block that is added protects information in the previous one," explains Kumar Abhishek, founder and CEO of ToneTag, a sound based proximity communication provider that enables contactless proximity communication, mobile payments, location based services, customer engagement services and more. The company recently adopted blockchain technology to make its transactions more secure.

Do Bitcoin, blockchain and distributed ledger technology (DLT) mean the same? People tend to use these terms interchangeably, much like they use Xerox to mean photocopier, but these are not the same.

A distributed ledger refers to a consensus of replicated, shared and synchronised data that is distributed across multiple locations, often spanning several institutions and individuals across the globe.

Bitcoin is one of the most well-known and earliest proven applications of DLT. It is a decentralised digital currency that enables you to make instant payments to anyone, anywhere in the world, without requiring any middlemen.

It is decentralised, that is, transaction management and money issuance are carried out collectively by the network. This is where the blockchain comes in. Devised as a method to keep track of all confirmed Bitcoin transactions, the blockchain is one type of distributed ledger in which data is distributed as blocks that form a linear chain with each one connected to the previous.

As explained in Bitcoin wiki, "Bitcoin uses public-key cryptography, peer-to-peer networking and proof-of-work to process and verify payments. Bitcoins are sent (or signed over) from one address to another with each user potentially having many, many addresses. Each payment transaction is broadcast to the network and included in the blockchain so that the included bitcoins cannot be spent twice. After an hour or two, each transaction is locked in time by the massive amount of processing power that continues to extend the blockchain. Using these techniques, Bitcoin provides a fast and extremely reliable payment network that anyone can use."

> "Blockchain technology continues to redefine not only how the exchange sector operates, but the global financial economy as a whole."
>
> ***—Bob Greifeld, chief executive officer, NASDAQ***

There are applications other than Bitcoin that use blockchain technology. And that blockchain is not the only form of DLT; there are others like Ethereum, Ripple, Hyperledger and MultiChain. But, by virtue of being the earliest and most famous example, Bitcoin, blockchain and DLT are used synonymously by many, and that is not always right.

In fact, blockchain technology can be used to develop apps more advanced than just supporting digital currency. This evolution is often known as Blockchain 2.0.

ToneTag's blockchain approach. "Blockchain was implemented as a way to keep record of all Bitcoin

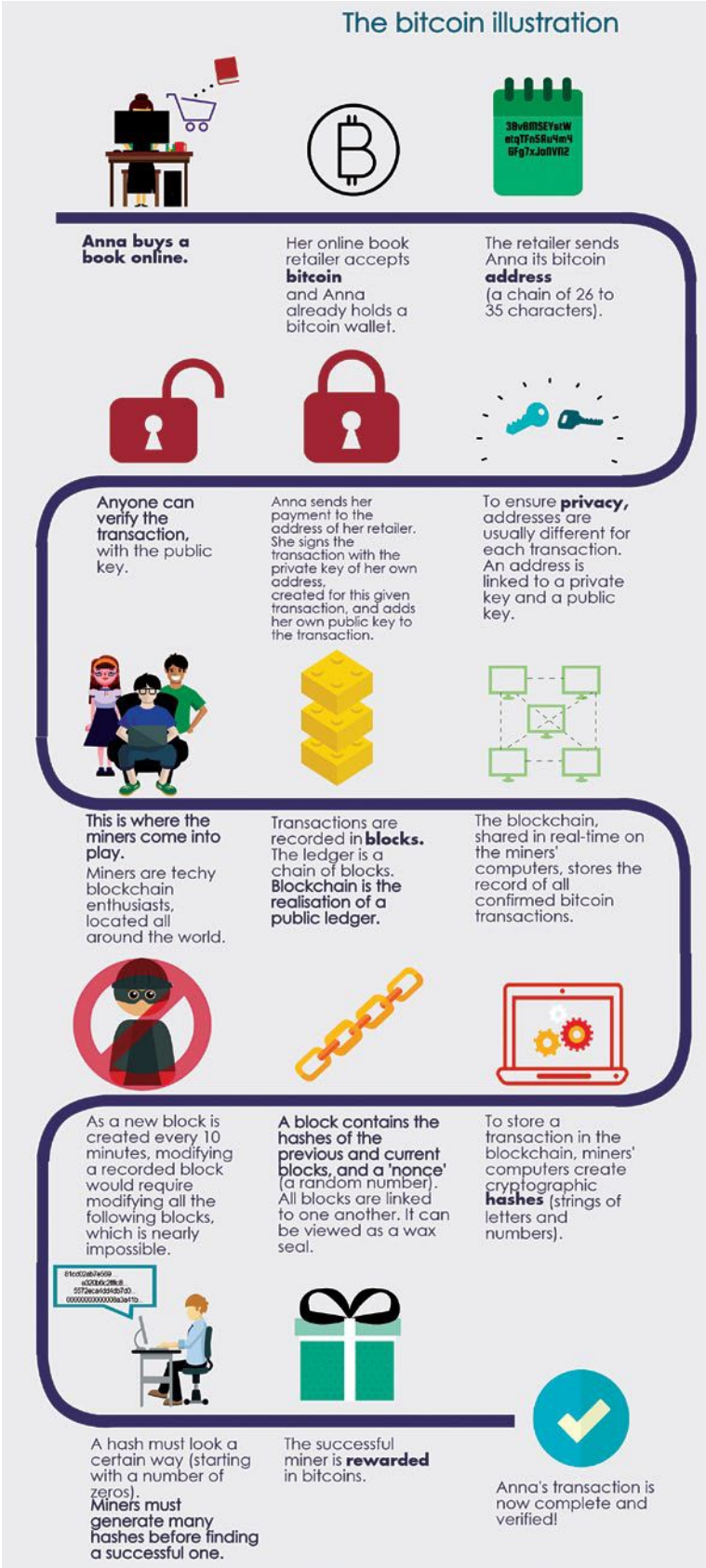


Fig. 2: Illustration showing how a blockchain works (Image courtesy: European Payment Council)

transactions. The payment system enables users to pay each other directly, without having to rely on a third party. Since Bitcoin is a digital cryptocurrency, it cannot be contained physically. There had to be an effective way to manage all transactions in the system, without giving control to any single party. This is where blockchain comes in. It is a distributed public ledger that records all transactions in a particular system," says Abhishek.

ToneTag follows a similar approach to Bitcoin blockchain, but the application varies. The way in which payment transactions are recorded at present is inefficient. The current system involves many entities and players, which leaves greater room for fraud. Every year hundreds of billions of dollars are lost due to fraudulent transactions. To address these security issues, ToneTag introduced blockchain technology to contactless payments. Blockchain technology has the potential to completely redefine the way transactions take place, as it brings unprecedented advancements in fraud prevention.

"ToneTag payments are tokenised, where a unique identifier replaces sensitive transaction information and none of the actual customer or merchant transaction information is revealed or shared, hence making the entire process highly-secure and fraud-proof," says Abhishek.

ToneTag enables contactless payments that are traceable, transparent and secure. Every party involved in the transaction is protected by the blockchain since it maintains a public record of every transaction that ever took place in the system. While paying through ToneTag, customers can identify whether the merchant outlet they are dealing with is exposed to risks or if it has witnessed fraudulent transactions in the past. Similarly, merchants can ensure whether a customer is genuine or not. Further, all transactions are validated to ensure these are authorised.

Miners, the quiet workers

We keep saying that, in a distributed ledger, data is stored in a distributed, decentralised way, spanning multiple digital locations across the globe. What makes this possible? The answer is mining.

Mining is the distributed computational review process performed on each block of data in a blockchain, which allows a consensus to be achieved despite each party not knowing or trusting the other.

Let us take the example of Bitcoin to understand this better. In order to conduct a transaction, a Bitcoin user has to sign it with his private key or seed. This helps prove that the transaction has been initiated by the right person, and also prevents third parties from altering the transaction in any way. After this, the transaction is confirmed through a process of mining and then included in the blockchain.

According to Bitcoin, "To be confirmed, transactions must be packed in a block that fits very strict cryptographic rules that are verified by the network. These rules prevent previous blocks from being modified because doing so would invalidate all the following blocks.

"Mining also creates the equivalent of a competitive lottery that prevents any individual from easily adding new blocks consecutively in the block chain. This way, no individuals can control what is included in the blockchain or replace parts of it to roll back their own spends."

Mining makes computer hardware do mathematical calculations for the Bitcoin network to confirm transactions and increase security. Any computer across the world can be a miner. As a reward for sharing their computational power, miners get a fee for each transaction confirmed by them, along with newly-created bitcoins. The reward depends on the amount of mining done. There are strict rules and procedures for this, and mining is not to be thought of as an easy way to make money.

Blockchain mining hardware. The blockchain mining process is mostly software based. In reality, anybody can become a miner using their personal computer. However, the speed and reliability demanded by upcoming mining protocols pose an opportunity for hardware innovation. We now have industrial-grade mining hardware (servers in data centres) and specialised application-specific integrated circuits (ASICs) for mining.

Antminer, Avalon6, SP20 Jackson and 21 Bitcoin Chip are some well-known ASICs for mining. Experts say you have to look at hash rate, efficiency and price when selecting a mining chip. Hash rate is the number of hashes per second that the Bitcoin miner can make. Usually, if the hash rate is more, the price will be higher. So you have to balance it with efficiency, which measures the electricity usage. This is important because miners usually consume a lot of power. Remember, we told you it is not an easy way to make money!

21 Inc. has come up with something more than ASICs. 21 Bitcoin computer is claimed to be the first computer with native hardware and software support for Bitcoin protocol. According to the company, it has the hardware to mine a stream of small amounts of Bitcoins for development purposes, and the software to make that Bitcoin useful for buying and selling digital goods. It can be used by developers and individual miners to create Bitcoin based apps, services and devices.

Embedded blockchain mining is a very nascent idea, which involves embedding mining chips into different kinds of Internet-connected devices. Last year, 21 Inc. revealed its plans to develop a chip (called 21 BitShare) that can be embedded into mobile phones, enabling them to silently mine in the background.

Another innovation from 2015, by Patric Lanhed and Juanjo Tara, is a chip that can be implanted in your hands for Bitcoin bio-payment. They have gone a bit overboard, but it might be a glimpse of what

the future holds. You never have to worry about forgetting your purse or phone at home, when tapping your hand can complete a payment.

Bit more than Bitcoin

Undoubtedly, Bitcoin, allegedly invented by Satoshi Nakamoto in 2008, is one of the best-known names in distributed ledger and blockchain technologies, but it is not the only one. Of late, there has been a lot of interest in this space, and many alternatives have come up. Here is a quick look at some of the contenders:

Ethereum. Ethereum is a decentralised platform that runs smart contracts. These are apps that run on a custom-built blockchain, with a platform-specific cryptographic token called Ether. The blockchain can move value as well as represent ownership of property. According to the company, "This enables developers to create markets, store registries of debts or promises, move funds in accordance with instructions given long in the past (like a will or a futures contract) and many other things that have not been invented yet, all without a middle man or counter-party risk."

Online reviews show that Ethereum transactions are confirmed in seconds compared to minutes for Bitcoin.

Another key difference is that Ethereum uses ethash, while Bitcoin uses secure hash algorithm SHA-256.

The two platforms also differ in purpose. While Bitcoin was intended to be an alternative to regular money, Ethereum is meant as a platform that facilitates peer-to-peer contracts and applications via its own currency vehicle. The focus of Ethereum is not to replace regular money but to facilitate and monetise the working of Ethereum to enable developers to build and run distributed applications.

Ripple. Ripple aims to be a global settlement network to facilitate instant, certain, low-cost international payments. According to the company, Ripple's distributed network allows foreign exchange to be externally sourced from a competitive foreign exchange marketplace or an internal foreign exchange trading desk via Ripple's FX Market Making Solution.

The backbone of Ripple's network is Ripple Consensus Ledger (RCL), a secure distributed ledger that uses the consensus process to settle transactions. Like other blockchain technologies, it does not require a middleman, and is very secure. The RCL holds the order book with bid/ask offers from payment initiators and market makers. Its path-finding algorithm enables it

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to find the lowest foreign exchange rate across all order books and currency pairs. It is basically a DLT, but with a specific purpose, which makes it more enterprise-ready.

Ripple aims to solve specific problems, which banks are likely to have with other public ledger based systems, such as delay in confirming transactions and lack of privacy. Ripple takes just three to five seconds to confirm a transaction through consensus among validators, as it does not use a proof-of-work method.

To solve the privacy problem, it advocates the use of Interledger Protocol (ILP), which can work with any bank or non-traditional payment network, regardless of its underlying technology.

ILP is an emerging standard that provides all benefits of public and private blockchains, while also ensuring that transaction data remains private to only the transacting parties. Ripple feels that ILP is a much better approach than private, bank-sponsored blockchains, as the latter approach can lead to a further fragmentation of payment networks.

Hyperledger. Hyperledger is a collaborative effort to develop a cross-industry open standard for distributed ledgers. The current implementation employs Bitcoin UTXO transaction model, which uses a system of public and private keys to ensure that transactions remain uncompromised while travelling to their destination. As of now, Hyperledger does not have any native currency. They believe that the technology will be useful for syndicated loans and capital markets infrastructure.

MultiChain. An interesting innovation, MultiChain is a platform that lets banks and other organisations develop their own blockchain. Customers can customise various aspects of the blockchain such as whether it is private or public, target time for blocks, who can connect to the network, how they interact, maximum block size, metadata that can be included in transactions and so on.

They also have their own improvised mining technique called mining diversity. The process enables miners to approve transactions in a random rotation. The company claims that this structure allows more miners to participate in the approval of transactions, while ensuring there is no fixed order of verification that could be corrupted.

India can benefit from blockchain technology

Every other day, there is a press release about a new DLT or platform. It is clear that it will play a key role in the future of the finance industry.

"For the financial services sector in India or abroad, blockchain offers the opportunity to overhaul existing banking infrastructure, speed up settlements, organise assets and streamline stock exchanges, although regulators want to be assured that it can be done securely. According to Santander, the banking industry could save about US$ 20 billion every year with the implementation of blockchain processes," explains Abhishek.

"According to many evangelists, the possibilities are limitless. Applications range from storing client identities to handling cross-border payments, clearing and settling bond or equity trades to smart contracts that are self-executing, such as a credit derivative that pays out automatically if a company goes bust, or a bond that regularly pays interest to the holder," he adds.

The emergence of enterprise-grade DLTs including highly customisable blockchains and enthusiastic support that banks and tech majors are extending to such companies make it clear that DLT is the way ahead for the financial services sector. EFY

MATERIAL AND DESIGN Come Together To Forge RELIABLE PCBs

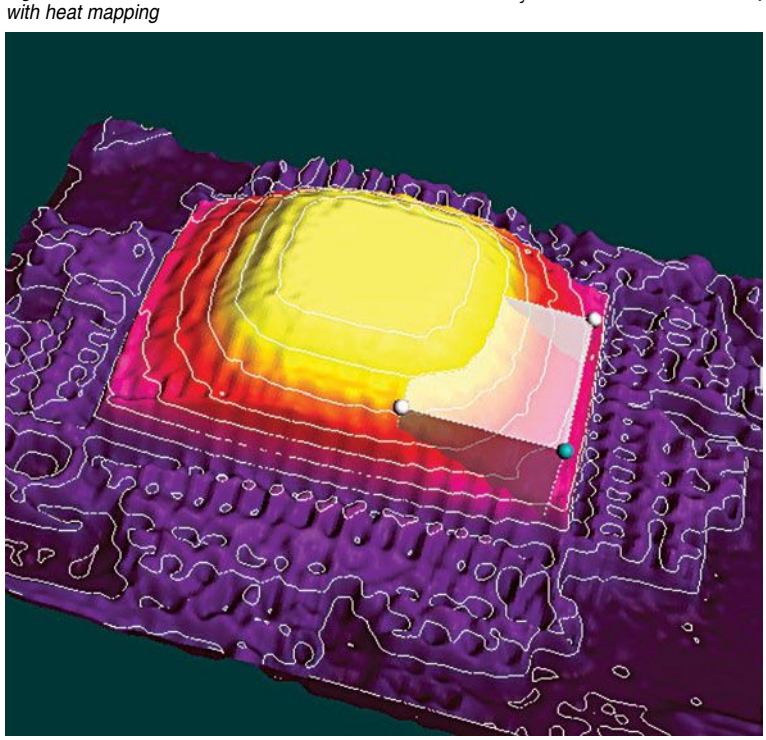
Saurabh Durgapal is working as technology journalist at EFY

As we moved towards touch-screen phones with ultra-smart features, we also reduced the lifetime of our mobile phones. A case that comes to mind from personal experience is a phone bought in 2004 that was still functioning in 2014, and was decommissioned only when a different phone was bought.

The newer phones, however, do not look as if these are built to last. You eventually have to go for a change of device every couple of years or so. What does this say about the reliability of these devices?

Major threat to the reliability of a printed circuit board (PCB) in an electronic device comes from the heat produced and improper dissipation of heat. Most aspects of the PCB such as traces, solder masks, white-marking, laminates and plating are relatively reliable and rarely fail in use. However, copper barrels in the vias and holes can lead to long-term operational failures. Hence, reliability begins with the designing of the PCB itself.

Fig. 1: 3D visulaisation with heat mapping



EDA tools help with the design

The new generation of electronic design automation (EDA) tools have been a huge help with PCBs. Satyan Prakash Raj, development engineer, Toradex, says, "Latest EDA tools support both pre- and post-layout simulations, and help engineers analyse and fix issues during the design stage, much before getting assembled, and test it."

New EDA tools provide advanced routing features, design simulations including signal-integrity and post-layout automated design checks, PCB stack-up management and impedance calculations, which enable designers to build better circuit boards, lower design risks and bill of materials (BOM) management, among others.

Thermal management is a focus area in design. Problems brought in by heat can be sorted out by effectively mitigating the heat by proper selection of material sets chosen for building the PCB. This includes the chemicals involved in the process. Multilayered board lamination, circuit density and plated through-hole (PTH) technology are also factors to be considered while building the boards. And the most important of all, take time to get the design right. You never know when the next Samsung Galaxy Note 7 will happen.

Raj adds, "Latest tools come with integrated simulation and analysis tools for thermal analysis and impedance calculation." This could help in managing the problems caused due to heat generation at a later stage of the PCB build.

From a mechanical point of view, EDA tools allow you to generate and view the

circuit board as a three-dimensional (3D) model. This would help you collaborate with mechanical designers. With support of rigid-flex design capabilities in the latest EDA tools, you can visualise the design in 3D and help check for mechanical issues like component collisions and clearance issues.

Open libraries are kind of a sour area. Some EDA tools also offer integrated open source libraries to help pick available components to start with the design. Some online tools provide availability and pricing across vendors. However, Hrishikesh Kamat, chief executive officer, Shalaka Technologies, feels that, to get the best in design, you need to manually build the components instead of blindly trusting open source libraries. He adds, "We have our own library to go to in case of non-regular components."

Anuj Deshpande, founder, Makerville Solutions, also believes in designing the components manually. He says, "A lot of times this can increase the timeline of the project, but the output is very reliable." However, the saving grace for open libraries, as Deshpande explains, is the extensive use of standard components that are easily available in open libraries.

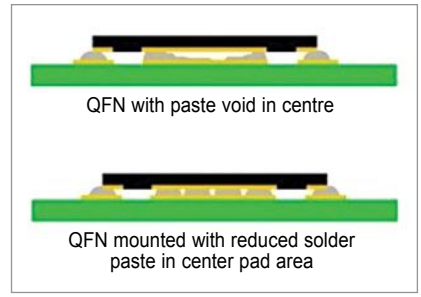


Fig. 2: Improper application of solder resulting in gaps

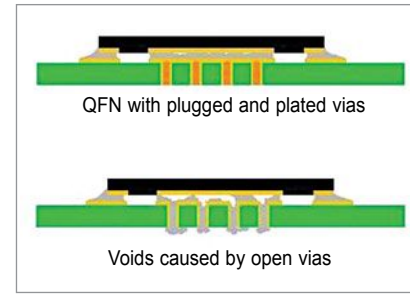


Fig. 3: Open vias need to be taken care of

Kamat explains some designing issues his team faces, "We have to take care while defining the power and ground planes, and avoid auto-correct most of the times." Auto-correct, on one hand, helps in getting the design right but, on the other, can cause unexpected problems while manufacturing.

Problems in manufacturing

When talking about manufacturing printed boards, the magic happens due to very minute particles. Dana P. Ilmer, Superior Flux & Manufacturing Co., says, "You have to be

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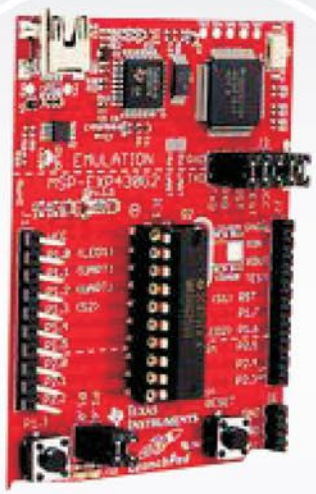

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At the heart of the Texas Instruments' LaunchPad range of development boards is the MSP430. The MSP430 is an easy-to-use flash programming microcontroller, just like other microcontrollers such as the ATmega range from Atmel. It was specifically designed to be low-cost and low-powered, suitable for a range of applications.

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very careful with the manufacturing process. The smallest of problems can lead to very disastrous PCBs." The boards need to be cleaned thoroughly and must be checked and rechecked for any remaining particles post processing before you add any components. He explains, "You cannot leave any flux on your boards post cleaning. Unless the board is clean of every individual particle, you are going to have problems."

Through-hole is an area that sees a lot of problems. However, are there solutions that can take care of these. Improved plating distribution has had positive effects like improving the reliability of the PTHs. Electrolytic plating is a cost-effective method for doing this. It uniformly increases the thickness of circuits and results in improved tracks.

For improved thermal shock and cycling, however, acid copper plating process is the one to go for. Throwing power can also be increased by improvements in plating cell design with anode configurations and proper selection of circuit components. Pulse plating could also help in this regard. Ilmer says, "There was once a case of phenolic paper boards being used for PCBs."

The material for the board is also important. Phenolic paper boards help in cutting cost, but bring in their own set of problems. Compared to glass epoxy boards, these have less adhesion for copper cladding and are more prone to environmental degradation and chemical attacks.

These are also mechanically weaker, which facilitates easy drilling and shaping. However, this ease can be easily looked over as these happen to be more brittle than glass epoxy boards. This highlights the fact that the material used in the boards is also a matter of concern.

Laminate materials present their own set of problems. These can be brittle and cause problems during inner layer treatment, leading to reduced bond strength between multiple layers of the board. Minute factors like moisture absorption become important factors at this point.

To ensure improved bond strength, longer lamination cycle times and pre-lamination bake cycles on inner layer materials become important as well. The pre-heat must be set right for the process to go smoothly.

Also, laminate materials could lead to poor plating adhesion due to the fillers involved. This calls for desmearing the resin prior to plating.

Recently, due to the influx of wearables, there is a high demand for flexible PCBs. Rigid and flex PCBs used in designing often use different materials, with the rigid sections consisting of more layers than the flexible ones. To improve reliability with additional layers of flexible material, stiffeners are added to bring rigidity to the PCBs. These are usually made of stainless steel or aluminium, mixed with a dielectric material. A common practice to avoid cracking at the convergence of rigid and flexible areas is to not place components in those locations.

Factors at a glance

Robert Tarzwell and Ken Bahl have explained some factors that affect the reliability of PCBs over a long term, in a paper they published some time ago:

1. The more assembly cycles that a circuit experiences, the less reliable the product will be in the field
2. The hotter or longer the assembly cycles are, the less reliable the product will be
3. The thicker the laminates, the less reliable the product will be, by a considerable factor
4. The lower the T/g, the less reliable the board
5. Copper ductility of the plating bath greatly affects reliability
6. Copper plating thickness, if too thin, will drastically lower reliability
7. The cure and selection of prepreg in multilayers plays a big role in future life cycles
8. Drilling quality affects hole-plating quality and therefore reduces the life in the field
9. The de-smear process is critical to reduce via cracking
10. Any small pinhole in the copper wall is a concern for reliability
11. A high number of thermal cycles over 100°C delta causes reduced operational life

A good PCB is a fine line indeed

Therefore you cannot depend solely on the EDA tool to get it right; you must maintain your own personal library for reliable components. Once a PCB design is with the manufacturer, you must recheck for the right components. Deshpande says, "Once I sent a design to a manufacturer and got back a list of components that my components could be replaced with. This helped with the final product." But you cannot always rely on things going your way, can you?

You can neither let the PCB stay in the flux for too long, nor can you go with just about any board. Everything must work just right until you have a working PCB that you can rely on. Constant vigilance seems to be the key to improving reliability. The age-old proverb 'Toiling in the Sun' will eventually get you a PCB that will not blow up in your hands. EFY

Major contributors to this report

- **Anuj Deshpande,** founder, Makerville Solutions
- **Dana P. Ilmer,** Superior Flux & Manufacturing Co.
- **Hrishikesh Kamat,** chief executive officer, Shalaka Technologies
- **Satyan Prakash Raj,** development engineer, Toradex

The Rhyme Of C OPERATORS

N. Abid Ali Khan is working as assistant professor in Department of ECE at Vasavi College of Engineering (autonomous) at Hyderabad. He has been working in the field of power-efficient embedded networking architectures, and is passionate about microcontrollers, ARM, RTOSes, embedded systems and programming

It is thanks to Dennis Ritchie and his team that the first C compiler was released way back in 1972. C language has found its own place in developing embedded system software, real-time operating system policy implementations and device drivers ranging from simple 8-bit microcontrollers to complex 32-bit FPGA targets. This article takes you through the basics of C-supported operators and describes an easy way to remember the priority of operators while evaluating an expression.

If you can remember the slogan 'M-A-S-G-E-A-R-O-Ca-Co-?-=' (left to right), any C expression can be calculated without actually typing the expression in a C compiler. Many books provide a standard table discussing the priority of operators and their associativity. But, when an expression is given, it is a little cumbersome to work it out by recalling the table all the time. This article also serves as an easy way to keep the order of priority on the fingertips.

Let us take the example of priority of execution of C expression shown in Fig. 2. This expression evaluation is simple; since only arithmetic operators are involved, where multiplicative operators (multiplication, division and modulo division) have high priority, while additive operators (addition and subtraction) have lower priority. If the expression is found to have operators of the same level of priority, evaluation starts from left to right (associativity). Step-by-step evaluation is also mentioned by specifying the high-priority operator with an underline.

Now, let us see how priority of the expression changes if we introduce bit-wise operators (bit-wise AND - &, bit-wise EXOR - ^ and bit-wise OR - |) in combination with arithmetic operators. For our use case, let us consider the expression shown in Fig. 3. Notice that, initially, multiplicative operators from left to right are evaluated. Then come additive operators; finally, when we land with only bit-wise operators, order of priority is first bit-wise AND, followed by bit-wise EXOR with bit-wise OR at the end. The expression, which has to be evaluated, is underlined for each step.

In the above expression, we missed the shift-left (<<) and shift-right (>>) operators. In fact, these are at the third position in the rhyme. Consider another expression given in Fig. 4, where multiplicative, additive and all bit-wise operators exist, including shift operators. This expression looks crispy, and no coder opts for it.

However, if you are asked to work on driver development with RAM memory organisation whose CPU registers are not bit-addressable, you may land up with expression(s) like this. As advised, you have to follow the order of the slogan, considering the priority with multiplicative→additive→shift-left or shift-right→bit-wise AND→bit-wise EXOR→bit-wise OR to evaluate the expression for arriving at the correct answer.

