

Keep Things Simple And Success Will Come Knocking At Your Door — Amrit Manwani, MD, Sahasra Group

Ten Industry-Ready Community Boards Designers Love

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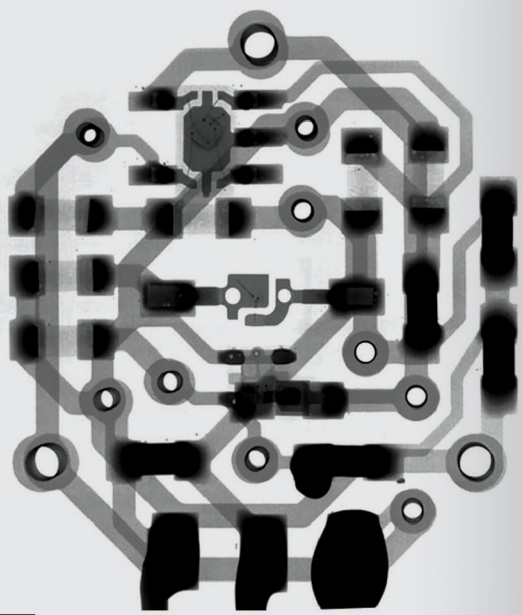
FEBRUARY 2022

electronics FOR YOU

What's So EXCITING About NEUROMORPHIC COMPUTING



The Wonderful World Of INGENIOUS PRINTED SENSORS



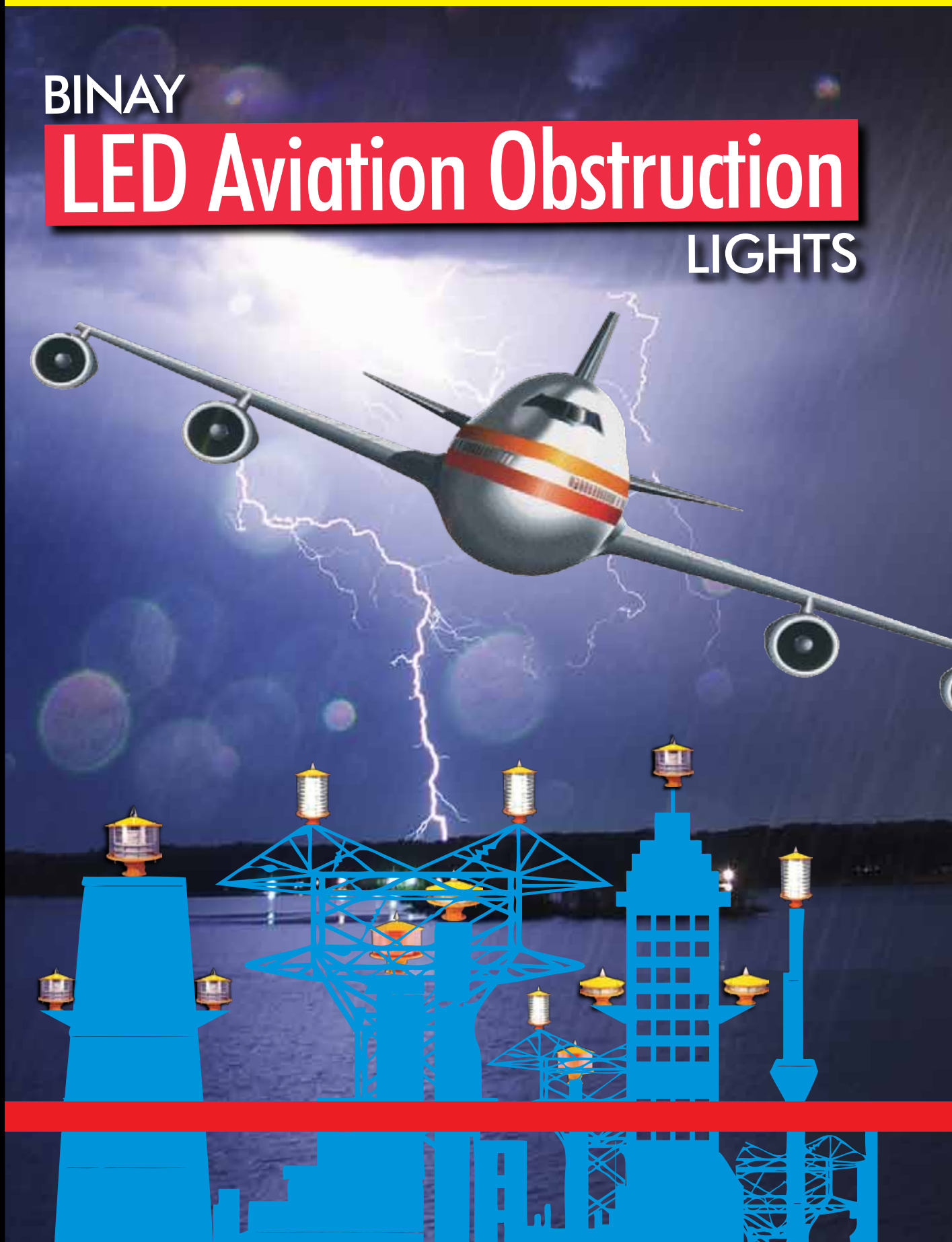
An EFY GROUP Publication
Vol. 54 No. 2
ISSN 0013-516X
Pages: 110
UK £5; US $10

MAKE YOURSELF

- Wireless EMG Controlled Prosthetic Hand
- Bluetooth Controlled Data Logger Robot For Soil Testing
- Introduction To Raspberry Pi Pico By Making Noise Generator

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BINAY LED-based HIGH, MEDIUM and LOW Intensity Aviation Obstruction Light Beacons

As per International Civil Aviation Organisation (ICAO) requirements
Available in Low Intensity, Medium Intensity and High Intensity versions (as per International Civil Aviation Organization guidelines), BINAY's patented LED Aviation Lights come with 5-year/3-year warranties



High Intensity
200,000 candela
(Flashing White LEDs)



Medium Intensity
20,000 candela
(Flashing White LEDs)



Medium Intensity
2,000 candela
(Flashing Red OR Fixed Red LEDs)



All BINAY Aviation Lights are based on Non-switching passive type circuitry (NO SMPS)

The circuitry incorporated inside the LED Aviation Obstruction Lights is passive electronic (solid-state) in nature, and does not use internal SMPS driver switching units to control the light unit. Internal LED current control is by non-switching electronic means only. No electrolytic capacitors are used inside the Aviation Obstruction Light unit.

The above is necessary to ensure reliability of the LED Aviation Obstruction Light. This system design effectively eliminates any active components and circuits inside the aviation light itself, and enhances the solid-state passive reliability of the LEDs (mounted in relatively inaccessible locations at the height of tall structures). This drastically reduces the possibility of component failure - and hence possibility of any maintenance requirement – in the LED Aviation Obstruction Lights themselves (which are mounted at extreme heights in the system).

The BINAY LED Aviation Obstruction Light offers the following advantages:

- Fit-and-forget maintenance-free operation
- A long life of 100,000 hours (20 years at 12 hours daily burning)
- Pays for itself within a short period of operation in the form of reduced installation, maintenance and servicing costs
- Quick Installation; Reliable operation 365 days per year
- Shock-proof and vibration-resistant
- Over-Designed Intensity to allow for natural LED intensity degradation over its operating lifetime

LED Obstruction Lighting for:

- Industrial chimneys and smokestacks
- Transmission, microwave and cellular towers
- Radio, TV and similar structural towers
- High-rise buildings and structures
- Airports and airfields

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

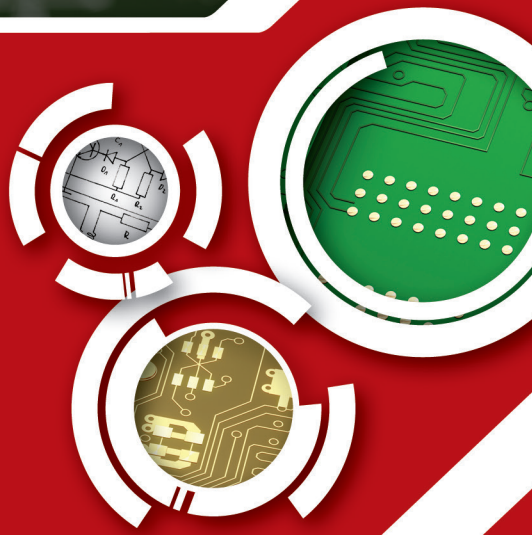
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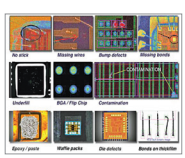
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UNITED STATES : E & Tech Media E-mail: usa@efy.in

Printed, published and owned by Ramesh Chopra. Printed at International Print-o-Pack Ltd, C-4 to C-11, Hosiery Complex, Phase-II Extension, NOIDA-201305, Gautam Budh Nagar, Uttar Pradesh, on the first day of each month and published from D-87/1, Okhla Industrial Area, Phase-1, New Delhi 110020. Copyright 2022. All rights reserved throughout the world. Reproduction of any material from this magazine in any manner without the written permission of the publisher is prohibited. Although every effort is made to ensure accuracy, no responsibility whatsoever is taken for any loss due to publishing errors. EFY will not be responsible for any wrong claims made by an advertiser. Disputes, if any, will be settled in a New Delhi court only.

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IMPROVED EFY

I am proud to say that I am subscriber to EFY from first issue. I developed my electronics knowledge through EFY only. Recently, EFY has improved a lot including quality of printing and quality of its contents equivalent to foreign magazines.

Dr Er P. Venkatesan

• • •

NON-STANDARD GPS RECEIVER

The 'Nonstandard GPS Receiver Using ESP32' DIY project published in August 2021 issue (also available on your website at *https://www.electronicsforu.com/electronics-projects/nonstandard-gps-receiver-using-esp32*) is a good one.

Aturnomkawi

EFY. Thanks for the feedback!

❑ Please send me the complete sketch of 'Nonstandard GPS Receiver Using ESP32' DIY project. I tried to compile it and got errors such as RXD1 not defined. Please help.

Ian Carruthers

EFY. The link to download the complete sketch of the project is given in the article itself. Regarding the error message you are getting while compiling, please make sure that you use the original source code and correct libraries. RXD1 is not used in original code. If you have installed ESP32 board and correct libraries, selected the correct board in Arduino IDE and used the original code with RXD2 defined, such error message should not show up.

• • •

AUTO WATER DISPENSER

This is regarding 'Auto Water Dispenser For Pets' DIY project published in September 2021 issue (also available on your website at *https://www.electronicsforu.com/electronics-projects/auto-water-dispenser-for-pets*). I am interested in this project. Please give an estimation to construct this project.

Archie

EFY. You can assemble the circuit for less than ₹2,000. If you want the complete project kit (including components, project descriptions, PCB, etc), please visit kitsnspares.com website or write to *info@kitsnspares.com*

• • •

FM BASED PROJECTS

I am interested in FM projects. I have seen such projects on your website and want to build some of them. I used to talk about this website with my friends and teachers in my college. Please send me all FM related projects or a collection of the FM projects in PDF files with schematic and PCB layouts (top and bottom views), so that I can reproduce them on copper boards.

Vishnu

EFY. Thanks! Most FM projects published in EFY are available on EFY website. Please download the projects including the schematics and PCB layouts from there. If you have query/doubt on any specific FM circuit please do let us know, we will try to help you. Right now we do not have a collection of the FM related projects in PDF files.

• • •

UV ROBOTS' APPLICATIONS

What are some applications of UV robots? Please let me know as I am deeply interested in the subject.

Varsha

EFY. Ultraviolet (UV) robots or UV-disinfection (UVD)robots are used as part of the regular cleaning cycle to prevent and reduce the spread of infectious diseases, viruses, bacteria, and other types of harmful organic microorganisms in the environment. UVD robots employ non-touch technique to deliver disinfection by irradiation to kill microorganisms.

There are generally two types of UV robots: remote controlled and autonomous. Both of these are commonly found in hospitals and targetted areas.



Fig. 1: Typical UVD robot (Credit: www.mobile-industrial-robots.com)

Remote controlled UV robot is controlled by a human operator and sent to various places in hospitals wherever disinfection is required by manually pressing a button to emit ultravoilet rays to kill microorganisms and sterilise the area. An autonomous UV robot, after setting the parameters like surface distance and UV exposure time for each area, moves on its own and emits UV-C irradiation in the targetted areas.

UV radiation spectrum is divided into three categories called UV-A, UV-B and UV-C. The UV robots use UV-C light for sterilisation, which is used as a key element to fight the novel Corona virus.

Most UV robots work in an unmanned fashion, without the need for human presence at the disinfection site. This considerably helps avoid exposure of healthcare workers to harmful UV radiation. Many UV mobile robots are used to disinfect risky contagion areas in hospitals, such as surgical operating rooms, toilets, patient rooms, bathrooms, etc.

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: **onedit@efy.in**)

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Microbots powered by soft actuators can fly like insects



MIT researchers have pioneered a new fabrication technique that enables them to produce low-voltage, power-dense, high-endurance soft actuators for an aerial microrobot (Credit: https://news.mit.edu)

MIT researchers have demonstrated diminutive drones that can zip around with bug-like agility and resilience, which could eventually perform tasks such as pollinating a field of crops or searching for survivors amid the rubble of a collapsed building. The soft actuators that propel these microrobots are very durable and operate with 75% lower voltage than their earlier versions while carrying 80% more payload. The actuators are like artificial muscles that rapidly flap the robot's wings. The artificial muscles with fewer defects dramatically extend the lifespan of the components and increase the robot's performance and payload.

Multi-sensor system for more accurate knee implant fitting

CEA-Leti has developed a smart, multi-sensor system for knee implants, thus allowing surgeons to position the implant with high accuracy, significantly reduce the risk of follow-up surgery, and enhance rehabilitation. Called FollowKnee, the system integrates a deformation sensor, a pH sensor, a temperature sensor, and an accelerometer in a titanium tibial baseplate. A more accurate implant fitting is achieved via the deformation sensor and accelerometer that guide the surgeon during the operation. The pH sensor with living tissue, the system's pH, and temperature sensors detect infection early, while the deformation sensor and accelerometer also trigger an alert if they detect mechanical problems, such as loosening of the implant.



Clear acrylic column and tablet for demonstrating FollowKnee. The green device shows comparative size of the system (Credit: www.leti-cea.com)

India's 1st Independent Survey



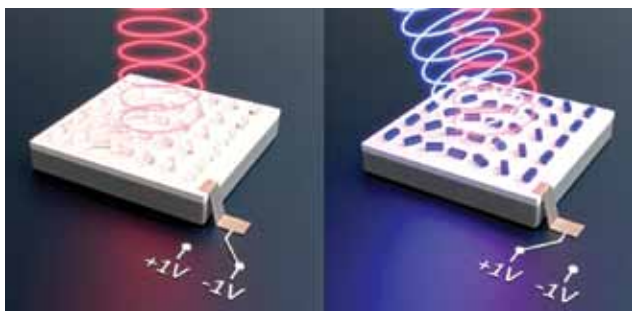
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Nanoantennas enable holograms for virtual conferences

Researchers at the University of Stuttgart have succeeded in breaking the constraints related to liquid-crystal technology by developing electrically switchable plasmonic nanoantennas with dimensions of only a few hundred nanometers and made from conductive polymers. This will help in

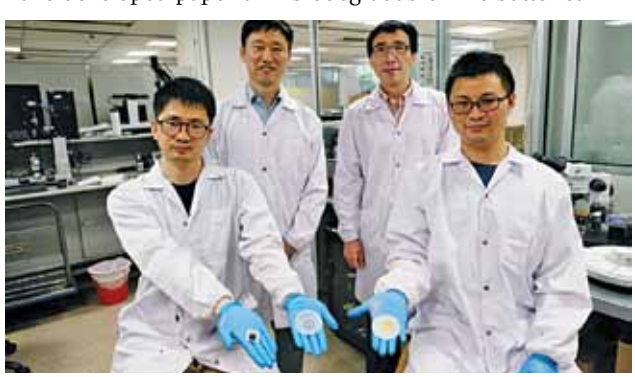


Left: Image displaying the plasmonic polymer nanoantenna, switched into the dielectric (glassy) state. The light beam from the bottom just passes through to the top without being deflected. Right: Image displaying the plasmonic polymer nanoantenna, switched into the metallic state. The light beam from the bottom is deflected to the side when passing through the sample. The light also changes its handedness when travelling to the top (Credit: www.uni-stuttgart.de/en)

realising dynamic holographic displays, which can enable virtual conferences with a 'real-life feeling. It was demonstrated that the optical appearance of the nanoantennas could be switched between that of a shiny metal and a transparent material by applying a voltage between minus and plus 1V at video rates of 30Hz. Despite being only a few tens of nanometers thick and less than 400 nanometers in size, the nanoantennas do the same job as the much larger and thicker liquid crystals used in current state-of-the-art technology.

Flexible, paper-thin biodegradable printed batteries

Nanyang Technological University, Singapore scientists have developed paper-thin biodegradable zinc batteries



Batteries of the future could be paper-thin and biodegradable (Credit: www.ntu.edu.sg)

that could one day become an environmentally sustainable option for powering flexible and wearable electronic systems. These zinc batteries are made up of electrodes screen-printed on to both sides of a piece of cellulose paper that has been reinforced with hydrogel. Once the battery has been expended, it can be buried in soil, where it breaks down completely within a month. The scientists think their printed battery could be integrated into flexible electronics, such as foldable smartphones or biomedical sensors, for health monitoring.

Non-invasive device can treat stroke and diabetes patients

A silicon device that can change skin tissue into blood vessels and nerve cells has been developed by researchers at the Indiana University School of Medicine, bringing us closer to potential use as a treatment for people with a variety of health concerns. The technology, called tissue

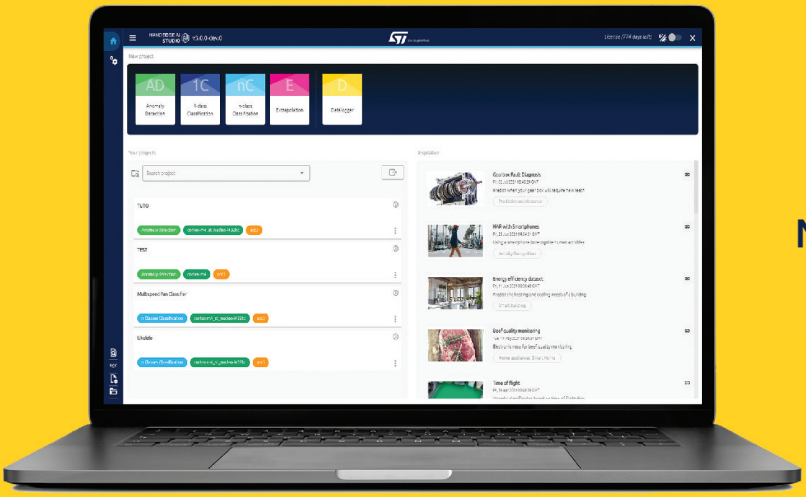


Silicon nanochip can reprogram biological tissue in living body (Credit: https://news.iu.edu)

nanotransfection, uses a non-invasive nanochip device that can reprogram tissue function by applying a harmless electric spark to deliver specific genes in a fraction of a second. It is suitable for reprogramming tissue for different kinds of therapies, such as repairing brain damage caused by stroke or preventing and reversing nerve damage caused by diabetes.

Smart bandage for onsite chronic wound monitoring

The research team from the National University of Singapore's (NUS) Department of Biomedical Engineering, in collaboration with Singapore General Hospital, has developed a smart wearable sensor that can conduct real-time, point-of-care assessment of chronic wounds wirelessly via an app. A world's first, the novel sensor technology can detect temperature, pH, bacteria type, and inflammatory factors specific to chronic wounds within fifteen minutes,



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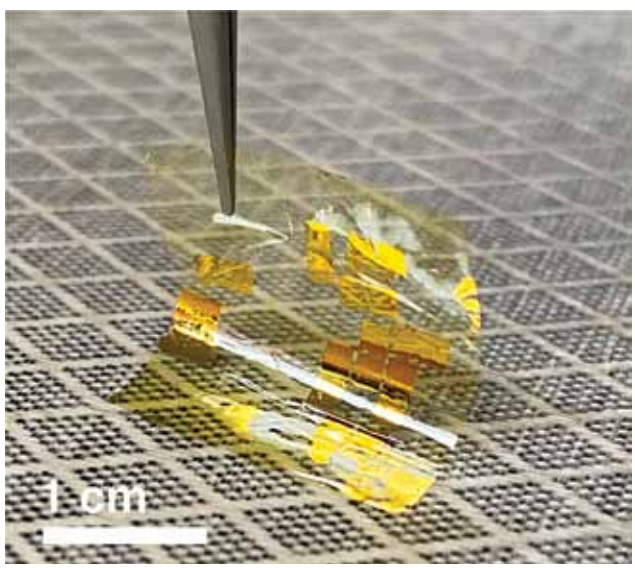


The VeCare platform comprises (clockwise from bottom left) a chip, wound sensor, bandage and app for real-time, point-of-care chronic wound monitoring (Credit: https://news.nus.edu.sg)

hence enabling fast and accurate wound assessment. Called VeCare, the point-of-care wound assessment platform consists of an innovative wound sensing bandage, an electronic chip, and a mobile app. The bandage comprises a wound contact layer, a breathable outer barrier, a microfluidic wound fluid collector, and a flexible immunosensor.

New material for ultrathin, lightweight solar panels

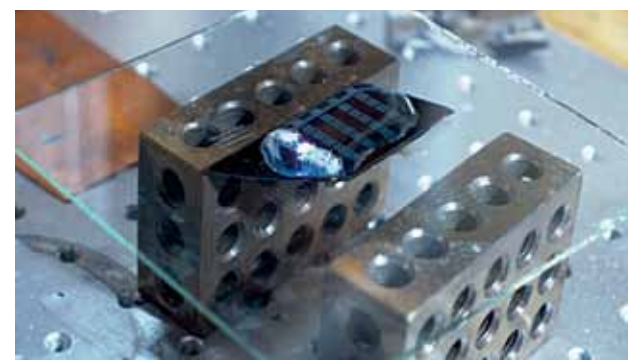
Researchers at Stanford University have a new group of photovoltaic materials that can be used in applications ranging from self-powered wearable devices and sensors to lightweight aircraft and electric vehicles. Chief among the benefits of these transition metal dichalcogenides—or TMDs—is that they absorb ultrahigh levels of the sunlight that strikes their surface compared to other solar materials. The prototype achieves 5.1% power conversion efficiency and could practically reach 27% efficiency upon optical and electrical optimisations. The biggest benefit, however, is the remarkable thinness, which not only minimises the material usage and cost but also makes TMD solar cells lightweight and flexible, and capable of being moulded to irregular shapes.