The shift-left and shift-right operators have significant improvements in terms of power because if you are shifting integer N by k times towards the left, you are multiplying N with 2^k. On the other

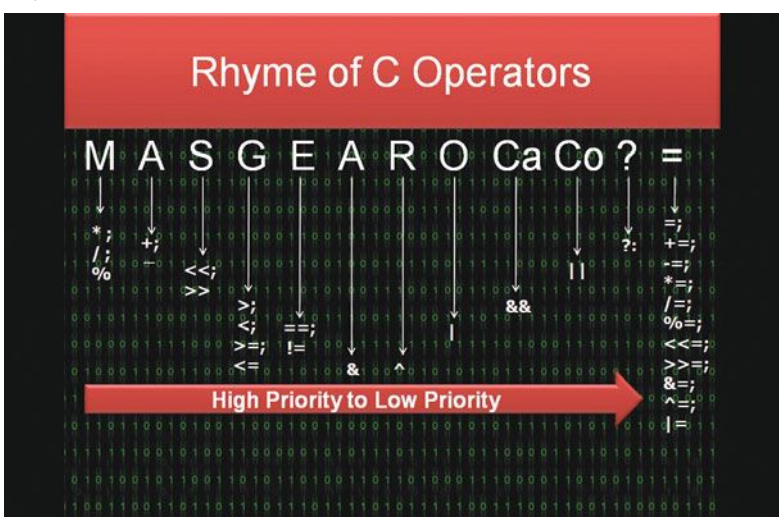

Fig. 1: Rhyme of C operators

```
int a = 5;
a = 10-a*6%7 + 14/3;     // a*6 is done as its priority is high from left to right. (Exp – 1)
a = 10-30%7 + 14/3;      // 30%7 is done next
a = 10-2 + 14/3;         // 14/3 is next.
a = 10-2 + 4;            // 10 – 2 is next.
a = 8 + 4;               // 8 + 4 is next.
a = 12;
```

Fig. 2: C statement with arithmetic operators (multiplicative and additive) operators

```
int a = 5;
a = 12^10-4&a*6%7 + 16/3|1;   // Now follow M-A-x-x-x-A-R-O-(Exp – 2) from L to R
a = 12^10-4&30%7 + 16/3|1;    // after a*6; 30%7 is next
a = 12^10-4&2 + 16/3|1;       // 16/3 is next
a = 12^10-4&2 + 5|1;          // 10 – 4 is next
a = 12^6&2 + 5|1;             // 2 + 5 is next
a = 12^6&7|1;                 // bitwise AND is next, irrespective of place.
a = 12^6|1;                   // bitwise EXOR is next.
a = 10|1;                     // bitwise OR is next.
a = 11;
```

Fig. 3: Statement with multiplicative, additive, AND, EXOR and OR operators

```
int a = 5;
a = 9 < < 2^a–a&a*2%3 + 2|9/2 > > 1 < < 2;     // M-A-S-x-x-A-R-O
  = 9 < < 2^a–a &10%3 + 2|9/2 > > 1 < < 2;     // First ax2 is done, next 10%3
  = 9 < < 2^a–a &1 + 2|9/2 > > 1 < < 2;        // next 9/2
  = 9 < < 2^a–a &1 + 2|4 > > 1 < < 2;          // next Subtraction.
  = 9 < < 2^0&1 + 2|4 > > 1 < < 2;             // next addition
  = 9 < < 2^0&3|4 > > 1 < < 2;                 // Shift left operation
  = 36^0&3|4 > > 1 < < 2;                      // Shift Right operation
  = 36^0&3|2 < < 2;                            // Again shift Left
  = 36^0&3|8;                                  // Bitwise AND
  = 36^0|8;                                    // Bitwise EXOR
  = 36|8;                                      // Bitwise OR
  = 44;
```

Fig. 4: With multiplicative, additive, AND, OR, EXOR and shift operators

```
int a = 6,b = 3;                          // We have M-A-S-G-E-A-R-O in the expression.
a = a/2 = = b|a < < a/b + b|a*b^b < a;
  = 6/2 = = 3|6 < < 6/3 + 3|6*3^3 < 6;    // First Division (6/2)
  = 3 = = 3|6 < < 6/3 + 3|6*3^3 < 6;      // Next Division (6/3)
  = 3 = = 3|6 < < 2 + 3|6*3^3 < 6;        // Next Multiplication (6x3)
  = 3 = = 3|6 < < 2 + 3|18^3 < 6;         // Next is Addition (2 + 3)
  = 3 = = 3|6 < < 5|18^3 < 6;             // Next is Shift left (6 < < 5)
  = 3 = = 3|192|18^3 < 6;                 // Next is Less than (3 < 6)
  = 3 = = 3|192|18^1;                     // Next is Equality Check (3 = = 3)
  = 1|192|18^1;                           // Next is Bitwise EXOR (18^1)
  = 1|192|19;                             // Next is Bitwise OR (1|192)
  = 193|19;                               // Next is Bitwise OR (193 | 19)
  = 211
```

Fig. 5: With multiplicative, additive, relational, bit-wise - &, |, ^ and shift operators

hand, if you are shifting N by k bits towards the right, you are dividing the number by 2^k.

That means, for an integer N,

N < < k≡N × 2^k // Power-efficient multiplication

N > > k≡N/2^k // Power-efficient division

Let us add relational operators of the two operands and try to get the value of the expression shown in Fig. 5 by following the priority order of the operator rhyme. Note that, within the available relational operators, there exist two priority levels among equality operators (low) and greater or less than operators (high).

Next, let us observe the behaviour of compound conditional AND (&&) and compound conditional OR (||) statements, too. Among these, logical AND (&&) has higher priority compared to logical OR (||). In the expression given in Fig. 6, again, by following the operator's priority rhyme, the step-by-step value is obtained.

Assignment operator (=) is the last priority in the rhyme. Note that, other than the regular assignment operator, a combination of assignment with arithmetic operators or with bit-wise operators too may fall under this observation. For example, consider the expression in Fig. 7. After evaluating the complete expression on the left-hand side, 63 is the result. Next, we have an assignment operator concatenated with an addition operator; this addition will be performed in the end, yielding the final value as 69.

Finally, consider the expression shown in Fig. 8, where most operators are deliberately used to understand how to evaluate to a final value, by following the order of priority as per the rhyme.

Although the expressions given in Figs 5, 6 and 7 are vague in nature—which a developer rarely adopts, for the other expressions, especially expressions that can be a combination of multiplicative,

```
int a = 6,b = 3;                          // We have M-A-S-G-E-A-R-O-Ca-Co in the expression.
a = a/b&b + b||a*b-a^b < < b&&a%b|a;      // Let's substitute the values of a and b in Exp.
  = 6/3&3 + 3||6*3-6^3 < < 3&&6%3|6;      // First Division (6/3)
  = 2&3 + 3||6*3-6^3 < < 3&&6%3|6;        // Next Multiplication (6x3)
  = 2&3 + 3||18-6^3 < < 3&&6%3|6;         // Next Modulo division (6%3)
  = 2&3 + 3||18-6^3 < < 3&&0|6;           // Next is Addition (3 + 3)
  = 2&6||18-6^3 < < 3&&0|6;               // Next is Subtraction (18-6)
  = 2&6||12^3 < < 3&&0|6;                 // Next is Shift Left (3 < < 3)
  = 2&6||12^24&&0|6;                      // Next is bitwise AND
  = 2||12^24&&0|6;                        // Next is bitwise EXOR
  = 2||20&&0|6;                           // Next is Bitwise OR
  = 2||20&&6;                             // Next is Logical AND (20&&6) = 1
  = 2||1;                                 // Next is Logical OR (2||1) = 1
  = 1.
```

Fig. 6: With multiplicative, additive, bit-wise and compound conditional (&& and ||) operators

```
int a = 6,b = 3;                          // We have M-A-S-G-E-A-R-O-Ca-Co-?- = in the expression.
a + = a/b > > 1&a + b|b*a-b^a < < b|a%b;
  = 6/3 > > 1&6 + 3|3*6-3^6 < < 3|6%3;          // First 6/3 is performed.
  = 2 > > 1&6 + 3|3*6-3^6 < < 3|6%3;            // Next is (3x6)
  = 2 > > 1&6 + 3|18-3^6 < < 3|6%3;             // Next is (6%3)
  = 2 > > 1&6 + 3|18-3^6 < < 3|0;               // Next is (6 + 3)
  = 2 > > 1&9|18-3^6 < < 3|0;                   // Next is (18-3)
  = 2 > > 1&9|15^6 < < 3|0;                     // Next is (2 > > 1)
  = 1&9|15^6 < < 3|0;                           // Next is (6 < < 3)
  = 1&9|15^48|0;                                // Next is (1&9)
  = 1|15^48|0;                                  // Next is (15^48)
  = 1|63|0;                                     // Next is (1|63)
  = 63|0;                                       // Next is (63|0)
  = 63;
Therefore a = a + 63  =  69;                    // Finally, (a = a + 3;)
```

Fig. 7: C expression with arithmetic, bit-wise (Shift, AND, EXOR, OR) and assignment operators

```
int a = 5,b = 7;                          // We have M-A-S-G-E-A-R-O-Ca-Co-?- = in the expression.
a < < = a + b*2%4 + b/a-a > b?a > > 1^b:b < < 2&b|3;
  = 5 + 7*2%4 + 7/5-5 > 7?5 > > 1^7:7 < < 2&7|3;    // Multiplication of (7x2)
  = 5 + 14%4 + 7/5-5 > 7?5 > > 1^7:7 < < 2&7|3;     // Next is (14%4)
  = 5 + 2 + 7/5-5 > 7?5 > > 1^7:7 < < 2&7|3;        // Next is (7/5)
  = 5 + 2 + 1-5 > 7?5 > > 1^7:7 < < 2&7|3;          // Next is (5 + 2)
  = 7 + 1-5 > 7?5 > > 1^7:7 < < 2&7|3;              // Next is (7 + 1)
  = 8-5 > 7?5 > > 1^7:7 < < 2&7|3;                  // Next is (8-5)
  = 3 > 7?5 > > 1^7:7 < < 2&7|3;                    // Next is (5 > > 1)
  = 3 > 7?2^7:7 < < 2&7|3;                          // Next is (7 < < 2)
  = 3 > 7?2^7:28&7|3;                               // Next is (3 > 7) which  =  0.
  = 0?2^7:28&7|3;                                   // Next is (28&7)  =  4
  = 0?2^7:4|3;                                      // Next is (2^7)  =  5
  = 0?5:4|3;                                        // Next is (4|3)  =  7
  = 0?5:7;                                // Next is Conditional Operator FALSE part = 7
  = 7;                                    // Next Left-shift in combination with assignment
a  =  a < < 7;
  =  640
```

Fig. 8: C expression with arithmetic, bit-wise, relational, conditional and assignment operators

additive, bit-wise and assignment operators in a single expression, precedence of operators will come in force. As per the operator's rhyme from left to right, value can be calculated. EFY

SmartMoo, An Agri-IoT Revolution

Ankita K.S. is audience development editor at EFY, and secretary of IEEE-YP. She is an engineering graduate, and also writes articles on technology for *electronicsforu.com*

Our daily diet includes dairy products in one form or the other, be it milk, ghee, butter or other milk based products. These play a very important role in maintaining the nutrient balance in our body. But, how do you know if the milk you drink is hygienic, with nutrients in proper portions, stored under correct conditions and is from a healthy cow? Definitely, a milk-packaging brand can answer these questions to some extent, but what about farmers, who have no idea about the milk's quality or contents? They would not even know if they are getting paid proportional to the quality of the milk or if their cow is under-nourished.

Milk is India's largest crop—India alone produces about 155 million tones of milk annually, and this number can increase further if the emerging markets perform well. So to resolve this issue, how about a full-stack Internet of Things (IoT) company that provides end-to-end dairy solutions? Here, an end-to-end solution covers tracking and monitoring of animal health, automated milking system equipped with smart machines, smart milk procurement peripherals, real-time payments and chilling milk using bulk milk coolers.

Fig. 1: Activity meter on a cow

Fig. 2: SmartMoo milk production application—SmartMoo-Herdman

This is what a team of five co-founders with combined 90+ years of experience have formulated. They are called Stellapps, and their creative product is called SmartMoo.

Spelling out SmartMoo

The innovative applications of SmartMoo use the IoT, Big Data, Cloud, mobility and data analytics to improve agriculture supply chain parameters like milk production, milk procurement, cold chain, animal insurance and farmer payments. Primary focus is on data application and smart learning, using

SmartMoo by Stellapps is an end-to-end dairy technology. SmartMoo IoT router and in-premise IoT controller acquire data via sensors that are embedded in milking systems, animal wearables, milk chilling equipment and milk procurement peripherals, and transmit the same to Stellapps SmartMoo Big Data Cloud SDP, where SmartMoo suite of applications analyse and crunch the received data before disseminating it to various stakeholders over low-end and smart mobile devices.

smartSDP (service delivery platform)—the full-stack IoT solution to optimise dairy supply chain.

The IoT at the farm. Milk production-side IoT intervention includes sensors in the milking system. For example, an electronic milk meter monitors the functioning of milking machinery, animal wearables such as cow pedometers, radio frequency identification (RFID) ear tags and Android applications to scan and capture data from small farmers who cannot afford automation. This data from sensors is acquired by SmartMoo IoT router and in-premise IoT controller and transmitted to Stellapps SmartMoo Big Data Cloud SDP.

Over the Cloud. In Cloud servers, SmartMoo suite of applications analyses and crunches received data before disseminating the analytics and data science outcome to various stakeholders over low-end and smart mobile devices. Data acquired is used by Cloud-side analytics and machine learning algorithms for yield improvement, preventive healthcare, accurate oestrus detection, reducing inter-calving period, nutrition improvement, optimised animal insurance and reduction in the cost of operations. The data acquired at the milk production level by SmartFarms is used in the next hop of the supply chain.

At milk-collection centres. Milk procurement side includes sensors to analyse the milk quality, assess adulteration-limiting antibodies leaving the milk, assess the farmer's performance and save solid not

fat (SNF), fatty acids (FAT) details using the farmer's RFID tags. The details are sent to the farmer via SMSes. Data acquired is used by Cloud-side applications to determine return on investment improvement, enhanced traceability, regional assessment of milk production pattern and automated real-time farmer payments.

At storage units. Milk cold-chain-side IoT intervention includes sensors for accessing milk temperature, volume of milk, energy optimisation and pilferage control. Data acquired is used by Cloud-side application to ensure adherence to the cold chain protocol, determine quality of milk and for preventive maintenance of milk-chilling equipment.

Fig. 3: SmartMoo milk procurement application

Fig. 4: The founding team behind SmartMoo (left to right: Ramakrishna Adukuri, Venkatesh Seshasayee, Ranjith Mukundan, Ravishankar G. Shiroor and Praveen Nale)

Putting agriculture and technology together

Agriculture, by default, is rural and remote. This causes troubles like remote management and difficulty in getting local expertise on premise. This is a major problem in emerging markets especially where farm productivity levels, quality of farm produce and production-side supply chain values are extremely low as compared to developed markets.

Stellapps team analysed this issue and found out that using sensors in the farms to automatically acquire data and apply analytics and machine learning on the Cloud and then using the outcome of the analytics and machine learning can solve both the issues efficiently.

A simple solution might be implanting a sensor on the milking equipment, storage units and pedometers, and deploying a milk-collection centre with milk-examining equipment. Connect all devices through the Cloud, collect data and send it to the dairy. However, this is not all.

Because the whole team were from IT and technology background, it took them a lot of time to understand agriculture and dairy verticals. "This lack of vertical experience was a disadvantage as well as an advantage. We were able to look at the problems from a fresh perspective," says the Stellapps team.

The major problem was to get customers to appreciate the need and value of the product, and obviously the major customers, farmers and the rural crowd found it difficult to digest too much technology.

Once the farmers understood and accepted the need, the next challenge arose—remoteness of deployments made it hard for support and maintenance. This challenge has been overcome today by providing most of the support via Cloud interfaces and also via training customer support teams.

Another issue is that customers expect software Cloud services to be free, which is a problem the team is trying to surmount.

The bigger picture

The whole company is bootstrapped using a corpus from career savings of the founders. The founding team members have strong technology-industry experience and come from IITs. In addition to this, a good technology-centric idea made it easy to get funding from various alumnus including IIT-Madras/ Rural Technology Business Incubator (RTBI). "We were lucky to run into Omnivore Partners, who had agriculture-technology-specific focus, and Stellapps' business vision aligned with Omnivore's," says the team.

The whole system does not benefit the farmers and the company alone but also ensures end customers with good-quality products. "We are touching more than 350,000 farmers every day through our solutions and around 4.7 million litres of milk every single day," the team adds.

The proprietary smartSDP platform and suite of apps touch close to two billion litres of milk annually. Proprietary solutions are deployed successfully at many private diaries in India, Kenya and Nepal as they continue to rapidly expand. Not just this, the response of SmartMoo users is also overwhelming—a lot of farmers from various districts of Karnataka like Kolar, Coorg, Mysore and others find SmartMoo very useful.

Through Stellapps technology solutions applied at the Nepal farm, there has been a substantial increase in productivity of the farm, touching 800 cattle, and the farm has been able to draw upon several thousands of litres of milk with clean milk technology and raise the health and monitoring services of cattle.

SmartMoo's centre of gravity is shifted towards software/data on the Cloud, thereby commoditising the hardware. This Bengaluru based startup aims to create a major revolution in the agriculture industry by revamping the dairy farms to boost productivity. EFY

Automotive:

"AI can increase efficiency... to about 90 per cent"

The rise of autonomous vehicles calls for improving the systems regularly. Every kilometre that an autonomous vehicle covers, delivers valuable data in its development. Puneet Gupta, chief technology officer, Brillio, talks about the challenges involved in autonomous vehicle development with Saurabh Durgapal of EFY

PUNEET GUPTA
CHIEF TECHNOLOGY OFFICER, BRILLIO

Q. What are the trends in automotive testing?

A. In the early stages of system development while building a core system, it is important to invest in building emulators. This helps in managing testing in the early stages and reduces costs. Cost of corrections increases significantly if you go for testing after the system has been developed. Use of artificial intelligence (AI) in creating user modelling and auto creation of new test scenarios is a high-potential area.

Q. How does AI help with testing?

A. While testing any autonomous system manually, the number of test cases are limited by the imagination of the tester in charge; whereas, a car can be driven by someone with a much different notion of driving. AI, on the other hand, can model various kinds of drivers based on their driving habits, and can give a better test case scenario. Adding AI can increase efficiency from 65 per cent that comes with manual testing to about 90 per cent.

Q. Please walk us through the systems in an autonomous vehicle?

A. There are three major parts in the system involved in autonomous vehicles. First is the intra-vehicle sensory network and associated edge processing, which is involved in instantaneous decision making.

Second is Cloud based analytics and control hub that process the enormous data being generated and draw insights and behaviour-modification decisions.

Third is the external sensor and communication infrastructure that can help enhance autonomous performance and experiences.

Q. Can we rely on middleware?

A. With the right architecture, we can rely heavily on middleware. Everything can be broken down to critical, medium- and low-critical decisions. Critical decisions happen inside the onboard computing device in the vehicle. Decisions that can wait, for example, driving behaviour and optimal speed, can be sent to the Cloud. There is also the possibility of some onboard component failing. Algorithms in this case are designed to take actions depending on the car health.

Q. How do these systems learn to be safe with human life?

A. At the core is learning and risk-calculation algorithms. Initially, the systems are overly cautious, which reduces over time in their tryst to imitate humans. Alternatively, these can operate in assisted mode. Once the systems learn to take calculated risks, these can graduate to autonomous mode. Algorithms are designed to work by carefully weaving in imperfections that result in more intelligent behaviours.

Q. How can modifying algorithms impact vehicles?

A. Accidents happen when we try to stretch the boundaries of algorithms in autonomous systems, and while trying to make these behave more like human beings. As humans, while driving, we do not stop at every turn. Instead, we take a calculated risk and go ahead. Computing systems are typically built around hard choices and, hence, are not tuned to calculated risks. This is where we begin pushing the boundaries of autonomous systems to take some calculated risks.

Q. What are the future expectations in delivering end experiences?

A. A smartphone on its own can bring in smart driving experiences today. A range of sensors are already available and more are getting added every day. So if a vehicle is involved in an accident, the smartphone instead of acting dead can react on sudden deceleration data and guide the driver.

Once data is accumulated, focus is going to be on innovative uses of that data.

Q. What are the available analytics tools for testing?

A. There are some good open source and commercial options available today, but most of these are in patches and must be clubbed together for extensive usage. So anybody doing extensive usage must build some core components of their own. That is the approach we are taking as well—leverage the good open source available but invest heavily to build a core integrated foundation. EFY

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Pocket Some MECHATRONIC TOOLS For The INDUSTRIAL IoT

SHANOSH KUMAR

Electronic Workbench (design and simulation)

Electronic simulation software by nature, this tool is aimed at making you an expert in drawing electronic circuit schematics using an array of components super quickly. You can start by choosing the required components and start connecting these one by one to create circuits easily. The software lets you connect many measurement tools to your predesigned circuit and run the simulation even before your project is implemented in real time. The application runs quite well on Windows platform, and you can download this from this edition of *Electronics For You Plus* DVD.

HOTINT (design and simulation)

If you are looking for software that helps you simulate Physics based flexible, multi-body systems, then this software is for you. This mechatronics simulation software allows modelling of complex mechatronic and multi-body systems including dynamic and static computation, Eigen mode calculations, elements for rotor-dynamics, IoT blocks for building controllers, beams suitable of large deformations, parameter variation and optimisation.

HOTINT also supports coupling with controllers created with X2C, which is a free and open source tool for model based development and code generation in real-time control algorithms using microprocessor units. X2C uses open source environment of Scilab/Xcos for building the graphical control model. This software is only available for Windows platform.

Some popular resources

DisplayCAL. DisplayCAL, previously called DispcalGUI, is a graphical user interface developed for the purpose of display calibration and profiling using Argyll CMS, which is an open source colour-management system. Using DisplayCAL, you can calibrate and characterise display devices using hardware sensors and play around with available settings like customisable white point, luminance and tone response curve as well as create matrix and look-up-table ICC profiles, with optional gamut mapping, as well as some proprietary 3D LUT formats. DisplayCAL is written in Python, and has been packaged for all supporting operating system platforms.

Apache OpenOffice. Apache OpenOffice is an open source office productivity software suite. It contains a word processor (Writer), a spreadsheet (Calc), a presentation application (Impress), a drawing application (Draw), a formula editor (Math) and a database management application (Base).

UNetbootin. UNetbootin allows you to create bootable live USB drives for Ubuntu, Fedora and other Linux distributions without burning it onto a DVD or CD. This software also lets you select and download many distributions of operating systems in its out-of-the-box repository.

PCB Creator (PCB)

PCB Creator is your one-stop solution for PCB layout and schematic capturing. With the capability to create two- to four-layer custom PCBs, new parts and footprints could be designed within a few hours of getting your hands on this software. You can import and export your designs and libraries with other EDA tools, use Schematic Capture and preview the designs. The software is powered by DipTrace platform and provides a four-in-one design environment that lets you customise designs and create PCB layouts with auto router, 3D PCB preview, and component and pattern editors. It also supports real-time 3D PCB preview and export.

TANGO control system (SCADA)

TANGO is an open source toolkit for building high-performance and high-quality distributed control systems for small and large installations. The toolkit design is based on the concept of distributed devices or objects, and provides native support for multiple programming languages. It implements a full set of tools for developing, managing and monitoring small and large control systems.

KnightOS (utility)

Some of us like using operating systems to their full potential. To do that there must be an operating system that matches the level of freedom, customisation and agility required. KnightOS is designed to run calculators or emulators on Z80 CPUs. This platform also gives you the freedom to use Assembly, C, Python, HTML/CSS and JavaScript, and use custom kernels during development. EFY

Shanosh Kumar is technology journalist at EFY. He is BCA from Bangalore University and MBA from Christ University, Bengaluru

Verilator: The Verilog to C++/SystemC Compiler

PRIYA RAVINDRAN

One of the biggest questions in a Verilog designer's mind is, "How would it be if the Verilog code can include synthesisable constructs?" A lot of issues that a verification engineer might come across can probably be solved by a simple display statement. We are not talking about the test-bench here but, simply, synthesisable Verilog, with some Property Specification Language (PSL), System Verilog and synthesis assertions thrown in.

If you could just use a single tool, use all of the above language constructs and end up with a SystemC or C++ code that does exactly what you intended the code to do, would that not be truly wonderful? Welcome to Verilator!

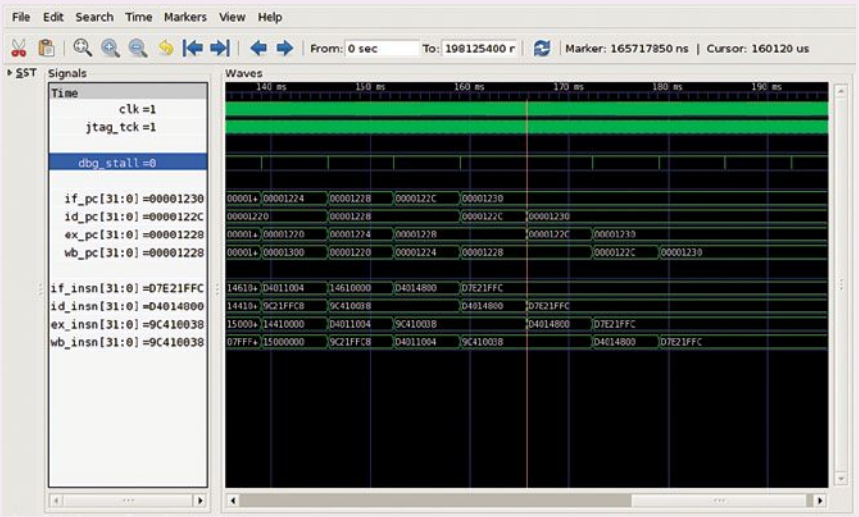


Fig. 1: A tutorial for cycle-accurate SystemC model creation and optimisation using Verilator, by Jeremy Bennett of Embecosm

Verilog simulation with a difference

Verilator is a free Verilog hardware description language (HDL) simulator. It is not simply an alternative for NC-Verilog, Verilog Compiler Simulator (VCS) or even Icarus Verilog. Instead, Verilator is your path to migrate synthesisable Verilog (not behavioural) code into registers and wires on your chip. The output you get is C++ or SystemC that mimics Verilog, plus the synthesisable constructs. Of course, you might need to add a touch of C or Makefile to finally get your code running. Take the files generated from Verilator, add a C++ wrapper file instantiating the top-level module, pass this onto Command Prompt and you are good to go.

The job of Verilator is not to simply translate Verilog to C++ or SystemC directly. Instead, it compiles your code into a much faster model. This highly-optimised version is wrapped inside a C++ or SystemC module. This combination of compiled Verilog and SystemC is about one hundred times faster than interpreted Verilog simulators and ten times faster than standalone SystemC.

Supporting all the right necessities. The fact that Verilator is free for anyone to use makes it an instant favourite. With support provided even for System Verilog assertions and coverage analysis, thorough analysis of your design is many steps easier. If you are working on a large project that requires fast simulations, this should be the tool of your choice—many multi-million gate designs with thousands of modules have been successfully implemented with Verilator. You might want to try that embedded software CPU you have been working on, trying to create an executable model with Verilator, soon.

As fast as it can get

The owners claim that Verilator is the fastest free Verilog HDL simulator and that it simulates faster than even most commercial ones. You might wonder how Verilator manages to run as fast as it does. The answer is that Verilator is not Verilog-compliant! Sounds a bit confusing, does it not? The question is 'How?'

Authors of Verilator explain that most simulators are Verilog-compliant, in the sense that these are event-driven. This makes these wait and follow a sequence, not allowing these to reorder blocks or make netlist-style optimisations. But this, the team believes, is where you stand to gain. It might seem against the natural order, but

Specifications

- Written by Wilson Snyder, with Duane Galbi and Paul Wasson
- Developed on 64-bit Ubuntu
- Should run any system with GCC and Perl
- Works on Redhat Linux, OpenSUSE, HPUX, Solaris, Windows NT under Cygwin (C++ only, no SystemC) and Microsoft Visual C++
- Typically needs a maximum of 1GB for functioning
- GNU lesser-public licence version 3
- Option of using Perl artistic licence
- Latest version 3.900

they make a compelling argument, "Synthesis tools do not comply with Verilog either!"