Transition metal dichalcogenide solar cells on a flexible polyimide substrate (Credit: https://news.stanford.edu)

Low-cost, self-fabrication of silicon wafers made possible

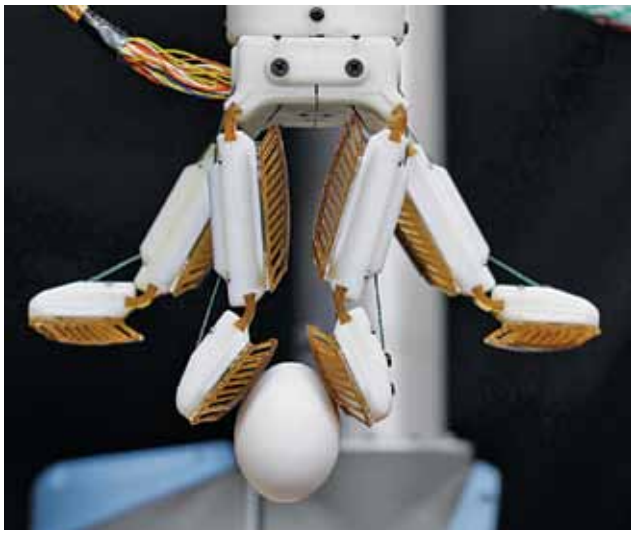
Zachary Tong on his YouTube channel Breaking Taps recently experimented doping a silicon wafer with phosphoric acid and a fibre laser that's near-infrared using a process called thermal diffusion to fabricate a silicon wafer at home. He used some advanced equipment—including a laser, a powerful electron microscope, and high-end software—for scanning probe microscopy purposes, etc, to accomplish the feat. UV laser was preferred over infrared laser while doping as the former tends to have less optical penetration, thereby damaging less silicon wafer. The aim of the experiment was to inspire others to fabricate their own semiconductors at low cost.



Doping liquid phosphoric acid on top of the silicon wafer and embedding it with precise laser pulses (Credit: Breaking Taps)

Robotic hand picks up fruits and veggies delicately but firmly

Engineers at Stanford University have developed a robotic hand, called farmhand, capable of handling various items from raw eggs and grape bunches to jugs and basketballs. The robotic hand has gecko-like adhesive on the inner surface of its grippers that creates a strong grip via microscopic flaps, thus applying no extra inward force to hold an object. On coming in contact with an object's exterior surface, the flaps create Van der Waals forces, allowing the

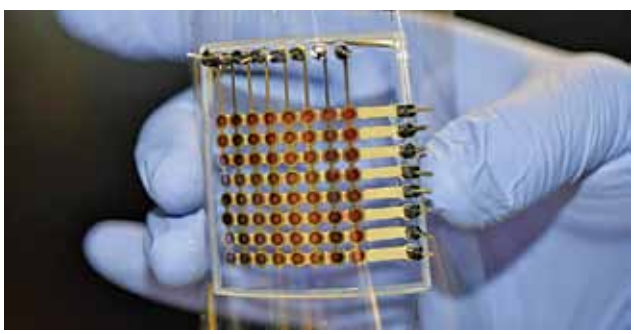


A close-up of the hand performing a highly hyperextended pinch on only the top surface of an egg (Credit: https://news.stanford.edu)

adhesive to grip strongly with only adequate pressure. The development helps in delicately yet firmly clamping and picking up objects having a soft composition, including fruits and vegetables, without causing any damage.

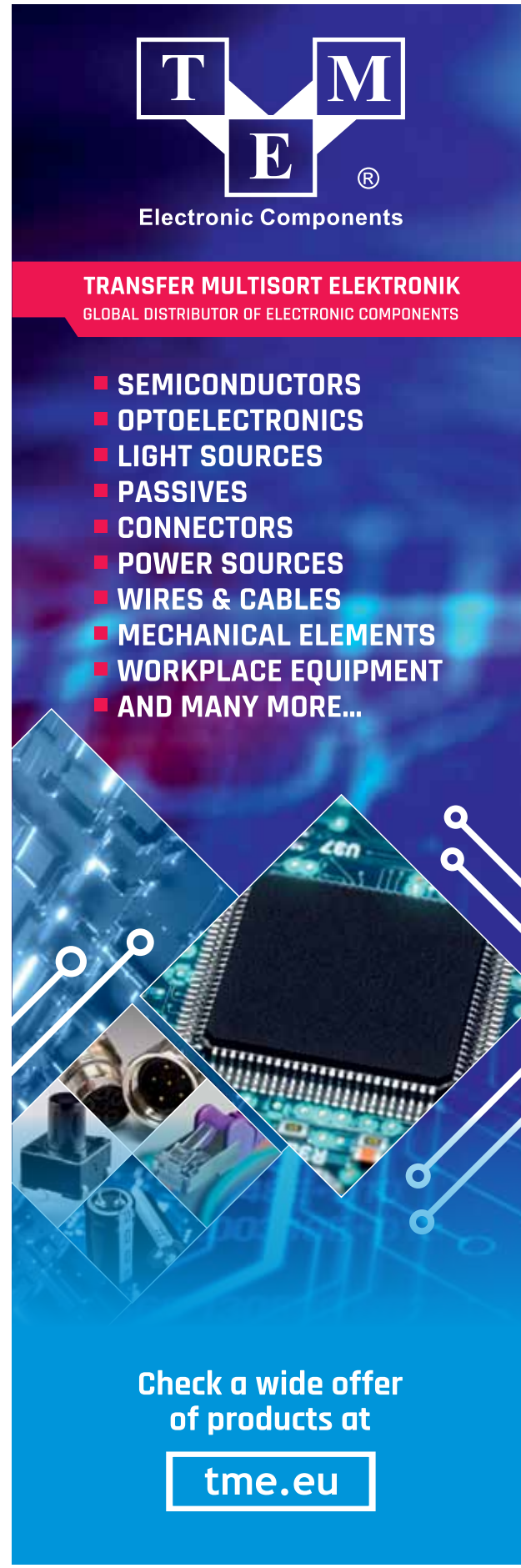
First fully 3D-printed, low-cost flexible OLED display

Researchers at the University of Minnesota used a customised printer to fully 3D-print a flexible organic light-emitting diode (OLED) display. The discovery could result in low-cost OLED displays in the future that could be widely produced using 3D printers by anyone at home, instead of by technicians in expensive microfabrication facilities. Two different



The fully 3D-printed flexible organic light-emitting diode (OLED) display prototype is about 3.8cm on each side and has 64 pixels. Every pixel works and displays light. The 3D-printed display is also flexible, which could make it useful for a wide variety of applications, such as foldable smartphone displays (Credit: https://twin-cities.umn.edu)

modes of printing were combined to print the six device layers that resulted in a fully 3D-printed, flexible OLED display. The electrodes, interconnects, insulation, and encapsulation were all extrusion printed, while the active layers were spray printed using the same 3D printer at room temperature.



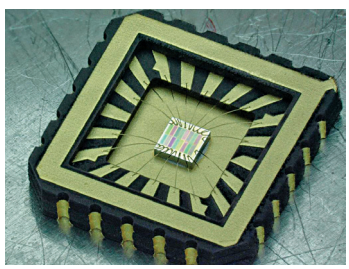
TRULY INNOVATIVE ELECTRONICS

INNOVATION UPDATES

Amongst numerous press releases of new products received by us, these are the ones we found worthy of the title *Truly Innovative Electronics*

Classifying and quantifying sensor

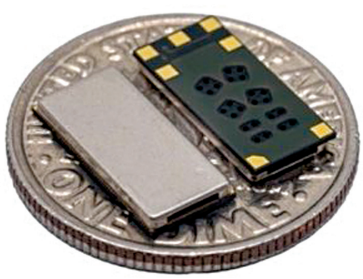
ChipSense, a tiny spectral chip containing sixteen detectors, is based on an array of resonant-enhanced photode-



tectors comprising an absorbing layer that has selective wavelengths in the near-infrared region (850-1700nm). It can classify different materials and quantify their composition, such as chemical content of milk and plastics. It relies on fully integrated technology based on the indium phosphide platform. Features include miniature size to fit in a smartphone, no moving parts, high signal-to-noise ratio (~ 10000 SNR), multi-pixel read-out in less than a few seconds, and scalability. Applications include smart farming, smart industry, and smart home.
MantiSpectra
www.mantispectra.com

MEMS speaker with vent

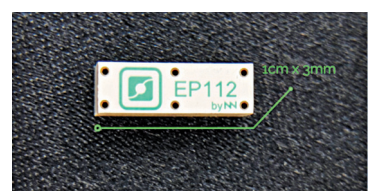
The Montara Pro is the world's first monolithic MEMS µspeaker with integrated DynamicVent that enables



smart TWS earbuds and hearing aids to create unique listening experiences by combining the benefits of closed-fit (occluded) and open-fit earbuds. The DynamicVent technology can be intelligently opened or closed by the earbud system DSP based on ambient noise levels. With the vent closed, Montara Pro creates a listening environment with the best passive isolation for music and media consumption or for improved focus in the presence of background noise. With the vent open, Montara Pro enables improved spatial awareness, increased listening comfort, and reduced occlusion effects, such as the perception of the user's own voice as too loud or 'hollow.'
xMEMS
www.xmems.com

Energy harvesting mini antenna

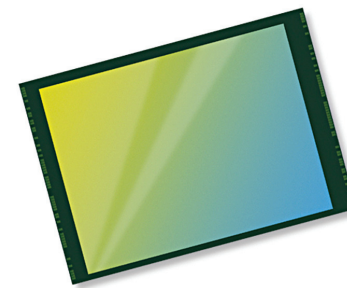
With the goal of providing a complete set of all the essential components required for RF energy harvesting, e-peas has now added an antenna solution for complementing its energy



harvesting dedicated power management ICs (AEM family). The e-peas energy harvesting antenna is ten times smaller than a standard off-the-shelf component, providing more space for customers' designs. It is well suited to a wide variety of industrial applications including building automation, smart metering, asset tracking, and other logistics applications. The same antenna can be used for any band and for any device form factor with a proper matching network design. Through use of this antenna, it will be possible to harvest energy at all frequencies within the 0.4GHz to 10.6GHz range.
e-peas Semiconductors
www.e-peas.com

Tiny sensor for smartphones

The OVB0B is the world's smallest 200MP image sensor with pixel size at just 0.61µm for smartphone cameras. The unique 16-cell binning of the OVB0B delivers 4K2K video and preview quality in 12.5MP mode with 2.44µm-equivalent pixel size using near



pixel 4 × 4 binning, especially in low light. It also offers 100% quad phase detection technology for excellent fast autofocus performance. An on-chip remosaic enables 50MP at 24 frames per second (fps) and 8k video at 30fps with 1.22µm-equivalent performance. The OVB0B can also output 12.5MP at 30fps with 3-exposure staggered HDR timing. The OVB0B supports CPHY, DPHY, and dual DOVDD (1.8V and 1.2V).
OMNIVISION
www.ovt.com

RF-to-DC converter chips

The Powerharvester RF-to-DC converter chips PCC114 and PCC110 are the core components which convert RF energy to DC power. When paired with tuning components and an antenna, these chips can harvest RF energy from 10MHz to 6GHz. They have an extremely small profile: 1mm x 0.6mm x 0.3mm (PCC114)

Electronics For You's Top 10 Thought Leaders on LinkedIn

Only if we are aware of what out readers should know but don't know–can we get them to know. That represents one of the key challenges faced by our journalists, and the question that we often find ourselves asking…

"How can we get all the updates that are important for our audience who represent different facets of the electronics ecosystem?"

The Idea

"Why not identify the most active and influential thought-leaders for electronics in India on LinkedIn, and then follow them?", asked a trainee during one of our recent brain-storming sessions.
"That made sense. But, was anyone aware about these thought-leaders who we should follow?", I asked. Silence. "Are we seeing any of our contacts share such updates?", I asked. Thankfully, few names got shared. "How about we build a system to review those who regularly post, and rate them on a regular basis? Not only will we know whom to follow, but so will our readers?", suggested a senior journalist. "And what if we released this ranking on LinkedIn and our websites and publications?", added a tech journalist. "Wow! We seem to be onto something here. Let's see if we can implement it", I challenged…

The Criterion

Within a couple of days, few of us held another meeting with two clear goals: 1. List all contacts whom we were seeing post actively related to India's electronics ecosystem 2. List all possible parameters that can be used to rank them
Within a few hours, we had a list of 127 contacts who seemed pretty active. Thankfully, while preparing this list, we got to review activities and posts of a large variety of thought-leaders. This helped us identify and freeze key metrics for ranking–pretty quickly.

Here's the list of questions (parameters) we sought data for, to rank them:

1. Did they post updates related to India's electronics industry or ecosystem at large, or were their posts primarily to promote themselves or their firm?
2. Did they post frequently or were they posting in bursts or only once in a while?
3. How many posts did they publish in last 2 months?
4. What was the highest engagement that any of their posts had received in the last one month?

We had listed a few more, but later realised that these four formed the Core. In fact, #1 and #2 acted as filters–that is whether they could be added to the list or not. And, #3 and #4 acted as the key parameters that decided their ranks. Thanks to parameter #1, we also realised that many whom we had considered as leading influencers were only promoting their brands and themselves, and were not sharing any important updates. Hence, we had to drop them.

The Result

It took a couple of meetings to collect and review all the data points. Few more got added to the list too, while we were going through the grind. And then–we had the sheet with all data and parameters updated! The top 10 emerged clearly, and we had our first set of…

Electronics For You's Top Thought Leaders on LinkedIn!

And, the names that emerged along with the data to back their ranks–made us proud…

We're Grateful

By the time we finished with the rankings, we were truly grateful for the original idea, and many that emerged later that enabled us to execute it. The beauty that emerged amongst the Top 10 was the diversity of applications of electronics itself. We have thought leaders representing the government, the consumer electronics and appliances; telecom and mobile; drones & robotics; EVs; solar and renewables; et al.

We believe that this list will surely help us to follow the leaders. Plus, it will motivate many to start leading too. And, we hope this list will expand from Top 10 to Top 20, and hopefully to Top 100 soon.

■ **Author:** Rahul Chopra

RANK #1



SAURABH GAUR
(Joint Secretary, MeitY (IAS), Government of India)

RANK #2



MANU KAPOOR
(Sr VP, Samsung Electronics)

RANK #3



DR. ALOKNATH DE
(Consulting Technologist, Cyber-Physical Systems & ex-CTO, Samsung India)

RANK #4



SMIT SHAH
(President, Drone Federation of India)

RANK #5



AMBER DUBEY
(Joint Secretary at Ministry of Civil Aviation, Government of India)

RANK #6



MANISH SHARMA
(Chairman and CEO, Panasonic India and South Asia)

RANK #7



SANJEEV KESKAR
(CEO, Arvind Consultancy & Ex-MD, Arrow Electronics India)

RANK #8



RAHUL LAMBA
(Co-Founder, The Energy Company)

RANK #9



VIVEK TYAGI
(GM, Rashi Peripherals and Vice Chairman, IESA)

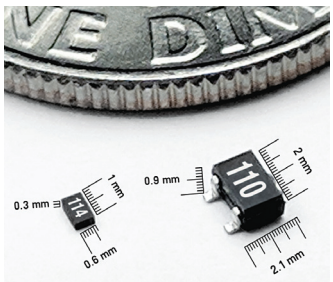
RANK #10



GANESH SHANKAR
(Founder & CEO at FluxGen Technologies)

What to follow these influencers? Visit: https://lnkd.in/g9ZbWVgF

and 2mm x 2.1mm x 0.9mm (PCC110), and have up to 75% conversion efficiency while harvesting energy from all



modulation types, enabling maximum power transfer and range. Due to their small size, they have a low cost of implementation and are RoHS compliant.
Powercast Corporation
www.powercastco.com

DSP and ML coupling chips

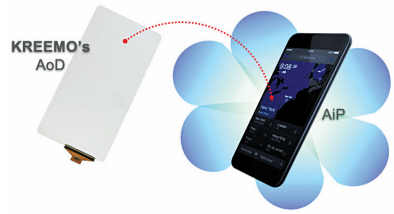
Tyr, a family of three different chips—called Tyr1, Tyr2, and Tyr3—uses a fully programmable and scalable architecture that tightly couples digital signal processing (DSP) cores with machine learning



(ML) accelerators necessary to design L3 through L5 autonomous driving vehicles. Delivering between 258-trillion and 1,032-trillion operations per second and consuming as little as 10 watts, Tyr allows users to implement autonomous driving functions previously not commercially viable. The Tyr companion chip is algorithm and host processor agnostic and can be integrated into new or existing environments without the need to redesign the entire system.
VSORA
www.vsora.com

Transparent built-in display antenna

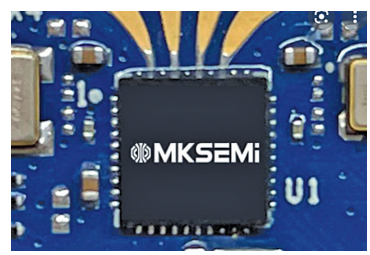
The world's first transparent antenna on display (AOD) is characterised by a smooth 360-degree high-capacity data transmission and reception. By combining an antenna and a display into one, more space can be utilised. The built-in display antenna can be mounted on high-definition screens and glasses in organic light emitting diodes (OLEDs) or liquid crystal displays (LCDs) of



smartphones, augmented reality (AR), and game devices. The antenna technology is expected to become a metaverse antenna platform in a rapidly-growing global market.
KREEMO
www.kreemo.io

Low-power, integrated SoC

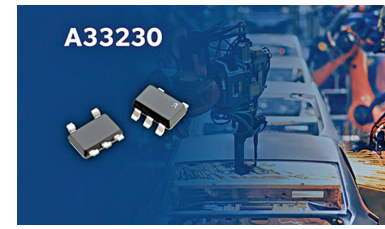
The MK8000 system-on-chip (SoC) is the world's lowest power, highest integrated chip solution that can empower IoT devices with the smallest batteries and size for high-precision sensing. MK8000 also enables OEMs and ODMs to rapidly design, integrate, and deploy



complete location and direction-finding solutions. With a high level of integration and computing power, the MK8000 SoC allows customers to implement UWB ranging products with only a handful of external components, ensuring the smallest possible footprint and lowest power consumption. Its low-power UWB technology significantly extends the battery life of electronics and enables even the smallest wireless devices to have high precision ranging and location capability.
Mauna Kea Semiconductors
www.mk-semi.com

Tiny Hall-effect position sensor

The new A33230 3D sine/cosine Hall-effect position sensor IC is the smallest 3D sine/cosine sensor currently available in the market. It offers system designers a cost-effective solution for



automotive and industrial applications with a quick time to market. The A33230 contains two discrete analogue signal paths for superior high-speed performance, and the tiny SOT23-W package size makes it ideal for situations where PCB space is at a premium. The IC can also be used as an angle sensor, provided the system includes an electronic control unit (ECU) capable of performing CORDIC calculations on the two outputs.
Allegro MicroSystems
www.allegromicro.com

Mini CPC capacitive sensors

Two unique, miniature carbon-nanotube paper composite (CPC) capacitive sensors, SomaControl and SomaSense, bring a better sense to the digital world by creating a new genre of gesture based digital interfaces, wellness monitoring, and safety applications. The SomaControl gesture monitor enables everyday tasks at home or integrated



into gaming devices for a more immersive experience. It also allows users to interact with and control a digital device using hand movements with no contact. The SomaSense 3D floor mat is a flexible sensing mat that observes, monitors, and reports on human wellness factors, including presence, gait, and foot pressure, with applications in health-tech and wellness, assisting individuals with balance, movement, and other challenges.
Somalytics
www.somalytics.com

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COMPONENTS

Automotive microcontroller

The RL78/F24 and RL78/F23 microcontrollers (MCUs) designed for automotive actuator and sensor control applications support edge evolution in next-generation electronic and electrical architecture.

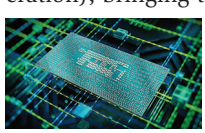


The expanded RL78 family of low-power 16-bit MCUs strengthens the company's automotive portfolio, offering customers highly reliable and high-performance solutions for systems ranging from actuators to zone control. Both MCUs support the CAN FD high-speed communication protocol and EVITA-Light security, delivering up to 70% faster operating frequencies, which can more than double the performance in brushless motor control applications.

Renesas Electronics
www.renesas.com

Mobile processors

The new 12th Gen Intel Core mobile processors are claimed to be the world's fastest mobile processors (40% faster than the previous generation), bringing their performance hybrid architecture to mobile platforms. Intel has introduced 28 such mobile processors that deliver a feature-rich suite of computing capabilities, powering designs across consumer, enterprise, IoT, and other applications. Based on the Intel 7 process, new 12th Gen H-series processors offer up to 5GHz frequencies, 14 cores (6 P-cores and 8 E-cores), and 20 threads. They have nearly three times faster connectivity on exclusive high-speed channels without legacy Wi-Fi interference.



Intel Corporation
www.intel.corporation

ADAS radar sensor

With the new AWR2944 radar sensor, Texas Instruments (TI) has expanded its extensive portfolio of analogue and embedded processing products and technologies that can help automakers improve how advanced driver assistance systems (ADAS) sense objects. The increased ability to quickly detect objects, monitor blind spots, and efficiently navigate turns and corners paves the way for automakers to achieve their vision of a collision-free future. The 77GHz AWR2944 radar sensor offers best-in-class radio frequency performance in a small form factor and provides 33% higher resolution than existing sensors. The sensor's unique hardware supported by Doppler division multiple access based signal processing improves the ability to sense oncoming vehicles at distances up to 40% farther away.



Texas Instruments
www.ti.com

Upgraded GaN ICs

The GaNFast power ICs with GaNSense technology have been upgraded to increase efficiency, power density, and access additional fast-charger markets. GaNFast power ICs integrate GaN power and drive plus protection and control to deliver simple, small, fast, and efficient performance. The voltage rating of NV613x and NV615x GaNFast ICs has been upgraded from 650 to 700V for continuous operation and is rated at 800V for transient conditions. Increased voltage rating enables more efficient power transformer circuit designs and higher capabilities for areas of the world with unreliable, widely-varying power grids with extreme voltage spikes. Autonomous system-level monitoring and reaction ensures 'detect and protect' within 30ns—10x faster than for discrete implementations.



Navitas Semiconductor
www.navitassemi.com

Automotive positioning chip

The STA8135GA is an automotive-qualified GNSS (Global Navigation Satellite System) receiver that integrates a triple-band positioning measurement engine on-chip, in addition to standard multi-band Position-Velocity-Time (PVT) and dead-reckoning. It helps driver-assistance systems make accurate decisions about the road ahead and delivers raw information for running any precise-positioning algorithm. The STA8135GA also enhances the performance of in-dash navigation systems, telematics equipment, smart antennas, and V2X communication systems, as well as marine navigation systems, drones, and other vehicles.



STMicroelectronics
www.st.com

5G smartphone chip

The Dimensity 9000 5G smartphone chip is built on the ultra-efficient TMSC N4 (4nm-class) production process for next-generation flagship smartphones, thus leading the

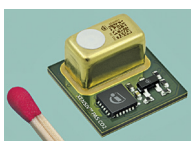
industry in computing performance, gaming, imaging, multimedia, and connectivity innovations. It integrates the cutting-edge Armv9 CPU architecture for a true flagship experience. The octa-core CPU has one ultra-Cortex-X2 core operating at up to 3.05GHz, three performance A710 cores operating at up to 2.85GHz, and four efficiency Cortex-A510 cores. With the integrated LPDDR5X supporting up to 7500Mbps, along with an 8MB L3 cache and 6MB system cache, the chip is built for the massive bandwidth demands of the mobile market.



MediaTek
www.mediatek.com

CO_2 sensor

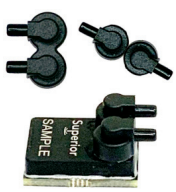
To meet the rising demand for sensors that measure the CO_2 concentration in the air, Infineon Technologies AG is launching an innovative CO_2 sensor known as the XENSIV PAS CO2 that can be used to monitor indoor air quality and reduce energy costs. Suitable applications include ventilation, air-conditioning systems, portable room air monitoring devices, and smart speakers. Based on the innovative PAS (photoacoustic spectroscopy) technology, the sensor has an integrated microcontroller that directly converts the CO_2 measurement into a ppm value, which is available via three interfaces: the serial I²C, UART, and PWM.



Infineon Technologies
www.infineon.com

Pressure sensors

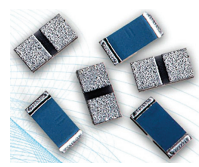
The new ND series absolute mid-pressure sensors and the differential and gauge mid-pressure sensors enable manufacturers to cost-effectively develop more accurate and stable products for numerous industrial equipment applications operating at low- to mid-pressure ranges. The absolute sensors support pressures up to 150psia with market leading accuracy and long-term stability of 0.10%, while the differential/gauge sensors support multi-range pressures from 0.5psi to 150psi with market leading accuracy and long-term stability of 0.05%. These are said to offer manufacturers a 2x advantage over other solutions.



Superior Sensor Technology
www.superiorsensors.com

HPDC resistors

The new high power density chip (HPDC) resistors are optimised for power management, actuator drive, and heating applications which benefit from the enhanced heat transfer from element to terminal. The use of such high power density components saves PCB area and boosts reliability by restricting the temperature rise in the component hotspot. The resistors use an aluminium nitride ceramic substrate and feature large area terminations for improved thermal contact with a PCB. As a result, heat generated in the resistor element is effectively conducted away, reducing the temperature rise and enabling the HPDC resistors to offer a high power density solution with ratings of 2.4W in 1206 and 3.5W in 2512 footprints.



TTElectronics
www.ttelectronics.com

Ultrasonic ToF sensors

The Chirp ICU-10201 and ICU-20201, two new high-performance, ultra-low-power integrated ultrasonic Time-of-Flight (ToF) sensors for short- and long-range detection include a powerful on-chip processor with higher computational power. The enhanced processing capabilities allow a wide range of application algorithms to fit and to run on-chip, completely offloading the system MCU. Compared to the previous generation, the ICU-10201 and ICU-20201 have 10 times faster DSP with HW multiplier for higher calculation power, larger memory, and a fast host interface (SPI). The sensors also support a wide range of IO supply voltages with range measurements to targets up to 5m (for ICU-20201) and 1.2m (for ICU-10201) away.

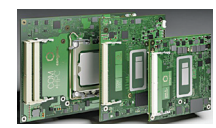


TDK Corporation
www.tdk.com

BOARDS & MODULES

Computer-on-modules

The 10 new COM-HPC and COM Express computer-on-modules feature the latest high-performance cores from Intel. The new modules in COM-HPC Size A and C as well as COM Express Type 6 form factors offer major performance gains and improvements for the world of embedded and edge computing systems. Offering up to 14 cores/20 threads on BGA and 16 cores/24 threads on desktop variants (LGA mounted), 12th Gen Intel Core processors provide a quantum leap in multitasking and scalability levels. Next-gen IoT and edge applications benefit from up to 6 or 8 (BGA/LGA) optimised Performance-cores (P-cores) plus up to 8 low-power Efficient-cores (E-cores) and DDR5 memory support to accelerate multithreaded applications and execute background tasks more efficiently.



congatec
www.congatec.com

IoT module

The AWS IoT ExpressLink module, ESP32-C3-MINI-1-N4-A, is based on the ESP32-C3 SoC and offers Wi-Fi + Bluetooth LE 5.0 connectivity, thus providing any host MCUs with out-of-the-box, seamless, AWS cloud connectivity. The module offers a simple

serial interface which the host MCU uses to get connected to AWS IoT services and transform any offline product into a cloud-connected product. Espressif's AWS IoT ExpressLink module handles complex yet undifferentiated workloads, such as authentication, device management, connectivity, messaging, and OTA. Thus, it relieves developers from developing and maintaining complex firmware, while it provides end-to-end security and fleet management at scale.



Espressif
www.espressif.com

In-circuit emulator

Embedded engineers seeking complete analysis of projects for rapid development can now use the MPLAB ICE 4 next-generation full in-circuit emulator, debugging and programming development tool for Microchip's PIC and AVR microcontrollers (MCUs), dsPIC digital signal controllers (DSCs), and SAM MCUs and microprocessors (MPUs). The MPLAB ICE 4 in-circuit emulator is a fast and feature-rich emulation and programming tool, debugging and programming with a powerful, easy-to-use graphical user interface of MPLAB X integrated development environment (IDE). It provides a flexible development experience including advanced debugging capabilities to write power-efficient code with reduced debugging time.



Microchip Technology
www.microchip.com

System-on-module

Building on the new industry standard 'Open Standard Module (OSM)' defined by SGeT, the iW-RainboW-G40M, the solderable i.MX 8M Plus OSM LGA module, integrates the powerful i.MX 8M Plus processor in the compact OSM 1.0 standard, delivering powerful AI and machine learning capabilities on a compact edge device. Two image signal processors (ISPs) and a dedicated neural network processor at up to 2.3 TOPS makes the i.MX 8M Plus an ideal fit in smart home, smart city, industrial IoT, and beyond with its machine learning, vision, and advanced multimedia capability. Industrial interfaces like CAN-FD, time-sensitive networking, and high-speed interfaces make the processor fit in Industry 4.0 and automation systems.



iWave Systems Technologies
www.iwavesystems.com

Panel kits

The newly launched panel kits can combine with any specification of motherboards and every kind of mechanical design. Based on flexible features of the panel kits, they not only provide high-quality display developing solutions but significantly reduce the product developing time. Primary target markets include smart factories (such as industrial automation, HMI, and package recognition system), smart retail (such as kiosk, interactive digital signage, multimedia kiosk, and public internet), intelligent transportation (such as outdoor payment terminal), and smart home (such as conference system and sports and fitness equipment).



Avalue Technology
www.avalue-tech.com

Location monitoring system

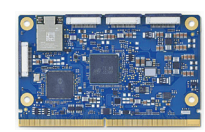
The AL300 LTE-M waterproof tracker with IP67 waterproof and dustproof functions is designed for heavy machinery or transportation equipment that needs to be monitored for a long time and placed outdoors, such as refrigerated trucks, scooters, trailers, and agricultural and construction heavy machinery. In addition to the powerful IP67 enclosure, AL300 can monitor the driving behaviour and the equipment operation data in real time and supports global LTE Cat M1 wireless communication. It allows real-time location monitoring of the machinery and mechanical operation, along with access to engine information to predict failure and maintain it accordingly, thereby avoiding high maintenance costs.



ATrack Technology
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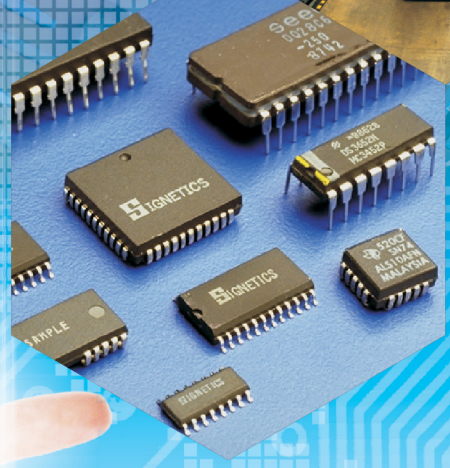
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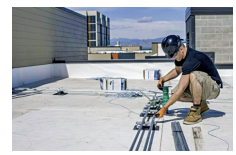
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Innovation

NEUROMORPHIC COMPUTING: It's Not Sci-Fi Anymore

What is Neuromorphic Computing? What are its applications? And, what's happening in India on this front? We were fortunate to get connected with Dr Shubham Sahay, Assistant Professor at IIT Kanpur, who specialises in neuromorphic computing and hardware security. Here are some extracts of his interaction with Aaryaa Padhyegurjar from EFY



DR SHUBHAM SAHAY
ASSISTANT PROFESSOR, DEPARTMENT OF ELECTRICAL ENGINEERING, IIT KANPUR

In layman's terms, how do you describe neuromorphic computing?

Let me give you a brief example. The most advanced machines that you see now are CPUs and GPUs in a server room. In these computing systems, memory and processing are two separate elements, two different entities. Every time you must process any data, you must send data back and forth between these two units. That transmission of data takes a lot of energy and creates a lot of delays. Typically, in your human brain, the architecture is such that the processing and the memory are co-located. In your brain, the whole architecture is different; it's happening at the same time at the same place. For instance, as you're listening to a conver-



Dr Shubham Sahay with a few members of NeuroCHaSe Research Group on the IIT Kanpur campus

sation, you're able to process it and, at the same time, some part of it is going into your memory. You're able to recall something from the conversation. You encounter different types of smells in your surroundings, but you're able to identify which is coming from which place. That is because you have such an efficient processing engine—your brain. In neuromorphic computing, you basically take inspiration from the principles of the brain and try to mimic those on hardware utilising knowledge from nanoelectronics and VLSI.

In semiconductor electronics, the passage of information takes place with the help of electrons. Electrons are fundamental particles that travel very fast. But in your brain, it is the calcium ions that carry the information from one neuron to another neuron via synaptic clefts. For ions to flow you must create a concentration difference, which makes it a very slow process. But even with such a slow process, you can perform everything so efficiently in real time and with such a small amount of energy. It is possible only because of the massive parallelism that our brain offers; computations are performed parallelly.

Even with its lower operating speed, neuromorphic computing is superior to what we're currently using in our systems, and that's only because of its inherent architecture.

> SO, WE WERE EXPLOITING FLASH MEMORY TO DEVELOP VECTOR-BY-MATRIX MULTIPLICATION ACCELERATORS WHICH CAN BE USED TO PROCESS THE DATA AT THE SAME PLACE WHERE IT IS STORED.

So how do we accomplish this?

We need to realise something like the processing elements in the brain on hardware, and memristors are one of the potential candidates (it would not be an exaggeration if I say most promising candidates) for realising processing entities such as neurons and synapses. Memristors basically can mimic synaptic elements. Apart from memristors, there are memtransistors as well, which are three-terminal devices, such as ferroelectric FETs, flash memories, etc. Nowadays, you also have all sorts of exotic materials coming into the picture—you have various devices showing neuron/synapse-like properties made up of organic substrates and even flexible substrates. But the most promising candidate, considering the present technical knowhow, is the memristor because it can be integrated with the present technology as well.

In theory, memristors existed in the 1960s itself, when a professor of UC Berkeley (Prof. Leon O. Chua) found out this missing element—

Skills needed

In terms of skill sets, since this is an interdisciplinary field, you need to be strong in the fundamentals from at least 3 or 4 fields, such as:

- Solid-state Physics
- Circuit Design and VLSI
- Computer Science and Neural Networks
- Computational Neurobiology

You need not be an expert in all these fields to get into neuromorphic computing. You need to be very focused on what information is required for your implementation, and hence good guidance is important in this area. I was fortunate enough to have been guided by eminent experts such as Prof. Dmitri Strukov, Prof. M. Jagadesh Kumar, and Prof. Manan Suri.

the fourth fundamental element apart from resistors, inductors, and capacitors. Many people gave some theoretical models for a memristor. My postdoc advisor Prof. Dmitri Strukov was among the people who invented memristors. He fabricated a memristor and proved that it shows all the properties (such as plasticity, STDP learning rule, etc) which could mimic the processing elements such as synapses and neurons in the human brain and could be harnessed for neuromorphic computing.

You worked on a neuromorphic chip at UCSB just two years ago. Could you elaborate on your experience there and what your team worked on?

The whole world is going through an artificial intelligence revolution. Neural networks are the driving force behind the artificial intelligence revolution. Neural networks exist in different flavours—artificial neural networks, SNNs, DNNs, CNNs, etc, which are efficient in performing different applications. However, the fundamental operation in all the neural networks is the vector-by-matrix multiplication or, in other words, multiply-accumulate operation. If we can somehow accelerate the vector-by-matrix multiplication, if we can execute this operation in an energy-efficient way, then we can realise ultra-low power hardware implementation of all neural networks. This is something that our group at UCSB realised and we developed different circuits and systems exploiting emerging non-volatile memories to perform vector-by-matrix multiplication in an efficient manner.

We utilised two kinds of non-volatile memories that were technologically advanced—one of them was flash memory. Flash memory is ubiquitous nowadays, ranging from memory cards and USB sticks to even cloud storage. In almost all devices in the internet of things (IoT) ecosystem, you'll find flash memory. They are already technologically mature. So, if these devices could be used for neuromorphic computing, if they could process information themselves, it would be one of the milestones in realising an ultra-energy-efficient green society. Currently, flash memories have the capability to store the data but there doesn't exist a conventional circuit or architecture with which you can make them process this data.

> THE MOST PROMISING CANDIDATE, CONSIDERING THE PRESENT TECHNICAL KNOWHOW, IS THE MEMRISTOR.

Another advantage of flash devices is that they are very dense. You can just imagine the density by looking at this scenario: In 2010, when I was purchasing my first phone, the internal memory was of the order of a few MB. And now, if you go for any smartphone, the internal memory (which is again a flash memory) is at least 64 or 128GB. The density has increased by more than a thousand times. So, if we can introduce processing power to flash, we can enable all smart devices to compute in-situ.

I also worked with oxide based resistive RAMs or memristors. We found out that they were even more promising with respect to energy efficiency. Probably, they will be able to achieve the levels of efficiency of the human brain for certain applications soon. We were collaborating with Applied Materials and Philips, who agreed to fabricate those chips for us.

You take a class on neuromorphic computing at IIT Kanpur. And you also have a research group called NeuroCHaSe. How has been the response of students in your class?

I introduced this course at IIT Kanpur immediately after I joined (one year ago). Although it was a PG-level course, I saw great participation from the UGs. In general, in PG courses, there are around 15-20 students. But in this course, there were 55 students, out of which around 20 students were from B.Tech. That was a very encouraging response and throughout the course they were very interactive. The huge B.Tech participation in my course bears testimony to the fact that undergrads are really interested in this topic. I believe that this could be introduced as one of the core courses in the UG curriculum in the future.

During the course, I introduced

some principles of neurobiology—how information is processed in the brain for a specific application like vision. Then I discussed how it can be mimicked on hardware utilising emerging non-volatile memories. We discussed all the other candidates that could be used as neural processing elements, apart from memristors—flash memories, magnetic memory devices, SRAMs, DRAMs, phase change memories, etc. I also talked about all memory technologies that exist right now and evaluated their potential for neuromorphic computing. Moreover, based on the students' feedback for this course, I got a commendation letter from the director for excellence in teaching.

Our NeuroCHaSe research group is also actively working on the development of neuromorphic hardware platforms and ensuring their security against adversary attacks. We are also going to tape out (fabricate) a 3D-neuromorphic computing IC soon. Stay tuned for the news!

Apart from IIT Kanpur, what opportunities exist in India? What does the future look like for Indians?

As of now, the knowledge, dissemination and expertise in this area is limited to the eminent institutes such as IITs and IISc, but with government initiatives such as India Semiconductor Mission (ISM) and NITI Ayog's national strategy for artificial intelligence (#AIforall), this field would get a major boost. Also, with respect to opportunities in the industry, several MNCs have memory divisions in India—such as Micron, Sandisk (WesternDigital), etc—that develop the memory elements which will be used for neuromorphic computing.

There are also many startups working on the development of neuromorphic ICs. One of them is Ceremorphic India Pvt Ltd. They are working on SRAM based neuromorphic computing systems. With the establishment of ISM, I expect more companies to eventually start their neuromorphic teams in India.

> THESE CHIPS ARE ALREADY PRESENT IN SOME PRODUCTS AS WELL. IF YOU LOOK AT APPLE'S LATEST IPHONE, IT ALREADY HAS AN AI PROCESSOR. THIS IS NOT SOMETHING THAT IS FAR OFF INTO THE FUTURE.

How will it affect normal people and the entire B2B marketplace? Or do we still have time for neuromorphic chips to come to the market?

A lot of companies are already fabricating these chips. Almost all companies have a dedicated team working on neuromorphic computing. These chips are already present in some products as well. If you look at Apple's latest iPhone, they have a chip called M1, which is an AI processor. This is not something that is far off into the future.

In terms of its impact on common people, just consider the field of healthcare. You need to get a lot of data from the patients for the development of personalised medicine, genome sequencing, etc. While the current sensor technology is efficient in extracting such data, processing it in real time is the bottleneck. Neuromorphic computing would enable processing capabilities within the sensors themselves. Therefore, in the future, we may expect significant developments in critical fields like personalised medicine, genome sequencing, etc, fuelled by the massive computing power of neuromorphic hardware.

Not just the healthcare sector, even for drones or warfare systems, the major problem is their processing capability. Their camera captures good quality images but extracting information from the images in real time is the bottleneck. Drones are connected to Wi-Fi and send images to the base station. The base station processes the data and sends the signals back. This is a power-hungry process and can be intercepted too. If the drone itself has the capacity to process the data, it can take immediate action. Just imagine how it can transform the world.

Also, we use all sorts of applications like Alexa, Siri, etc, but they do not work without Wi-Fi. The main problem with these systems is that their processing power is limited. Whenever we give them any input, they just transfer it to the server, where the processing happens. The output comes from the server to the device, and the device simply gives us the output. If you can give such processing power to all the energy-constrained smart devices around you, communication between the server and the device is not needed. In such a scenario, we not only make these devices compute independently but we also reduce the cloud dependence, which is a major source of security vulnerabilities and adversary attacks.

Even in space, rovers capture images and send them back to the earth station for processing. If an energy-efficient processing system is installed there, we'll have Mars rovers and Moon rovers driving on their own. Autonomous driving is not fiction anymore. It just requires an energy-efficient processor to do that, and that is what neuromorphic computing is all about. EFY

What's So EXCITING About NEUROMORPHIC COMPUTING

The human brain is the most efficient and powerful computer that exists. Even after decades and decades of technological advancements, no computer has managed to beat the brain with respect to efficiency, power consumption, and many other factors. Will neuromorphic computers be able to do it?