Verilator takes a cue from here, follows a path closer to the synthesis interpretation and ends up putting together a simulator that gives the same results, but faster. How about when you take the design to the silicon stage? No issue there either, as it is the synthesised netlist that goes into the final wafer.

Optimise and re-optimise

Focus of Verilator lies in optimising your code to the maximum possible extent, while not compromising on performance. It internally creates all states of the resulting simulation and uses a large symbol table for accomplishing its functionality. Thus, each signal access takes about two to three fewer assembly instructions than the usual case, making the execution time 10 to 15 per cent faster. But if there is a change in even one signal, the symbol table needs to be recompiled. Else, it can lead to a lot of complication.

Tightly integrated with C and the like

Just like with Verilog codes, you can make use of C functions the way you wish to. Although there is no support for programming language interface (PLI) as such, common PLI-ish calls like $display, $finish or $time are converted into C++ equivalents. You can even write your own C++ code and integrate it with Verilator to realise an otherwise complicated piece of functionality. Accessing signals in C just needs a Verilator public comment added, which then allows you to scope into C++ class to read the value of the signal, as you would with any other member variable.

Filling in the gaps

Working with a mix of two languages has its own complications. The easiest, or maybe the most difficult of it all, is finding the right interconnect. If you have a block that just connects cells together, do you code it in Verilog or SystemC? The website of Verilator says, "Everything else being equal, best performance is when Verilator sees all of the design. So, look at the hierarchy of your design, labelling cells as if these are SystemC or Verilog."

Group only SystemCs separately and, similarly, Verilogs separately for achieving best performance. The one place where a pure Verilog might be better off in SystemC category would be if there are multiple instantiations of the same; SystemC might help achieve the result faster! Remember to put any block that uses a combination of the two below SystemC, as Verilator cannot connect to lower-level SystemC cells.

Added support

Verilator makes it easier for you to work with a comprehensive package by extending support to many features that are otherwise limited. In this context, Verilator supports SystemVerilog Direct Programming Interface (DPI) import and export statements, a limited subset of Verilog Procedural Interface (VPI) and even cross-compiling Verilog code. The latter is often exploited for running the tool on a Linux based system, generating C++ code and then compiling it on Windows. The fact that some parts of System Verilog, Verilog analogue/mixed signal and synthesis directive assertions are also supported, makes the tool popular among regular users. New features are added as and when a user requests it.

See the values changing on the big screen

Verilator provides support for dumping out waveform traces in C++, SystemC or even SystemPerl. You just need to have the necessary packages and point environment variables correctly. For viewing these waveforms on the screen, dump out the standard value change dump (vcd) files and view these with open source tools like Dinotrace or GtkWave. The same will also work with commercially-available tools for waveform viewing, if you so wish.

The website for Verilator, *https://www.veripool.org/wiki/verilator*, has a collection of rather interesting tutorials and presentations that answer doubts about whether this is the right tool for you, how to get high-performance designs and the like. There are also many other applications that are discussed, all of which have used Verilator at some point of time. It even goes on to explain how you could use a tool called vmodel to simuate verilated Verilog modules inside MATLAB simulations. Go ahead and take a look for yourself! EFY

Priya Ravindran is M.Sc (electronics) from VIT University, Vellore, Tamil Nadu. She loves to explore new avenues and is passionate about writing

OpenSCAD: Solid 3D Modeller For Programmers

PRIYA RAVINDRAN

Three-dimensional (3D) modelling has been in vogue for decades. The first thing you would imagine on hearing the term is a piece of complicated graphics on the screen—something you can move around and view from different angles. The mind creates small videos of choosing one extra component and moving it into that small hole you can see on the screen, moving around the rest to make space for this or deleting that extra length from rectangular section R2; in essence, a powerful graphical user interface (GUI).

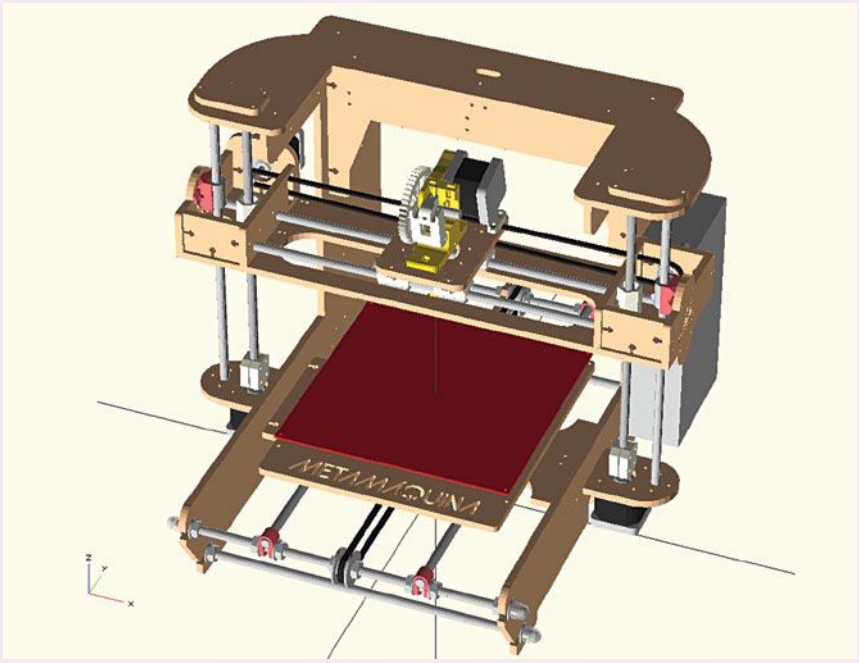


Fig. 1: A fully parametric 3D printer designed using OpenSCAD by Sara Rodriguez

A look at OpenSCAD

OpenSCAD is one such tool for 3D modelling, but this is where the similarities end. Although you still get to physically see things on the screen, you do not move these around. Instead, you code. You code to create something new, edit the code to make changes in what you see and delete lines of the code to remove something. You have direct access to your very own backend library—the script you write.

OpenSCAD software lets you create solid 3D computer-aided design (CAD) objects. Taking help from OpenCSG library and Computational Geometry Algorithm Library (CGAL), the tool creates beautiful geometry and graphics on the screen. This text based tool is what we try to explain in this article.

What OpenSCAD is not

Before you begin with the tool's specialities, let us clear out general misconceptions.

Not for the artist in you. OpenSCAD is a 3D modelling tool that focuses on CAD aspects of designing. So this is not your typical tool for, say, creating a computer animation. But if it is a machine part you want to model, or maybe an exploded view of a heart, this is your go-to tool.

Not an interactive modeller. Unlike the usual case where you have a window on which you draw the object, OpenSCAD works like a 3D compiler. Whatever you want to model has to be scripted into a file. The tool reads the file and renders the 3D model.

What OpenSCAD offers

Does describing your model in textual form limit your design in the way you make it or view it? Decide for yourself! Let us take a step back and figure out what all features OpenSCAD offers to you.

Flexibility. As you write a script for every aspect of your model, you have complete control in your hands. Consequently, making any change during any step of modelling or designing something with configurable parameters is not difficult.

Customisability. The way you introduce customisability into your design is by parametrising it using parameters or top-level variables. There was even a project under Google Summer of Code programme in 2016, which aimed at offering an auto-generated GUI associated with a customisable design, making it easier to both create and use such designs, and an authoritative standard for how to specify meta-data to guide

the generation of such a GUI. Details for the above can be found at *https://amarjeetkapoor1.wordpress.com/2016/07/04/user-interface-for-customizing-models/*

A variety of model views. Thorough analysis of a model is very important to arrive at needed precision and accuracy in replicating any 3D structure. To help you achieve this level of perfection, OpenSCAD allows you to view every model in different ways or views.

The initial model view that crops up is CGAL surface view, indicating surface-level representation. It then proceeds to CGAL grid view for complex 3D models. The scaffolds beneath can be seen as a wireframe, creating an effect like the view of Eiffel Tower. If you need a high screen frame rate, this relatively-simple and fast-rendering view should be your choice. You could also have OpenCSG view, or put all of these in one frame for a thrown-together view that gives you as wholesome a look at your design as possible.

Creating animations. An animate option lets you create something similar to GIF files that keep circulating online. Specify the number of steps and frames per second, and you can observe the animation as the program re-evaluates the code as time progresses.

Use with your favourite editor. Be it Emacs, Notepad++, VIM or Visual Studio Coke, minimise OpenSCAD editor, open your own, save after changing the file. OpenSCAD automatically updates its database, letting you smoothly mix and match tools to find the combination that works for you. You can also extend this to work with multiple screens—one for 3D view and another for the code, side by side.

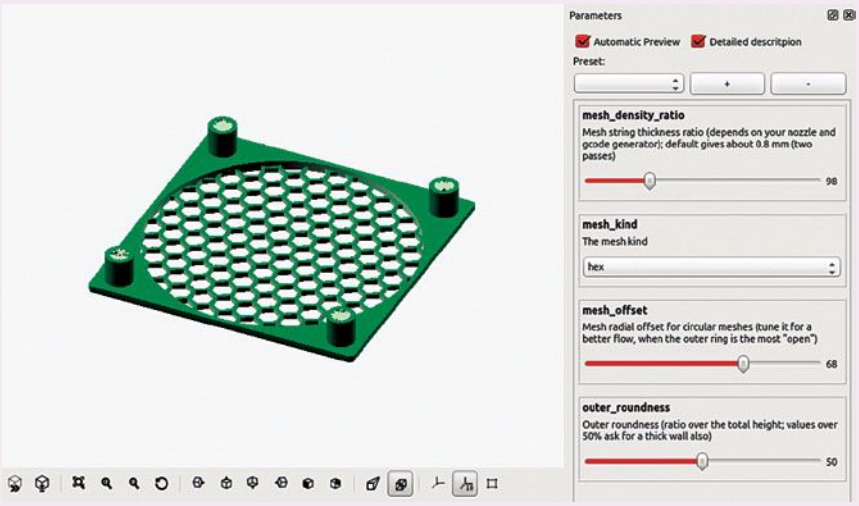


Fig. 2: OpenSCAD customiser

How to work with OpenSCAD

It is clear that this software is different and has some useful tricks up its sleeve. It might seem a little complicated to use at first, but once you know your way around, you will surely enjoy the experience.

Built-in functions. We saw that you do not design, but you code, in OpenSCAD. The script file simply has to make use of functions that are already defined and the graphical image pops up on the screen. Say, you want to draw a cuboid. You would only need to write "cube([2,3,4]);" and then compile the code and go to the graphical view. Preview before you render the image to play around with dimensions or colours. A cuboid of two units length, three units width and four units height appears on the screen, at the origin.

Scrolling around. The UI of OpenSCAD comes segregated into viewing area, console window and text editor. To work around the rendered image, you can use the mouse to rotate, move or zoom in and out of an image. As you scroll, values on the screen/axis change to reflect the action you performed. You can create replicas by simply translating an earlier defined line of code; just take care of positioning, lest you end up overlapping the two. If you are beginning your first program, go into Example under Files and you will find enough codes to get acquainted with the tool.

Model using these techniques. Create complex surfaces or objects using Boolean operators to combine simpler objects, namely, constructive solid geometry (CSG). CSG builds complex forms as intersections, unions and differences of simple primary shapes like boxes, cylinders, cones and ellipsoids. For objects of a fixed cross-sectional profile, you could use extrusion of 2D outlines to your satisfaction.

Specifications at a glance

- Licence: Free software released under GPLv2
- Supported by Linux/UNIX, MS Windows, Mac OS X; it is possible to build OpenSCAD on other systems as long as a C++ compiler and prerequisite software libraries are available
- Built on top of free software libraries like:
  - Qt for user interface
  - CGAL for CSG evaluation
  - OpenCSG and OpenGL for CSG previews, boost, eigen and glew
- Also held at Github
- Latest release: 2015.03
- Website: *http://openscad.org/*
- You can even choose to work with OpenJSCAD, a port of OpenSCAD that runs in a Web browser, if your browser supports WebGL

Working with files. Feed in your 2D outlines using AutoCAD DXF files. Design parameters included in these files can also be understood by the tool. You can even choose to work with STL and OFF files, also creating 3D models in the respective formats.

Securing the help you need. OpenSCAD also enjoys an active community support that you can reach out to. Simply navigate to Community tab on their website and you can find all details about the issues faced by users so far. You could report a new bug, or provide a solution to one already enlisted.

The website also provides ample help to a new designer. There is a cheat sheet to help you create designs as simple as a function or a circle, to projections or transformations. Tips and Tricks and FAQ sections discuss most problems you might be facing.

Many blogs by users explain how to use the tool, get familiar with advanced features and how to make simple projects. Bored to read? Log on to video tutorials—all from Documentation page.

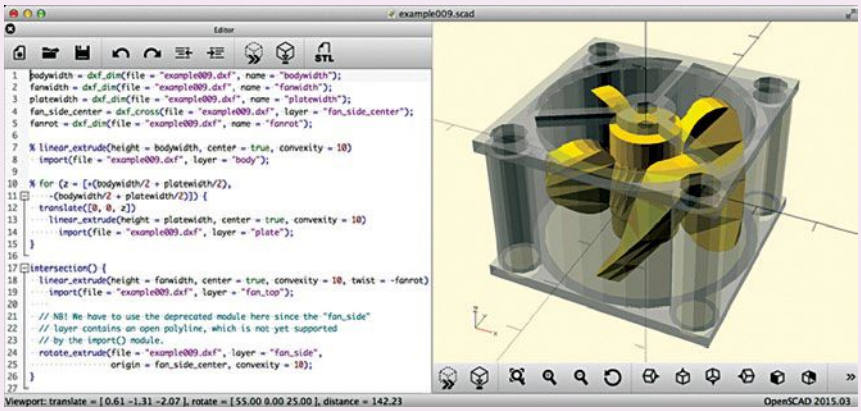


Fig. 3: OpenSCAD user interface

Igniting the spark of inspiration

OpenSCAD works as a good entry-level CAD tool for designing open source hardware, such as scientific tools for research and education. The tool has also inspired or been involved with many others such as OpenJSCAD, CoffeeSCAD, Libre 3D and FABFabbers, to name a few. Now that you have the package with your DVD, why not try it for yourself? EFY

Priya Ravindran is M.Sc (electronics) from VIT University, Vellore, Tamil Nadu. She loves to explore new avenues and is passionate about writing

Gazebo: Let Your Robots Do The Talking

ASHWIN GOPINATH

Behind every robot there is a story of how it was made. Though there was no mama robot or papa robot, there is a story of ideation, prototyping, debugging and the usual repeat till satisfied. In my humble opinion, if humans could be brought into this world the same way, we would all be far better off, but that is a different story and a different scheme of thinking.

A robotics simulator is kind of a nanny equivalent for a robot baby. It teaches it the basics of obeying commands, lets it foster in a safe environment, not unlike how Neo trained with Morpheus in the movie Matrix. Robots can learn from this environment and proceed to become the best version of the idea that birthed them. There are a lot of solutions easily available for people interested in taking up this task but, without doubt, the one solution which I am a huge fan of is Gazebo simulator.

Development for Gazebo began in the fall of 2002 at University of Southern California, USA. To fill the need for simulating robots in outdoor conditions, bringing together the various elements that affect the body of one, Dr Andrew Howard and Nate Koenig started work on a high-fidelity simulator. The name Gazebo, which means an outdoor pavilion-like structure, was to reflect the fact that the work was to simulate outdoor environments. A little too easy, but the fact remains that most of the work on Gazebo is done to simulate indoor environments.

Fig. 1: Drone on Gazebo

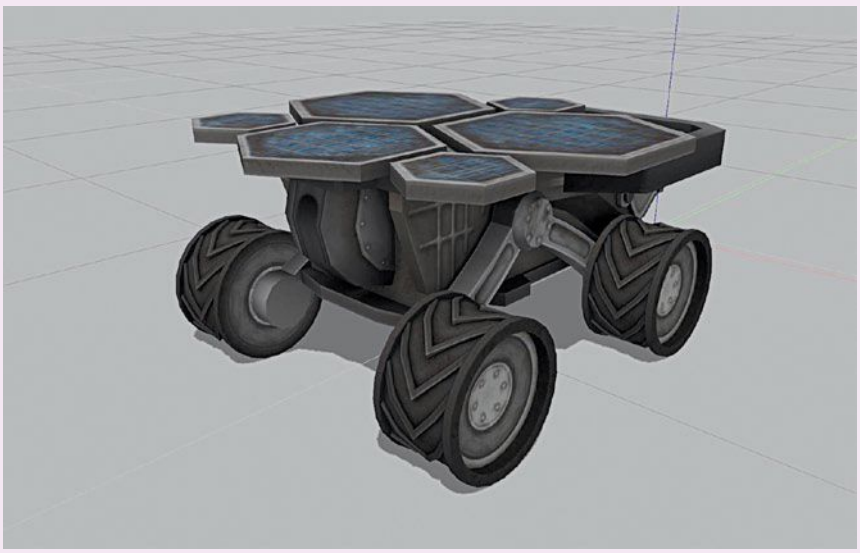


Fig. 2: Mars rover on Gazebo

The simulator to have

An ideal robotics simulator makes testing of environments and the actual robot very simple. It makes it possible to rapidly test algorithms, design robots, perform regression testing and train artificial intelligence (AI) systems that can be adaptive as well as possessive of

System requirements

Currently, Gazebo is best used on Ubuntu, the Linux flavour. You will need a computer that has:

- A dedicated GPU
- Intel i5 or higher
- 500MB of disk space
- Ubuntu trusty, or later (recommended)

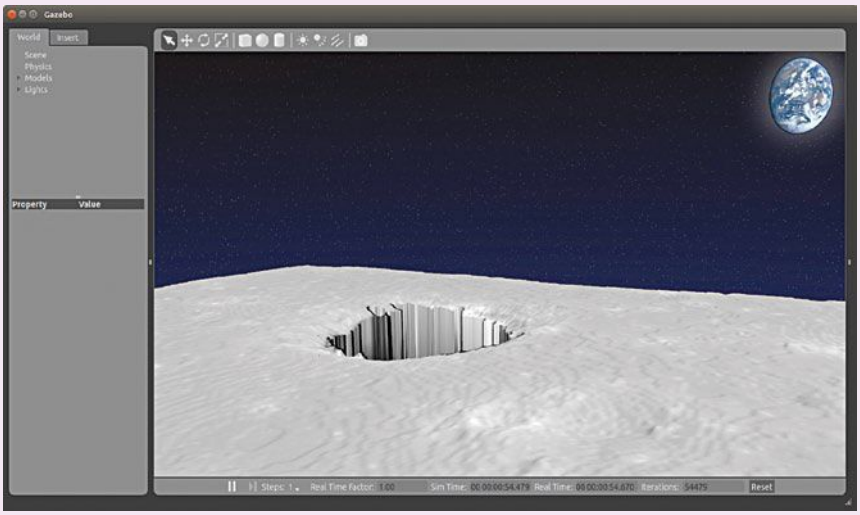


Fig. 3: Lunar Pit on Gazebo

Software details

Name: Gazebo, version 7.1.0 (April 8, 2016)
Developers: Open Source Robotics Foundation
Licence: Apache 2.0
Programming Language: C++
Platforms supported: Linux, Mac OS, Windows

the tenacity trait. Gazebo is a simple, easy-to-learn simulator that lets you conduct simulation of a variety of robot forms in a bevy of environment options. Gazebo possesses a very robust physics engine, high-quality graphics, and convenient programming and graphical interfaces. And as you may have guessed, if you are a regular reader of my feature in *Electronics For You Plus*, this software is open source and fully free to use and distribute. Do install this software available in the DVD so you can see first-hand what I am talking about.

Features

Gazebo has access to multiple high-performance Physics engines including ODE, Bullet, Symbody and DART. This allows it to have dynamic simulation environments, which are a huge benefit to the developing robot as it can be configured to specific tastes.

OGRE 3d, another brilliant graphics rendering engine, is also available on Gazebo platform, thereby making sure your environment rendering is coming from the best open source engines available.

Lighting, which is a crucial element of behaviour based robotics, is extremely realistic, as are the shadows and textures. Gazebo also has provisions to generate sensor data from a huge repository of sensors in its database, which includes 2D/3D cameras, Kinect-style sensors, force-torque and so on.

In addition, there are a number of robots already available for use off-the-cuff, like the traditional PR2, Pioneer2 DX, iRobot Create and TurtleBot. There are also many ways to make your own custom bot using the platform itself. The software uses TCP/IP transport by letting you run simulation from a remote server, while allowing for interfacing through socket based messaging.

Last, since everyone we now know is on the Cloud, one way or the other, Gazebo has not left that avenue at all. It is possible to run Gazebo on your personal Cloud, or on Amazon, Softlayer or OpenStack. As always, the sheer number of people who use Gazebo are also a source of immense documentation and code, to help us small little birds out with early flight lessons.

Gazebo for robot development

Gazebo now comes with a very cool graphical model editor, so that your model can be built by utilising graphical building blocks instead of code blocks. Inclusion of torsional friction and wide-angle camera sensors for when you need to go in so much detail that you would not mind the friction of rotating wide-angle cameras. ArduPilot based plugin simulates lift and drag forces, so you can now be in 2017 *vis-à-vis* the drone and aircraft fad.

There is a bundle of complex robots that can now be simulated effectively in Gazebo, for example, Atlas, Valkyrie or the impressively-named Robonaut 2. The code that you run on Gazebo is the same one that you will run on your final robot. In that way, it reduces a lot of efforts from all sides.

I would say the effects of a great simulator cannot be overstated. Simulators allow the development of robots offline, so that this aspect does not create any downtime on the jobs that the robot might be needed to perform. The whole environment can be projected from a third person point of view, in realistic 3D environments so you feel as cool as George Lucas when he was dreaming up the Storm Troopers.

So while Gazebo is now on your minds as the robotics simulator to try out, I would suggest reading up more on the latest robots available and ensure that you send your little one to any robotic pathfinder competitions so as to keep it fun and innovative. The amount of online documentation on Gazebo is extensive and, as such, is a huge repository of help. EFY

Ashwin Gopinath, an engineer, enjoys following innovators, Arduinos and migratory birds

Government IT spending in India to grow 9.5 per cent in 2017

The government of India, together with state and local governments, is expected to spend US$ 7.8 billion on information technology (IT) in 2017, an increase of 9.5 per cent over 2016, according to Gartner Inc. This includes spending on internal services, software, IT services, data centre systems, devices and telecom services.

The software segment includes enterprise resource planning, supply chain management, customer resource management, desktop, infrastructure, vertical specific software and other application tools. The software segment is expected to grow 15.7 per cent in 2017 to reach US$1 billion. Desktop will be the fastest growing segment with 16 per cent growth in this category.

IT services (which include consulting, software support, business process outsourcing, IT outsourcing, implementation and hardware support) is expected to grow 14.6 per cent in 2017 to reach US$ 2 billion, making it the largest segment within the IT-spending category.

Government plans startup district with incubators

India will soon have its first startup district with incubation centres and about 20 tinkering labs for schools, aimed at encouraging the creation of innovative solutions in agriculture, health and education.

Commerce and industry minister Nirmala Sitharaman, who is a Rajya Sabha MP from Karnataka, is keen that the entire cluster be developed in Mangalore.

The government will fund the effort and ensure that roads, electricity and digital networks are provided for one of the largest incubation facilities in the country. It wants to encourage startups to provide innovative solutions for challenges unique to India, especially in education, health, manufacturing, agriculture and infrastructure, and not just be skewed towards developing apps. Government departments have been asked to suggest areas where startups can pitch in with ideas.

IESA launches Hyderabad and Chennai Chapters

India Electronics and Semiconductor Association (IESA) has announced the launch of their Hyderabad Chapter and Chennai Chapter. Key objective of setting up offices in Hyderabad and Chennai is to widen the ecosystem, acquire new members and strengthen the supply chain in the regions. This move will boost the electronics, hardware and semiconductor startups and firms in the state with the required support and information.

Telangana contributes to six per cent of the electronics production in the country, and aims to reach a revenue of more than US$10 billion and

On The Move

Chandana Gupta joins Acer India as AD - consumer sales

Acer India has appointed Chandana Gupta as associate director for consumer sales. Gupta will lead an experienced team to drive deeper engagement with the partners and help grow the consumer business to greater heights.

Infosys appoints Ravikumar S. as deputy COO

Country's second-biggest IT firm Infosys has elevated its president and chief delivery officer, Ravikumar S., as deputy chief operating officer. He will report to Infosys chief operating officer, U.B. Pravin Rao, with immediate effect.

Cybage appoints Avinash Lele as president

Pune-headquartered Cybage Software has appointed Avinash Lele as president, Cybage Inc. Lele will be a part of Cybage executive management team and will operate out of the company's headquarter in New Jersey, USA.

Krishna Kumar joins Hexaware as CTO

Hexaware Technologies Ltd, a global provider of application, infrastructure, BPS and digital services, has announced the appointment of Krishna Kumar as chief technology officer. Kumar has more than 25 years of experience, including about a decade each at Tata Consultancy Services and Yahoo.

T.K. Kurien leaves Wipro

Wipro vice chairman T.K. Kurien is set to leave the US$ 7.5-billion IT firm Wipro after almost two decades of straddling various roles. TK, as he is popularly called, served as Wipro chief executive officer for five years before being elevated as its vice chairman early last year.

Calendar of Forthcoming Electronics Fairs/Exhibitions/Seminars/Events

Name, Date and Venue	Topics	Contact address for details
India Electronics Week March 2-4, 2017 Bangalore International Exhibition Centre, Bengaluru	An exhibition for the global electronics industry showcasing concurrently seven events: Electronics For You Expo, DIY Expo, Electronics Rocks, T&M India, LED Asia, Raksha India and IoT Show	EFY Enterprises Pvt Ltd Phone: +91-11-40596605 Website: www.indiaelectronicsweek.com
Conference on Automotive R&D Trends March 9, 2017 Hotel Taj Coromandel, Chennai	Conference that aims to help stakeholders understand the current scenario of automotive R&D, challenges ahead, technologies involved and share their expectations	Confederation of Indian Industry Websites: www.cii.in, www.tntdpc.com
Embedded World 2017 March 14-16, 2017 Nuremberg, Germany	Fair with the focus exclusively on embedded technologies, it reflects the trends in the sector	Embedded World 2016 Website: www.embedded-world.de/en
IoT Summit 2017 March 16-17, 2017 Convention Center, Santa Clara, California, USA	Forum to present and highlight the latest trends, products, applications, development and business opportunities in the IoT	Iot Summit 2017 Website: www.iot-summit.org
Chinese Information Technology Expo (CITE) April 9-11, 2017 Shenzhen Convention & Exhibition Center, Shenzhen, China	Organised by Ministry of Industry and Information Technology (MIIT) and The Municipal Government of Shenzhen, CITE is designed to be a national platform for the next-generation information technology industry	The Organizing Committee of CITE Website: www.citexpo.org/en
Hong Kong Electronics Fair (spring edition) April 13-16, 2017 Hong Kong Convention and Exhibition Centre, Hong Kong	Exhibition for leading-edge electronics products	Hong Kong Electronics Fair Website: http://m.hktdc.com/fair/hkelectronicsfairse-en/HKTDC-Hong-Kong-Electronics-Fair-Spring-Edition.html
Hannover Messe 2017 April 24-28, 2017 Hannover, Germany	Trade fair for industrial technology	Hannover Messe 2017 Website: http://www.hannovermesse.de/home
Windergy India 2017 International Conference & Exhibition April 25-27, 2017 The Ashok, New Delhi	Wind power event in India that provides networking opportunity for members of the wind industry	Windergy India 2017 Website: www.windergy.in
Consumer Electronics China (CE China) May 4-6, 2017	Global IFA event, designed to be China's premier trade show for consumer electronics and home appliances brands in China	Berlin Exhibition (Guangzhou) Co. Ltd cechina-ifa@messe-berlin.com
China Coil Winding and Electronic Transformer Expo 2017 May 18-20, 2017 Shenzhen Convention and Exhibition Center, China	Professional exhibition for small motor, magnetic material, electronic transformer, coil winding and insulation material	Wise Exhibition (Guangdong) Co. Ltd Website: www.motor-expo.cn/En/
Computex Taipei 2017 May 30-June 3, 2017 Taipei, Taiwan	B2B ICT/Internet of Things trade show	Computex Taipei organising team Website: http://www.computextaipei.com.tw
E3 2017 June 13-15, 2017 Los Angeles, California, USA	Annual video game conference and show	Entertainment Software Association Website: www.e3expo.com
TechXLR8 June 13-15, 2017 ExCeL, London, UK	Festival of technology for a journey between networks, tech and consumer services	TechXLR8 Website: https://tmt.knect365.com
IFA 2017 September 1-6, 2017 Berlin, Germany	Meeting place for key retailers, buyers, and experts from the consumer electronics industry and the media	The German Association for Entertainment and Communications Electronics and Messe Berlin Website: http://b2b.ifa-berlin.com
Open Source India October 13-14, 2017 NIMHANS Convention Center, Bengaluru, India	Asia's annual convention to celebrate open source computing	Open Source India Website: http://opensourceindia.in/osidays/
ELEXCON 2017 December 21-23, 2017 Shenzhen Convention & Exhibition Center, China	Annual expo for the electronics industry based in Shenzhen	ELEXCON 2017 Website: www.elexcon.com/elexcon/en

Since this information is subject to change, all those interested are advised to ascertain the details from the organisers before making any commitment.

provide employment to 175,000 citizens.

Chennai is known as the electronics manufacturing services (EMS) hub of India with EMS Corridor stretching from Sriperumbudur to Oragadam. Being one of the fastest-growing manufacturing metros, its accessibility as a seaport and having a significant share of manufacturing units for major technology companies with automotive and OEMs being the core hub, was an obvious choice for IESA's expansion.

ELCINA's EMC to have facilities for workers

The ELCINA Electronics Manufacturing Cluster in Bhiwadi, located 71km from IGI Airport in New Delhi, is set to get a dedicated power supply feeder and distribution system, which will be installed through its own grid sub-station, according to Vinod Sharma, managing director of Deki Electronics Ltd and director of ELCINA Bhiwadi Cluster SPV.

The MSME entrepreneur has also said that the cluster will have its own water distribution and sewage systems. The workers' hostel complex will have residential facilities for about 400 workers for phase I, which covers 50 acres. The EMC's Centre of Excellence will include an R&D and incubation facility, training centre, conference/seminar facility, video-conferencing room, auditorium and more. The cluster will create direct employment opportunities for about 6000 people and indirectly lead to the employment of about 10,000 people.

RS Components sets up innovation hub in Bengaluru

RS Components has announced the opening of their innovation hub in Bengaluru. The high-service-level supplier of electronic components and tools plans to invest close to US$ 15 million over the next two to five years at the centre.

The new office has been set up to support electronic design engineers and manufacturers in the region. The company also plans to set up a warehouse that will enable RS Components to undertake next-day delivery to its customers.

Snippets

Airtel eyeing Telenor's India business

India's largest telco, Bharti Airtel, is evaluating the option of buying Telenor's India business. Bharti Airtel has valued the business at US$ 350 million, which is half of Telenor India's liabilities. The structure of the deal currently being discussed would entail Bharti Airtel taking over half of Telenor's liabilities worth US$ 700 million for upcoming spectrum payouts and payments for tower deals.

e-Wallets may soon have to insure customers' money

The government of India is looking to introduce insurance for transactions done through e-wallets, and it has held three meetings with insurers and mobile wallet companies in this regard. Through new regulations, the government hopes to make it mandatory for mobile wallets to insure users' money.

Subsidised LED bulbs distributed in Nagaland

Nagaland State Department of Environment, Forests and Climate Change has taken up the initiative of providing subsidised LED bulbs to the residents of Nagaland villages, namely, Chingphoi, Changlang, Chingdang, Wanching, Wakching, Wakching Chingla, Namthai, Shiyong, Hotahoti, Kongan and Naginimora, under the Naginimora Forest Range, Mon Forest Division.

Sasken Communication Technologies announces corporate name change

Sasken Communication Technologies Ltd has changed its name to Sasken Technologies Ltd, to reflect its broad range of services. The change is effective from February 14, 2017.

The Bengaluru centre will have technical marketing and support teams, and specialised sales force that will focus on specific industry verticals like the IoT, medical electronics, aeronautics, automotive and R&D sector.

Apple to start manufacturing in India

Tech giant Apple has reached an agreement with Karnataka government to set up a manufacturing plant in Bengaluru. "Apple's decision on initial manufacturing in Bengaluru has further enhanced the reputation of Bengaluru as the most preferred destination for foreign investment," according to a press release by Karnataka government.

The release, signed by state IT minister Priyank Kharge, has mentioned that Apple's intentions to manufacture in Bengaluru "will foster a cutting-edge technology ecosystem and supply chain development in the state, which are critical for India to compete globally."

India will be the third country globally to assemble iPhones, an indication of how important the country has become for one of the world's most valued companies.

Corephotonics, Samsung Electro-Mechanics partner for smartphones

Corephotonics has partnered with camera module integrator Samsung Electro-Mechanics (SEMCO) to develop a complete reference design, based on its revolutionary dual-camera technology. Through this reference design, which is now in volume production, smartphone manufacturers will benefit from dramatic enhancements in image quality without any impact on the slim designs that consumers now expect from their handsets.

The partnership combines SEMCO's universally-recognised expertise in camera module design and manufacturing, with Corephotonics' innovative camera-related technologies. It enables a far greater number of smartphone manufacturers to access ground-breaking imaging technology that will help them to elevate user experience.

LED scheme triggers price battle in lighting industry

The government's LED distribution scheme has sparked a price war in the lighting industry. Domestic LED lamp manufacturers have alleged that some firms are indulging in monopolistic practices to bag government tenders at unviable prices, driving away competitors.

The latest tender by EESL, the nodal agency for LED lamp procurement, seeking 50 million lamps has received interest from 11 companies including Philips Lighting, Crompton Greaves and Surya Roshni. EESL had first purchased the LEDs at ₹ 310 per piece in 2014. The sales figure of LED lamps sold by EESL has crossed 200 million, while the industry is expected to have sold over 260 million LED lamps till December 2016.

Tata Motors, Microsoft partner for enhanced in-car connectivity

Tata Motors and Microsoft have announced a strategic agreement aimed at redefining the connected and personalised driving experience for Indian passenger vehicle buyers. The partnership announcement comes after Tata Motors revealed its new passenger vehicle strategy and TAMO sub-brand on February 2.

Tata Motors will leverage Microsoft's connected vehicle technologies that bring together artificial intelligence, advanced machine learning and the Internet of Things (IoT) capabilities on the global hyper-scale Azure Cloud. This will help create a highly-personalised, smart and safer driving experience across digital and physical worlds.

The Futuro concept car, billed as the first product from the TAMO initiative, will utilise Microsoft-enabled functionalities like advanced navigation, predictive maintenance, telematics and remote monitoring features.

Budget:

UNION BUDGET 2017: What's In Store For The Indian Electronics Industry

The Union Budget 2017, presented by the NDA government on February 1, 2017, has put forth various initiatives to give a boost to the digital economy. The budget has offered some incentives as well as various tax and duty benefits to the electronics system design and manufacturing (ESDM) industry. Will these go a long way in strengthening the manufacturing capabilities of Indian companies? Here is a collation of key points related to the ESDM industry.

Finance minister Arun Jaitley before presenting Union Budget 2017

Key tax reforms

Populated PCBs for mobile phones. Populated PCBs for mobile phones are being excluded from the purview of Nil SAD under S. No. 1 of Notification No. 21/2012-Customs (which exempts SAD on items, which are exempt from BCD and CVD).

Simultaneously, two per cent concessional SAD is being prescribed on populated PCBs for use in manufacture of mobile phones, subject to actual user conditions. Concessional SAD will be valid till June 30, 2017.

Micro-ATMs, fingerprint readers/scanners and iris scanners. Basic custom duty (BCD), CVD (by way of excise duty exemption) and, consequently, SAD are being exempted for micro-ATMs as per standards version 1.5.1, fingerprint readers/scanners and iris scanners.

Further, BCD, CVD (by way of excise duty exemption) and, consequently, SAD are also being exempted on parts and components for the manufacture of these devices, subject to actual user conditions.

Miniaturised POS card readers for mPOS. BCD, CVD (by way of excise duty exemption) and, consequently, SAD are being exempted on miniaturised POS card readers for mPOS (other than mobile phones or tablet computers).

Further, BCD, CVD (by way of excise duty exemption) and, consequently, SAD are also being exempted on parts and components for manufacture of miniaturised POS card readers for mPOS (other than mobile phones or tablet computers), subject to actual user conditions.

LED lights or fixtures including LED lamps. Five per cent concessional BCD is being prescribed on all parts for use in the manufacture of LED lights or fixtures including LED lamps, subject to actual user conditions.

Five per cent concessional BCD is being prescribed on imports of inputs for use in the manufacture of LED drivers or metal-core PCBs for LED lights and fixtures or LED lamps, subject to actual user conditions.

Solar Cells. BCD is being reduced from 7.5 or 10 per cent to five per cent on all items of machinery including, instruments, apparatus and appliances, transmission equipment and auxiliary equipment (including those required for testing and quality control) and components required for initial setting up of fuel cell based systems for the generation of power or for demonstration purposes, subject to conditions.

BCD has been reduced to nil on solar-tempered glass for use in the manufacture of solar cells/panels/modules. CVD on parts of solar-tempered glass has been reduced to six per cent from previous 12.5 per cent.

CNC systems. Concessional BCD of 2.5 per cent is being extended to ball screws (8483 40 00), linear motion guides (8466 93 90) and CNC systems (8537 10 00) for use in the manufacture of all types of CNC machine tools falling under headings 8456 to 8463, subject to actual user conditions.

Ease of doing business and good governance

- Over 90 per cent of FDI proposals now processed through automatic route
- e-Filing and online FDI processing to ease investments
- FIPB abolished to encourage foreign investments
- Proposal to reduce corporate tax for companies with annual turnover up to ₹ 0.5 billion to 25 per cent
- CBEC to continue to strive to implement GST

Incentives for Make in India

- Allocation of ₹ 7.45 billion for MSIPS and Electronic Development Fund to make India a global electronics manufacturing hub
- Defence budget increased by about 5.8 per cent to ₹ 2740 billion with provision for strategic electronics

- No change in excise and service tax rates due to upcoming GST
- Tax relief to startups for seven years

Overall tax reliefs given to startups and MSMEs will boost sustainable employment and the quality of start-ups in the design-led manufacturing sector.

Encouraging Digital India

- A mission to be set up with a target of ₹ 25 billion digital transactions for 2017-18 through UPI, USSD, Aadhaar Pay, IMPS and debit cards
- Aadhaar based payment system to help people not having debit/credit cards
- Allocation of ₹ 100 billion for BharatNet project for providing high-speed broadband Internet in FY18
- Under BharatNet, OFC laid in 155,000 kilometres
- By the end of 2017-18, high-speed broadband connectivity on optical fibre to be available in more than 150,000 *gram panchayats*, with Wi-Fi hotspots and access to digital services at low tariffs
- DigiGaon initiative to be launched to provide tele-medicine, education and skills through digital technology
- Rural and semi-urban areas to get more funds for creating a digital economy

Facilitating cashless economy

- Aadhaar based payment system to help people not having debit/credit cards
- Rural and semi-urban areas to get more funds for creating a digital economy
- Banks to introduce additional one million point-of-sale machines by March 2017 and two million Aadhaar based swipe machines by 2020

Enabling Skill India

- *SANKALP* programme for skill development with allocation of ₹ 40 billion
- Proposal to leverage ICT with the launch of *Swayam* platform that has 350 free courses
- Innovation fund for secondary education to be set up
- Prime Minister's *Kaushal Kendras* to be extended to 600 districts; 100 international skill centres to be opened to help people get jobs abroad EFY

This report is compiled from information provided by ELCINA Electronic Industries Association of India, by Sudeshna Das, senior executive editor, EFY

Market Survey:

The INDIAN ELECTRONICS INDUSTRY IN 2017-18: Key Trends

Sudeshna Das is senior executive editor at EFY

What are the factors likely to shape the Indian electronics industry this year and beyond? We talked to industry members about the trends expected to impact businesses in this sector, and the developments and opportunities companies can look forward to.

India's electronic system design and manufacturing (ESDM) sector continues to be a critical force for growth, innovation and disruption across multiple segments. Perhaps nothing demonstrates this more clearly than the widespread application of electronic components and products in sectors like lighting, automotive and communications.

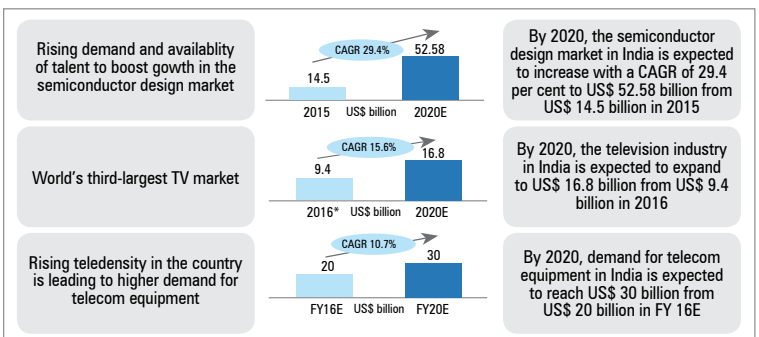
Electronics has become an agent of change in these segments, enabling the creation of products that enhance efficiency. As we enter fiscal year 2017-18, we anticipate even more opportunities for the electronics industry to meet the needs of the various sectors where electronic products are used.

Market projection

The Indian electronics market is one of the largest in the world and is expected to reach a turnover of US$ 400 billion in 2022, up from US$ 69.6 billion in 2012. According to an Indian Brand Equity Foundation (IBEF) report, the market is projected to grow at a compound annual growth rate (CAGR) of 24.4 per cent during the period 2012-2020 (Fig. 1). Total production of electronics hardware goods in India is estimated to reach US$ 104 billion by 2020.

The growing customer base and increased penetration in the consumer durables segment has provided excellent scope for growth of the Indian electronics sector. Also, greater digitisation could lead to increased broadband penetration in the country and open up newer avenues for companies in the electronics industry.

Fig. 1: Growth forecast for the Indian electronics industry



Source: Ministry of Electronics & Information Technology; India Semiconductor Association; FICCI, TechSci Research
*Notes: CAGR—Compound Annual Growth Rate; E—Estimated, *2016—Data has been projected till December 2016*

Methodology

To prepare this report, we collated information through primary interviews and conducted 11 brief survey interviews with stakeholders from global and Indian companies. This sample group is a microcosmic representation of the Indian electronics, chemicals and materials industry ecosystem. It comprises suppliers of chemicals and materials and their users, including component manufacturers, PCB manufacturers, component and product distributors, EMS providers, original equipment manufacturers and more. These senior professionals shared their insights on:

- Market drivers
- Technology trends in the market

A collation of their insights and our analysis is presented in this article. In forthcoming issues, we will share industry views related to other aspects of the industry.

Applications that will drive the market

LED lighting applications will be the major driver for the Indian electronics market in the coming financial year. Considering the huge demand for communications and broadband equipment, including mobile handsets, this segment is also likely to drive the demand for electronic components and products. The market will also see demand from the automotive electronics segment. According to the survey participants, future growth in the electronics industry will predominantly come from the following top three demand-generating sectors (Fig. 2):

- LED lighting
- Communications and broadband equipment
- Automotive

Technologies that will shape the market

The electronics industry is going through an exciting phase due to revolutionary changes in technology, launch of innovative products and the challenge of global competition. This has made it necessary for electronics product and component manufacturers to focus on continuous improvements in order to stay ahead of the pack. Survey participants have shared insights about emerging technology trends that will shape the market in India, and create more efficient, user-friendly products by using better production techniques. Here is a collation of their views and our analysis.

Evolution of components and products. *Miniaturisation.* This refers to the creation of smaller devices or components for mechanical, optical and electronic products. Convergence is helping manufacturers integrate multiple devices into one. Demand from consumers to reduce the size of the products so that these are easy to manage has also led to these products becoming smaller in size.

The greater density of components in these products is usually made possible through VLSI designs. This also enables a lower cost of production, which translates to lower overall product pricing. Miniaturisation is on the rise and will impact the traditional components market as most of these components will get replaced by chip components and integrated circuits (ICs).

Artificial intelligence. Consumers are becoming increasingly technology-conscious and are demanding products with built-in intelligence. This is resulting in electronics and consumer durable products being manufactured with intelligent functions and logic. For example, there are now washing machines that can sense the load and decide the appropriate washing cycles.

Intelligence has moved beyond consumer products, and is also available in several medical and industrial electronic products with CNC-controlled functions.

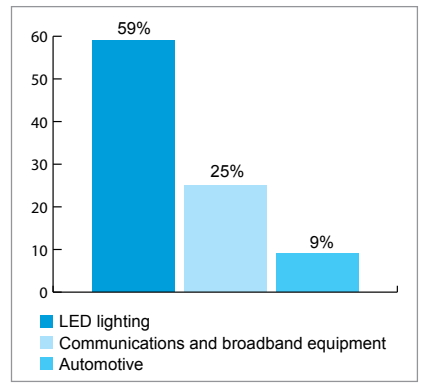


Fig. 2: Top three demand-generating sectors

High-frequency applications. Electronic ICs and modules for high-frequency applications will be in demand considering the increasing amounts of data that need to be transmitted within a very short period of time, whether in applications for communications, sensors or astronautics.

Advances in IC technology are driving packaging and interconnect designers to accommodate more input/output connections and larger-sized dies, which dissipate more power and operate at higher speeds. This, in turn, will generate demand for components and products suitable for high-frequency applications.

Leading changes in LEDs. There will be changes in onboard technology due to the use of IC based drivers to support touch based technology, which is the need of the hour for smart lighting systems. This, in turn, will reduce the number of components used in traditional drivers. Use of fewer components can reduce costs, while enhancing the efficiency of the final product.

There will be higher usage of chip-scale packaging or flip-chip packaging technology to enhance lumen output while increasing the reliability of the final product. Use of chip-scale packaging eliminates the traditional sub-mount, enabling manufacturers to directly attach the LED die to the PCB, allowing for overall system cost reductions.

Introduction of driverless low-voltage direct-current-operated products will enable energy savings by reducing AC-DC current conversion losses. This will also make the products compatible with solar photovoltaic systems, and help these run as LED-solar hybrid systems, which will be very useful in India.

Shift in manufacturing techniques from through-hole to surface-mount technology will enhance efficiency while reducing operational costs. This, is turn, will help achieve a breakeven point quickly, in spite of relatively higher capital expenditure.

The electronics behind the IoT. Each IoT device will require, at the very minimum, a microcontroller to add intelligence to it, one or more sensor(s) to allow for data collection, one or more chip(s) for connectivity and data transmission, and a memory component. Connected devices that transmit information across relevant networks will rely on innovations from semiconductor players—highly-integrated microchip designs, for instance, and very low-power functions in certain applications.

A new class of system(s)-on-chip (SoC) based devices with the provision for optimal power and connectivity features as well as with sensor integration will be in demand to support the wide adoption of the ĺoT. The first generation of such chips is already on the way, although it will probably be a few generations before chips can deliver all the required functionality.

A new array of sensors based on micro-electromechanical systems technology are rapidly being developed to enable IoT applications beyond motion and image sensing to include those that measure humidity, altitude, food calorie composition and human health indicators. This is the result of an increasing variety of consumer IoT applications such as wearables and clustered systems.

Points of concern

According to a recent report by Ministry of Commerce, import of electronics in the country has increased by 26 per cent to ₹ 267.58 billion in January 2017 and exports have reduced by 10 per cent to ₹ 31.62 billion. The same report also provides comparative figures for the year 2016, mentioning that electronics imports stood at ₹ 212.2 billion in the same month a year ago and exports were at around ₹ 35.26 billion.

Industry members attribute the surge in imports to low value addition in electronics manufacturing, quick surge in demand for point-of-sale (POS) machines and related products. While commenting on the above figures, industry members opine that value addition in goods manufactured in India is low and even manufacturing is not at the scale required to meet local demand. Demand for products like mobile phones and telecom equipment has been rising but most of the parts used in these are imported, which is a reason for the rise in imports.

Even in high demand-generating segments like mobile phones, manufacturing is just in track to meet committed numbers, but local value addition is very low.

The recent push for digital transactions has led to demand in POS machines and related devices like fingerprint readers and biometrics scanners where there is duty arbitrage between domestic production and imports. The industry feels that, to capitalise on such a huge demand, a large number of imports of POS machines may have added to the import figures.

Moving forward

The industry feels that the government has to implement measures to encourage domestic manufacturing and boost exports in the electronics sector. We have received consolidated policy recommendations from Electronics Industry Association (ELCINA) for the same. They believe that this is the right time to revamp National Policy of Electronics (NPE) 2012. Some of the suggestions are addressed in Union Budget 2017-18. Some key suggestions that are yet to be addressed are collated below.

Recommendations on EMC scheme. EMC scheme was formulated to provide a supportive and efficient infrastructure for electronics manufacturing. In all countries, where the ESDM sector has developed well, modern infrastructure is provided beforehand. This is possible only if the government is involved in these projects—providing land, long-term finance and statutory approvals, licences and permissions from the state government.

This will reduce financial pressure on the private developer and provide ample time for development work to be completed. The industry will invest only once the electronics cluster parks are developed. Necessary modifications may be made in the scheme's notification and guidelines to make it a success.

Recommendations on preferential market access (PMA) scheme. Preference for domestically-manufactured electronic goods under NPE 2012 across central government purchases was announced on December 23, 2013. Following the announcement, guidelines for the procurement of ten product categories like desktop PCs, contact smartcards and LED products were announced.

Currently, PMA scheme covers only central government purchases. It is suggested that the scope of PMA be extended to cover state government purchases as well as procurement of items for which PMA guidelines have been notified by the government of India's Ministry of Electronics and Information Technology (MeitY), and should be done as per the guidelines prescribed during the tendering process.

Production subsidy. Provision for a ten per cent production subsidy on value addition by the manufacturing unit was introduced under MSIPS on August 3, 2015. This includes high-value-added items such as semiconductor wafers, logic microprocessors, ICs and newly-added components such as PCBs, discrete semiconductors, power semiconductors as well as assembly, testing, marking and packaging facilities. Urgent implementation of this is recommended.

ELCINA has also recommended that this production subsidy be extended to include all components and raw materials that are covered under ITA-1. Electronics manufacturing services (EMS) companies are playing a vital role in the ESDM value chain and encouraging local manufacturing, value addition and demand for local components and raw materials/parts. It is recommended that output from EMS companies is included in this production subsidy. EFY

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TEST & MEASUREMENT

Emulator

Renesas has announced E2 emulator, a new-generation on-chip debugging emulator. The E2 is intended as a development environment for the latest devices in Renesas RH850, RX and RL78 families of microcontrollers, and for a selection of automotive system(s)-on-chip (SoCs).

The emulator supports the extended debugging functionality of RH850 family and contributes to shortening the time required for CAN communication debugging and current consumption debugging.

Renesas Electronics Corp.
www.renesas.com

Spectrum analysers

Anritsu has introduced Spectrum Master MS2760A family, the world's first ultra-portable, millimetre-wave (mmWave) spectrum analysers that verify high-frequency designs, including those used in 5G and E-band applications.

In addition to 5G and E-band, the MS2760A significantly improves test procedures and lowers the cost of test in other fast-growing mmWave applications such as 802.11ad/WiGig, satellite communications, electronic warfare and automotive radar.

Anritsu India Pvt Ltd
www.anritsu.com

Videoscope

The new FLIR VS70 is a waterproof and extremely-rugged videoscope that features user-friendly handset controls. It comes with camera options from 3.8mm to 28mm, which enable you to clearly view extremely-confined areas as per different industrial applications such as power-generation plants, petrochemical and refineries, aircraft and marine inspections, industrial maintenance, vehicle diagnostic, HVAC troubleshooting and building inspection.

FLIR Systems India Pvt Ltd
www.flir.in

Voltage tester

The recently-launched Testo 745 non-contact voltage tester with a voltage range of up to 1000V AC is well-suited for initial checking of suspected fault sources. When the presence of AC is determined, Testo 745 gives a warning via a visual and acoustic signal. In order to increase reliability, Testo 745 has a filter for high-frequency interference signals and is also waterproof and dustproof according to IP 67.

Testo India
www.testo.in

Power analyser

Mangal Instrumentation introduces AC/DC power analyser to test LED drivers and LED lamps for AC parameters in volts, amps, watts, power factor, Hertz, annual energy consumption, and DC parameters in volts, amps, watts and so on.

Mangal Instrumentation
www.mangalinstrumentation.com

Oscilloscope

Rohde & Schwarz has launched a robust, handheld R&S Scope Rider that combines the functionality of eight instruments, making it the most versatile oscilloscope in its class. Features include a spectrum analyser, a frequency counter and a harmonic analyser for evaluating the quality of power supplies.

Since the fully-insulated, handheld instrument meets measurement category CAT IV requirements, it can be used to perform measurements at the source of low-voltage installations up to 600V.

Rohde & Schwarz India Pvt Ltd
www.rohde-schwarz.com

All-in-one instrument

NI has introduced VirtualBench (all-in-one instrument) that combines a mixed-signal oscilloscope with

protocol analysis, an arbitrary waveform generator, a digital multimeter, a programmable DC power supply and digital I/O. The device features are simple, convenient and provide more efficient circuit design, debugging and validation. The included software lets you view all measurements on a single screen.

National Instruments
www.ni.com

Temperature and humidity recorder

This newly-released temperature and humidity recorder, HT20, is equipped with Ethernet interface for connection to a local or global network (LAN or WAN). Through an intuitive and friendly-to-use Web server, you can always have access to information about measured values, status of the device, configuration of device and device information such as serial number, code execution, software and bootloader version.

Rishabh Instruments Pvt Ltd
www.rishabh.co.in

Phase sequence indicator

Meco's latest phase sequence indicator is used to determine phase sequence R, Y and B of three-phase voltages.

Features are:

- Three-phase sequence indication
- Reverse-phase indication
- Open-phase indication
- Coloured test probes with heavy-duty insulated crocodile clips for R, Y and B phase connections
- Phase presence indication from 60V AC (PH-N)

Meco Instruments Pvt Ltd
www.mecoinst.com

Multimeter

Model-702 is a new, low-cost, multi-functional digital multimeter that has a 3½-digit, 1999-count LCD display. It is an average-sensing digital multimeter with 0.8 per cent DC voltage basic accuracy. It can measure:

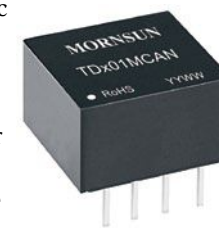
- DC voltage ranges from 100µV to 1000V in five steps, that is, 200mV, 2V, 20V, 200V and 1000V
- AC voltage ranges from 100µV to 750V in five steps, that is, 200mV, 2V, 20V, 200V and 750V
- DC/AC current ranges from 100µA to 10A in five steps, that is, 200µA, 2mA, 20mA, 200mA and 10A
- Resistance ranges from 0.1Ω to 20MΩ in six steps, that is, 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ and 20MΩ
- Capacitance ranges from 1pF to 20µF in five steps, that is, 2nF, 20nF, 200nF, 2µF and 20µF

Kusam Electrical Industries Ltd
www.kusamelectrical.com
www.kusam-meco.co.in

COMPONENTS

CAN bus transceiver modules

The recently-introduced TD301MCAN and TD501MCAN series are cost-effective CAN bus transceiver modules that integrate power isolation, signal isolation, CAN transceiver and bus protection in one module. The series convert TTL/CMOS level to difference level of CAN bus to achieve signal isolation. Moreover, the modules feature 2500V DC electric isolation and a miniature package that enable these to be better embedded in a device to achieve connectivity functions of a CAN bus network.