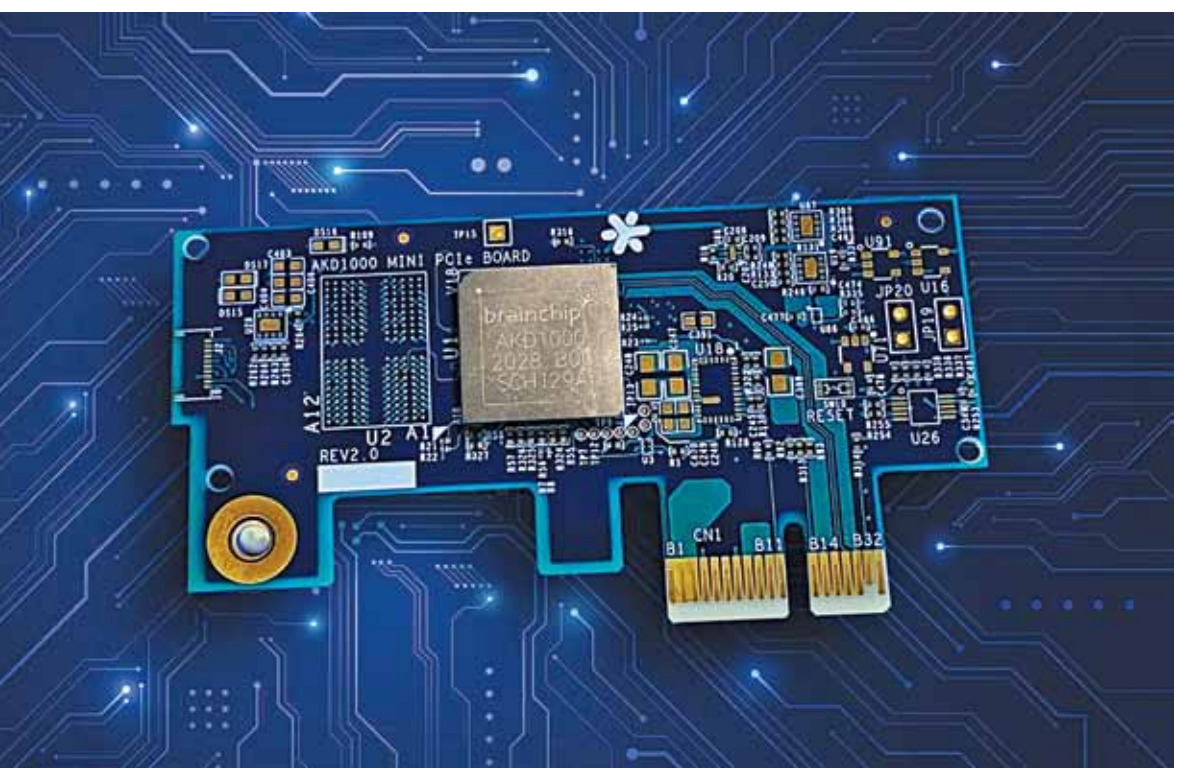
AARYAA PADHYEGURJAR

The exact sequence of events that take place when we do a particular activity on our computer, or on any other device, completely depends on its inherent architecture. It depends on how the various components of the computer like the processor and memory are structured in the solid state.

Almost all modern computers we use today are based on the Von Neumann architecture, a design first introduced in the late 1940s. There, the processor is responsible for executing instructions and programs, while the memory stores those instructions and programs. When you think of your body as an embedded device, your brain is the processor as well as the memory. The architecture of our brain is such that there is no distinction between the two.

Since we know for a fact that the human brain is superior to every single computer that exists, doesn't it make sense to modify computer architecture in a way that it functions more like our brain? This was what many scientists

> In his paper titled 'Neuromorphic Electronic Systems,' American scientist and engineer Carver Mead writes, "Biological information-processing systems operate on completely different principles from those with which engineers are familiar. For many problems, particularly those in which the input data are ill-conditioned, and the computation can be specified in a relative manner, biological solutions are many orders of magnitude more effective than those we have been able to implement using digital methods."



The AKD1000-powered Mini PCIe board (Source: BrainChip Inc.)

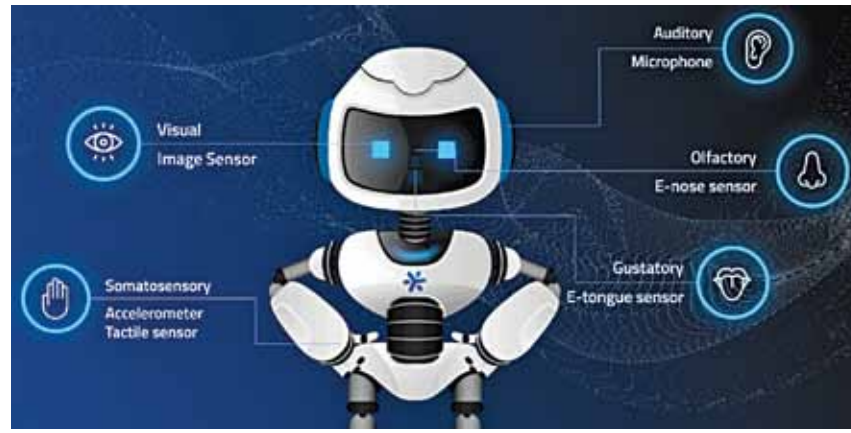
realised in the 1980s, starting with Carver Mead, an American scientist and engineer.

Fast forward to today

Nowadays, almost all companies have dedicated teams working on neuromorphic computing. Groundbreaking research is being done in multiple research organisations and universities. It is safe to say that neuromorphic computing is gaining momentum and will continue to do so as various advancements are being made.

What's interesting to note is that although this is a specialised field with prerequisites from various topics, including solid-state physics, VLSI, neural networks, and computational neurobiology, undergraduate engineering students are extremely curious about this field.

At IIT Kanpur, Dr Shubham Sahay, Assistant Professor at the Department of Electrical Engineering, introduced a course on neuromorphic computing last year. Despite being a post-graduate level course, he saw great participation from undergrads as well. "Throughout the course, they were very interactive. The huge B.Tech participation in my course bears testimony to the fact that undergrads are really interested in this topic. I believe that this (neuromorphic computing) could be introduced as one of the core courses in the UG curriculum in the future," he says.



The 5 sensor modalities (Source: BrainChip Inc.)

Getting it commercial

Until recently, neuromorphic computing was a widely used term only in research and not in the commercial arena. However, as of January 18, 2022, BrainChip, a leading provider of ultra-low-power high-performance AI technology, commercialised its AKD1000 AIOT chip. Developers, system integrators, and engineers can now buy AKD1000-powered Mini PCIe boards and leverage them in their applications, especially those requiring on-edge computing, low power consumption, and high-performance AI.

"It's meant as our entry-level product. We want to proliferate this into as many hands as we can and get people designing in the Akida environment," says Rob Telson, Vice President of WorldWide Sales at BrainChip. Anil Mankar, Co-founder and Chief Development Officer of BrainChip, explains, "We are enabling system integrators to easily use neuromorphic AI in their applications. In India, if some system integrators want to manufacture the board locally, they can take the bill of materials from us (BrainChip) and manufacture it locally."

What's fascinating about Akida is that it enables sensor nodes to compute without depending on the cloud. Further, BrainChip's AI technology not only performs audio and video based learning but even focuses on other sensor modalities like taste, vibration, and smell. You can use it to make a sensor that performs wine tasting! Here is a link to their wine tasting demonstration: *https://youtu.be/RwWTietRioM*

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Here's a small glimpse of what all has been happening in this field

- Intel's Loihi is a neuromorphic AI chip that can implement spiking neural networks (SNNs). Quite recently, Intel announced the next generation of this chip, Loihi 2.
- Accenture, Airbus, GE, and Hitachi have joined forces with the Intel Neuromorphic Research Community (INRC).
- Samsung, along with researchers from Harvard, published a paper titled 'Neuromorphic electronics based on copying and pasting the brain' in Nature Electronics in September 2021. It presented a new way of reverse-engineering how our brain works.
- The US Air Force and IBM are working together to build a neuromorphic supercomputer, probably based on the next generation of IBM's True North chip.
- A team of Chinese researchers has developed an AI chip, called Tianjic, and deployed it in an autonomous cycle.
- TCS collaborated with BrainChip in 2019 for a demonstration on hand gesture recognition featuring the Akida neuromorphic technology.
- IIT Kanpur's NeuroCHaSe research group is actively working on the development of neuromorphic hardware platforms and ensuring their security against adversary attacks. They are also going to tape out (fabricate) a 3D-neuromorphic computing IC soon.
- MemryX Inc., a startup at the University of Michigan, is developing a programmable AI accelerator chip that promises unmatched performance at relatively low power for high-performance applications.

Another major event that occurred this year was when Mercedes implemented BrainChip's Akida technology in its Vision EQXX electric vehicle. This is definitely a big deal since the Akida technology is tried and tested for a smart automotive experience. All features that the Akida provides, including facial recognition, keyword spotting, etc consume extremely low power.

"This is where we get excited. You'll see a lot of these functionalities in vehicles—recognition of voices, faces, and individuals in the vehicle. This allows the vehicles to have customisation and device personalisation according to the drivers or the passengers as well," says Telson. These really are exciting times.

Neuromorphic hardware, neural networks, and AI

The process in which neurons work is eerily similar to an electric process. Neurons communicate with each other via synapses. Whenever they receive input, they produce electrical signals called spikes (also called action potentials), and the event is called neuron spiking. When this happens, chemicals called neurotransmitters are released into hundreds of synapses and activate the respective neurons. That's the reason why this process is super-fast.

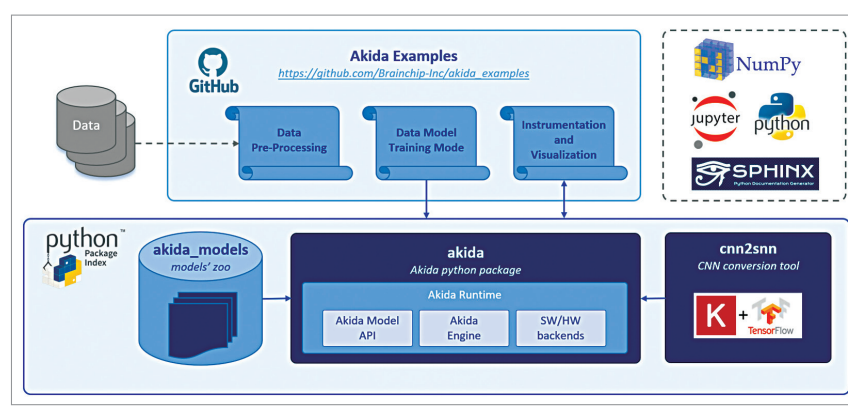
Artificial neural networks mimic the logic of the human brain, but on a regular computer. The thing is, regular computers work on the Von Neumann architecture, which is extremely different from the architecture of our brain and is very power-hungry. We may not be able to deploy CMOS logic on the Von Neumann architecture for long. We will eventually reach a threshold to which we can exploit silicon. We are nearing the end of Moore's Law and there is a need to establish a better computing mechanism. Neuromorphic computing is the solution because neuromorphic hardware realises the structure of the brain in the solid-state.

As we make progress in neuromorphic hardware, we will be able to deploy neural networks on it. Spiking Neural Network (SNN) is a type of artificial neural network that uses time in its model. It transmits information only when triggered—or, in other words, spiked. SNNs used along with neuromorphic chips will transform the way we compute, which is why they are so important for AI.

How to get started with SNNs

Since the entire architecture of neuromorphic AI chips is different, it is only natural to expect the corresponding software framework to be different too. Developers need to be educated on working with SNNs. However, that is not the case with MetaTF, a free software development framework environment that BrainChip launched in April 2021.

"We want to make our environment extremely simple to use. Having people learn a new development environment is not an efficient way to move forward," says Telson. "We had over 4600 unique users start looking at and playing with MetaTF in 2021. There's a community out there that wants to learn."



Akida MetaTF ML Framework (Source: MetaTF)

India and the future of neuromorphic computing

When asked about the scope of neuromorphic computing in India, Dr Sahay mentions, "As of now, the knowledge, dissemination, and expertise in this area is limited to the eminent institutes such as IITs and IISc, but with government initiatives such as India Semiconductor Mission (ISM) and NITI Ayog's national strategy for artificial intelligence (#AI-forall), this field would get a major boost. Also, with respect to opportunities in the industry, several MNCs have memory divisions in India—Micron, Sandisk (WesternDigital), etc—that develop the memory elements which will be used for neuromorphic computing." There's a long way to go, but there is absolutely no lack of potential. More companies would eventually have their neuromorphic teams in India.

An overview of Meta TF, BrainChip's software development framework

- MetaTF is a free and easy-to-use ML framework that leverages the TensorFlow framework and PyPI for BrainChip tools installation.
- Since it is built on TensorFlow, deep-learning professionals need not learn a new framework and can start working on Meta TF immediately.
- In-depth documentation with multiple examples is provided on the MetaTF website. (Do check the example section.)
- You can continue to design your CNNs in TensorFlow. Convert them for deployment on the AKIDA neural processor by the following CNN2SNN flow examples.
- The resulting SNN model runs on the AKIDA neural processor MetaTF Runtime.
- All of this in just a few steps!

Check MetaTF out: *https://doc.brainchipinc.com*

BrainChip Inc. is also building its university strategy to make sure students are being educated in this arena. Slowly, the research done in neuromorphic computing is making its way into the commercial world and academia. Someday, we might be able to improve our self-driving cars, create artificial skins and prosthetic limbs that can learn things about their surroundings!

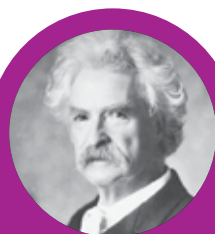
Consider your smart devices. All of them are dependent on the internet and the cloud. If equipped with a neuromorphic chip, these devices can compute on their own! This is just the start of the neuromorphic revolution. EFY

The author, Aaryaa Padhyegurjar, is an Industry 4.0 enthusiast with a keen interest in innovation and research.

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"Many a small thing has been made large by the right kind of advertising."



-Mark Twain



REMOTE MONITORING
Of Cardiac Devices

Rapid progress in information technology and medical sciences has resulted in several implantable devices. This article focuses on the heart and related devices, which are used to provide cardiac resynchronisation therapy, help maintain rhythm, and prevent sudden cardiac death



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The focus in personal healthcare has shifted from hospital care to home care and ultimately to healthcare on-the-move. As a result, the usage and popularity is rapidly shifting from fixed medical devices and systems to portable ones and ultimately to the wearable devices. The first-generation devices needed user involvement to obtain and record the data that was processed offline—for example, the heart holter used for monitoring and recording cardiac activity.

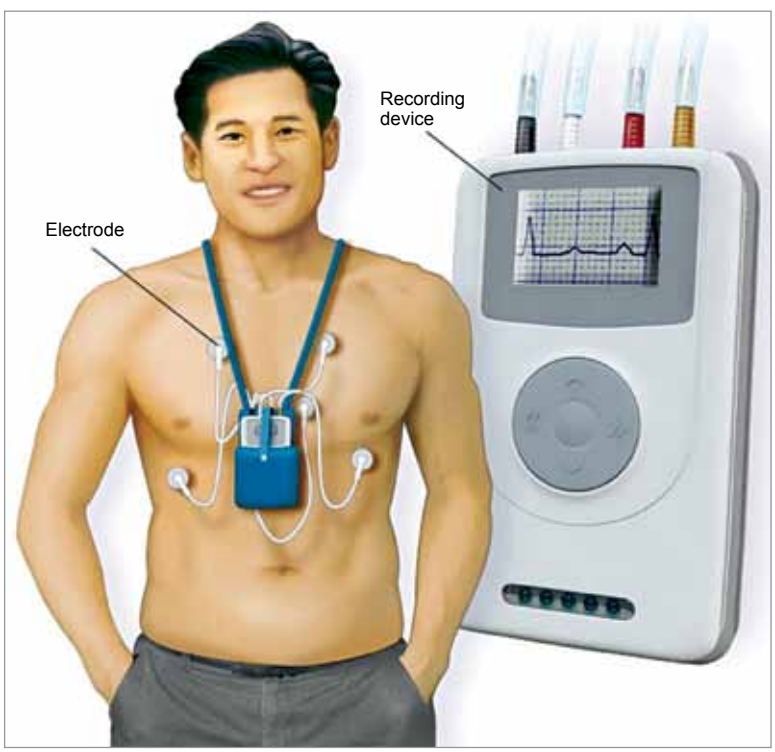


Fig. 1: Heart holter, a wearable device that keeps track of heart rhythm (Source: www.mayoclinic.org)

Rapid progress in information technology and medical sciences has resulted in several implantable devices. This article focuses on the heart and related devices. Implanted electronic cardiac devices (IECDs) include a broad spectrum of devices, such as pacemakers (PMs), implantable cardioverter defibrillators (ICDs), cardiac resynchronisation therapy (CRT) devices, implantable loop recorders (ILRs), and implantable hemodynamic monitors (IHMs). These devices are used to provide cardiac resynchronisation therapy, help maintain rhythm, and prevent sudden cardiac death (see box).

The heart of all these devices is a microprocessor with a miniature on-board power source. The microprocessor is programmed to collect data 24 × 7 and initiate the necessary action when it detects an event. For example, if the heart starts beating too fast, the device delivers a therapy to restore the normal heart rhythm.

The device, when implanted in a patient, needs regular monitoring. The patient has to make visits to the healthcare centre every three to six months to enable the healthcare team to check the device. During the visits, the data recorded by the device is downloaded to provide information regarding the significant events that have occurred, such as device malfunction, arrhythmia, changes in hemodynamic status or inadvertent changes in programmed parameters. This enables assessing the effects of the therapy as a part of a complete cardiac evaluation and optimisation of the device function.

With increasing number of patients and the cardiac related problems, visits are becoming a heavy burden on healthcare systems. Remote monitoring communicates the information from the implanted device without the patient physically visiting the centre while the patient stays connected to the healthcare centre all the time. In remote monitoring, the data collected is synchronised and shared by the device with a transmitter located near the patient. The transmitter communicates the data online to a secure portal accessible by the healthcare team.

The evolution of remote monitoring technology

The first pacemaker was implanted in a human in 1958. The pacemaker did not last long but the patient lived to the age of 88 with as many as 26 pacemakers replaced one after the other in his lifetime. The modern era began in 1969 with the development of demand pacemakers, which generated a regular electrical pulse without variation on its own, on sensing that the heart was not beating regularly.

Initially, the pacemakers were able to pace only the ventricle. Next, the dual-chamber pacing, called physiologic pacing, was developed that could pace both the atrium and the ventricle. These pacemakers paced at a fixed rate without increasing the heart rate with the increased activity. The present-day 'rate responsive pacemakers' are able to increase the heart rate with increased activity.

Later, other implantable cardiovascular devices were developed to restore normal cardiac activation sequence and/or detect and treat a malignant arrhythmia. The need for remote monitoring was felt when the follow-up procedure became overwhelmingly resource-consuming and demanded differentiated human and technical resources. Moreover,

Implanted Electronic Cardiac Devices (IECDs)

A pacemaker is a small device that is placed under the skin in the chest area to help control heartbeats. It helps the heart beat more regularly if the patient has an irregular heartbeat (arrhythmia), particularly a slow one. Pacemakers use low-energy electrical pulses to control the rate and rhythm of heartbeat. Traditional pacemakers have three main parts—a pulse generator to create the electrical pulses, wires (also called leads) to carry the pulses to heart, and electrodes to sense natural heartbeat. When the heartbeat is slower than normal, the electrodes deliver electrical impulses to the heart to make it beat normally.

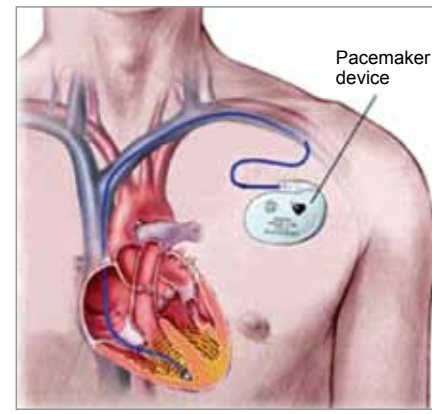


Fig. 2: Pacemaker (Source: http://caifl.com)

An ICD, like a pacemaker, is a small battery-powered device that monitors the heart rhythm and detects irregular heartbeats. If an abnormal heart rhythm (heart beating chaotically or too fast) is detected, the device delivers an electric shock via one or more wires connected to the heart to restore a normal heart rhythm. ICDs help in preventing cardiac arrest in high-risk patients who are at risk for life-threatening ventricular arrhythmias. Newer-generation ICDs may have a dual function, which includes the ability to serve as a pacemaker.

Cardiac resynchronisation therapy (CRT) devices. A CRT system consists of a pulse generator and thin insulated leads. The device delivers tiny amounts of electrical energy to the heart through these leads to restore normal timing of the heartbeats. This results in both ventricles pumping together and more efficiently.

There are two types of CRT devices. One is a special kind of pacemaker, called cardiac resynchronisation therapy pacemaker (CRT-P). CRT-P coordinates the timing of the upper heart chambers (atria) and the lower heart chambers (ventricles). The device monitors the heart's rhythm, detects the irregularities, and corrects them with electrical pulses. The other, called cardiac resynchronisation therapy defibrillator (CRT-D), is the same as CRT-P but includes a built-in cardioverter defibrillator (ICD) to deliver small electrical pulses to the left and right ventricles to help them contract at the same time in a more synchronised manner.

Implantable loop recorder (ILR). An ILR is a device, somewhat like a pacemaker, that records electrical activity in a patient's heart. One of the main differences is that the ILR does not regulate heart rate. Rather, it is a single-lead ECG monitoring device used for diagnosis in patients with recurrent unexplained episodes of palpitations or syncope. The device stores ECG data automatically in response to a significant bradyarrhythmias or tachyarrhythmia, or in response to patient activation. It is mostly used when symptoms are infrequent or when aggregate long-term data is required.

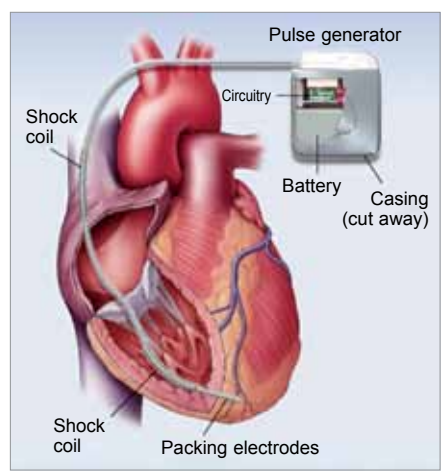


Fig. 3: Implantable cardioverter defibrillator (ICD) (Source: www.nejm.org)

Implantable hemodynamic monitors (IHMs). An IHM is used as means of measuring intra-cardiac pressures and understanding the nuances of the hemodynamic derangements of this condition for accurately assessing and monitoring filling pressures to more precisely adjust therapy. IHMs also assist in management of other cardiovascular diseases, such as pulmonary arterial hypertensions.



Fig. 4: MRI-compatible pacemaker (Source: www.medgadget.com)



Fig. 5: Disassembled St. Jude Medical Merlin@home EX1150 transmitter (Source: www.mddionline.com)

the long distance between the pacing centres and the population agglomerates posed various problems.

Initially, Furman and his team transmitted data from a pacemaker through telephone connection using the trans-telephonic monitoring (TTM) method. The TTM device used was a 30-day looping event monitor, about the size of a pager that recorded and captured irregular heartbeats by constantly tracking the heart rhythm. The device provided a rudimentary evaluation of pacing and sensing function and the patient was still required to make in-clinic visits.