Mornsun Guangzhou Science & Technology Co. Ltd
www.mornsun-power.com

Power modules

Texas Instruments has introduced a pair of 12V, 10A, 4MHz step-down power modules that provide a power management solution that is 20 per cent smaller than any other 10A power module based solution available today. The easy-to-use SWIFT TPSM84A21 and TPSM84A22 DC/DC modules integrate power MOSFETs, shielded inductors, input and output capacitors, and passives into a tiny, low-profile footprint. These also provide one per cent overshoot in transient conditions without special magnetics or additional capacitors.

Texas Instruments Inc.
www.ti.com

PWM controller

BP3319MB is a new, high-precision primary-side regulation PWM controller with single-stage active PFC, specially designed for universal input offline flyback or buck-boost constant current LED lighting. The controller with on-chip PFC circuit achieves high power factor and low THD. Operating in critical conduction mode, the power MOSFET switching loss is reduced and the inductor is fully utilised. BP3319MB adopts the proprietary primary-side current-sensing scheme. It can precisely control LED currents

without secondary-side sense and feedback circuits.

Regency Semiconductors Pvt Ltd
www.regencysemiconductors.in

LEDs

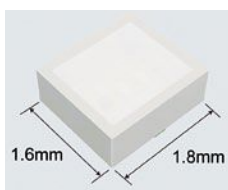
Solar charge controller

The new McUD series solar charge controllers are meant for solar LED street lighting and high mast lighting purpose. These support loads from 6W to 40W with solar PV panel support up to 200Wp. These come with all required protections like short-circuit/overload, reverse battery and panel, reverse flow of current from battery to panel during night, lightening and no-battery protection.

Macon Power Pvt Ltd
www.macon.in

Three-colour LED

ROHM has announced an ultra-compact reflector-type LED, optimised for consumer devices such as matrix light sources for gaming and wearables that demand increased miniaturisation. The MSL0402RGBU reflector-type three-colour LED leverages miniaturisation technology to achieve 1.8mm × 1.6mm size. This enables high-density mounting and provides excellent colour-mixing characteristics, ensuring support for high-resolution LED matrices.



ROHM Semiconductor India Pvt Ltd
www.rohm.com

Downlights

The latest anti-glare downlight series by iLux Electricals is designed to reduce glare and provide balanced, comfortable lighting in any home or business. It can be used in commercial

spaces, shopping malls, stores, bars, casinos, restaurants and homes. The lights are available in 2700K/3000K/3500K/4000K/5000K/6500K colours.

iLux Electricals Pvt Ltd
www.iluxelectricals.com

MISCELLANEOUS

Smart battery

The new smart batteries from Vision Mechatronics claim to last up to 20 years. These are tested to be fireproof and non-explosive, and use lithium ferro-phosphate technology with further doping, which increases life and efficiency. The batteries are completely eco-friendly as these have no emissions and require zero maintenance.

These also come with an in-built remote monitoring system, which allows you to keep track of every cell in the battery.

Vision Mechatronics Pvt Ltd
www.vmechatronics.com

MCU finder

STMicroelectronics has released MCU Finder for PC, enabling embedded developers to access essential STM32 32-bit ARM Cortex-M and STM8 8-bit microcontroller information conveniently from the same desktop environment used for application development.

Leveraging the features of ST's popular MCU Finder mobile app (ST-MCU-FINDER), the PC version (ST-MCU-FINDER-PC) provides easy-to-use selection tools, self-maintaining documentation and connections to MCU communities.

STMicroelectronics
www.st.com

LCD display

The new 16 × 2 LCD display is based on HD44870 display controller and, hence, is easy to interface with most

microcontrollers. It works off 5V and has a green backlight that can be switched on and off as desired. Contrast of the screen can also be controlled by varying the voltage at the contrast control pin.

Rajguru Electronics
www.rajguruelectronics.com

Materials for connectors

Royal DSM—a global science based company—is extending its ForTii Ace family of high-performance materials based on high-temperature polyamide. Its latest is a product developed for electronic connectors in automotive applications that will not blister during high-temperature soldering processes, whatever the design of the connector.

ForTii Ace JTX8 is currently the only polyamide grade in the world to have secured, in all product designs, the JEDEC MSL 1 (moisture sensitivity level 1) rating. This means that connector and component designers will be able to enjoy benefits of a polyamide material in creating a robust product, without worrying at all about blistering during assembly even after long shelf time.

ForTii Ace JTX8 is an ideal match for automotive electronics applications in environments of up to 200°C. It can match thermal stability of a standard copper-iodide-stabilised polyphthalamide (PPA) grade, even though it contains no halogen based stabilisation system, making it a truly electrical-friendly material. It also offers much better chemical resistance than most PPAs in the market.

DSM
www.dsm.com

FIRST LOOK

ESTYLE

EFY BUREAU

Price ₹9999 (for 2G+32G variant)

Smartphone by Xiaomi

Puts more power in your pocket

Redmi Note 4 is supercharged by Snapdragon 625, an octa-core processor chip that uses the most advanced 14nm FinFET technology. It is 20 per cent more power efficient than Redmi Note 3 (its predecessor), and is bound to put more power in your pocket. The 4100mAh powerhouse has a 2.5D curved glass and slimmer, tapered edges that feel great in your hands. It also offers up to 4GB of RAM and a 13MP CMOS camera for amazing low-light results. It also comes with up to 64GB of storage.

The winning combination of 4GB RAM and 14nm FinFET technology delivers more thermal reduction and greater sustained performance. Redmi Note 4 uses a noise-eliminating CMOS sensor with backside illumination and larger pixels to give you stunning images even in low light. It also comes with face detection autofocus for 0.1s ultra-fast focusing, which is especially useful for shooting moving objects.

OPPLE Lighting launches portable table lamps

A stylish table lamp with a flexible pipe style

This product by OPPLE has been designed to offer smartness and portability to everyday life. The lamp comes with a flexible angle that can be twisted as per your convenience. It also offers a clip that can be attached to any kind of base like a table or laptop. This handy lamp provides flicker-free and uniform light output that is safe for your eyes. It allows adjustment of brightness levels as per requirement. You can adjust the illumination to 10, 40 or 100 per cent by using a touch button. This way it protects your eyesight and brings in additional visual relaxation.

Price ₹1455

Samsung launches curved gaming monitors

For professional and hardcore gamers

Price ₹35,000 (for LC24FG70 model)

The LC24FG70 and LC27FG70 curved gaming monitors unite the visual refinement of Samsung's Quantum Dot picture technology with the comfort and widespread view of its curved gaming monitors to create the ultimate gaming experience. A host of gamer-friendly features provide a more customised and enjoyable experience. Various ergonomics such as HAS, pivot, swivel and tilt provide an optimised gaming experience.

By combining Samsung's advanced motion blur reduction technology with its VA panel, the LC24FG70 and LC27FG70 are the first curved gaming monitors to produce a 1ms moving picture response time (MPRT). The rapid MPRT rate reduces display transitions between moving and animated objects and, in turn, eliminates potential visual distractions.

The monitors also leverage integrated AMD FreeSync Technology over HDMI functionality to synchronise the screen's 144Hz refresh rate with AMD graphics cards. This connectivity minimises image tearing, input latency and stutter that can disrupt game-play and escalate visual fatigue.

Compact camera from Sony

With 50x optical zoom

Price ₹28,990

The HX350 compact camera features 20.4MP Exmor R CMOS sensor for detail-packed stills and movies, indoors or in dim light; BIONZ X engine for high-speed continuous shooting at 10 frames per second and finely-detailed image quality; Carl Zeiss Vario-Sonnar T 50x optical zoom lens for travel, wildlife and more, full-HD video capability for beautiful video; Lock-on AF for enhanced photo opportunities (automatically adjusts AF target frame size to match subject size, improves tracking performance and takes full advantage of every photo opportunity) and a lot more.

Take the guesswork out of composing shots and get exactly the result you are looking for. A 201k-dot resolution electronic viewfinder gives you a clear, real-time preview with 100 per cent field coverage, which is ideal for framing, focusing and reviewing shots using various settings. Intelligent Active Mode, featuring Sony's advanced frame-analysis technology and 5-axis image stabilisation, compensates for camera shake.

Bluetooth speakers from Genius

Let the colours spill music

The vibrantly-coloured Bluetooth-enabled SP-906BT series delivers clear, vibrant sound, making it a highly-potent audio source. Whether listening to music, audio books or phone calls, the Genius SP-906BT series delivers amazingly clear and loud sound. It perfectly fits different usage scenario, be it sports like jogging, rock-climbing or biking, or hanging out and partying with friends. You can simply clip the speakers on your belt or bag, and instantly hear incoming alerts or play audio while you carry on with your activities.

Smart t-shirt from Broadcast Wearable

Helps you attain fitness goals like never before

Sygnal fitness t-shirt can track the number of steps you walk or the floors you have climbed. It also keeps a record of the number of calories burnt and the distance travelled by walking or running. You do not have to worry about it getting ruined when you sweat out on treadmill because it is waterproof.

It comes with a micro-USB port to recharge the battery. Once fully-charged, the battery is expected to last for five days. The microcontroller box is fitted with an accelerometer and a smart Bluetooth connector. There is a soft button on sleeve that can be used to power on or off the t-shirt.

Sygnal app helps connect the t-shirt to your phone. Data recorded by the t-shirt is displayed on your phone screen. The app also helps you to navigate to a desired location.

DIGISOL launches IP camera

With 2MP HD resolution and PoE support

DIGISOL has launched a 2MP outdoor bullet IP camera with IR LED and IR cut filter. The camera offers the latest compression technology with CMOS sensor and real-time image-processing hardware. With its high-performance H.264 compression, you can stream high-quality video at low bandwidth and storage capacity requirements. Its modular design helps it to be recessed into suspended ceilings without additional mounting brackets. DG-SC5303 supports Power over Ethernet (PoE), which helps in easy installation by eliminating the need of a dedicated power source for the camera.

DG-SC5303 has IR LEDs for better visibility under no light environment. If the environment light is not sufficient enough to view the camera, then the IR LEDs are triggered on automatically for better visibility. The IP camera enclosure complies with IP66 standard, thus protecting it from dust and direct sprays from all directions (limited ingress permitted). It is an ideal solution for outdoor applications.

GizMo ByTes

Microsoft StaffHub for everything work

Microsoft StaffHub is a Cloud based platform that puts work tools into your back pocket. With Microsoft StaffHub, you can view schedules, swap shifts and request time off. As a manager, you can create schedules, approve requests and share information.

Peek Launcher, a no-frills Android launcher

Peek Launcher uses state-of-the-art machine learning to suggest the apps you are most likely to use based on where you are and what you are doing. Peek Launcher learns from your behaviour and only gets smarter the longer you use it.

Sound Off Reborn, a scheduler

This app is a mute scheduler that allows you to turn the sound off at scheduled times. It is similar to Don't Disturb functionality built into newer Android phones, but it has a much simpler and more intuitive user interface. Simply schedule when your phone or tablet should be muted, and the app turns the sound off at given time.

Automate your life with Stringify

Stringify is an advanced version of IFTTT. It connects all your physical and digital things together in one place so you can take better care of yourself, your family, your home or just get more done. Create and add powerful Flows that automate your life.

Organise your apps with Smart Drawer

Smart Drawer works on top of most launchers and uses an algorithm to organise and sort apps on your smartphone. Replace your app drawer with Smart Drawer, and you would not have to move your apps in folders—everything will be done automatically. You can also hide unwanted apps or protect these using your fingerprints or PINs.

The prices, features and specifications are based on information provided to us, or as available on various websites and portals. EFY cannot vouch for their accuracy.

Breathe Easy With INTELLIGENT AIR PURIFIERS

Shanosh Kumar is technology journalist at EFY. He is BCA from Bangalore University and MBA from Christ University, Bengaluru

Air purifiers make use of two common types of filters to remove extremely small particles from the air. One is called high-efficiency particulate air (HEPA) filter, which uses very fine glass threads with diameter less than one micron to collect particles down to 0.3 micron in diameter.

Then there is the electrostatic precipitator (ESP) that uses electrostatic charge created by a cloud of free electrons, like plasma, into which dust particles are forced in. These filters collect and filter out particles down to a diameter of 0.01 micron (0.00001mm).

In addition, both types generally use special carbon filters to clear out volatile organic compounds and obnoxious smell due to burning fossil fuels, vehicle exhausts and chlorofluorocarbons.

The filters

Electrostatic precipitators draw polluted air into the purifier unit where the particles get charged using an ionising mechanism. Then, the particles pass through a filter that carries an opposite charge to that of the passing particles. The particles stick to the filter and are removed from flowing air.

Ion generators in some filters send out ions into the air instead of charging these inside the purification unit. When the surrounding air gets charged, ions attach themselves to airborne particles. In this process, these acquire charges and newly-charged particles get attracted to surfaces of surrounding objects, walls and drapes, and fall or settle down on the floor with other particles.

Activated carbon filters. The activated carbon filters are used for odour reduction. These filter out volatile organic compounds and odour. Made up of carbon-impregnated cloth or foam, these are manufactured by infusing powdered activated carbon, which is wrapped around the inside or outside of the HEPA filter.

In an electrostatic precipitator unit, these are stretched in a frame at the inlet or outlet.

Pre-air filters. These help capture large dust particles that can clog the HEPA filter and, hence, are a must have.

What to look for

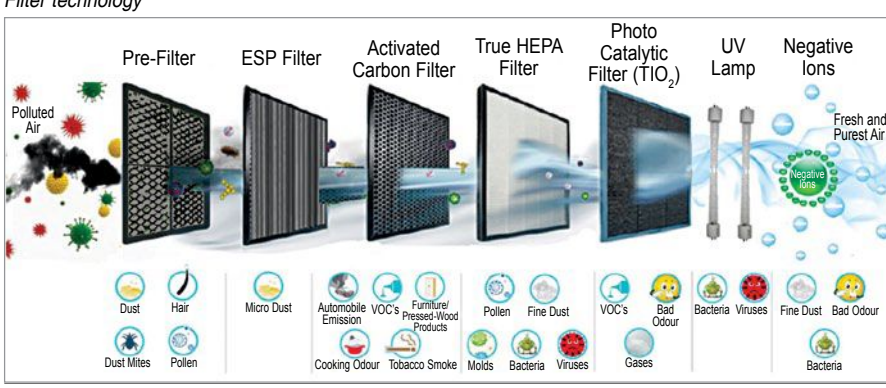
There are some elements that you should look at while shopping for an air purifier.

Performance. Performance and efficiency of air purifiers are measured by minimum efficiency reporting value (MERV) for air filters installed in the ductwork of HVAC systems. MERV performance value ranging from the one (lowest) to 20 (highest) could be used to compare the performance while buying these units.

MERV rating of one to four is commonly found in residential air-conditioning systems. Medium-efficiency filters fall in the range of five to 13 MERV, and these are capable of removing small to large particles in the air. Filters having 14 to 20 MERV fall under high-efficiency range, and are used for large halls.

Portability. Air purifier manufacturers are also focussing on localised air cleaning, and are striving to make these handy and portable. The only flipside is that these smaller air purifiers may not perform as efficiently as the

Filter technology



Some mechanisms

The type and size of air purifiers that needs to be purchased depend on three major factors:

- Air pollution (heavy, medium or light)
- Area occupied by the air purifier where it is to cleanse the air
- Amount of air flow that could move through the air purifier (room size)

Once the above-mentioned factors are determined, you can calculate the number of units or places within a building that need attention.

larger ones with respect to making air contaminant-free, which is measured as cubic metres of air filtered each minute, but are great for medium-sized rooms.

Ease of cleaning. Air purifiers with ion generators are designed to ionise the surrounding air. Most filters can be easily cleaned, except the HEPA filters.

HEPA filters are quite tricky to clean, as these get embedded with very fine dust particles. Caseless cleaning or washing of these filters can easily spoil these. So the manufacturers recommend their replacement after about a year's time.

Remote control using smartphone applications. Air purification systems also come with smart remote controls and some with smartphone control. With smartphone-interactive applications and sensors on the units, you can gauge the quality of indoor air and set the purification mode (high or low speed) accordingly. Notifications on the smartphone application can also remind you of crucial actions to be kept in mind while switching the system on. Reminders for replacing the filters and servicing can also be automated in this process.

UV light treatment. With this feature, all airborne pathogens are killed by ultraviolet (UV) rays. These kill the micro-organisms passing through the air filter and vent out air that is free of such contaminants. UV rays are ozone-free but sometimes this treatment might create ozone, which can be harmful.

Pollution sensors. These are made up of LEDs and photodiodes arranged such that these pick up any light scattered from the particles of the passing air. In higher-end air purifiers, this mechanism is replaced by lasers, which are far more sensitive, and can detect individual particles. You can guess how dustry the air is by observing the LED lights on the display panel.

Some popular brands

The all-rounder Philips. Almost all higher-end purifiers from Philips now come with real-time indoor air-quality monitoring system with display. Their Intelligent Purification System claims to remove almost all allergens and ultra-fine particles. Most models come with two HEPA layers and activated carbon filters to filter out air impurities.

Anion-generating technology from Eureka Forbes. Negative ions produced by the air purifiers from Eureka Forbes bind airborne particles and pollutants, creating a fresher environment. Some models also have humidifiers (these introduce water in the form of vapour or mist into the environment) apart from having HEPA and active carbon filters.

Atlanta Healthcare for home and office spaces. Best suited for home or living spaces, air purifiers from Atlanta Healthcare provide effective filtration and protection against obnoxious gasses and other odours. These can remove cigarette odour, smoke, smell of food and varnishes including particulates (PM2.5/PM10) in their installation space.

Air purifiers for vehicles from Honeywell. Honeywell also has an effective range of air purifiers with all the above-mentioned enhancements. What stands out is their car air purifier range, which is equally effective for a small room—proportionate to space in a medium-size car. EFY

How To FREE UP SPACE On ANDROID

EFY BUREAU

Android phones usually come with a decent amount of storage, but can still run out on memory. Let us see how you can get more storage on your Android device(s).

Back up photos and video to Google Photos. Photos and video take up the most space on Android phones, especially the ones that come with cameras that provide increasingly high megapixel counts.

Download the free Google Photos app from Google Play and in Settings menu, select to back up all photos and video over Wi-Fi. Once the media has transferred to the Cloud, delete these from the phone. Be careful to delete these from Gallery app rather than Google Photos.

Move other files to Google Drive. In a fashion similar to moving your photos and video to Google Photos, use Google Drive (also free) or any other Cloud storage app to store other files.

The above two steps would help you out even if you are not running low on storage, as you would never lose your media if your device breaks or you lose it. These also help when you are upgrading your phone—makes transferring data easier.

Delete apps and games you do not use. Some apps and games consume a lot of storage, and if you do not use these, you must delete these. You can download these (including paid ones) later from Google Play to any Android device using your Google ID.

Clear out cached files. Cached files are little bits of data stored by apps every time you use these. Over time, you can collect an alarming amount of cached data, so to save some space, clear out these old files instantly. Open Settings menu and select Storage. Then, scroll down to and tap on Cached Data. Select OK to clear cached data for all apps.

Delete old downloads. Every time you download a document from the Web, it gets stored in Downloads folder. Very often you do not need these after using once. Use File Manager app to browse your Downloads folder and delete anything you do not need.

Alternatively, you may have shortcut icon in your app tray. Use that to access the folder.

Move files to a microSD card. If your phone supports a microSD, use it for storing photos, video and other files currently on your phone. Depending on your phone and its operating system, you may not be able to save apps to the microSD card.

If your phone or tablet supports microSD, go ahead and use that. But be sure to check the capacity it can accept; some phones only support a 32GB external card, so there is no point in getting a 128GB card, as it will not work on the said phone.

Add a microSD card, even if your device does not support one. If your phone or tablet does not support microSD, you can attach one on an *ad-hoc* basis using a microSD card reader, which connects to your phone's micro-USB port.

Plug in a flash drive on OTG-enabled Android devices. These days, most Android devices support USB OTG (on-the-go), which allows you to plug in peripherals such as storage drives. To check if your device supports OTG, use USB OTG Checker app, which is available for free on Google Play.

Get a wireless hard drive. Last, but not the least, to get more storage on your Android device, use a wireless hard drive. It works exactly the same as a regular portable hard drive, but you connect to it via Wi-Fi. EFY

Arduino Based DIGITAL CAPACITANCE METER: An Interrupt Based Approach

SAIKAT PATRA AND SHIBENDU MAHATA

Capacitive sensors are widely used to measure various physical and chemical process parameters such as displacement, acceleration, thickness, force, pressure, stress, level and humidity. The measured value of capacitance is then calibrated in terms of the process parameter for indication and/or control. This project presents an interrupt based approach by employing an NE555 timer and Arduino Uno to measure capacitance in the range of 1µF to 1mF, and provide local indication using an LCD and data acquisition using a PC display (serial monitor of Arduino IDE). The authors' prototype of the digital capacitance meter is shown in Fig. 1.

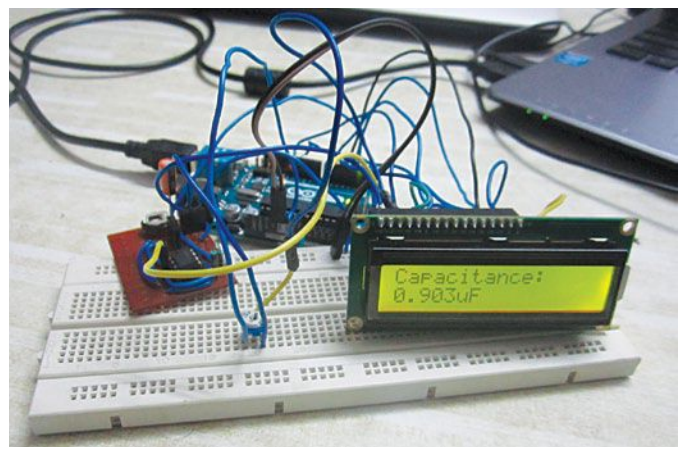


Fig. 1: Authors' prototype of Arduino based digital capacitance meter

Two methods have been described here: first with NE555 timer configured in astable multivibrator mode and second with NE555 timer configured in monostable mode.

Circuit and working

Block diagram of Arduino based digital capacitance meter is shown in Fig. 2 and its circuit diagram with NE555 timer in astable multivibrator mode is shown in Fig. 3.

Here, NE555 timer (IC1) is operated with two external resistors (R1 and R2) and an unknown capacitor (Cx), whose value is to be measured. IC1 is powered with +5V from Arduino board (Board 1); thus, eliminating the need for an external DC power supply.

IC1 generates a square-wave output of +5V amplitude at a specific frequency (depending on values of R1, R2 and Cx), which is available at its output pin 3. Output pin 3 of IC1 is connected to pin 2 of Arduino board. Since this pin of Arduino is a hardware interrupt pin (called Interrupt 0), source code (capacitance1.ino) uploaded to Arduino uses an interrupt handler, which is executed whenever the timer output makes a low-to-high transition. Thus, time period of the square-wave is continuously obtained by calculating the time difference between two such consecutive transitions. Time-period (T) of oscillation for the square-wave output from IC1 is given as:

Fig. 2: Block diagram of Arduino based digital capacitance meter

$$T = 0.693 \times (R1 + 2 \times R2) \times Cx$$

Thus, value of Cx is given as:

$$Cx = 1.443 \times T/(R1 + 2 \times R2)$$

Measured value of Cx (in µF) is then displayed on a 16 × 2-character LCD and PC.

NE555 timer. NE555 timer IC1 operates as an oscillator in astable multivibrator mode with free-running frequency, and duty cycle is accurately controlled by R1, R2 and Cx. Pins 4 and 8 of IC1 are connected to +5V connector of Board 1.

R1 and R2 of 100-kilo-ohm each are connected between pins 6 and 7, and pins 7 and 8, respectively, of IC1. IC1 shares the same ground with Arduino board. The author's designed breakout board for the timer is shown in Fig. 4.

Arduino Uno board. Arduino Uno is an AVR ATmega328 microcontroller based development board with six analogue input pins and 14 digital I/O pins. The microcontroller has 32kB of ISP flash memory, 2kB RAM and 1kB EEPROM. The board provides serial communication via UART, SPI and I2C.

The microcontroller can operate at a clock frequency of 16MHz. In this project, digital I/O pins 3, 4, 5, 6, 11 and 12 of Arduino are connected with pins 14, 13, 12, 11, 6 and 4, respectively, of the LCD.

16 × 2 character LCD. Since our Arduino program (capacitance.ino) uses the LCD in 4-bit mode, only LCD data lines D3-D7 are configured for reading data from Arduino. Pins 1 and 2 of the LCD are connected to GND and 5V, respectively, from Arduino board. Read/write pin (pin 5) of the LCD is connected

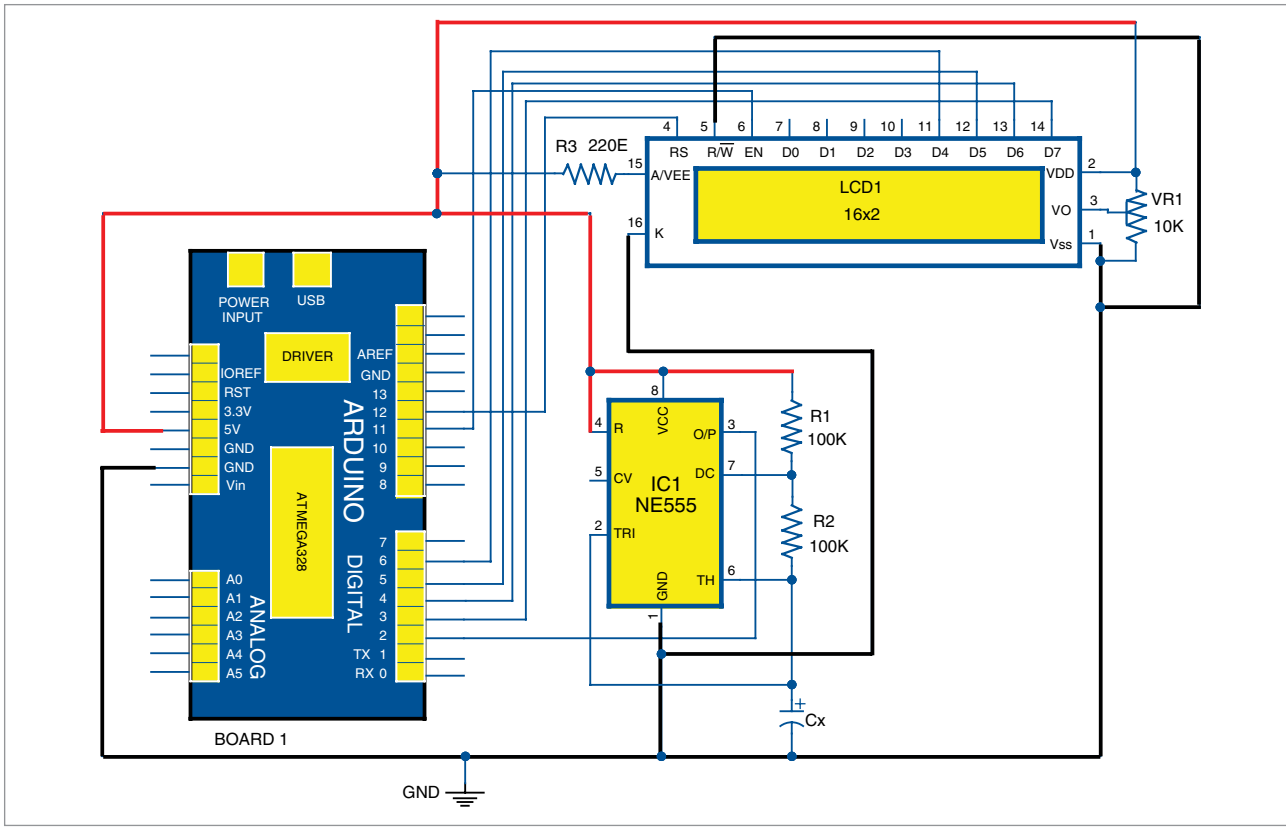


Fig. 3: Circuit diagram of Arduino based digital capacitance meter with NE555 timer in astable mode

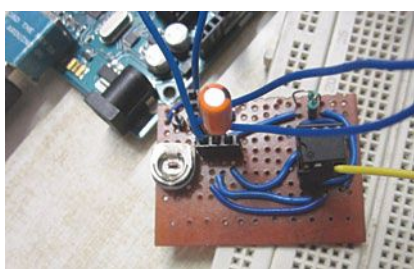


Fig. 4: NE555 timer connection in author's breakout board

to GND. A 10-kilo-ohm potentiometer (VR1) is provided for adjusting the contrast of the display.