The modern, reliable, safe, and secure devices became viable in the 1970s with the availability of the advanced IECD technology, compact longer lasting batteries, microprocessors with fast speeds, and improved analysis techniques and interpretation algorithms. Biotronik was the first company to market a wireless remote home monitoring system that was FDA-approved. Later, other companies followed. Medtronic introduced CareLink in 2005, Boston Scientific brought out Latitude in 2006, and St. Jude started selling House Call in 2007.

Over the last few years, a number of advanced interpretation algorithms have emerged, improving the scope of analysis and diagnosis, and making the devices more and more complex.

How remote monitoring works

During the traditional follow-up visits to a health centre, a sensing wand is placed by the doctor over the device to download the data into a dedicated computer provided by the manufacturer. Analysing the data, the doctor learns retroactively the events that have happened, such as a high-energy shock or an abnormal activity of heart or the device. Remote monitoring makes possible the information available wirelessly without the patient visiting the centre.

The remote monitoring systems used earlier were non-wireless and transmitted the data when the patient placed a magnetic sensor over the device. The sensor fed the data into a phone modem to transmit it to the clinic or a remote monitoring service.

The present-day remote monitoring systems are wireless and automated. The data from an implanted device, which is compatible with the mostly proprietary remote monitoring system, is downloaded and shared automatically with a home monitor, located within three metres of the patient, using radio transmissions.

Some systems use a smart phone instead of the home monitoring device. The monitor dials up a phone based internet connection and transmits the data to a central server. The healthcare team accesses the data on their computer or a mobile device using a password-protected secure link. The system can transmit data at specific dates and times and/or can be set to transmit when triggered by the programmed alerts, such as the settings going out of range, delivered shocks, or abnormal heart rhythms.

The transmitted data includes such information as heart rhythm changes, device malfunctioning, fluid retention in the lungs, etc. The receiving devices are programmed to look for the specific alerts triggered by events and notify the information automatically to the doctor via a text message, fax, e-mail, or a website message. The information also gets downloaded into the patient's electronic medical record (EMR).

Remote monitoring provides the healthcare team an easy access to information, enabling them to manage the patient's heart condition and the function of the implanted device in a better and quicker way. The quality of life of patients is improved with reduced hospitalisation and curtailed visits to the clinics, and they also get a sense of security and peace of mind.

Electromagnetic and RF interference

Medical Implants Communication Services (MICS) frequency band,

ranging from 402 to 405MHz, is available for use by implanted medical devices to provide high-speed communication between patients' IECDs and medical practitioners. Choice of the frequency is made based on associated body losses and antenna efficiency. The 400MHz region offers optimisation in this respect with better ability to transmit radio signals in the human body.

However, IECDs are susceptible to electromagnetic interference (EMI) and radio frequency interference (RFI) when exposed to electromagnetic fields or radiations from radio transmitters. Potential sources include high-voltage transformers, powerful electromagnets, radio transmitters, and various types of electronic equipment and devices, such as mobile phones and antitheft devices.

The interference risk depends on factors such as distance from the source, transmitted power, and the level of protection provided in the device itself. The malfunctions of IECDs include over/under sensing, induction of asynchronous ventricular dysrhythmia, and electronic noise. As a safeguard, precautions are required to be taken by the patient, such as using cellular phone in the ipsilateral ear and maintaining distance from high-voltage transformers, machines, and gadgets/devices emitting strong electromagnetic radiations.

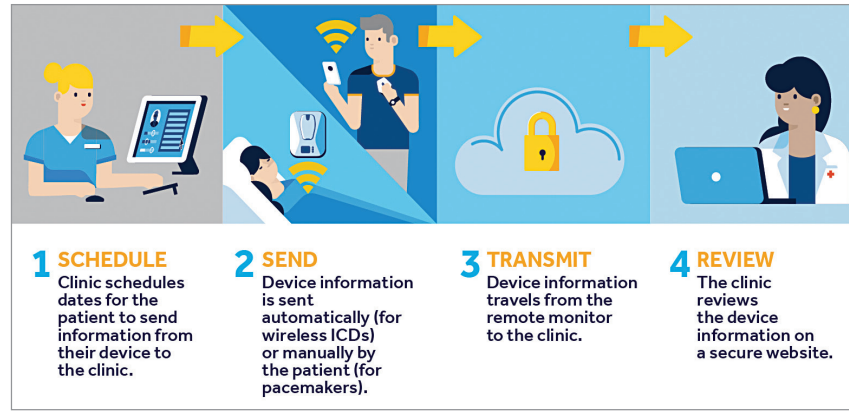


Fig. 6: Remote monitoring steps (Source: www.medtronic.com)

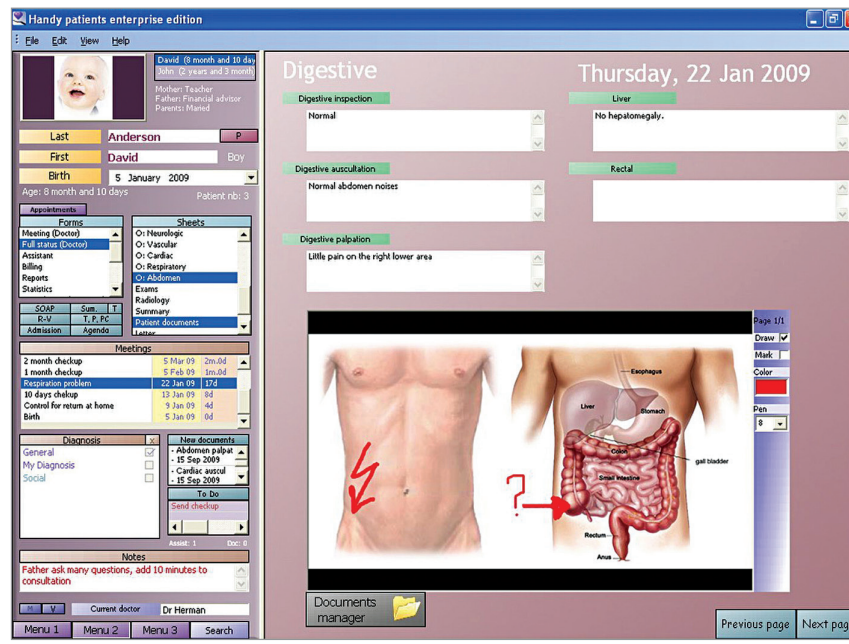


Fig. 7: Example of an electronic medical record (Source: www.medtronic.com)

The systems available

Almost all the manufacturers are marketing proprietary IECDs that are compatible with their own remote monitoring systems and protocols only. As a result, collection and management of data requires manufacturer-specific equipment. Although there are operational differences, the general flow of information is similar. Some of the systems in use are:

Home monitoring. Biotronik, a German firm, was the first to introduce their remote home monitoring system in 2001. The system transmits data on a daily basis at fixed time intervals and on the occurrence of a clinically relevant event. A cell-phone-like patient device sends encrypted data automatically via mobile phone to a central database in Europe. On reception, the data is processed and made available to the caregiver.

Caretaker network. The CareLink network of Medtronic, USA, is one of the leading remote monitoring systems, which can be used by a compatible Medtronic patient implanted heart device. The system is customisable and flexible, and has a monitor that interfaces with the device and a telecommunications link to transmit data to the healthcare team.

CareLink also enables display of diabetes information, such as continuous glucose monitoring and insulin pump data. The network enables the healthcare team to access the information on a secure website or through a mobile app. Colour-coded notifications are made available to the patients via options that include website, voice message, pager, text message, or email message.

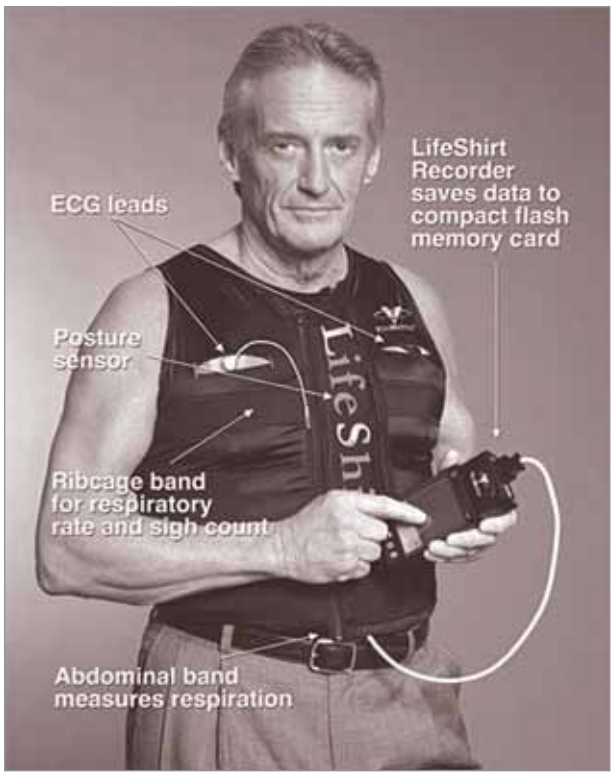


Fig. 8: The LifeShirt that monitors the wearer's vital signs (Source: www.virtualworldlets.net)

Lattitude. Pacemakers and defibrillators manufactured by Boston Scientific are available for use with their automatic latitude home monitoring system. However, they do not conduct continuous monitoring; they send the information automatically or prompt the patient to send it at the scheduled times. They can also monitor and send weight and blood pressure data to a secure website. The system delivers notifications at two levels—Red alerts and Yellow alerts. Security protocols are used to protect the medical information and only authorised people have access through a password.

Advantages of remote monitoring

The most significant benefit of remote monitoring is that it almost eliminates the routine visits to the doctor and substantially improves the survival rate of the patients. The system can detect in real time the cardiac events, abnormal heart rhythms, and any problems with the functioning of the implanted devices—allowing the healthcare team to respond faster.

Remote monitoring helps in reducing the volume of in-office patients, allowing healthcare team to attend to more patients. Hospitalisation need is reduced, improving the quality of life and allowing improved patient management by the heathcare team.

Studies carried out over a period of five years have shown that the people using home monitoring had a 50% relative risk reduction compared to the people making regular follow-up visits to the clinics. Also, in case of patients using implanted pacemakers and a smart device for remote monitoring, there was a significantly higher rate of scheduled transmission success compared with the traditional monitoring technologies.

It was observed that some people, especially, old and aged, found it cumbersome to set up the system on their own and needed technical assistance. Also, people travelling for a long period of time may find it inconvenient to carry the monitor with them.

Conclusion

Remote monitoring of cardiovascular implantable electronic devices was developed to complement the compulsory calendar based in-person evaluations and provide convenience to the patients as well as clinics. It has the potential to reshape monitoring of the patients as it substantially reduces the number of in-clinic visits without compromising patient safety, makes possible an early detection of clinically actionable events, and detects any malfunctioning of the implanted devices. Some systems can even connect with an ECG machine, a weighing scale, and a blood-pressure monitor.

The technology greatly assists the healthcare professionals in better managing the patients as well as the devices. Remote monitoring makes it possible to increase the number of patients that can be attended to without adding extra resources. Its use results in reduced expenses in follow-ups, possible admission, and treatment in a hospital, as well as the expenses incurred in consultation fees and transportation. There is time saving since travelling time is eliminated and there is no waiting period at the clinic for consultation.

IECDs compatible with Web based, remote monitoring systems are readily available in the market and almost all are proprietary in nature. The current technology does not allow remote reprogramming of devices, and the different proprietary systems remain a major obstacle to data integration. Ensuring the personal medical data security is another potential problem as the data is vulnerable to hacking.

These issues are likely to be resolved with future technological developments. Vivometrics LifeShirt is a non-invasive ambulatory monitoring garment with embedded sensors, which is used to monitor up to 40 physiological parameters, such as heart rate, breathing, and lung capacity. Today's devices have already far outpaced the capabilities of trans-telephonic monitoring and continuous development is taking place to enable them improve healthcare and at a lower cost. EFY

What It Takes To DESIGN And MANUFACTURE An INDIAN MICROPROCESSOR

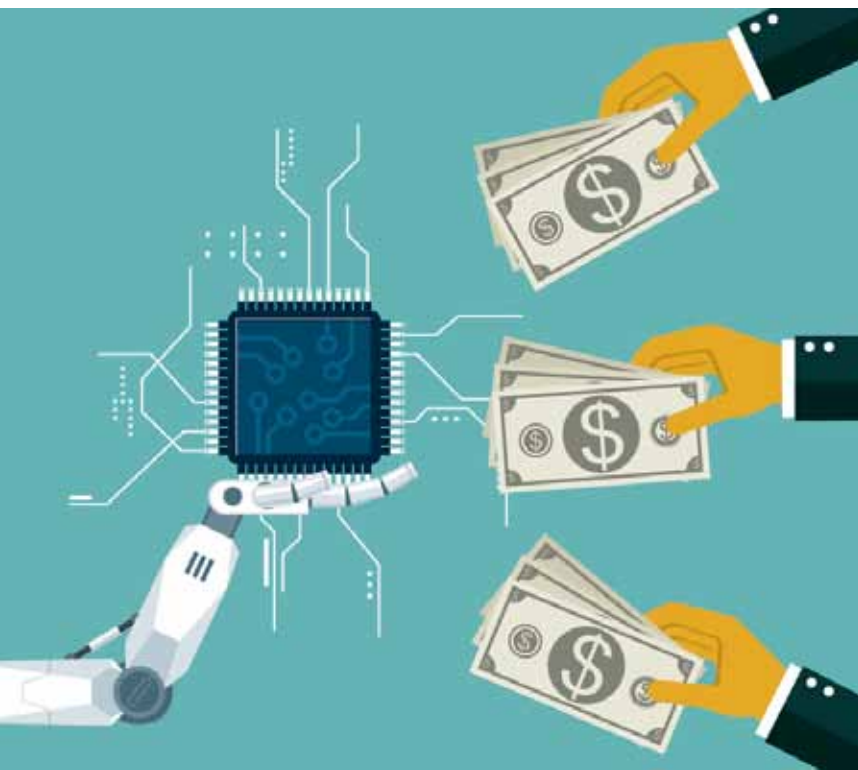
There have been several acquisitions in the microprocessor and microcontroller industry recently. Let us take a look at the state of affairs and how the industry is facing. Designing, manufacturing, and selling a new processor is not easy, but open source seems to help



S.A. SRINIVASA MOORTHY is Director Engineering Design, D4X Technologies Pvt Ltd

We have x86 processors made by Intel and AMD, and ARM processors by various IC vendors who make them in multiple flavours. These are the only high-end microprocessors at present. Whereas 8- and 16-bit microcontrollers are available from multiple vendors like Microchip, Texas Instruments, NXP, ST, and Infineon, to name a few.

But during the last two years, the high-end microprocessors—especially with x86 architecture—have started facing competition from ARM based controllers in power consumption, speed, and multiple cores. This has put huge pressure on the legacy microprocessors, which are the mainstay for PCs and servers.



However, Apple has broken their monopoly in PCs by switching over to ARM based controllers, which deliver far superior performance, putting pressure on the x86 processor family. But ARM is not a semiconductor as an integrated circuit but rather an IP (intellectual property) core, which the licensees can customise to create devices as per their needs.

This has led to proliferation of ARM based products across the board and major beneficiaries are mobile phones and embedded systems (not the PCs and servers!). Things had been going fine but suddenly the company ARM was bought over by the graphics processing units (GPUs) producer NVIDIA, leading to a major consternation. This has left every semiconductor company wondering what is going on.

The current situation

Since fast few years, x86 based processors are being challenged by the ARM based controllers in critical aspects like power, speed, size, and number of cores, with ARM based processors capturing the complete mobile market. Also, software for the ARM processors was never an issue as the volume of mobiles was much higher than of the PCs shipped.

Adding to this was ARM's business model of just licensing IP and leaving the realisation of devices to the vendors, which gave a lot of freedom to the mobile vendors. In addition, next-generation

RISC-V—A brief introduction

RISC-V (pronounced 'risk-five') is an open standard instruction set architecture (ISA) based on established reduced instruction set computer (RISC) principles. Unlike most other ISA designs, the RISC-V ISA is provided under open source licenses that do not require fees to use. Several companies are offering or have announced RISC-V hardware. Open source operating systems with RISC-V support are available and the instruction set is supported in several popular software tool chains.

The project began in 2010 at the University of California, Berkeley, but now many volunteers who are not affiliated with the university have started contributing. Unlike other academic designs, which are typically optimised only for simplicity of exposition, the designers ensured that the RISC-V instruction set be usable for practical computers.

As a RISC architecture, the RISC-V ISA is a load-store architecture. Its floating-point instructions use IEEE 754 floating-point. The instruction set is designed for a wide range of uses. The base instruction set has a fixed length of 32-bit naturally aligned instructions, and the ISA supports variable length extensions where each instruction could be any number of 16-bit parcels in length. Its subsets support small embedded systems, personal computers, supercomputers with vector processors, and data centre computers.

The instruction set specification defines 32-bit and 64-bit address space variants. The specification includes a description of a 128-bit flat address space variant, as an extrapolation of 32- and 64-bit variants.

As of June 2019, version 2.2 of the user-space ISA and version 1.11 of the privileged ISA are frozen, permitting software and hardware development to proceed. The user-space ISA, now renamed the Unprivileged ISA, was updated, ratified.

fabless vendors, who designed the best-performing processors and got them manufactured through outsourced semiconductor foundries, added more traction to the ARM based systems.

One interesting event that happened on sideline was the acquisition of mainline programmable logic device vendors, mainly FPGA (field programmable gate array) vendors like Xilinx and Altera, by mainline processor vendors. Intel bought Altera and AMD bought Xilinx. These acquisitions changed the game further.

These vendors acquired the programmable logic vendors to bolster their datacentre products as the datacentre interconnects were reaching 100Gps speed and there was need for hardware based solutions, which typically only FPGAs can offer! When things were coasting along, NVIDIA announced the takeover of ARM. (There are some issues which the Competition Commission is looking at, but as of now ARM is owned by NVIDIA.)

It is not that low-end 8- and 16-bit microcontrollers business was hale and healthy. There was a huge churn in that market too, but the controllers made by different companies have not been dropped (so far!). Microprocessors like 68000 family and 8086 family have become obsolete. In the 8-bit controller side the situation is pretty bad! Processors like 65C02 from Rockwell, 6800 and 6809 from Motorola, 8085 processor and 8051 microcontroller from Intel have all become obsolete.

Interestingly, 65C02 is still being offered by some vendors as a custom ASIC (application specific integrated chip). 8051 does have incarnations from vendors like Atmel, Silicon Labs, and Nuvoton, who have processors supporting 8051 instructions but through their own custom IC architecture. Today 8- and 16-bit controllers are pretty much dominated by TI, Microchip, and NXP, who have significant market share. But this is not an exhaustive list. The idea is to set the context on what it takes to develop a microcontroller in the current situation.

With ARM being acquired by NVIDIA, one big challenge facing the ARM processor vendors is that they do not have access to a vendor-neutral processor (where the core vendor is not associated to any major vendor but is independent), making the situation dicey. How NVIDIA will handle the ARM core licensing going forward is not known. So far the vendors are safe producing their existing products, but future will depend on what NVIDIA decides.

This has forced companies and countries to start worrying about the impact of these acquisitions and consolidations. With electronics taking over most of the day-to-day life, the equipment are getting critically impacted. This is especially true in the case of defense equipment. Independence of the technology, and even freedom to develop, will be under pressure due to access to advanced processor architecture and even the IP core, going forward!

Strategic issues

One of the biggest issues that everyone is facing is, how to develop products and solutions without any restrictions. Under this circumstance the only way to find a solution is to look at open source solutions. We in India have a successful track record of using Linux. With Linux taking over the internet servers and other critical applications (have to admit Linux couldn't replicate the success in the desktop market, barring the developer communities) we have demonstrated that open source technologies can be successfully adopted.

The logical thinking is to replicate the same model for processors. This has become feasible with the availability of RISC-V, an open source architecture which basically defines the instruction set architecture, leaving the implementation to the designers. This has led to multiple versions of RISC-V implementations available for designers to develop.

One advantage of the RISC V

architecture is that it offers device options that can compete with 8/16-bit processors and high-end 32- and 64-bit variations with single and multiple cores. This offers multiple options with. a single open architecture. One question as laymen we get is, why a processor has become the critical issue now?

Three critical aspects are important for any country to maintain independence and progress on the technology front. These are:

1. Independence to decide and develop technologies that are a must for the country's progress.

2. Availability of parts (no supply chain bottlenecks) freely. We should avoid the current situation of companies waiting for ICs and other parts.

3. With the world becoming connected and proliferation of connected devices, one of the worrisome aspects is the security. We are not talking about the phishing and hacking but the connected devices being hijacked and spoofed to impact the day-to-day life of the citizens. One example would be, as part of smart city project there will be sensors which monitor the environment—especially pollution. Imagine if a hacker replaces the installed (good/genuine) devices with faulty devices so that even when the environment is polluted the devices report everything is fine. You can understand the impact on the society as a result.

This essentially means that the communication must be encrypted and, above all, the devices have to be validated and approved by the installer. While this looks easy, implementation is a challenge which needs a solution that mandates the devices to be uniquely identified (yes, each IC should have a unique certified ID!). In addition, these devices should be validated before they are allowed into service, and need to be periodically checked for presence of a valid device.

IIT Madras RISC-V projects

SHAKTI is an open source initiative by the Reconfigurable Intelligent Systems Engineering (RISE) group at Indian Institute of Technology, Madras to develop the first indigenous Indian industrial-grade processor. The aim of SHAKTI initiative includes building an open source production-grade processor, complete systems on chips (SoCs), development boards, and SHAKTI based software platform.

The primary focus of the team is architecture research to develop SoCs, which are competitive with commercial offerings in the market concerning area, power, and performance. All the source codes for SHAKTI are open-sourced under the Modified BSD License. The project was funded by Ministry of Electronics and Information Technology (MeITY), government of India.

Two tapeouts (ICs fabricated and tested) of the C-class processors have been performed. They have been codenamed as RIMO and RISECREEK (test chip).

RIMO is the code name of the SHAKTI C-class based SoC that has been taped-out at Semi-Conductor Laboratory (SCL) at Chandigarh using 180nm process technology. The 144sq mm chip has been tested to operate at a frequency of up to 70MHz. The chip has been packaged on a 208-pin ceramic quad flat pack (CQFP).

RISECREEK is the code name of the SHAKTI C-class based SoC that has been taped-out at Intel's Oregon fab using a 22nm FinFET process. The 16mm^2 chip has been tested to operate at a frequency of up to 350MHz. The chip has been packaged on a 208-pin ball grid array (BGA).

MOUSHIK is the code name of the SHAKTI E-class based SoC that has been taped-out at Semi-Conductor Laboratory (SCL) at Chandigarh using 180nm process technology. It operates at 100MHz and was developed along with a motherboard called Ardonyx 1.0.

We can see the evolving situation demands that the processors cannot be a plain vanilla type but a device whose history can be traced and identified. This requirement is going to be implemented as we go forward. USA NIST has released NISTR 8228 (Considerations for Managing Internet of Things (IoT) Cybersecurity and Privacy Risks) standard for this purpose.

Incidentally, in the Indian context, UIDAI has already updated its next-generation fingerprint sensor's compliance to secure processors and to be independently verified and validated by STQC before the sensors are put in the field. This ensures absolute safety of the customer's data. The same is true for military equipment too.

The situation in India

Real purpose of this article is to educate readers on what it takes to design a processor in India and persuade companies and other organisations to use it. Let us first see the lifecycle of a semiconductor design, which would help us understand where we stand today.

Fig. 1 shows very simple flow chart of an IC design for easy understanding. The lifecycle consists of three major blocks:

1. Design phase, which has two steps before the design is ready for the IC's fabrication. This is purely an engineering effort that requires experienced designers who can develop an IC using languages like Verilog or VHDL. The process of coding an IC using one of these languages is typically called front-end design.

Typically, a processor design involves the coding of the main core and integration of libraries for different peripherals needed in the processor/controller. In the next step, the coded IC has to be tested completely using test benches. These are Verilog/VHDL codes written exclusively for testing (something very close to simulation of the boards for their working before committing to the PCB).

2. The tested code is converted into the GDSII format, which is used by the IC fabricators—also



Fig. 1: IC design flow chart

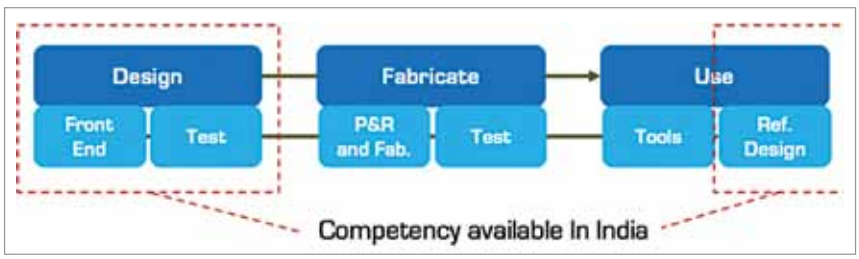


Fig. 2: Boxes encircled In red show what can be done In India

known as foundries—to manufacture the ICs. Fabrication process has four steps before it is converted to individual ICs:

(i) First process in fabrication is the Place & Route (P&R) (also known as back-end), which is the equivalent process of PCB routing. P&R process is very specific to each foundry as it is dependent on semiconductor process used by the foundry.

(ii) P&R output is converted to masks and the ICs are fabricated in a large 20.3cm or 30.5cm (8-inch or 12-inch) wafer. A wafer will have multiple ICs known as dies.

(iii) Foundries test each of the ICs (dies) and mark the good and the bad ones in the wafers.

(iv) Typically, foundries deliver the tested wafers to the OSAT (outsourced semiconductor assembly & testing) vendors. These OSAT vendors cut the individual ICs, package them based on the chip vendors' design, test and mark them and deliver. OSAT is typically an intensive manual process, and most semiconductor foundries outsource this to companies who specialise in this service. Malaysia, Vietnam, and Indonesia are the major OSAT locations.

3. At this stage the IC is ready and can be used for designs. Life would be easy if the IC happens to be a simple device like an op-amp. (This is not true as you still need a datasheet with specifications to use the device). But if the IC happens to be a microprocessor, the life is different. Any microprocessor that is introduced in the market needs three critical items as a must to succeed:

(i) Foremost are the software development tools consisting of assemblers, compilers, integrated development environment (IDE) to help the software developers to work with the processor. Tools have to be efficient in terms of compilation efficiency, optimal (size) compiled code, and libraries for the peripherals in the devices.

(ii) Second part of the tools is the operating system support. Typically, a standard OS like Linux and real-time operating systems like FreeRTOS should be ported on to the processor and delivered as ready-to-use component for the designers to focus only on the application development. Along with this board support package (BSP), a piece of firmware which allows the OS to work without worrying about the underlying processor variation, should be ported.

(iii) With focus on reduced time-to-market, another support item that is expected by the designers is the reference designs that demonstrate the hardware features of the processor. These reference designs have to be a total package covering the schematics files, PCB CAD files, Gerber files, and the firmware code that runs on the reference board. This helps the designers understand the design and develop their designs. Many times, designers use this for their proof-of-concept prototypes.

Now we can see what processes can be done in India to develop a processor from scratch. Considering the current situation in India, Fig. 2 shows what can be done in India and what can't be! The ones under the red boxes are skills that are available in India. For the rest we need infrastructure.

We can see that while we have good competency in designing, we have very less in the subsequent stages—barring some experience in the reference design. Having understood the current status let us see why we need an Indian processor.

Need for Indian processor

This was the main reason for this article. Three key elements that drive the need for an Indian processor are:

1. Primary reason is the security. With the proliferation of connected devices ensuring end-to-end security is the most critical issue. This calls for secure communication (encryption) and authorised devices. While the encryption is easy to implement, designing authorised/certified devices calls for certifying every device and the authentication mechanism must be located inside India. This ecosystem is extensive and needs to be installed before the production of ICs starts. Today, even though authorised/certified devices (also called trusted devices) are available from global vendors, the device data is located outside India, which is a security risk.

2. Avoiding supply chain risks. As we have seen, severe shortage

of semiconductor devices due to Covid, especially of processors, is leading to lower sales, even though products are in demand. One question people may ask is, if we don't have the foundries, how it will improve the supply chain? The answer is in the business model. Foundries like TSMC work based on committed contracts, and if you have signed up for a fixed number of devices and you have honoured the commitments previously, they do supply as per the agreement.

3. Third is having own microprocessor helps to train the designers in design and also ensures the knowledge is captured and used. This design knowledge is very critical for the defence and smart city applications, which are critical and need to be secured as they impact the society.

In addition, an Indian processor would also bring the cost down and reduce the development time as the processor proliferates. Above all, it would save the country from obsolescence of the processors in a short time, leading to support and new design effort issues. Having Indian processor allows the product to be obsoleted based on a planned strategy instead of panic mode reaction. (The panic is despite the IC vendors giving proper obsolescence notice as well as last time buy options, which product companies tend to ignore!)

How India can have own processor

With the semiconductor supply chain crisis hitting every domain, the issue of supply chain security has come to fore and shown how critical it is to secure a supply chain. Having learnt, it is high time that India has its own microprocessor with a secured supply chain. With most processors being supplied by global vendors, India must have own processor that can use the RISC-V architecture as the best option.

In this regard, IIT Madras has been a pioneer and has developed two processors, RISECREEK and MOUSHIK. IITM's team has been successful in the conversion of the RISC-V architecture into ASICs as well as FPGA based processors. Since RISC-V defines the instruction architecture, speed and other aspects can be decided by the design teams offering flexibility.

One advantage is that the architecture is not technology specific, and designers can target different fabrication technologies to get different speeds. One of the biggest advantages of the IITM's design is the availability of operating systems for these processors. IITM team has ported both Linux and Free RTOS on to these processors. They have used open source tools for the software development, making the ecosystem truly open source.

Yet, one challenge that designers face will be that the tools being open source will not have the integration of the commercial IDE provided by the regular vendors. The tools are a little difficult to use. But this will change once the adoption of RISC-V picks up. Newer versions will address the security and other aspects needed for trusted devices.

Key to success in having an Indian processor lies in how quickly commercial device developers adopt the RISC-V architecture and develop different flavours of the processor. While it is easier said than done, need for the Indian processor will only increase as the time passes. Some of the challenges that need to be overcome are:

1. A processor development needs a huge investment to get a working processor taped out commercially (through outsourced foundry services). Waiting for a foundry to come up is not a viable option as foundries with advanced technologies are expensive.

2. However, India should focus on setting up OSAT (outsourced semiconductor assembly & test) facilities which convert the processed wafers with ICs into individual devices. OSAT facilities are less expensive and more manual work oriented, so they can be a good option as a business model too. Also OSAT facilities are device-independent and very close to the business model of EMS (electronic manufacturing services) vendors.

3. Creation of software tools, libraries, domain-specific applications (like avionics, automotive, and medical, which need reliable software modules) and reference hardware and circuits for the designers to try their ideas before they commit to the product design.

4. Training designers, especially students, in the RISC-V architecture and its ecosystem so that when they start designing, they have the knowledge needed for developing products. Today, students still study 8085 and 8086 processors, which are obsolete and not in production. At the same time teaching them RISC-V without the devices being available is a wasted effort.

5. Startups who work on RISC-V based system to kick start the next wave of products.

From the support point of view, government should support the effort by incentivising the designs based on RISC-V and mandating the use of these processors in critical government departments like defense, citizen's benefit programmes like Aadhaar, and backing devices.

To conclude, with so much of hype around an Indian processor, we need to remember that for a processor to become successful it needs support at multiple levels. Harping on a foundry is not going to solve the problem and creating an ecosystem is a must. EFY

The Wonderful World Of INGENIOUS PRINTED SENSORS

The electronics industry has heavily relied on sensors that have rigid proportions. But can the rise of flexible, printed sensors become a game-changer for a myriad of applications, where form-factor and convenience play the core role to implement a particular technology?



DR MATTHEW DYSON is a Senior Technology Analyst at IDTechEX

Conventional electronics based on PCBs are produced efficiently, resulting in a very high yield. However, they are rigid, take up a lot of space, possess a fixed form-factor, and are not always lightweight. Although sensors such as thermistors can be small in terms of size, the majority are large and rigid. On the other hand, printed sensors are very thin and flexible. Also, their large-scale, cost-effective production allows rapid prototyping and customised printing for different applications.

So, what trends drive the adoption of printed, flexible sensors? A large part of this answer lies in the revolution brought forth by Industrial IoT (IIoT), or Industry 4.0. Here real-time monitoring can be performed digitally by retrofitting such sensors to industrial equipment for predictive maintenance.

Healthcare is the next area that drives their adoption, where electronic skin patches offer the benefit of remote patients' health monitoring. Following it, smart homes and cities are the next segment that could drive this adoption. The idea of having several connected low-cost sensors around our lives is quite appealing and valuable for long-term use.

In a typical workplace, printed sensors would be able to check room temperature, monitor humidity, measure air-quality, and help in preventive maintenance. They do so by identifying vibrations, force-sensing via trackpads, printed fingerprint sensing, leak detection, and many more. Fig. 2 paints a vivid picture of this. However, not every sensor performs the same function as the other.

Types of sensors

Besides automation, electric pianos and medical applications, pressure sensors (piezoresistive or piezoelectric) have a scope for smart flooring and force-sensitive touchpads on laptops. Till date, temperature sensors were made with inorganic materials, but with printed flexible technology they can be done in 2D at a relatively cost-effective rate.

Optical (or light) printed sensors have a similar architecture to organic photovoltaics but are optimised for light detection rather than power generation. When it comes to e-textiles, capacitive strain sensors are an ideal choice as they

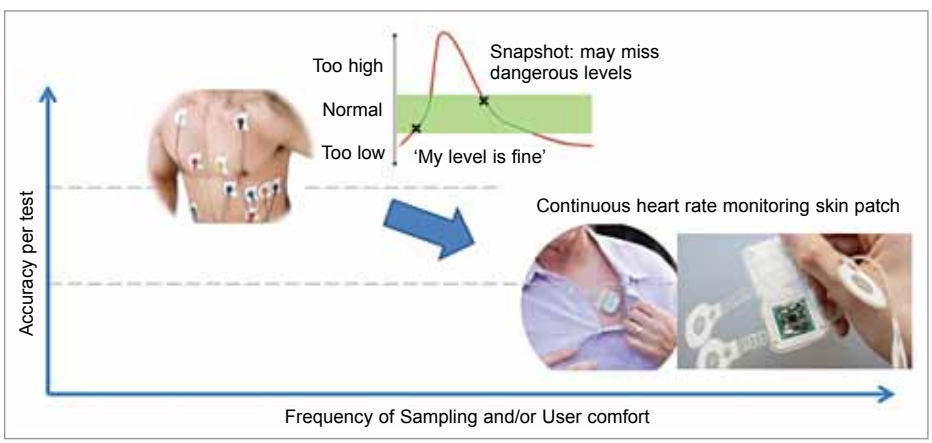


Fig. 1: Electronic skin patch for healthcare applications (Credit: IDTechEx)

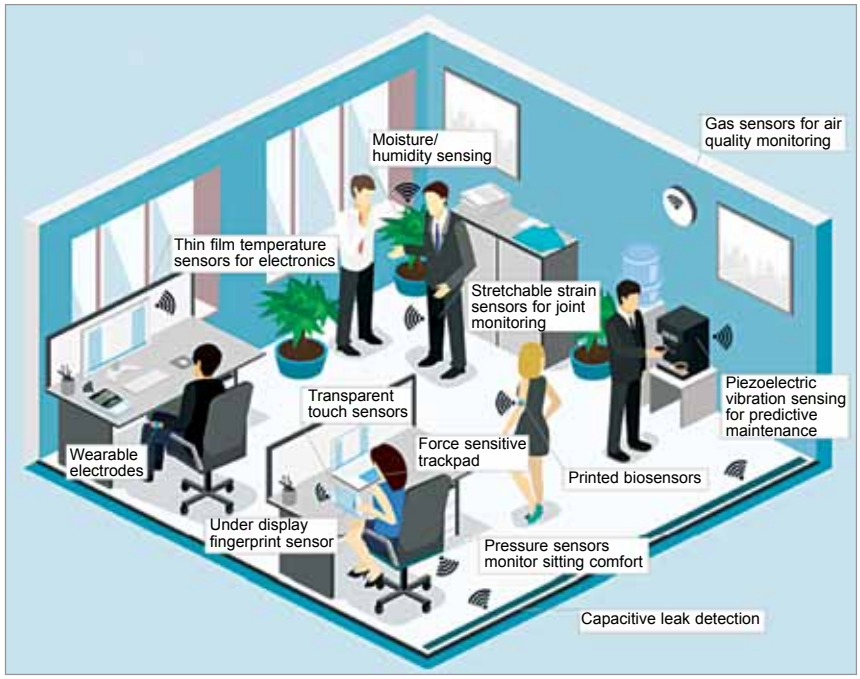


Fig. 2: Various sensing features in an office space (Credit: IDTechEx)

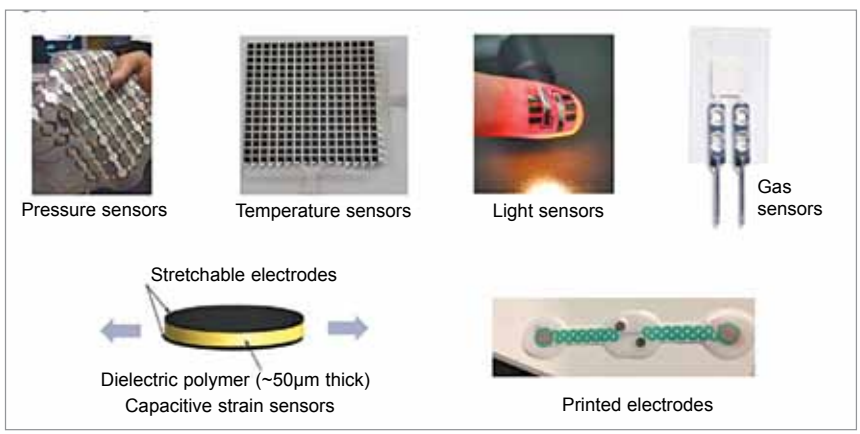


Fig. 3: Different types of printed flexible sensors (Credit: IDTechEx)

enable monitoring of medical rehabilitation or can be incorporated in gloves for augmented reality. With many compelling applications that provoke curiosity, let's take a deeper look at some of the applications.

Spatially resolved temperature sensors. Thermistors and RTDs are generally quite small, inexpensive, and adept function-wise. Hence, printed electronics is preferred as it enables a spatial array of temperature sensors. While the amount of charge stored in a battery depends a lot on temperature, these sensors are well suited for implementing battery monitoring in mobile phones and electric vehicles. The range of batteries can be significantly increased by making appropriate adjustments in temperature. Subsequently, the sensor can also alert any problems occurring in the battery that can cause heat spikes.

Healthcare monitoring

There are applications that include monitoring compact electronics with the help of a thin spatially arrayed temperature sensor for more efficient tracking and packaging.

Healthcare monitoring is another place where you can wrap a flexible, comfortable temperature sensor around your arms or legs and monitor the healing process. This induces a change in temperature due to the increased blood flow.

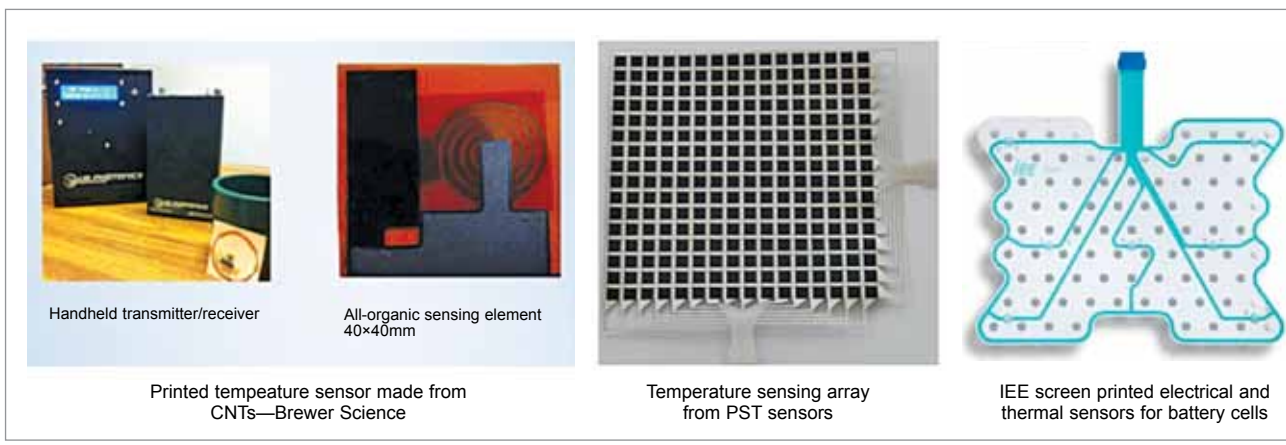


Fig. 4: Different types of spatial arrayed temperature sensors (Credit: IDTechEx)

Capacitive touch

Even though the words 'capacitive touch' make us think only about smartphones or tablet screens, there are other areas where its implementation is quite sensitive to the environment and can immediately identify any changes. Some of the lesser-known applications are:

Functional touch-sensitive walls. These can be created by using low-cost carbon based inks in graphics printers for promotional or control purposes. It allows people to interact with these walls, be it at museums, exhibitions or even homes.

Floor and wall integrated capacitive sensors. A tape-like capacitive touch sensor containing carbon ink can be placed across the floor of a room. It sends real-time notifications to the phone whenever a change in capacitance is sensed. This is especially promising for leak detection.



Fig. 5: Integrated pressure/temperature sensors for battery cells in a single printed foil (Credit: InnovationLab)

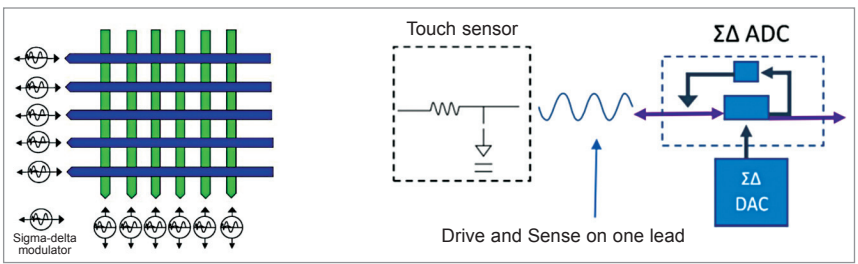


Fig. 6: Disruptive matrix sensor readout technology (Credit: SigmaSense)

Fig. 5 shows an integrated pressure/temperature sensor that can predict the failure of lithium-Ion batteries when they start producing gas and swell up. These thin, printed sensors can be laminated on top of each other and wrapped around each battery cell to detect temperature and pressure. Such laminated sensor films also contain heating elements to provide an integrated solution.

Disruptive read-out technology for matrix sensors. This is a unique method to obtain signals from a passive matrix array, commonly used for capacitive sensing purposes. So, rather than using voltages to scan each line and then read off the columns, this technology (see Fig. 6) measures variation in the electric current that needs to be supplied to each row or column.

Each element can be simultaneously monitored, while everything else is kept at a steady state; and then the extent of those adjustments is monitored rather than sequentially scanning through the voltage. This solves many issues associated with capacitive touch sensors and also improves signal-to-noise ratio (SNR) and temporal resolution.

For instance, it is impossible to operate a phone with gloves on.