Software

The source code (capacitance1.ino) is written in Arduino programming language. Atmega328/Atmega328P is programmed using Arduino IDE software. Select the correct board from Tools→Board menu in Arduino IDE and burn the program (sketch) through the standard USB port in your computer.

Here, code written in Arduino uses LiquidCrystal.h header file provided by Arduino library for working with the LCD.

lcd.begin(16, 2) function helps configure the 16 × 2 character LCD.

Serial.begin(9600) function initialises the serial port with a baud rate of 9600.

attachInterrupt(0,cap,RISING) function calls interrupt handler 'cap' whenever a signal connected to interrupt 0 pin (pin 2) of Arduino makes a low-to-high, that is, rising-edge transition.

Serial.print(capacitance, 3) function prints the measured value of capacitance up to three decimal places using the serial port on the PC monitor.

lcd.setCursor(0, 1) function sets the LCD cursor position to print from first column of second row.

lcd.print(capacitance, 3) function prints the measured value of capacitance up to three decimal places on the LCD screen.

NE555 timer in monostable mode

In the second method (Fig. 5), NE555 timer (IC1) is operated in monostable multivibrator mode with external resistor R1 and an unknown capacitor (Cx), whose value is to be measured. IC1 is powered with +5V from Arduino board (Board 1); thus, eliminating the need for an external DC power supply.

In this mode of operation, when trigger pin of the timer is made low (0V) by sending an active low pulse from pin 9, output of the timer (from pin 3) goes high (+5V) for a certain period of time, which is determined by the values of R1 and Cx. Time period (T) for which the timer's output remains high is given as:

$T = 1.1 \times R1 \times Cx$

Output of the timer is connected to pin 2 of Arduino, which is a hardware interrupt pin (called Interrupt 0). The source code (capacitance2.

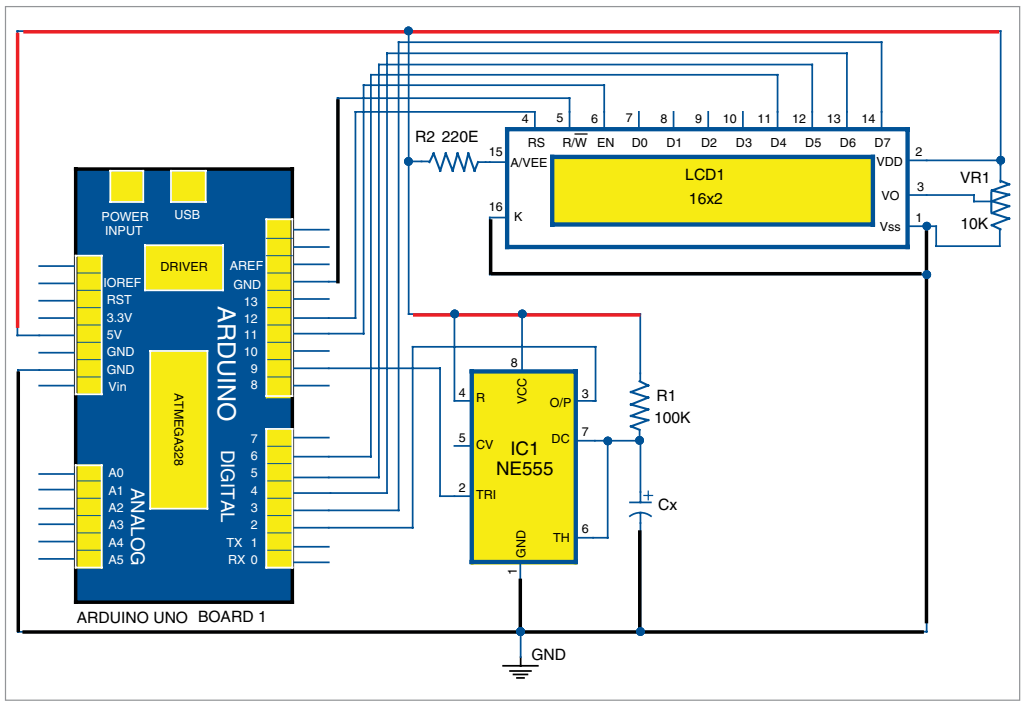


Fig. 5: Circuit diagram of Arduino based digital capacitance meter with NE555 timer in monostable mode

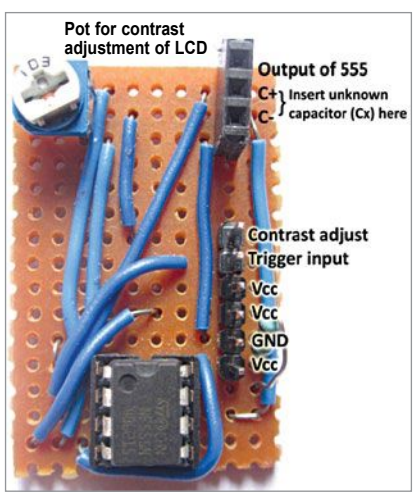


Fig. 6: NE555 timer connection in authors' breakout board

ino) uploaded to Arduino uses an interrupt-within-an-interrupt handler, that is, a two-level nested interrupt sub-routine (ISR).

The first interrupt-handler gets executed whenever the timer output makes low-to-high transition, and the second ISR is called from within the first when timer output makes high-to-low transition. Thus, time for which the output of the timer remains high is obtained by calculating the time difference between two such consecutive interrupts, which is equal to T.

Thus, value of Cx is given as:

$Cx = T/(1.1 \times R1)$

Measured value of Cx (in µF) is then displayed on a 16 × 2-character LCD and serial monitor of Arduino IDE.

NE555 timer. NE555 timer IC1 operates in monostable multivibrator mode, where time for the output goes high, after applying high-low-high pulse from pin 9 of Arduino, which is controlled by R1 and Cx connected externally to the IC.

Output of timer pin 3 is connected to interrupt pin (pin 2) of Arduino. Pins 4 and 8 of the IC1 are connected to +5V connector of Board 1. R1 of 100kΩ is connected between pins 8 and 7. IC1 shares the same ground with Arduino board. The authors' designed breakout board for the timer is shown in Fig. 6.

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*

Software

The code (capacitance2.ino) written in Arduino programming language uses LiquidCrystal.h header file provided by Arduino library for working with the LCD.

attachInterrupt(0,analyze1,RISING) function calls the interrupt handler named analyze1 whenever output of IC1 connected to interrupt 0 pin (pin 2) of Arduino makes low-to-high, that is, rising-edge transition.

attachInterrupt(0,analyze2,FALLING) function calls the interrupt handler named analyze2 whenever output of IC1 connected to pin 2 of Arduino makes high-to-low, that is, falling-edge transition.

The high-low-high trigger pulse applied to pin 2 of IC1 is generated by pin 9 of Arduino using the following code within void loop() function. Refer source code for the same.

```
void loop ( ){
digitalWrite(9, HIGH);
delay(10);
digitalWrite(9, LOW);
delay(1);
digitalWrite(9, HIGH);
while (1);
}
```

Note. To test a new capacitor (Cx), connect the capacitor and press Reset on Arduino Uno board. EFY

Saikat Patra is passionate about electronics and MCU based embedded system applications

Shibendu Mahata is M.Tech (gold medallist) in instrumentation and electronics engineering from Jadavpur University. Currently, he is pursuing Ph.D from NIT, Durgapur. He is interested in MCU based real-time embedded signal processing and process control systems

POWER SUPPLY HUB With Battery Charger, Quad-USB And Variable Outputs

PETRE TZV PETROV

This article presents a simple, universal low-cost power supply hub with quad-USB and variable voltage outputs, plus a battery charger. There are electronic equipment like battery chargers, electronic lamps and MP3 players that take power from USB ports, but there may not be sufficient ports or sufficient power available from the USB ports on a computer. In the simplest case, we use linear voltage regulators and not switched regulators.

Fig. 1 shows one possible implementation of a power supply hub with the following main characteristics:

1. 9V to 12V AC/DC input
2. Four 5.1V outputs with USB connectors
3. One variable output from 1.2V to 6.5V
4. A constant-current output with a minimum of 10mA and a maximum of 400mA
5. Individual on/off switches (S1 through S6) or jumpers for each output; all outputs controlled by adjustable linear voltage regulators LM317T in TO-220 package

Circuit and working

LM317T is a low-cost, adjustable voltage regulator. It can dissipate up to 20W as heat and produce up to 1.5A of current (refer the datasheet). Six LM317T regulators are used in this project to build a useful power supply hub that provides power supply for four USB devices (USB1 through USB4) at connectors CON3 through CON6.

In addition, one variable output (1.25V to 6.5V) is available at CON7 and a current generator output at CON8 for charging and maintaining the rechargeable batteries. Connector CON9 in parallel with CON8 is provided as an extra but optional outlet.

Voltages across the battery charger available at CON8 and adjustable output from IC5 available at CON7 should be measured with a voltmeter. Outputs at the USB connectors (CON3 through CON6) have LEDs for visual indications. Glowing of the LEDs indicates the presence of the power supply at each USB connector.

Switches. The circuit has ten switches, S1 through S10. S1 through S5 are used for switching on/off IC1 through IC5 and corresponding V_{OUT1} through V_{OUT5}, respectively.

S6 is the on/off switch for IC6 and for output currents for charging and maintaining rechargeable batteries at CON8 and CON9. S7 through S10 determine the output current produced by IC6.

Voltage and current calculation. Voltage (V_{OUT1}) produced from IC1 can be calculated with the formula:

$V_{OUT1} = 1.25V \times (1 + R3/R2) = 1.25V \times 4.09 = 5.11V$

Similarly, you can calculate voltages V_{OUT2}, V_{OUT3} and V_{OUT4}.

These four voltages should be in the range of 5.1V to 5.2V or near the maximum of 5.25V for the USB standard voltage.

Maximum voltage produced by IC5 can be calculated using the relationship:

TABLE I: CURRENT PRODUCED BY IC6

Closed switch	None	S7	S8	S9	S10
Active resistor	R18=130-ohm	R17=24-ohm	R16=13-ohm	R15=6.2-ohm	R14=3.3-ohm
Approximate output current	9.6mA	52mA*	96mA*	201mA*	379mA*

Note (*) - Current through R18 is neglected

PARTS LIST

Semiconductors:
IC1-IC6 - LM317/LM317T adjustable voltage regulator
D1-D4 - 1N5404 rectifier diode
D5-D15 - 1N4007 rectifier diode
LED1-LED7 - 5mm LED

Resistors (all 1/4-watt, ±5% carbon):
R1, R7-R9, R19-R21 - 3.3-kilo-ohm
R2, R4, R10, R12 - 220-ohm
R3, R5, R11, R13 - 680-ohm
R6 - 240-ohm
R14 - 3.3-ohm
R15 - 6.2-ohm
R16 - 13-ohm
R17 - 24-ohm
R18 - 130-ohm
VR1 - 1-kilo-ohm potmeter

Capacitors:
C1 - 10n ceramic disk
C2, C3 - 4700µF, 35V electrolytic
C4-C12, C16-C24 - 100nF ceramic disk
C13-C15, C25, C26 - 100µF, 25V electrolytic

Miscellaneous:
USB1-USB4 - Type-A USB connector
CON1, CON2, CON7-CON9 - 2-pin terminal connector
CON3-CON6 - PCB mounted USB connector
S1-S10 - On/off switch
F1, F2 - 3A fuse with holder
X1 (Not shown in circuit) - 230V AC primary to 9V AC/12V AC, 3A secondary transformer or 9V DC to 12V DC, 3A adaptor or 9V-12V battery
- Heat-sink for IC1 through IC6

$V_{OUT(max)} = 1.25V \times (1 + VR1/R6) = 1.25V \times (1 + 1000\text{-ohm}/240\text{-ohm}) = 6.46V$

For $V_{OUT(min)}$ you have around 1.25V from the datasheet of LM317T.

Minimum output current produced by IC6 is calculated using the relationship:

$I_{OUT(min)}$ = 1.25V/R18 = 1.25V/130-ohm = 9.6mA

Maximum output current produced by IC6 is calculated using the relationship:

$I_{OUT(max)}$ = 1.25V/R14 = 1.25V/3.3-ohm = 379mA

Table I gives the current produced by IC6 if you close only one of the switches between S7, S8, S9 and S10.

Heat-sink. IC1 through IC6 are

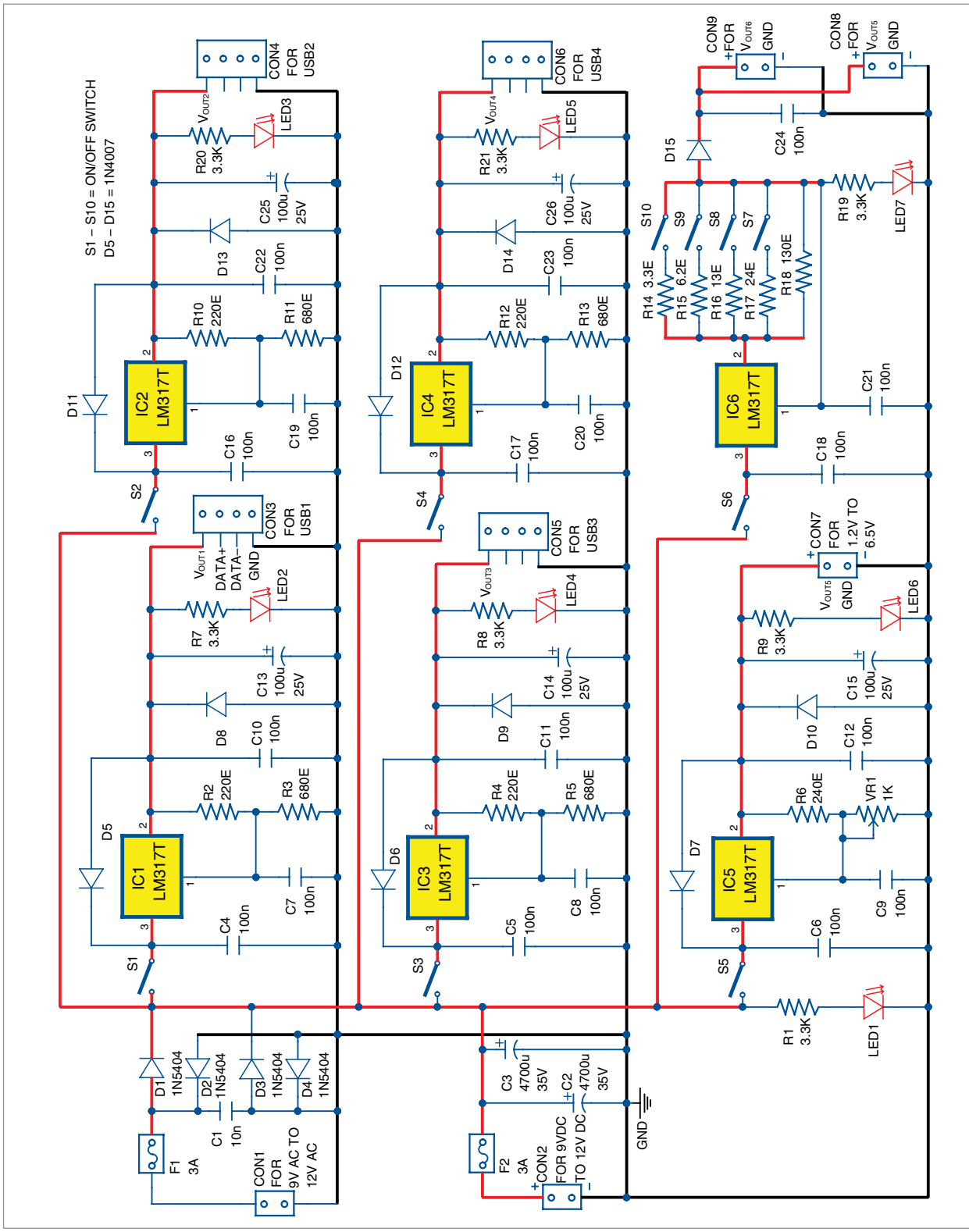


Fig. 1: Circuit diagram of the power supply hub

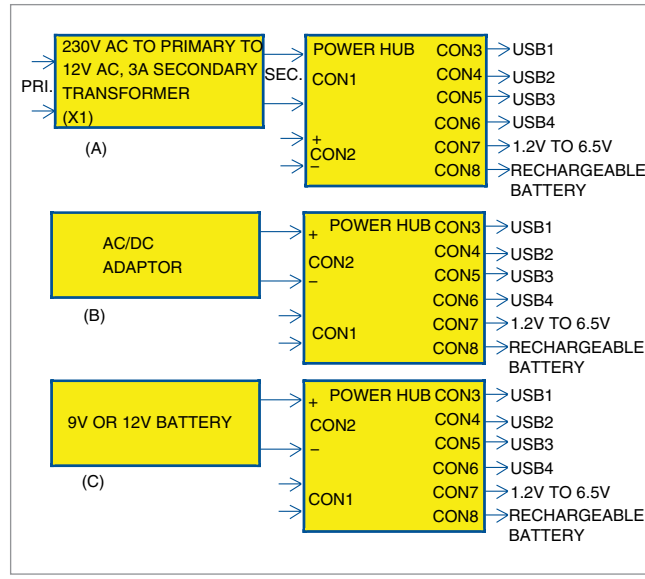


Fig. 2: Power supply hub with quad-USB outputs

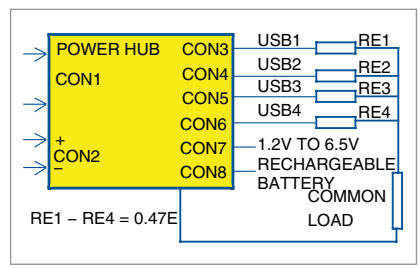


Fig. 3: USB outputs in parallel with equalisation resistors

mounted on individual heat-sinks with thermal resistance below 10°C/W.

Alternatively, IC1 through IC6 can be mounted on a common heat-sink with thermal resistance below 2°C/W, under the condition that these are properly isolated from the common heat-sink.

Input voltages. These are applied to CON1 or CON2. Fig. 2 shows the following three possible cases for input voltages to the power hub:

1. AC/AC transformer to CON1. CON 2 is not used.
2. AC/DC wall adaptor to CON2. CON 1 is not used.
3. 9V or 12V battery, including car battery, to CON2. CON 1 is not used.

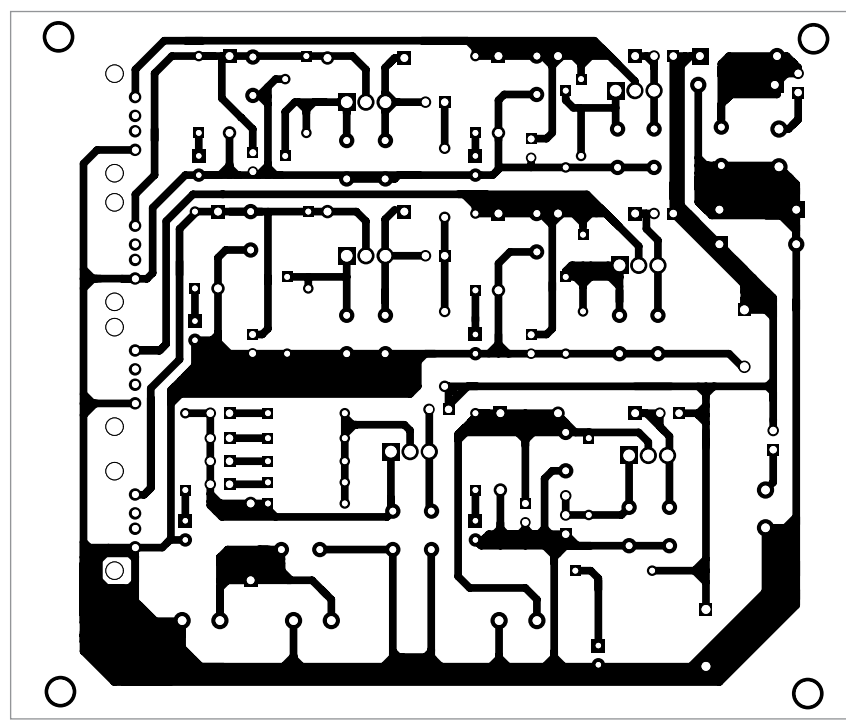


Fig. 4: Actual-size PCB layout of the power supply hub with quad-USB outputs

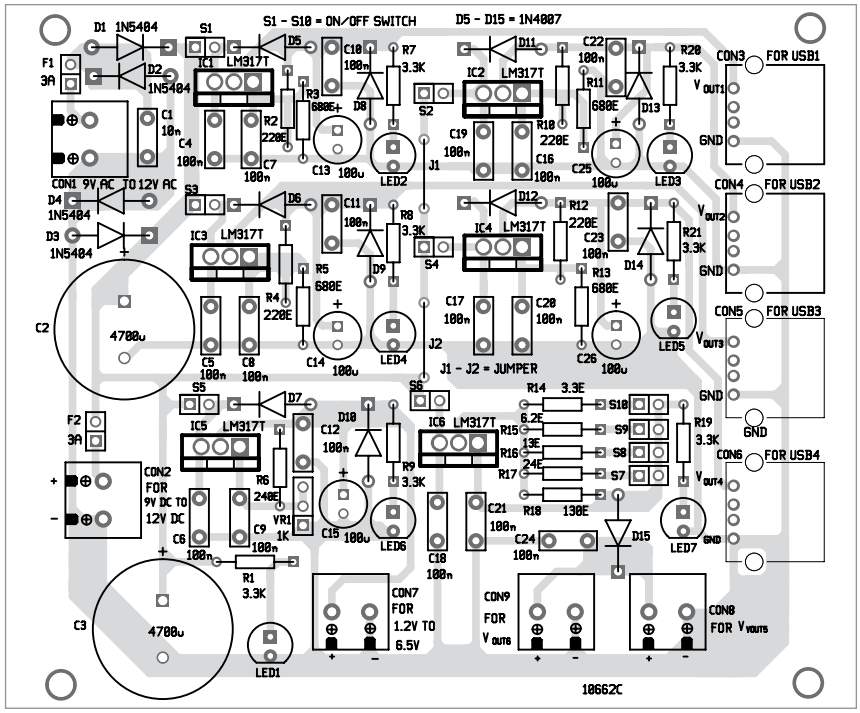


Fig. 5: Component layout of the PCB

You may connect two to four USB outputs in parallel, as shown in Fig. 3. The condition is to use appropriate equalisation resistors (RE1 through RE4). In most cases, 0.47-ohm resistors are used.

Construction and testing

An actual-size, single-side PCB for the power supply hub is shown in Fig. 4 and its component layout in Fig. 5. After assembling the circuit on the PCB, enclose it in a suitable box.

The circuit can be connected to a 230V AC primary to 9V/12V, 3A secondary transformer X1 (not shown in Fig. 1). Secondary terminals of X1 should be connected across CON1. You can also use any 9V-12V AC/DC, 3A power adaptor or 9V-12V DC battery. EFY

Petre Tzv Petrov was a researcher and assistant professor in Technical University of Sofia (Bulgaria) and expert-lecturer in OFPPT(Casablance), Kingdom of Morocco. Now he is working as an electronics engineer in the private sector in Bulgaria

RGB COLOUR DETECTOR
Using TCS3200 Sensor Module

PAMARTHI KANAKARAJA

This is a simple colour sensor using Arduino Uno R3 and TCS3200 colour sensor module. It can be useful for colour identification and detection for food-processing units, colour printer applications, paint-mixing applications and other industrial applications including robotics.

This project is used for detecting primary colours (red, green and blue, or RGB)—colours that are physically available in LEDs in one package; for example, common cathode or common-cathode RGB LED. We can display primary colours and also generate specific colours by modifying the Arduino code. The project demonstrates the basic interfacing of TCS3200 sensor, Arduino Uno and common-cathode RGB LED.

TCS3200 colour sensor module (SEN0101) is shown in Fig. 1 and microscopic view of the RGB arrays is shown in Fig. 2. On the microscopic level, you can see the square boxes inside the eye on the sensor. These square boxes are arrays of the RGB matrix. Each of these boxes contains three sensors: one each for sensing red light, green light and blue light intensity. It is better than TCS230 colour sensor module. This sensor can be used to identify any number of colours with an accurate programming code.

Fig. 1: TCS3200 colour sensor module

Fig. 2: Microscopic view of TCS3200 chip

PARTS LIST

Semiconductors:

Board1	- Arduino Uno R3
RGB1	- Common-cathode RGB LED
TCS3200	- Colour sensor module

Resistors (all 1/4-watt, ±5% carbon):

R1	- 100-ohm

Miscellaneous:

CON1	- 2-pin connector
CON2	- 11-pin connector
	- 9V battery

Circuit and working

Fig. 3 shows the circuit diagram of the RGB colour detector using TCS3200. It works off 9V power supply connected across connector CON1. However, an Arduino Uno board requires only 5V. So it has a bridge rectifier with a regulator that converts 9V to 5V logic, which can further be converted to 3.3V with the help of LM1117 voltage regulator.

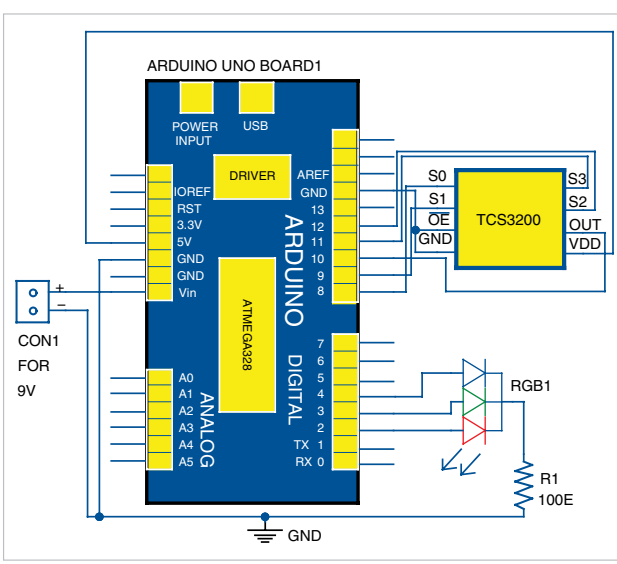


Fig. 3: Circuit diagram of the RGB colour detector using TCS3200

Brain of the circuit is Arduino Uno R3 board having ATmega328 or ATmega328P microcontroller (MCU). It has 14 digital input/output (I/O) pins and six analogue input pins, 32k flash memory, 16MHz crystal oscillator, USB connection, power jack, ICSP header and reset button.

TCS3200 module has eight pins as shown in Fig. 4. This module consists of programmable colour light-to-frequency converters that combine configurable silicon photodiodes and current-to-frequency converter on a single monolithic CMOS integrated circuit. Output is square-wave (50 per cent duty cycle) with frequency directly proportional to light intensity (irradiance).

Digital inputs and outputs allow direct interface to the MCU or other logic circuitry. Output enable ($\overline{OE}$) places the output in high-impedance state for multiple units sharing an MCU input line. In TCS3200, the light-to-frequency converter reads an 8 × 8 array of photodiodes. Sixteen photodiodes have blue filters, another sixteen have green, yet another sixteen have red and remaining sixteen are clear with no filters.