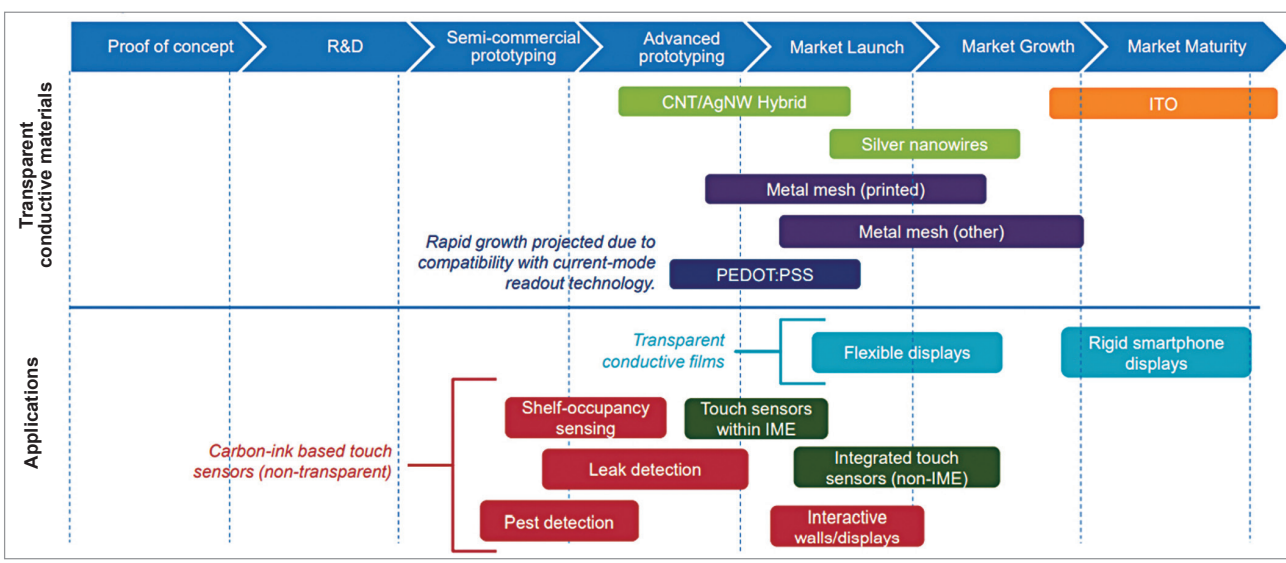


Fig. 7: Readiness level of capacitive touch sensor materials and technologies (Credit: IDTechEx)



I-STEM INTERNSHIP PROGRAM

Objectives

- To engage unemployed technical manpower with a Diploma/graduate degree in Science, Engineering and Technology
- To develop trained technical manpower to maintain and operate R&D facilities, that otherwise remain idle most of the time
- To train technical manpower to open-up, strip, repair, and/or retrieve useful spare parts from written-off equipment and maintain a library of such accessories at I-STEM portal
- To create a pool of such technical manpower trained to meet the need for equipment and maintenance engineers at R&D facilities across the country.
- To enhance the working life of sophisticated instruments by regular maintenance and thereby making (import) capital-expenditure more cost-effective.
- To enable optimal use of the high-end equipment and provide opportunities for host institutions to generate funds by sharing the equipment and by conducting skill development training using in-house experts (faculty members/technical staff/students).
- To fill the void to operate an instrument when trained technical manpower (e.g. Research/PhD candidate) leaves a facility, or promoted to another laboratory of importance, also to reduce dependency of facilities on research students.

Mechanism

- Host Institutions may provide the details of their requirements in prescribed format at the portal
- Advertisement of the internship program/requirement through I-STEM national portal
- Registration and Selection of interns on a regional basis in coordination with I-STEM team
- Interns will be paid a suitable stipend by I-STEM for a limited period
- After being trained, Interns may be offered employment by the host/different institution; or they may seek opportunity through I-STEM portal or practice on their own as Tools Consultant, via the I-STEM, at any of the labs listed on the portal across the country.

How to get engaged with various R&D Labs:

Interested candidates may apply to the internship program throughout the year via the I-STEM portal https://www.istem.gov.in/employment-opportunities.
Suitable candidates will be shortlisted from time to time and be asked to join the program as and when custodian institutions send request for an internship to the I-STEM team. For more details, please visit www.istem.gov.in

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The water droplets on the touch screen add to the discomfort. This new readout methodology enables a much-improved sensitivity, ignoring any element (water or fabric) present between the finger and screen for a seamless operation.

It also enables the usage of low-cost printable transparent conductive polymer known as PEDOT:PSS rather than expensive silver nanowires or printed metal mesh.

Electronic nose. As interesting as it sounds, an electronic nose is basically an array of gas sensors with each having a slightly different function than the other. When exposed to a mixture of gases, there is a distinct relative response from each individual pixel. With proper software, a composite response can be worked out to disentangle the contributions from each of the pixels on this array.

Fig. 8 shows an electronic nose made from carbon nanotubes and injected on a flexible polymer substrate. The inks on the bottom-right display real-time responses to methane, carbon dioxide, and ammonia concentrations, showing that the gas sensor is capable of effectively analysing a wide range of gases.

However, it cannot detect tiny traces of hazardous gases, mainly because it's not designed to identify specific gases at a molecular level. For common gases, it works quite well and can disentangle a mixture of gas concentrations.

As seen in Fig. 9, PragmatIC and Arm along with Manchester University have collaborated to produce an electronic nose that includes eight gas sensors based on organic transistors. The ICs used are much more cost-effective than silicon chips placed on a flexible plastic.

Progress made in 2021

Since printed flexible electronic circuits offer a wide range of benefits such as flexibility, rapid prototyping, lower costs as compared to conventional electronic circuits, it is worth noting the progress made so far. Here's a brief rundown of their growth.

Healthcare and wellness. Advancing from electronic skin patches that have a rigid box to house electronic circuitry, Accensors (a German firm) has created flexible electronic skin patches that monitor temperature and cardiovascular parameters such as heart rate, ECG, and pH. Some microfluidics are added to monitor iron concentrations in sweat.

Quad Industries, in association with Henkel and Byteflies, has deployed skin patches in Belgian hospitals for epilepsy monitoring. Mekoprint has commercialised smart diapers that consist of electrodes made with carbon inks. On detecting moisture, the resistance changes, which is then processed

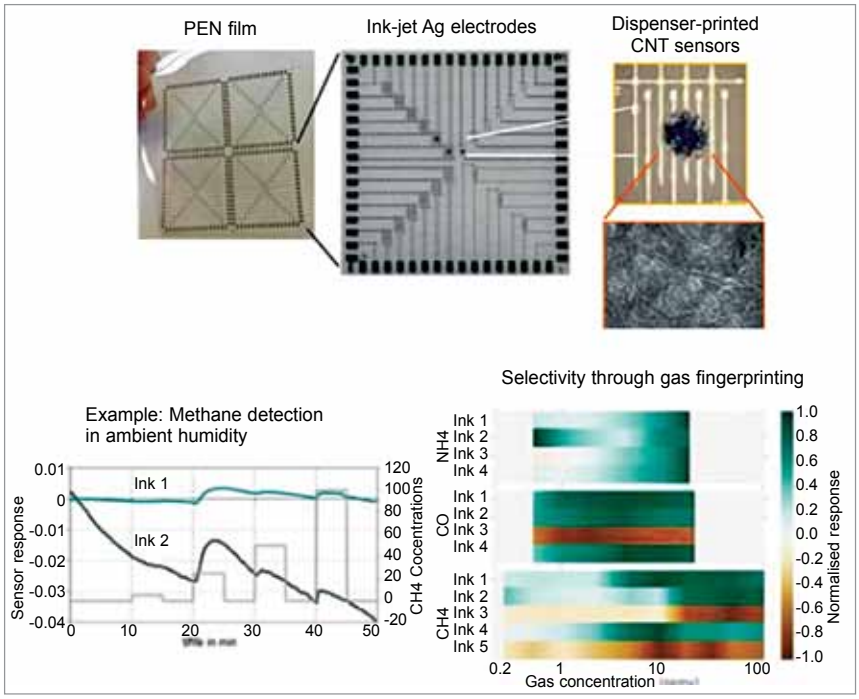


Fig. 8: Electronic nose for gas fingerprinting (Credit: Xerox PARC)

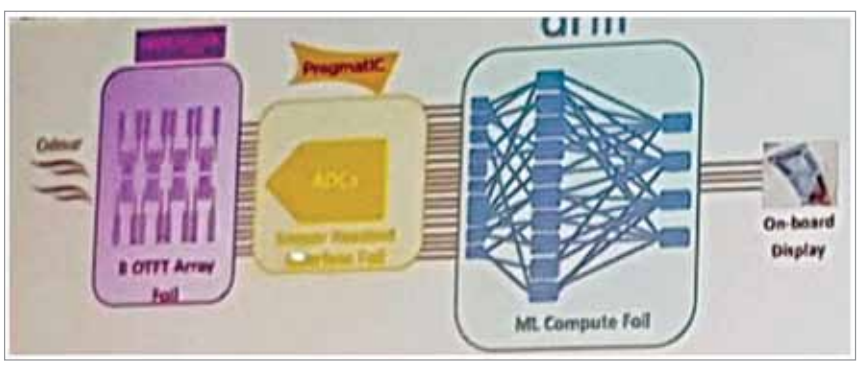


Fig. 9: Electronic nose with FHE (Credit: PragmatIC)

and sent to an app for providing efficient care.

CareWear and Atlantic Therapeutics provide light-emitting skin patches that monitor the human body's healing process, and pants that have embedded electrodes for improving thigh muscle strength.

Smart packaging and IoT/IIoT. Wiliot has released flexible, wireless RFID tags that have a silicon IC and an antenna for harvesting energy from electromagnetic radiation. It can also perform sensing by analysing a metal's conductivity. Applications include supply-chain tracking and cloud sensing.

Boeing's prototype sensor for smart factory or Industry 4.0 incorporates a thin, flexible IC that offers numerous functionalities for monitoring temperature, strain, humidity, force applied, etc on industrial equipment and aircraft parts.

Thanks to the large investment by PragmatIC, a UK based company that produces flexible metal-oxide ICs, it is now possible to inexpensively manufacture such ICs on a large scale for enhanced RFID functionalities. The Swedish firm, Ynvisible, has partnered with Evonik and Epishine to develop self-powered shelf-level packaging signage along with digital item price indicators.

A unique capacitive sensor made by Bare Conductive from a low-cost carbon based ink changes its capacitance with a rise or fall in water level. This information is then sent to the cloud for processing.

Automotive. PolyTC has successfully used its transparent functional films in some of Volkswagen's and Audi's latest models. The transparent capacitive film consists of a metal mesh that can detect changes in capacitance when in contact with different areas.

Printed conductors for heating is another attractive prospect. Instead of inefficiently heating the entire vehicle interior, the printed heaters focus on heating only specific areas near the occupants such as doors, windows, and seats - thus reducing the total required heating energy by 20%. This technique has been tested out in Volkswagen and BMW models.

Ideal for the future

After going through all the above innovations, we can conclude that the massive growth of IoT will surely increase the demand for sensors. As of now, printed flexible electronics can greatly fulfil this cost-effectively and with few materials.

The year 2021 has been quite encouraging for printed electronics companies to raise funds for applications and address the needs of large markets. This is expected to continue in 2022, thus leading to a wider adoption in areas where processing is still done using conventional electronics. EFY

The article is based on the presentation 'Commercially Compelling Printed/Flexible Sensor Innovations' at IDTechEx and the market research report 'Printed and Flexible Sensors 2021-2031.' The article was compiled by Vinay Prabhakar Minj, Technology Journalist at EFY.

SMART ADC SELECTION
Can Simplify And Improve Design

There are so many standalone and integrated analogue-to-digital converters available today. Which ADC is best for your application? How important is sampling rate or architecture type? How can you pick a cost- and time-efficient ADC?



WASIM SHAIKH is Product Applications Manager at Analog Devices

Converters rule the world of embedded systems as they communicate with real-world signals, starting from a sensor that converts data (temperature, pressure, etc) to analogue voltage/current output. An analogue-to-digital converter (ADC) transforms the analogue output to digital form for digital systems to read and process.

Considering the varieties and price range, finding the best ADC for your application may be a difficult task. While the first step is to look for speed, resolution, and accuracy, here are a few more parameters to check before selecting the ADC.

Resolution, Bits (n)	2^n	LSB, mV (2.5V FS)	% Full Scale	ppm Full Scale	dB Full Scale
8	256	9.77	0.391	3906	-48.0
10	1024	2.44	0.098	977	-60.0
12	4096	0.610	0.024	244	-72.0
14	16,384	0.153	0.006	61	-84.0
16	65,536	0.038	0.0015	15	-96.0
18	262,164	0.0095	0.00038	3.8	-108.0

Fig. 1: ADC resolution vs quantisation parameters

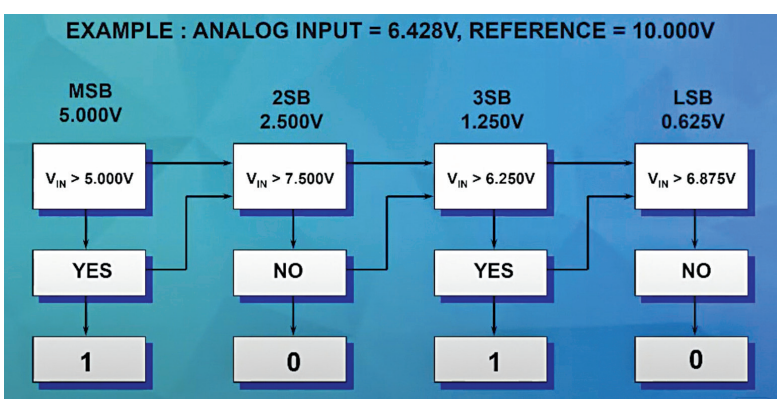


Fig. 2: Working of SAR ADC

What to look for

Analogue-to-digital conversion involves two steps—sampling and quantisation. Inside an ADC, a switch capacitor takes snapshots of the input signal at regular intervals (known as sampling frequency). These snapshot values are rounded off to the nearest value for digital representation.

Resolution is the first factor to consider here. It refers to the number of output bits that the ADC can generate per conversion and determines the smallest input signal that the ADC can represent.

Then comes accuracy—the close matching of the input to the desired output. Third is the sampling rate or speed, which is decided based on how fast the input signal is changing or input signal bandwidth.

A perfect reconstruction is possible only if sampling rate is equal to or greater than twice the highest frequency in the original signal. This minimum required sampling rate is known as the Nyquist rate. Though this little detail sounds harmless, it can create a major challenge between theoretical sampling and analogue-to-digital conversion. This can be avoided by band limiting the input signal to meet Nyquist rate.

In quantisation, it is important to have a very low quantisation error; even an ideal ADC will have some minimal noise. This can be achieved by increasing the number of levels or the resolution of ADC,

say, for instance, 8-bit, 10-bit, 12-bit or 24-bit.

The goal of an ADC is always to detect even a very small range of signals. So, for example, it is possible to resolve only a signal bound by the quantisation error. In lower numbers, it may be extremely difficult to detect that signal because it will all be represented by the same digital code. But when you increase the number of levels, you can detect even smaller signals.

The ratio of the smallest resolvable signal to the largest resolvable signal is defined by the maximum achievable dynamic range. With higher resolution, you get better dynamic range and capability to even detect small signals.

For example, in a 2.5V full scale ADC, even a 95-microvolt signal can be detected with an 18-bit ADC, and a 12-bit ADC can detect only around 610 microvolts of signal. And for some analogue inputs, one must define polarity—single ended, unipolar, or differential. This should be considered if you are looking for high precision systems and want to ensure less components.

Picking the right architecture

Each ADC architecture comes with its own pros and cons. Being aware of these will help you select the right type of architecture for your requirements. Some of the well-known architectures are flash, successive approximation (SAR), delta-sigma, and pipelined.

SAR ADC is the predominantly-used architecture, tailored for instrumentation, industrial control, and data type of applications. Its key features involve the ability to control conversion process, start pulse, reset logic, and comparator efficiency and other notable advantages over low power, small die area, and cost. So, this type of architecture is very well used in 8-bit, 10-bit, and 12-bit ADCs.

But the flip side is, the number of resolutions and comparisons will significantly increase conversion optimisation time. Hence, this architecture is feasible when the resolution parameter is not very high.

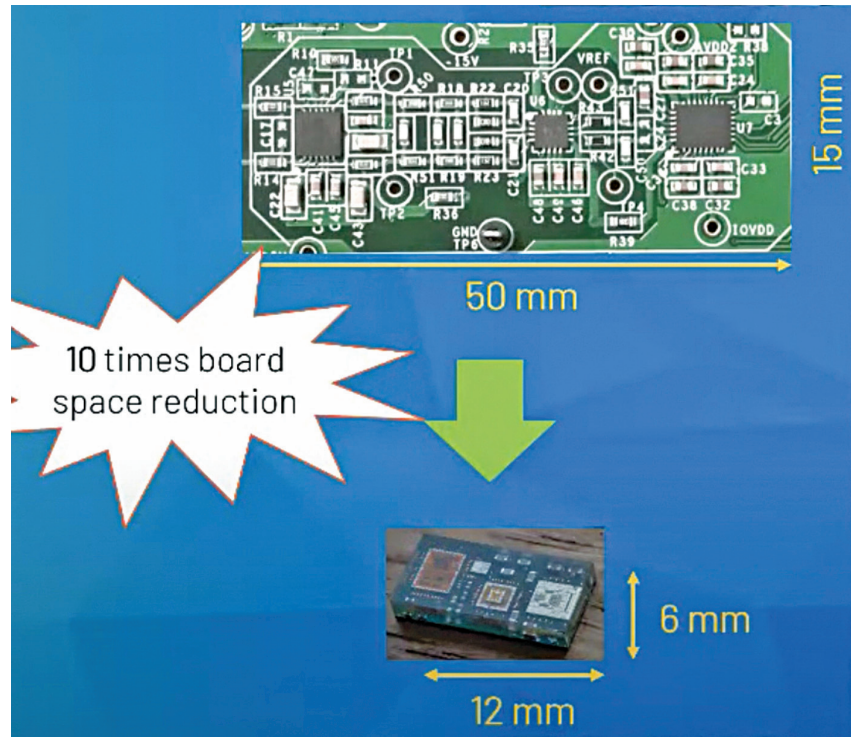


Fig. 3: MM module data acquisition system (Source: Analog Devices)

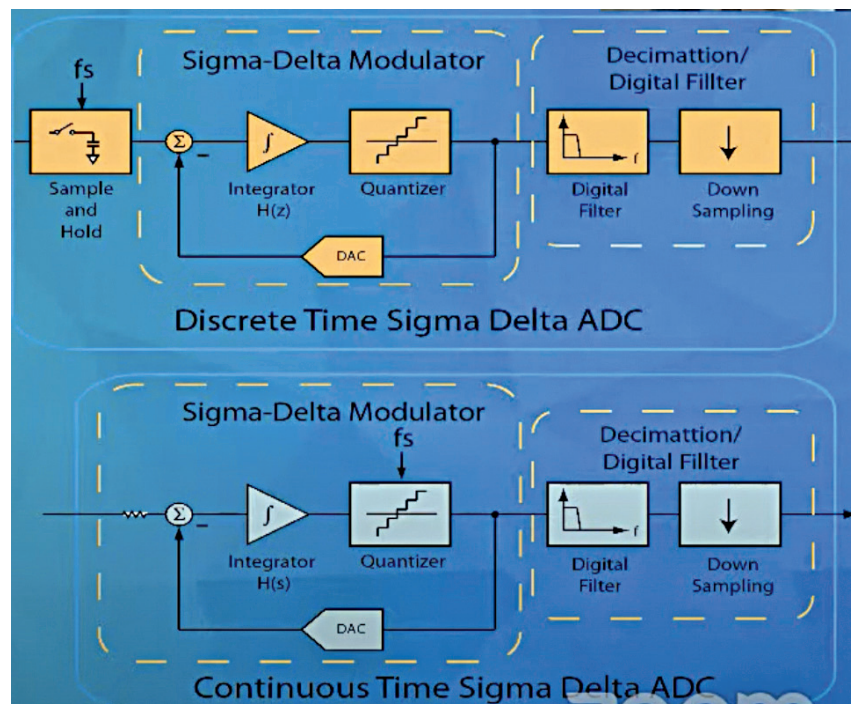


Fig. 4: Discrete time signal delta ADC vs continuous time sigma delta ADC

The other architecture is sigma delta ADC, which is used for high-precision applications requiring higher resolution. Concepts of over-sampling and noise shaping, wherein

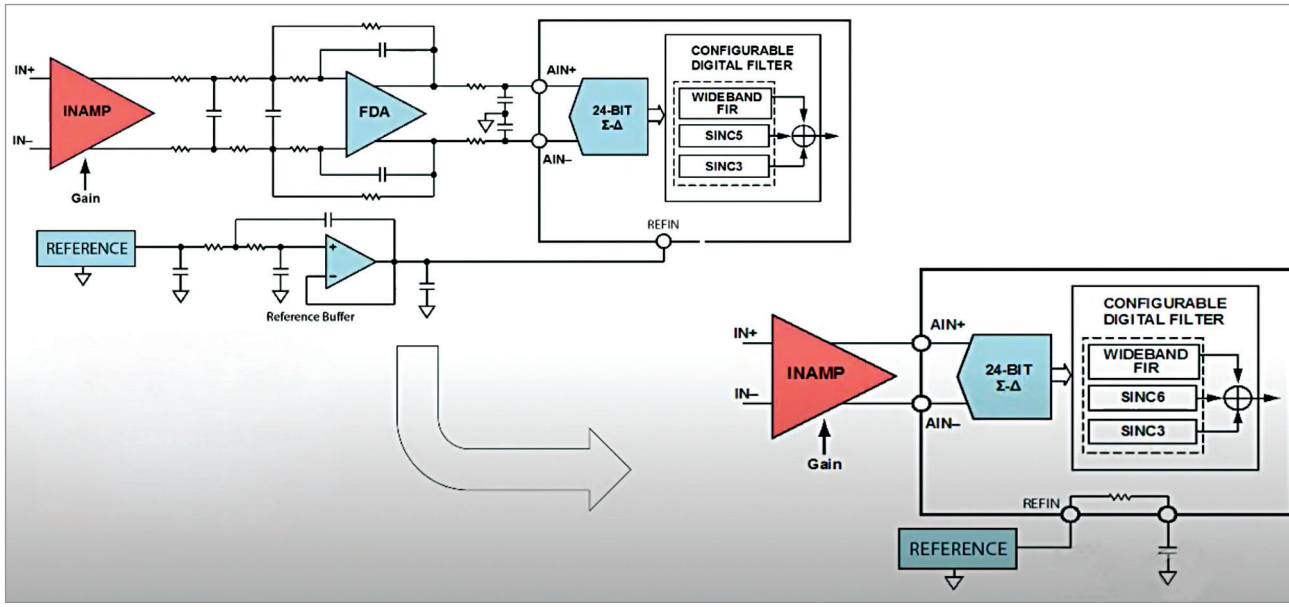


Fig. 5: Simplified ADC design

TABLE 1
MINIMUM AND MAXIMUM SPECIFICATIONS FOR ADCs

ADC Architecture/Specs	Sample Rate/Speed	Resolution/Bits	Price	Power
SAR	Up to 15Msps	8 to 24	Low to medium	Lowest per ksps
Sigma Delta	Up to 20Msps*	12 to 32	Low to medium	Low to medium
Pipeline	10Msps to 5Gsps	8 to 16	Highest	Highest
μModules	DC to 1Msps	16 to 24	Medium to high	Low to medium

**Modulator output speed*

the modulator frequency rate is high, the noise inline gets spread across large bandwidth. Further, noise shaping is used to shift noise out of the band of interest, which can then be removed with low pass digital filtering. Such ADCs are very popular when high resolution is desired and find application in slow-moving input signals like temperature and pressure.