All photodiodes of the same colour are connected in parallel. Pins S2 and S3 of TCS3200 are used to select the group of photodiodes (red, green, blue and clear) that are active. The detailed pin description is shown in Tables I, II and III, respectively.

Each sensor array in these three

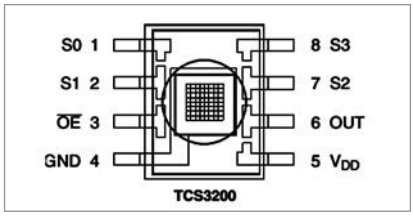


Fig. 4: Pin diagram of the TCS3200 colour sensor module

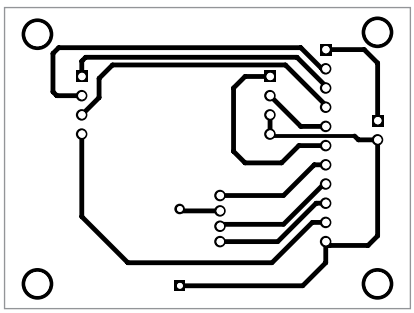


Fig. 5: Actual-size PCB layout of the RGB colour detector using TCS3200

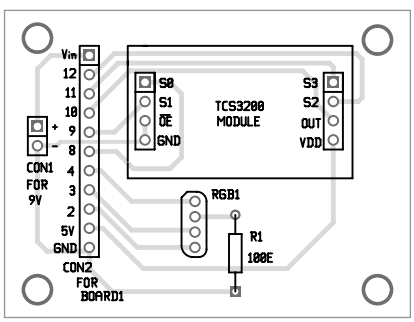


Fig. 6: Component layout of the PCB

TABLE I
TERMINAL FUNCTIONS

Pin name	Pin number	I/O	Description
GND	4		Power supply ground. All voltages referenced to GND
$\overline{OE}$	3	I	Enable for fo (active low)
OUT	6	O	Output frequency (fo)
S0, S1	1, 2	I	Output frequency scaling selection inputs
S2, S3	7, 8	I	Photodiode type selection inputs
V_{DD}	5		Supply voltage (5V)

TABLE II
S0 AND S1 FUNCTIONS

S0	S1	Output Frequency (fo)
L	L	Power down
L	H	2%
H	L	20%
H	H	100%

TABLE III
S2 AND S3 FUNCTIONS

S2	S3	Photodiode type
L	L	Red
L	H	Blue
H	L	Clear
H	H	Green

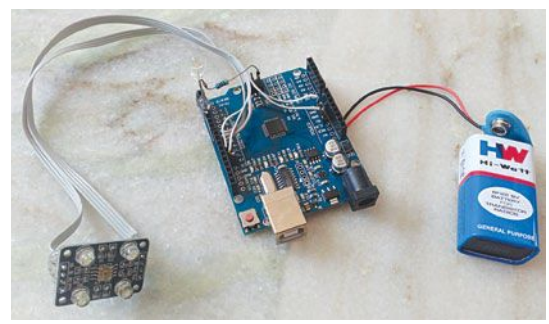


Fig. 7: Author's prototype

arrays is selected separately, depending on the requirement. Hence, it is known as a programmable sensor.

The module can be used to sense a particular colour only. It contains filters for selection purpose. There is a fourth mode with no filter. With no filter, the sensor detects white light.

Construction and testing

An actual-size, single-side PCB layout of the RGB colour detector using TCS3200 is shown in Fig. 5 and its component layout in Fig. 6.

Working of the project is simple because this is a basic circuit for interfacing a TCS3200 sensor. When red colour is kept near the sensor, it automatically detects the colour with the help of photodiode arrays and then RGB colour intensity value is displayed in Arduino serial monitor window along with colour name. At the same time, a red LED glows in the RGB LED. Similarly, the remaining two colours (green and blue) are shown in Arduino serial monitor window and the respective colour LED glows in RGB LED.

Software

Software is written in Arduino programming languange. Arduino Uno Board1 is programmed using Arduino IDE software. ATmega328P on Arduino Uno board comes with a pre-programmed boot-loader that allows you to upload a new code to it without using an external hardware programmer.

Connect Arduino board to the PC and select the correct COM port in Arduino IDE. Compile the program/sketch (TCS3200.ino). Select the correct board from Tools→Board menu in Arduino IDE and upload the sketch.

Load the program to the internal memory of the MCU. The sketch is at the heart of the system and carries out all major functions. It is compiled and uploaded using Arduino IDE 1.6.4.

In this project, external header files are not required for programming. It is a simple way to detect RGB colour intensities on the serial port. The author's prototype is shown in Fig. 7. EFY

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*

Parmarthi Kanakaraja is assistant professor in Usha Rama College of Engineering and Technology, Andhra Pradesh

Wireless DOORBELL

A. SAMIUDDHIN

Installing a doorbell in an existing building is a difficult task as it involves wiring that can look shabby if not concealed properly. Presented here is a circuit that does not require external wiring and can be placed in small enclosures. This circuit can be used as a call bell in office, too.

Circuit and working

This circuit consists of transmitter and receiver units.

Transmitter. Circuit diagram of the transmitter is shown in Fig. 1. The transmitter circuit is built around 5V voltage regulator 7805 (IC1), encoder HT12E (IC2), a DIP switch (DIP1) and a few other components. IC2 converts 12-bit (8-bit address and 4-bit data) parallel data to serial data, which is available at its DOUT pin.

DIP1 is used to set the address bit either high or low. All 4-bit data pins (AD8 through AD11) are connected to ground to reduce power consumption because 433MHz RF transmitter module (TX1) uses on-off key (OOK) modulation. When the doorbell pushbutton switch (S2) is pressed, data along with the address is sent serially through wireless transmitter module TX1.

OOK modulation is the binary form of amplitude modulation. When data being sent is low, the transmitter is fully off, suppressing the carrier. In this state TX1 consumes very low current of about 1mA.

When data being sent is high, the transmitter is fully on. In this state current consumption of TX1 is high of about 11mA with 3V power supply.

Receiver. Circuit diagram of the receiver is shown in Fig. 2. The receiver circuit is built around 5V voltage regulator 7805 (IC3), decoder HT12D (IC4), NE555 timer (IC5), melody generator UM66 (IC6), audio amplifier LM386 (IC7) and a few other components.

Serial data transmitted through TX1 is received by RF receiver module RX1. It is fed to pin 14 of the

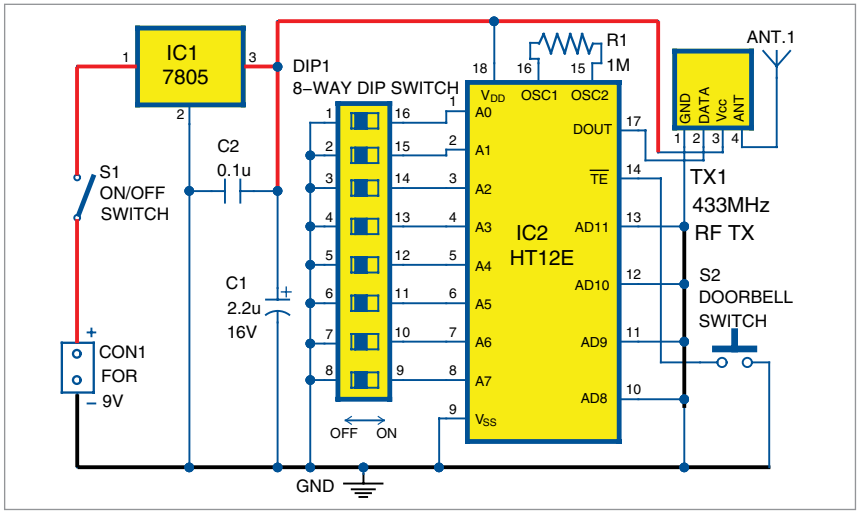


Fig. 1: Circuit diagram of transmitter unit for the wireless doorbell

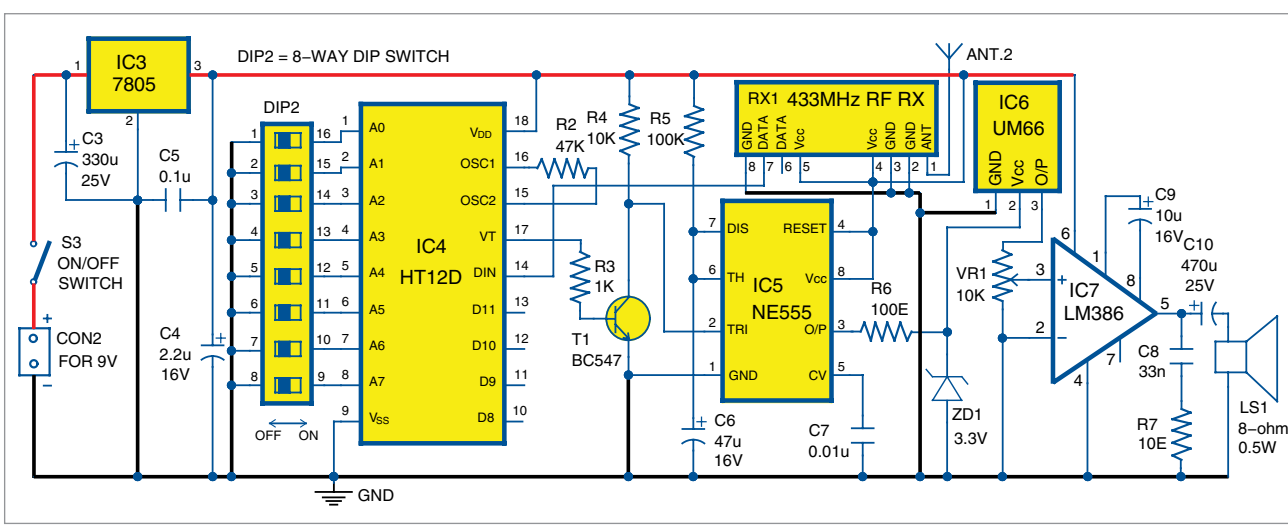


Fig. 2: Circuit diagram of receiver unit for the wireless doorbell

decoder. IC4 converts the 12-bit data into 8-bit address and 4-bit data. DIP2 is used to set the address of the decoder.

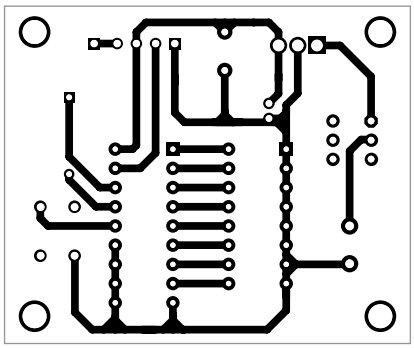


Fig. 3: Actual-size PCB layout of the transmitter unit

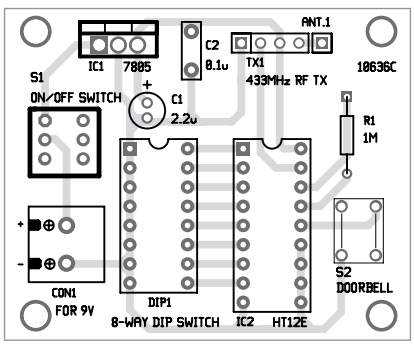


Fig. 4: Component layout of the PCB shown in Fig. 3

The 8-bit address of the decoder must match with the encoder to receive the information. The decoder checks the serial input three times continuously. If address bits of transmitter and receiver match, data is decoded and valid transmission VT pin of IC4 goes high. This triggers NE555 configured in monostable mode.

NE555 generates a high pulse for about five seconds, whose period is determined by resistor R5 and capacitor C6. Time period of NE555 is determined by the relationship:

Time period (in seconds) = $1.1 \times R5 \times C6$

It means, when S2 is pressed momentarily, provided S1 and S3 are closed, output pin 3 of IC5 goes high for about five seconds. This output pulse activates the melody generator (IC6) and so the melody sounds up to about five seconds.

Zener diode ZD1 regulates the output of IC5 to 3.3V, which drives IC6. Output of IC6 is given to IC7 through potmeter VR1. Gain of the audio amplifier is set to 200. VR1 controls the volume of the sound before amplification.

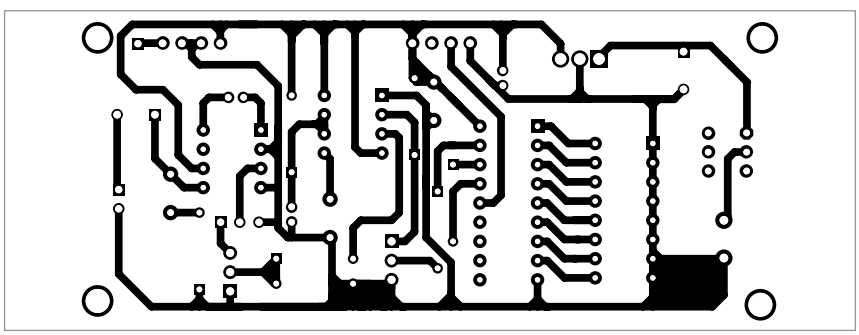


Fig. 5: Actual-size PCB layout of the receiver unit

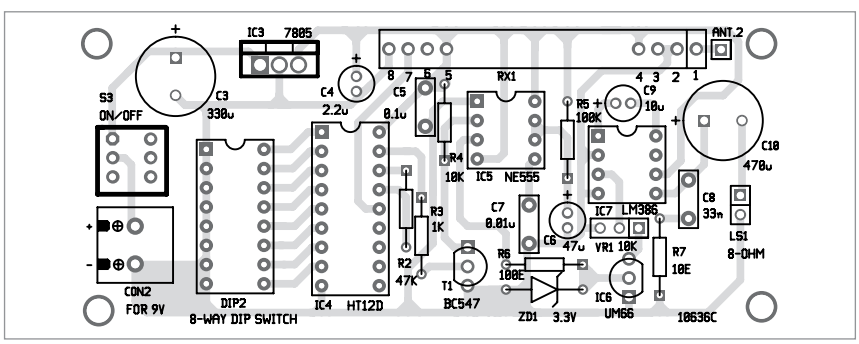


Fig. 6: Component layout of the PCB shown in Fig. 5

PARTS LIST

Semiconductors:

IC1, IC3	- 7805, 5V voltage regulator
IC2	- HT12E encoder
IC4	- HT12D decoder
IC5	- NE555 timer
IC6	- UM66/BT66 musical melody
IC7	- LM386 audio amplifier
T1	- BC547 npn transistor
ZD1	- 3.3V Zener diode

Resistors (all 1/4-watt, ±5% carbon):

R1	- 1-mega-ohm
R2	- 47-kilo-ohm
R3	- 1-kilo-ohm
R4	- 10-kilo-ohm
R5	- 100-kilo-ohm
R6	- 100-ohm
R7	- 10-ohm
VR1	- 10-kilo-ohm potmeter

Capacitors:

C1, C4	- 2.2µF, 16V electrolytic
C2, C5	- 0.1µF ceramic disk
C3	- 330µF, 25V electrolytic
C10	- 470µF, 25V electrolytic
C6	- 47µF, 16V electrolytic
C7	- 0.01µF ceramic disk
C8	- 33nF ceramic disk
C9	- 10µF, 16V electrolytic

Miscellaneous:

CON1, CON2	- 2-pin terminal connector
S1, S3	- On/off switch
S2	- Pushbutton switch
TX1	- 433MHz RF transmitter
RX1	- 433MHz RF receiver
LS1	- 8-ohm, 0.5W loudspeaker
ANT.1, ANT.2	- 17cm single-strand hook-up wire antenna
	- 9V battery or 9V DC power supply

Construction and testing

An actual-size, single-side PCB layout for the transmitter is shown in Fig. 3 and its component layout in Fig. 4. Similarly, an actual-size, single-side PCB layout for the receiver is shown in Fig. 5 and its component layout in Fig. 6.

After assembling the circuits on two separate PCBs, enclose these in suitable plastic boxes. Use approximately 17cm long single-strand hook-up wire antenna for the transmitter and the receiver each. The receiver unit requires a well-regulated 9V DC power supply for low noise and efficient operation. Alternatively, a 9V battery each for the transmitter and the receiver may be used as power supplies. EFY

A. Samiuddhin is B.Tech in electrical and electronics engineering. His interests include LED lighting, power electronics, microcontrollers and Arduino programming

Electrolysis-Free WATER-LEVEL ALARM

PRADEEP G.

In most water-level monitors and alarms, corrosion of the probes makes the systems unusable in a few months. This water-level alarm uses a phase-locked loop (PLL) circuit to generate a particular frequency at its probes to avoid electrolysis of the water. The circuit uses two NE567 PLL ICs.

Circuit and working

Circuit diagram of the electrolysis-free water-level alarm is shown in Fig. 1. It is built around two NE567 ICs (IC1 and IC2), npn transistor BC547 (T1), pnp transistor BC557 (T2) and piezo buzzer (PZ1), along with a few other components.

IC1 generates around 500Hz signals through its voltage-controlled oscillator, which is applied to first probe P1. When P1 gets shorted with second probe P2 via water, IC2 decodes this signal and activates buzzer PZ1. When a frequency of around 500Hz is received by IC2, its output pin 8 goes low. This makes pnp transistor T2 to conduct, which, in turn, makes LED1 glow and PZ1 beep.

As the signal is passed through water, there is no electrolysis and, hence, corrosion of the probes (P1 and P2) does not occur.

The circuit works off any 5V DC to 9V DC power supply.

PARTS LIST

Semiconductors:
IC1, IC2 - NE567 PLL
T1 - BC547 npn transistor
T2 - BC557 pnp transistor
LED1 - 5mm LED

Resistors (all 1/4-watt, ±5% carbon):
R1, R5 - 10-kilo-ohm
R2 - 470-kilo-ohm
R3, R6 - 1-kilo-ohm
R4 - 100-kilo-ohm
R7 - 470-ohm

Capacitors:
C1, C2, C7 - 10µF, 25V electrolytic
C3, C9 - 0.22µF ceramic disk
C4, C5 - 0.47µF ceramic disk
C6 - 0.01µF ceramic disk
C8 - 4.7µF, 25V electrolytic
C10, C12 - 220µF, 25V electrolytic
C11 - 0.1µF ceramic disk

Miscellaneous:
CON1 - 2-pin terminal connector
S1 - On/off switch
PZ1 - Piezo buzzer
P1, P2 - Steel sensor probes
- 9V battery/9V DC power supply

Construction and testing

An actual-size, single-side PCB layout for the electrolysis-free water-level alarm is shown in Fig. 2 and its component layout in Fig. 3. After assembling the circuit on the PCB, enclose it in a plastic box and connect the sensors using a two-wire cable to the PCB.

Install the probes in the overhead tank in such a way that when the tank gets filled, both probes get shorted through water. EFY

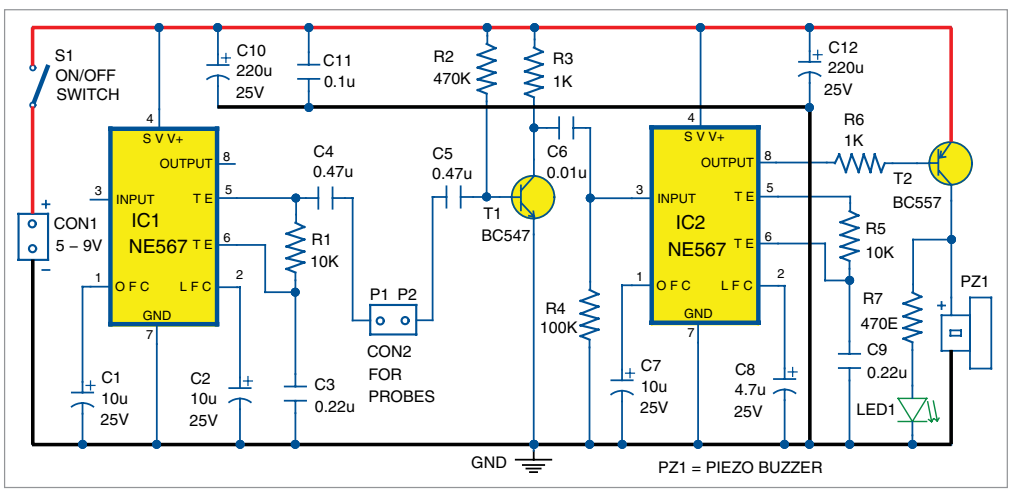


Fig. 1: Circuit diagram of the electrolysis-free water-level alarm

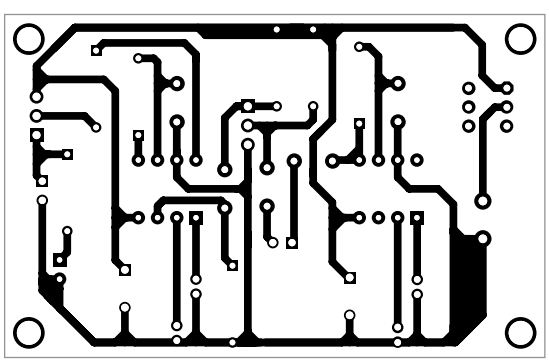


Fig. 2: Actual-size PCB layout of the electrolysis-free water-level alarm

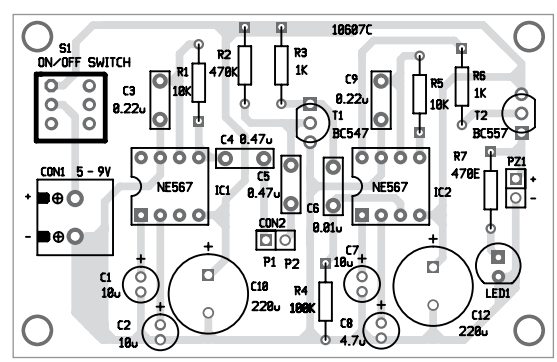


Fig. 3: Component layout of the PCB

Pradeep G. is B.Sc. (Physics) and a regular contributor to international magazines. He is also a small-business owner in south India

IoT BASED NOTIFICATION SYSTEM
Using Android App

BISWAJIT DAS

Presented here is a smart notification system for a door sensor, motion detector, fire alarm and doorbell using Raspberry Pi (RPi) and Pushover app. The project triggers an event through various sensors and sends notifications to your smartphone. Sensors used in this project include a magnetic reed switch for a door or window, PIR sensor for motion detection and NTC thermistor for fire alarm.

The issue of security is becoming more prevalent. The Internet of Things (IoT)-enabled home security solutions like this use sensors to collect and share data from multiple edge devices. If an attacker gains access to these smart systems through malicious means, the underlying functional logic of control systems can alert the owner. Connected home security systems offer a myriad of features including door and window sensors, motion detectors, fire alarms and so on, all connected via the Cloud to a mobile device or the Web.

Block diagram of the smart alert notification system using Android app is shown in Fig. 1.

Pushover app

Pushover is a service on the Web and an app for your phone or tablet that acts as a gateway for notifications. It can alert you to anything, including job postings, status of rain, emails from important people or a sensor activated in your home. Pushover lets you set up as many noise-free time periods as you like, using a feature called Quiet Hours. You can access alarm indications from anywhere in the world.

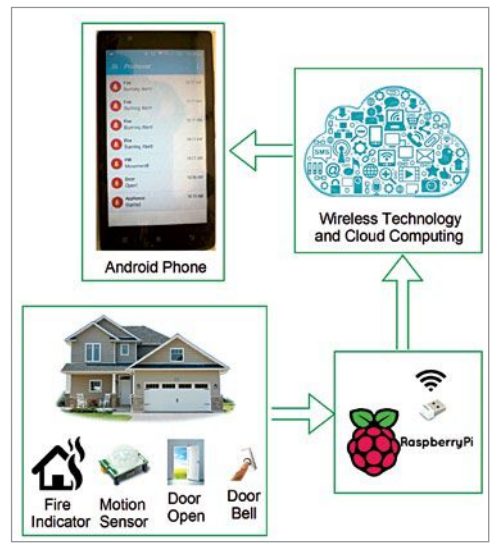


Fig. 1: Block diagram of the IoT based notification system

Circuit and working

Circuit diagram of the smart notification system using RPi is shown in Fig. 2. Hardware includes Raspberry Pi, Android phone, PIR sensor, reed switch, NTC thermistor, doorbell and a few other components.

The PIR sensor connected across CON1 detects the presence of people through changes in infrared radiation from the human body in front of the door. It outputs around 3.3V high signal whenever it detects radiation change and correspondingly sends alert signals to your Android phone.

The magnetic reed switch connected across CON2 is usually installed on the frame of an exterior door or window. When the door or window opens, it moves away from the frame, magnetic field around the switch gets removed and corresponding alert signal is sent to your Android phone.

NTC thermistor connected across CON3 is used as the temperature-cum-fire sensor. Resistance of the NTC thermistor de-

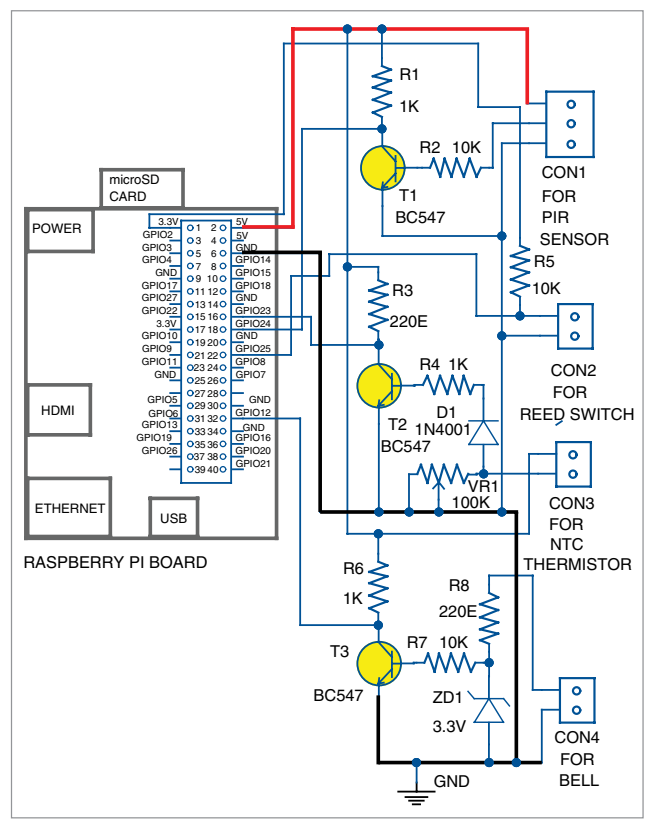


Fig. 2: Circuit of the IoT based notification system using RPi

creases with increase in temperature.

At room temperature, transistor T2 conducts. When temperature of the sensor goes above 70°C [depending on thermistor constant (K)], T2 stops conducting. When T2 stops conducting, an alert signal is generated in RPi, which is sent as a push message to the Android phone.

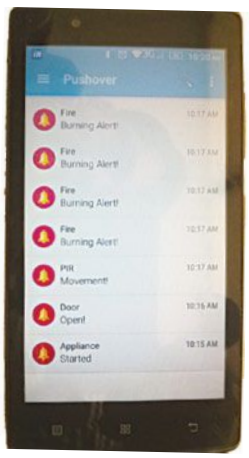


Fig. 3: Alert notifications in Android mobile

Most doorbells produce pulse-wave modulation waves while ringing. You need to hack the doorbell so that it produces at least 2V (pulse-wave modulation with low-pass filter) output signal. You may use this signal as an interrupt signal to drive RPi pin and generate an alarm log in your Android phone. Door-bell signal is fed to RPi through CON4.

When someone rings the doorbell, you will get a notification on your phone. Various alert notifications received on Android smartphone are shown in Fig. 3.

Software

Pushover makes it easy to get real-time notifications on your smartphone. Follow the steps given below to activate Pushover app on your Android device.

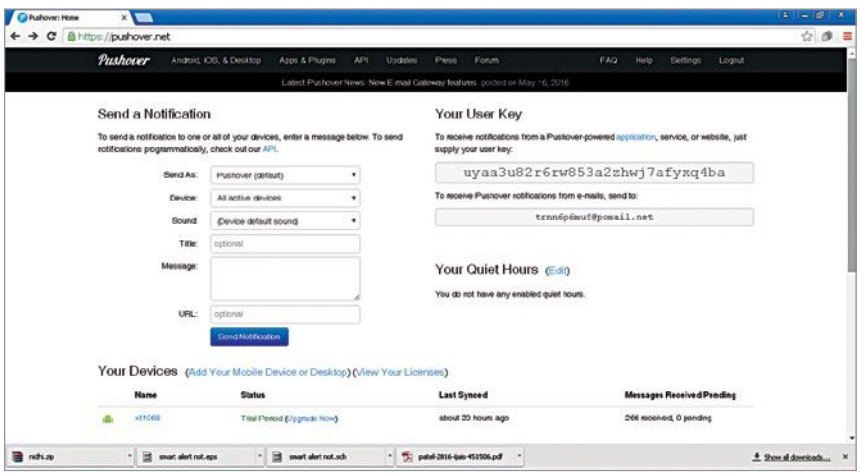


Fig. 4: Typical user key generated on Pushover app

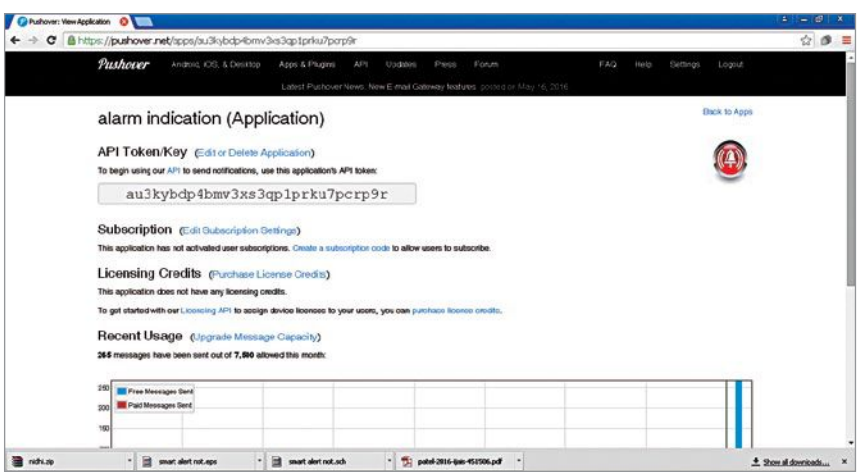


Fig. 5: Typical API key

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*

1. On your mobile device, open Pushover app and log into your account. You will be asked to register your device by providing a name for it.

2. Visit *https://pushover.net* on your computer and log into your account. You should see your devices listed in a section called Your Devices, a little way down the page. Verify that the devices you have registered are on this list and are enabled.

3. Note down your user key (like, uyaa3u82r6rw853a2zhwj7afyxq4ba) as shown in Fig. 4. You will need it for your Python code.

4. To get API key, click on Your Applications (doorbell) and note down your API token/key (like, au3kybdp4bmv3xs3qp1prku7pcrp9r) as shown in Fig. 5.

5. Under Settings in Pushover, you can set an audio alert for quiet hours, etc for your mobile as per your requirement.

Testing Pushover app

Open Pushover app on your Android mobile. Open appliance.py file on the terminal in RPi. Change user_key and application_key in the code with your keys obtained as shown in Figs 3 and 4. Run the following command:

```
$ sudo python appliance.py
```

With the server connected to RPi, you will get 'Appliance Server Started' message in the terminal and 'Appliance Started' message on your mobile. As per the interrupt signal received from the input sensors (motion, door break, fire, doorbell, etc), the corresponding alert notification will be received on your Android phone through Pushover app. EFY

Biswajit Das was manager - R&D, EFY Labs, when he prepared this article

DUCK HUNT GAME
Using Arduino And Python

OSHO GERA

This is a shooting game based on pygame, using Arduino and an accelerometer sensor. In this project a gun pointer is made on the screen, which is moved along x and y coordinates of the accelerometer, and a switch is used to fire at the target.

The gun pointer is aimed by tilting the hardware (accelerometer). A push-to-on switch (S1) is pressed (pulled like a trigger) to shoot and send a signal to the PC that a shot has been fired. The gun pointer is moved towards the bird, and the bird is killed if the positions coincide.

Two or more birds can be shot at a time. Accuracy of the aim reduces if you are continuously shooting and moving the Arduino board. Screenshot of the duck hunt game is shown in Fig. 1.

This game uses the basic concept of interfacing between Arduino and Python using pyserial package. Python version used in this project is 3.4.4. Details on Python packages are given in the software section.

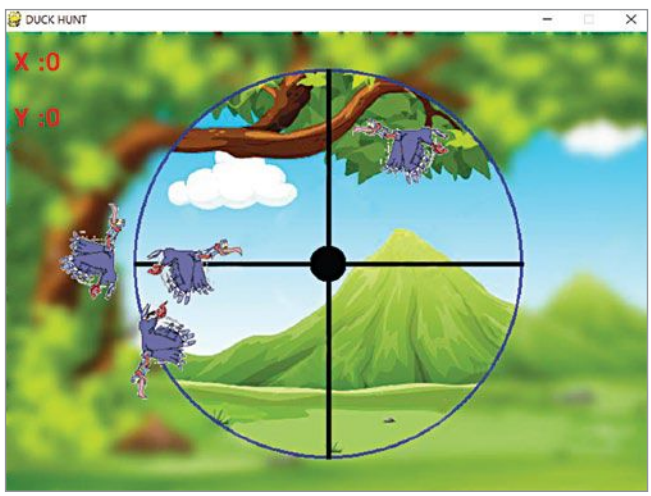


Fig. 1: Screenshot of the duck hunt game

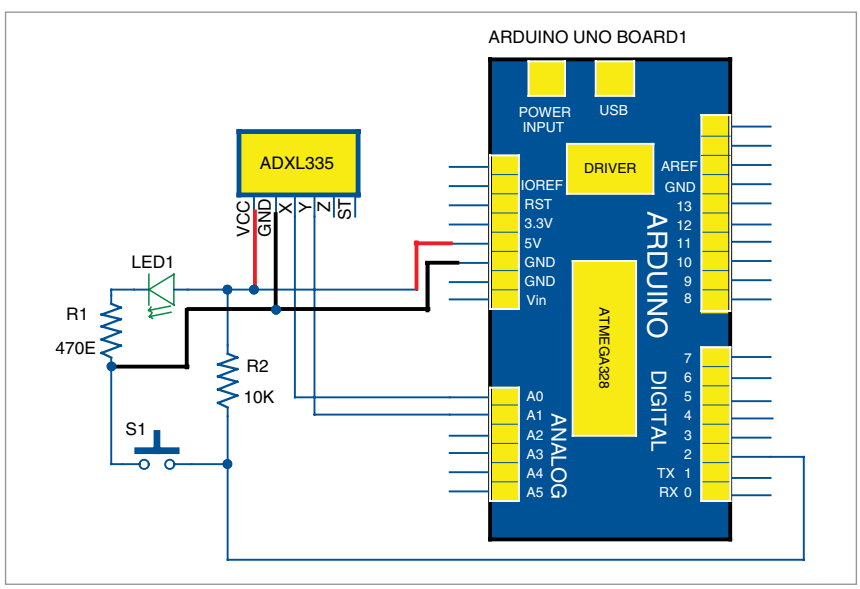


Fig. 2: Circuit diagram of the duck hunt game using Arduino Uno

Circuit and working

Circuit diagram of the duck hunt game using Arduino Uno and Python is shown in Fig. 2. The x and y pins of the accelerometer are connected to analogue pins A0 and A1 of Arduino. The accelerometer can have different values according to different manufactures. The x and y analogue values are displayed on the serial monitor of Arduino IDE.

Tilt your hardware and note down the minimum and maximum values for x and y. Put these values in Arduino code. This will be mapped from 0-20 in the program. Then, send serial data to Python and press S1 to connect it to pin 2 of Board1, which is used to fire the gun. The accelerometer is powered by 5V pin of the Arduino board. The accelerometer used for this project is shown in Fig. 3, and the author's prototype is shown in Fig. 4.

Software

Python packages. Download the packages before compiling Python program (duck_hunt.py). These can be downloaded by typing 'unofficial windows binaries Python extension packages' on Google. Download 3.4.4 version of Python.

Python packages used in the program are pyserial, pygame, random, time and math, of which you would only have to download pyserial and pygame; the rest are pre-installed.

Fig. 3: ADXL355 accelerometer sensor

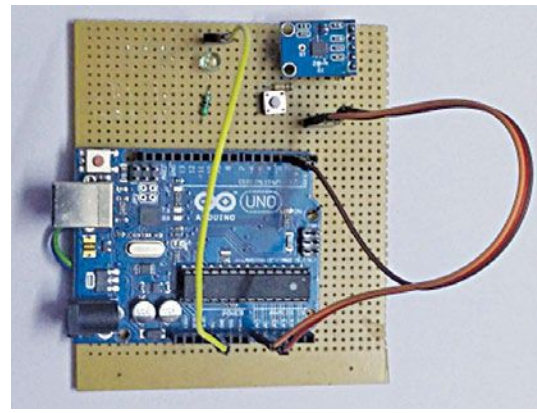


Fig. 4: Author's prototype

PARTS LIST

Semiconductors:	
Board1	- Arduino Uno
Accelerometer	- ADXL335
LED1	- 5mm LED
Resistors (all 1/4-watt, ±5% carbon):	
R1	- 470-ohm
R2	- 10-kilo-ohm
Miscellaneous:	
S1	- Push-to-on switch
Cable	- Arduino USB cable

The game is designed on pygame library that shows the images of birds and the gun with the entire graphical interface. Communication between Python code and Arduino is done using serial communication; therefore you need to add your COM port number after the program starts. This will prompt you for a confirmation. Press y to start the game. The program screen will appear along with a circle.

Birds or ducks appear at random locations with random directions. Directions are depicted using numbers, where 1 represents north, 2 represents north-east and moving in clockwise direction to 8, which represents north-west.

At every 200ms, a 4-byte data is sent from Arduino that includes a start byte (*), followed by the location of x and y coordinates scaled between 0 and 20, and ending with 0 or 1, where 1 depicts that a gun was fired using S1.

Byte 1 is sent continuously so that data is not lost. After Python code detects the firing of gun, it sends feedback to Arduino and the byte is changed back to 0. Frames of birds are taken from a .GIF file, and these are loaded one by one on the screen to show motion of the birds.

In the end, total score is shown on the screen along with the time taken and the shooting accuracy. It is possible to kill two or more coincident birds at one shot, and extra points are awarded for this.

Arduino code. Software (duck_hunt.ino) is written in Arduino programming language. Arduino Uno Board1 is programmed using Arduino IDE software. Connect Arduino board to the PC and select the correct COM port in Arduino IDE. Compile the program (sketch). Select the correct board from Tools→Board menu in Arduino IDE and upload the sketch.

Steps for testing

Step 1. Download Python 3.4.4 from its website. Select 64- or 32-bit software based on your Windows PC configuration. Install it.

Step 2. Go to command prompt Start→Run. Type cmd, and change your folder directory (where Python was installed). In my case it was in C drive, so I typed 'cd C:\Python34'.

Step 3. To avoid errors, update pip module type python -m pip install pip –upgrade. This will download the latest version of pip.

Step 4. Download Python packages from *www.lfd.uci.edu/~gohlke/pythonlibs/*. Search for pyserial and pygame (these two packages are required) from the list and download cp34 version or the latest one in pyserial. Also, download amd64 if your Windows is 64-bit or else download the 32-bit version.

Step 5. Save .whl files in a folder and install using pip. Type 'C:\Python34\Scripts\pip'. Install [[PATH]]\[[FILENAME]].whl. And, import the package in Python shell. It should work properly.

Step 6. After installing Python and its libraries, test Python code. It is simple—code given with a set of images has to be kept in the same folder. Open the code; there is a variable called PORT. Change that COM port number as per your PC, after you have attached, Arduino board.

Step 7. Attach the USB cable and after uploading the code in Arduino, run Python code by pressing F5. This will open a GUI with four birds flying around on the screen and a scope view of a gun as shown in Fig. 1.

Step 8. The gun's point can be changed by tilting the hardware, and bullets can be fired using S1.

Step 9. When you shoot while moving, the aim would not be accurate. After killing four birds, if time limit (150 seconds) is over, status of your game will be displayed on the screen. EFY

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*

Osho Gera is an electronics hobbyist

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Time FOR A BREAK

POOJA JUYAL

This is a computer based program to remind you to take regular breaks while working on your desk for good health. Some of us spend at least sixty per cent (if not more) of our day sitting on a chair working on a computer or for some other work. This physical inactivity for such long durations causes diseases like varicose veins, weak bones, back problems, weak digestion and can even increase the risk of cancer. Doctors around the world suggest good posture while sitting and taking regular breaks from your work. You can walk around and stretch a little bit for a healthy life.

Here is what the software does. Once installed, it reminds you to take a break after a predetermined time through an audio announcement. It also randomly selects a video from a list (already fed in the program) and plays it to further motivate you to leave the desk and move around.

Software program

The software is written in Python programming language. All steps, from installation, program creation to running the program, are included in this article to help you get started with Python programing language. Various modules including web-browser, random, time and pyttsx are used in the program that could be useful for other Python based projects including embedded systems. The software performs well on Window7/Windows10 systems.

Download and install Python. Python is available in two versions: Python 2 and Python 3. We have used Python 2.7.11 for our program. Download and install this version of Python before writing the program. You can download it from *https://www.python.org/downloads/*

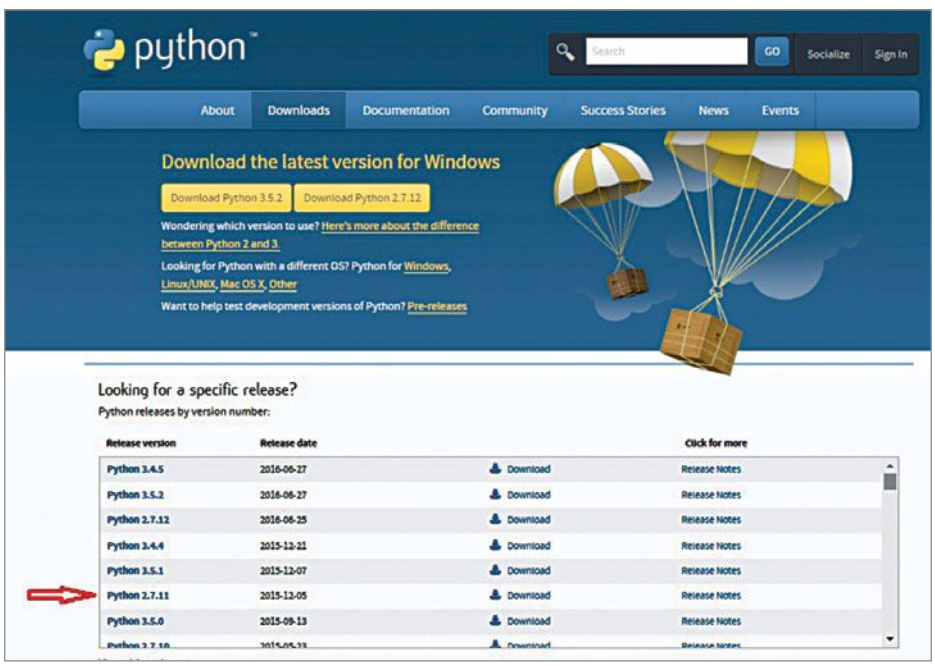

Fig. 1: Download page

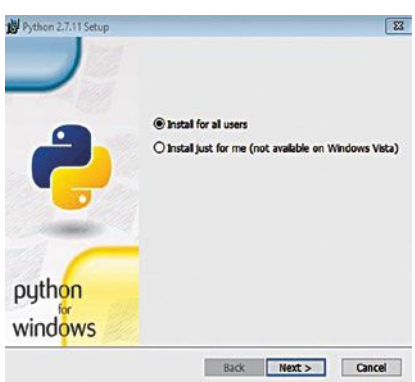

Fig. 2: Selecting Install for all users option

Fig. 3: Choosing the default destination path

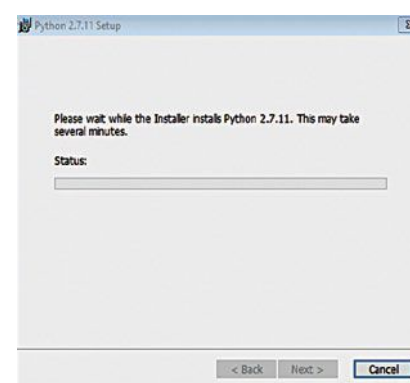

Fig. 4: Screen showing the status of installation

Fig. 5: Finish installation screen

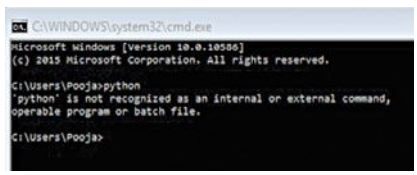

Fig. 6: Error message

Open the link; you will see the page as shown in Fig. 1. Click on Download Python 2.7.11 (marked by red arrow in the figure).

Once downloaded, install the software by following the steps given below:

1. Double-click on the downloaded file.
2. Select Install for all users option and click Next (Fig. 2).
3. Select the location to install Python. Click Next.
4. Keep the default selection (Fig. 3) and click Next.
5. You will be prompted for permission to install the software; select Yes. Page shown in Fig. 4 will appear to indicate the status of installation. Once finished, Next tab will be activated.
6. Click Finish to complete the software installation.

Add Python to path environment variable

Python can be directly run through Command Prompt on Windows. But this needs addition of Python directories to the path under System Variables as explained below. If you run python.exe command immediately after installation without adding the path, you may encounter the error shown in Fig. 6.

Follow the steps below to add Python to Environment Variables path:

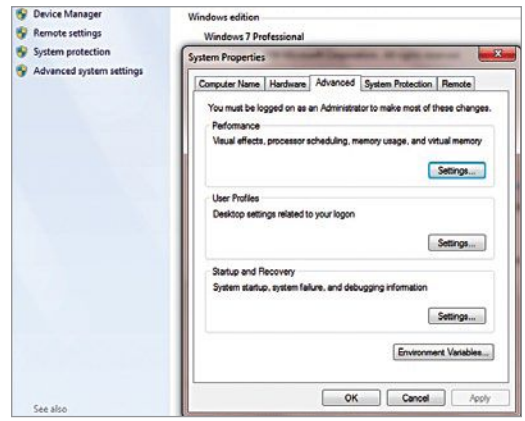

Fig. 7: Advanced System Settings

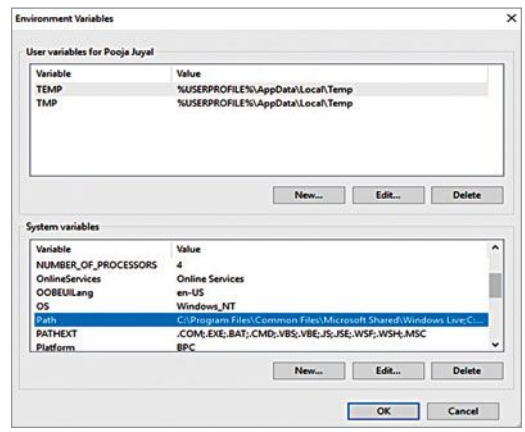

Fig. 8: Path under System Variables

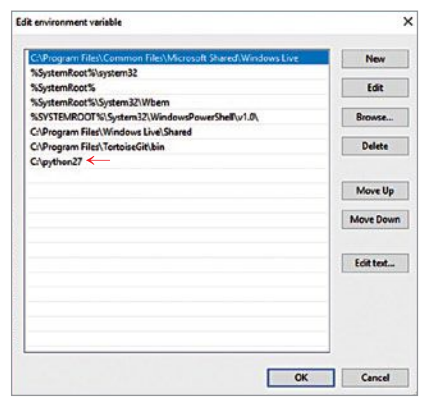

Fig. 9: Path in Windows 8

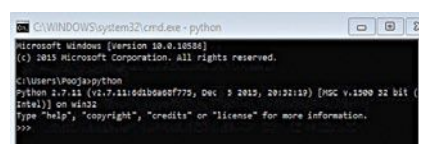

Fig. 10: Command Prompt

1. Right-click on My Computer, then Properties and then Advanced System Settings (Fig. 7).

Click on Environment Variables and search for the Path variable. Select Path variable and click on Edit (Fig. 8).

2. In case of Windows 7, add the following at the end of the variable value:

C:\Python27

3. In case of Windows 8 or above, window shown in Fig. 9 will appear. Click on New and add:

C:\Python27

4. Select OK, and it is done.
5. Open Command Prompt and type python (Fig. 10). This screen confirms proper installation of Python.

Note down the Python version and architecture. This will be required later in the article while downloading pywin.

6. Now, you can directly run Python commands from Command Prompt.

Python IDE

Python IDE comes with Python installation and is used to write, test and debug Python programs.

You can run it directly from the installed applications by clicking on its logo. Or, you can write IDLE in the search tab on Windows start button, click on IDLE (Python GUI) option. You will get Python shell screen as shown in Fig. 11.

Python is an interpreted language, so you can immediately start writing the commands, followed by pressing Enter on the keyboard. Commands get executed when you do this. Test by typing 2 + 2 and then press Enter. You should get four as the answer in the next line.

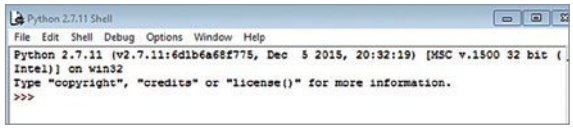

Fig. 11: Python IDLE (GUI) screen

Fig. 12: takabreak.py on Python GUI window

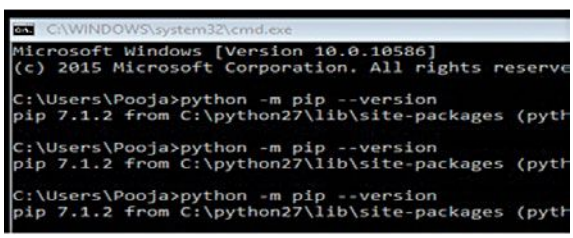

Fig. 13: Checking the pip version

Create new program

Run Python IDLE→File→New File.

Start writing the program in IDLE. The complete program has been provided in takabreak.py file (Fig. 12), and it is recommended to copy the code from this file, or use the file as it is, because Python is an indentation-sensitive language.

Importing modules

Let us start with importing different modules that would be required in the program.

```
import webbrowser
# importing webbrowser module to run videos from youtube
import random
# importing random module to select randomly from a list
import time
# importing time module for delays
import pyttsx
# text to speech module
```

The first three modules are packaged with Python standard library, so you do not have to install these. You can check all different modules in Python standard library from *https://docs.python.org/2/library/*

The fourth module (pyttsx) does not come packaged with Python standard library. So it needs to be installed before importing in the program. This module is used for making audio announcements.

Pyttsx installation

This project requires conversion of text to speech. To achieve this, a ready-made Python package called pyttsx is available. It provides the text-to-speech synthesis facility and is tested on Windows, Linux and Mac.

To install pyttsx package, you need a package manager like pip, which automatically downloads all necessary files. It also puts the files in correct directories to set up the system.

Python 2.7.11 already has this package included. To check if pip is installed, run the following command on Command Prompt (Fig. 13):

```
python -m pip -version
```

If pip is installed, the response will be something like:

```
pip 7.1.2 from C:\python27\lib\
site-packages (python 2.7)
```

Run the following command in Command Prompt to install pyttsx:

```
python -m pip install pyttsx
```

If you see the message to upgrade pip version, upgrade it by running the following command in Command Prompt:

```
Python -m pip install -upgrade pip
```

This completes the installation of pyttsx.

Installation of pywin32

pyttsx package is dependent on pywin32, so install it by downloading the same from *https://sourceforge.net/projects/pywin32/files/pywin32/*

The window shown in Fig. 14 will appear. Download the correct file depending on your Python version and its architecture installed on your PC. (Remember the Python version noted in previous steps.) In this case, it is the one highlighted in Fig. 14.

Once downloaded, install the file. Make sure that while installing, all applications using Python should be closed. This completes the installation of pywin32.

Functions used

1. pyttx setup functions:

```
engine = pyttsx.init()    # initialise
                  text to speech engine
engine.setProperty('rate', 150)  # set
                           speech rate
voices = engine.getProperty('voices')
                  # set voice property
engine.setProperty('voice', voices[0].
id)                # set female voice
```

Above functions initialise text-to-speech engine and set various parameters.

2. To play audio message:

```
engine.say('Hey SPARKY. Take a break
now.'
 ' Its been a long time you are sitting
on the chair.'
 ' I have selected some videos from the
internet to motivate you')
```

This is the audio message that will be played every time the software has to remind you to take a break.

3. Function used to play video from youtube:

```
webbrowser.open(random.choice(videos))
```

This will play random videos from the list in the program as given below:

```
videos = ('https://www.youtube.com/
watch?v=GSO6g3dNR7s',
```

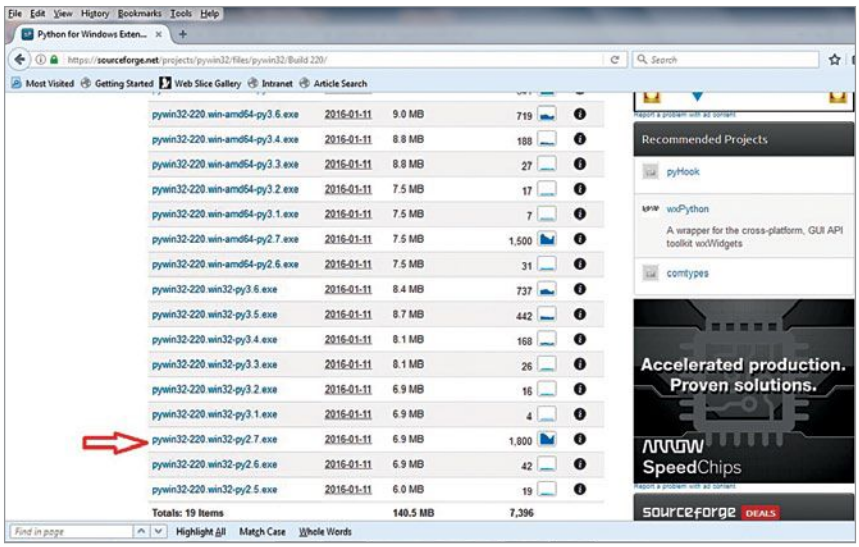

Fig. 14: Downloading pywin32 file

```
 'https://www.youtube.com/
watch?v=Y2dHYfb5OnE',
 'https://www.youtube.com/
watch?v=uiKg6JfS658',
 'https://www.youtube.com/
watch?v=azCzW_0GADM')
```

The list can be further extended and any number of videos can be added.

4. To set time for breaks:

```
time.sleep(10)
```

Please note that ten seconds time is only for testing purpose. If you want to set the breaks to every two hours, you need to replace it with 7200.

Running the program

Run Python IDLE→File→Open.

Open takabreak.py file.

Click on Run→click Run Module.

This opens the interpreter that will print 'Take a break! buddy!!' and there will be audio announcement. There will also be a randomly-selected video that will start running in the browser.

The program can be terminated by pressing Ctrl + c keys in the interpreter window. You can also double click takabreak.py file to directly run it on Windows. EFY

Pooja Juyal is manager at Samtel Avionics Ltd

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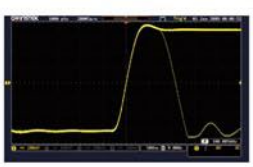
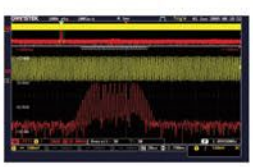


Waveform update rate of 120,000wfm/s



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