Staying on top of the tech

A lot of interesting innovations are happening in this space, which could in turn do a lot of good to your application too. Integration and simplification seem to be the most effective mantras today.

Designers are trying to integrate single-chain components like amplifiers and filters on the ADC chip itself. All discrete implementations have been moved onto a single IC, called a micro-module. This can help reduce board space significantly.

The continuous time sigma delta ADC is another new development worth watching, as this architectural approach offers major benefits of inherent anti-aliasing and resistive inputs.

In traditional signal chains there would be a requirement of high bandwidth driver to drive the switch capacitor input and low pass filter to make sure Nyquist is met and there is no aliasing. Also, there would be a reference buffer needed to drive the switched cap reference input. This adds to components and increases the bill of materials.

The continuous time sigma delta ADC has a resistive input and the sampling part is introduced at a much later stage, keeping the entire loop continuous. This removes the requirement of the high bandwidth driver, which is already present to solve the sample problem with it. The other benefit of this continuous loop is that any aliasing that gets introduced automatically gets rejected. Hence, the requirement of high-bandwidth driver and low-pass filter is totally removed from the signal chain, which reduces number of components, simplifies design, and makes bill of materials management simple.

It is recommended for designers to use manufacturers' selection guides along with some basics on architecture types. The designers can use tools, devices, and design aids to support the selection process. Do not overlook input, output signals and consult data sheets or application notes, if any. As ADC technologies improve, it will lead the way for efficient electronics devices. EFY

The article is based on a talk by Wasim Shaikh, Product Applications Manager, Analog Devices, at the Design Unconference.

Ten Industry-Ready COMMUNITY BOARDS Designers Love

Selecting the right development boards for your products is challenging due to the myriad of types and sub-categories. Let's try to understand what industry-ready community boards are before incorporating them into our designs

AARYAA PADHYEGURJAR

Microcontroller boards like Arduino Uno and ESP32 have certainly made it easy for DIYers and hobbyists to implement their fun ideas and projects in a cost-effective way. But in a professional scenario, where commercially viable embedded devices are to be made, most engineers use these boards for just implementing their proof-of-concept. The next stage of the product development process requires developers to finalise their components, create specification sheets, and ensure that their device is capable of working successfully as a product and not a prototype.

While it is a common practice to migrate from a development board to a custom PCB design, one should also consider the possibility of using industry-ready community boards in one or more steps in the product development life cycle.

Most semiconductor manufacturers create a development board for each microcontroller chip they launch. Nearly all can be programmed using open source integrated development environments (IDEs) and are extremely easy to use. But some of the chips like ATMega328P (the one used in Arduino Uno) offer only basic features.

Then there are others like XMC47xx from Infineon that have a larger memory size, more embedded interfaces, more input-output pins, and, in general, better performance. Simply put, industry-level boards are development boards based on these chips. Although these boards are created for an engineer to get familiarised with the chip and for easy firmware development, they are often considered to be production-level boards. Thanks to their comprehensive features and a wide range of desirable attributes, engineers can choose to deploy them directly in their products. Moreover, they are backed by multiple online forums and communities.

According to their specifications, applications, and areas of production, development boards need to be certified by FCC (Federal Communications Commission) or similar organisations. Most of them are also under the scope of RoHS (Restriction of Hazardous Substances) and need to be RoHS compliant.

When to use them

For prototyping. Instead of using a general-purpose development board that is not specifically designed for a particular application, engineers can use an industry-ready development board even at the prototyping stage. Migrating from the Arduino framework to one that is a little advanced might be viewed as a hassle. But it should be considered as an investment for a smoother transition from R&D to production.

For alpha and beta testing. After the proof-of-concept is made, it is time to start testing it. Alpha and beta testing for hardware is very different from its software counterpart. This testing is done in a controlled environment that mimics the environment in which the end product is to be located. A custom PCB takes approximately 7 to 10 revisions before being ready. Since

Pros and Cons

Pros:

- Low time to market
- Application-specific nature
- A smooth transition from prototype to product

Cons:

- A learning curve at the initial stages of development
- There are extra peripherals that are not used in the final product

hardware development is an iterative process, using industry-ready boards at this stage will definitely save time and money. With a huge variety of boards to select from, engineers can do their due diligence and select one whose microcontroller chip can be used in their PCBs after successful testing. Thus, industry-ready boards can be used as a temporary solution to reduce time to market.

For your minimum viable product (MVP). Although the full form says that it is a product, more often than not companies treat their MVP as a part of their development process. Most hardware startups do not prefer to invest too much money in the first version of anything that launches into the market. In such a scenario, using an industry-ready board will not only benefit the company financially but also ensure a quality product. Similar to the case of alpha and beta testing, engineers can migrate to custom PCBs once they are sure of the product's maturity on the field. In this case, these boards provide an interim solution that allows the R&D team to understand the viability of the technology they have developed.

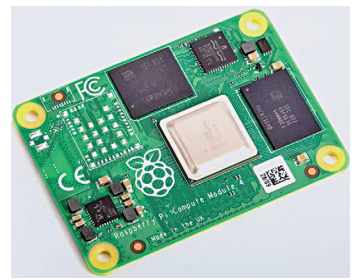
When to use in end products

By definition, development boards contain peripherals and circuitry that allow engineers to experiment and prototype. Generally, development boards are not used in appliances because they contain circuitry that may not be required in the final product. This affects the battery life and efficiency of the device. Hence, a custom PCB is made at this stage.

That being said, almost all industry-ready boards are tailored for a particular application. If selected wisely according to the requirements of the final product, they can even be used as a permanent solution. Using them is easier if the final product is to be stationary and connected to a continuous power supply, like a gateway node in Industrial IoT (IIoT) applications. Nevertheless, rigorous quality assurance must be done based on the environment in which the final product is to be launched.

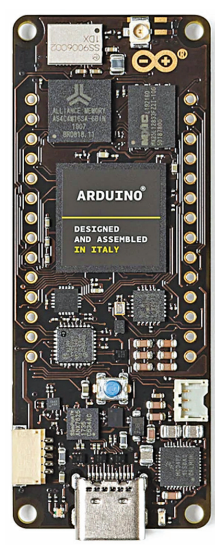
Ten industry-ready boards

1. Raspberry Pi Compute Module 4 (CM4002008). This module is particularly designed for end applications. It has a powerful compute engine that is far superior to its predecessors. It is also the first to offer an external antenna connector, which is vital in industrial applications. This is because the circuitry is always present in an enclosure, which inhibits Wi-Fi connectivity. But here, we can directly connect a certified antenna (also sold by Raspberry Pi) and enjoy a really good Wi-Fi connection.



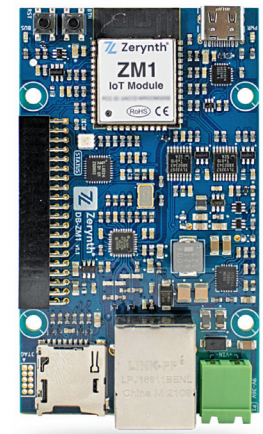
(Source: Raspberry Pi)

2. Portenta H7 (ABX00042). It is Arduino's industry-grade development board that intends to satisfy the needs and demands of Industry 4.0. It has a wide range of pins and can be programmed using high-level languages including C++ (Arduino framework), JavaScript, and MicroPython. An interesting feature is that it can run TensorFlow for machine learning. Considering all its characteristics, the Portenta H7 is well suited for robotics applications.



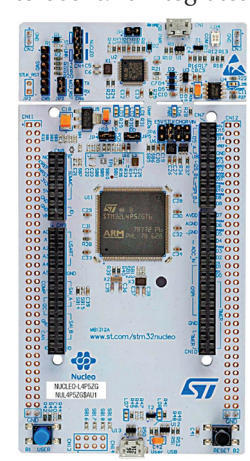
(Source: Arduino)

3. ZM1-DB. This board is a complete package for IoT applications. It contains an ESP based microcontroller, which makes it easy for developers with prior experience in ESP8266 or ESP32 to start using this board. With its industry-grade hardware and IoT cloud platform (Zerynth Cloud), ZM1-DB can be viewed as a useful solution for prototyping as well as direct deployment. It contains an interface standard called zBus, which allows us to easily expand the board's capabilities using various expansion boards provided by Zerynth. Therefore, it is heavily customisable and can be tailored to any end application.



(Source: Zerynth)

4. NUCLEO-L4P5ZG. This board from STMicroelectronics provides a cost-effective and energy-efficient solution to developers. The STM32 ecosystem and communities provide a good platform for understanding this board and learning how to use it. It integrates an on-board debugger/programmer and can be programmed using various IDEs. It is suitable for applications with many peripherals since all STM32 input-output pins are available for use. It



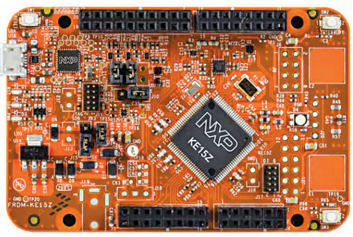
(Source: STMicroelectronics)

TABLE 1
COMPARISON OF INDUSTRY-READY COMMUNITY BOARDS

Board Name/ Part Number	Family Name	Board Manufacturer	Silicon Manufacturer	MCU/ Silicon Core Number	Number of Bits	Architecture	Most Notable Feature	Compatibility	IDEs	MRP ($/€)	Use Case	Supported by
Raspberry Pi Compute Module 4 (CM4002008)	BCM2xxx	Raspberry Pi	Broadcom	BCM2711	64	ARM Cortex-A72	Inclusion of U.FL Antenna Connector	Connection with Arduino is possible	-	$25 onwards	Applications involving gaming or networking	Raspberry Pi Community
Portenta H7 (ABX00042)	STM32	Arduino	STMicroelectronics	STM32H747XI	32	ARM Cortex-M4F, Cortex-M7F	Two parallel cores that via a 'Remote Procedure Call' mechanism	Arduino IoT Cloud compatible	Arduino IDE (Desktop), Arduino IDE (Cloud)	$103	Parallel computing and multitasking operations like robotics controllers	Arduino Forum
ZM1-DB	ESP32	ZERYNTH	-	ESP32-D0WD	32	-	Extremely customisable due to the presence of zBus. It also has a crypto IC ATECC608A from Microchip	Connections available with a vast variety of expansion boards	Zerynth SDK (VSCode extension is available)	$127	IIoT applications that involve transfer of sensitive data	Zerynth Community and ESP Community
NUCLEO-L4P5ZG	STM32 Nucleo-144	STMicroelectronics	STMicroelectronics	STM32L4P5ZGT6U	32	ARM Cortex-M4	Low power consumption	Supports Arduino, ST Zio and morpho connectivity	IAR Embedded Workbench, MDK-ARM, and STM32CubeIDE	$19	Applications with I/O management (when there are lots of sensors, actuators and peripherals)	ST Community
FRDM-KE15Z	Kinetis-E	NXP	NXP	MKE15Z256VLL7	32	ARM Cortex-M0+	Has a complete set of analogue/digital features	Compatible with FRDM-TOUCH, FRDM-MC-LVBLDC and Arduino boards	IAR Embedded Workbench	$50	Embedded systems development and prototyping	NXP Community
BBONE-AI	AM57x	BEAGLEBOARD	Texas Instruments	AM5729	32	ARM Cortex-A15	It is possible to run a neural network	Has dual C66 DSP, four PRU and four Embedded Vision engines	-	$127	AI, ML and time-critical tasks like motor drivers	BeagleBoard Forum
SIMBA-DKL	-	SensiEDGE	STMicroelectronics	STM32L476RG	32	ARM Cortex-M4	Has a variety of sensors and peripherals on board	Its development kit, SIMBA-DKL comes with Arduino compatible connectors	Arduino IDE is compatible with its dev kit	$106	Can be used as a sensor node in IoT based data acquisition systems	Partners with many community forms including Arrow.com
KITXMC47RELAXV1TOBO1	XMC4000	Infineon Technologies	Infineon Technologies	XMC4700F144	32	ARM Cortex-M4	MicroSD card slot makes firmware updates easier	Arduino hardware compatible	DAVE IDE by Infineon	€30	IIoT applications, can be used as a node	Infineon Developer Community
Nvidia AGX Xavier Industrial	-	Nvidia	Nvidia	8-core NVIDIA Carmel Armv8.2 64-bit CPU	64	Armv8.2	Contains AI software that can be used 'on the edge'	-	-	$1,449	AI-powered applications like robots, drones and autonomous machines	Jetson Community
Particle Argon	-	Particle IO	-	Espressif ESP32-D0WD, Nordic Semiconductor nRF52840 SoC	32	ARM Cortex-M4F	Allows the creation of MESH networks	Supports parts of the Arduino API	Particle Web IDE, Particle Workbench	$28	Battery operated Mesh networks for IoT applications	Particle Community

consumes extremely low power despite having a few components that are in general power-hungry.

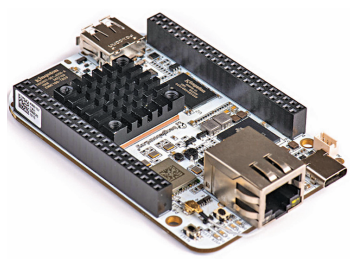
5. FRDM-KE15Z. The Freedom Development board range from NXP is appropriate for embedded hardware and IoT development



(Source: NXP Semiconductors)

and is packed with NXP sensors. Each board has different features, and hence an engineer can select a board according to a particular application. The FRDM-KE15Z board contains an RGB LED, a 3-axis gyroscope, a temperature sensor, and two capacitive touchpads. Also, the NXP community is a good platform for beginners to post their queries and get them solved by experienced developers.

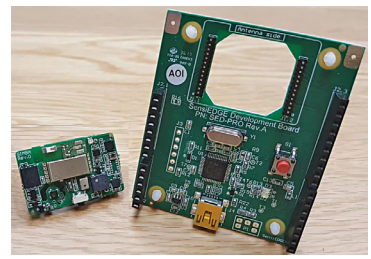
6. BBONE-AI. In several applications, IoT, ML, and AI go hand in hand. The BeagleBone AI is particularly suited for embedded artificial



(Source: BeagleBoard Org)

intelligence and has become popular in the BeagleBoard community. It allows users to implement neural networks and TensorFlow models. Moreover, it has programmable real-time units (PRUs) that can be used for time-sensitive applications while the intense computing tasks are done on its ARM processor.

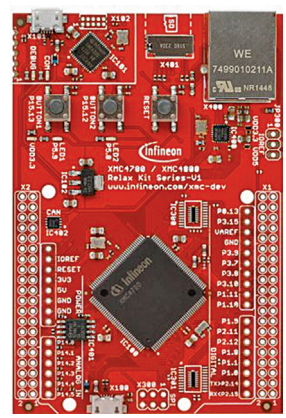
7. SIMBA-DKL. It has all the necessary features needed for IoT prototyping and embedded product development including light sensor, pressure sensor, accelerometer,



(Source: SensiEdge)

gyroscope, and BLE (Bluetooth Low Energy) connectivity. Since it is compatible with Arduino IDE, you can leverage your knowledge in the Arduino framework to make innovative projects.

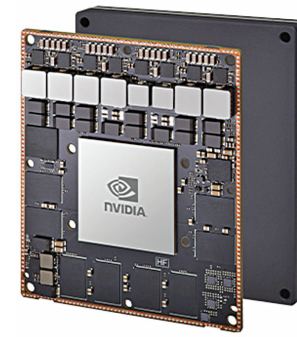
8. KITXMC47RELAXV1TOBO1. Commonly known as the XMC4700 Relax Kit, this board can be used as an Industrial IoT (IIoT) node or as a



(Source: Infineon Technologies)

gateway in commercial applications. It has an onboard micro SD card slot that not just expands the memory but can also be used to ensure that data is stored locally on the device, thus preventing data loss. Infineon has also created several user groups on its community website where developers can participate in discussions and post queries regarding this board, if required.

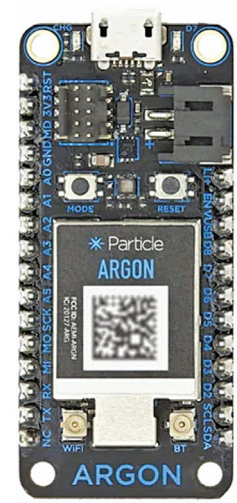
9. Nvidia AGX Xavier Industrial. It promises fast AI development and AI inferencing capabilities on edge devices. It can be useful for applications involving edge computing, which is significant in modern AI devices these days. It has an operating lifetime of ten years



(Source: Nvidia)

and works on extremely low power. Smart cities, logistics, and autonomous robots are desirable application areas for this board. Nvidia also offers AI certifications to those who submit their Jetson based projects to the Jetson developer community.

10. Particle Argon. This board is known for its usage in Wi-Fi applications. It allows the creation of mesh networks. This means that even if one device is connected to the internet, all devices in the network are connected to the internet. You can even power it using a LiPo (lithium-ion polymer) battery. Programming and troubleshooting the board is extremely easy due to the user-friendly Particle Web IDE and the Particle community.



(Source: Particle IO)

Detailed comparison of these boards is given in Table 1. EFY

The author, Aaryaa Padhyegurjar, is an Industry 4.0 enthusiast with a keen interest in innovation and research.

EFY TESTED Ashwini K. Sinha

Wireless EMG Controlled PROSTHETIC HAND

ASHWINI KUMAR SINHA

What if you had an extra pair of hands to carry out tasks somewhere else while you controlled them from another location wirelessly. Seems unrealistic, right? But it's possible.

This project describes how to design a prosthetic hand that can replicate natural hand movements and muscle contractions. Although artificial, it works like a biological hand by following the muscle signals.

To achieve this, the muscle contraction and stress values are captured and then through muscle signals used to wirelessly control the prosthetic arm located somewhere else. The project can be developed further to help the physically challenged and also to grip objects lying in places where you do not want to dirty your own hands.

Assembly

There are various open source prosthetic body parts available in the market. You can also 3D print them at home. In this project the InMoov robotic arm has been used. After getting the required parts comprising fingers and servo, assemble the prosthetic hand as shown in the figures.

Coding

We need to make two devices—a

TABLE 1
MATERIALS

Component name	Quantity	Description
3D Printed prosthetic hand	3	Prosthetic hand
Arduino Pro Micro	2	ATmega32u4
Jumper wires	6	Female to female
9V battery	2	9V DC MN1604 battery
Servo motor	1	12kg/cm^2
EMG sensor	1	EMG sensor
Bluetooth HC 05	2	Bluetooth module



Fig. 1: Inside view of the prosthetic arm



Fig. 3: Outside view of the prosthetic arm



Fig. 2: The prosthetic arm with servo move mechanism



Fig. 4: The prosthetic hand

```
int senpin=A7;
int senval=0;

void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
Serial1.begin(9600);

}
```

Fig. 5: Transmitter code1

```
void loop() {
  senval=analogRead(senpin);
  Serial.println(senval);
  delay(100);
  // put your main code here, to run repeatedly:

}
```

Fig. 6: Transmitter code for updating value from EMG sensor

```
#include<Servo.h>
Servo arm;

int recvvval=0;

void setup() {
  // put your setup code here, to run once:
arm.attach(9);
Serial1.begin(9600);
}
```

Fig. 7: Connection for receiver

```
void loop() {
recvvval= Serial.parseInt();
// put your main code here, to run repeatedly:
int pos= map(recvval,60,400, 0, 180);
arm.write(pos);
}
```

Fig. 8: Receiver code loop function

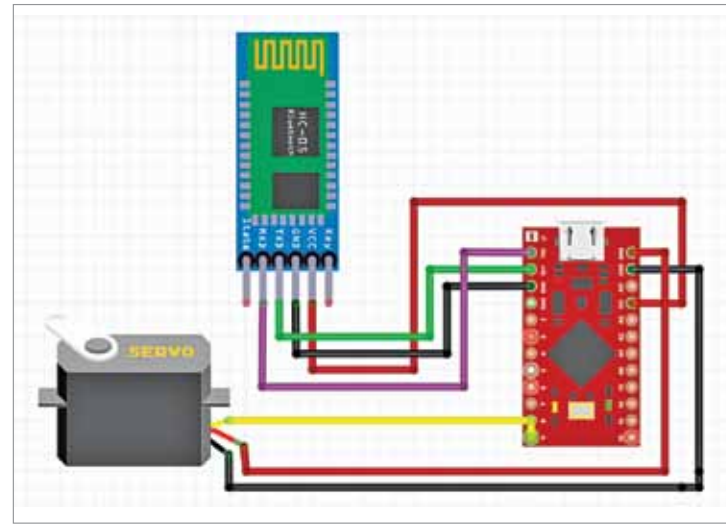


Fig. 9: Receiver circuit connections

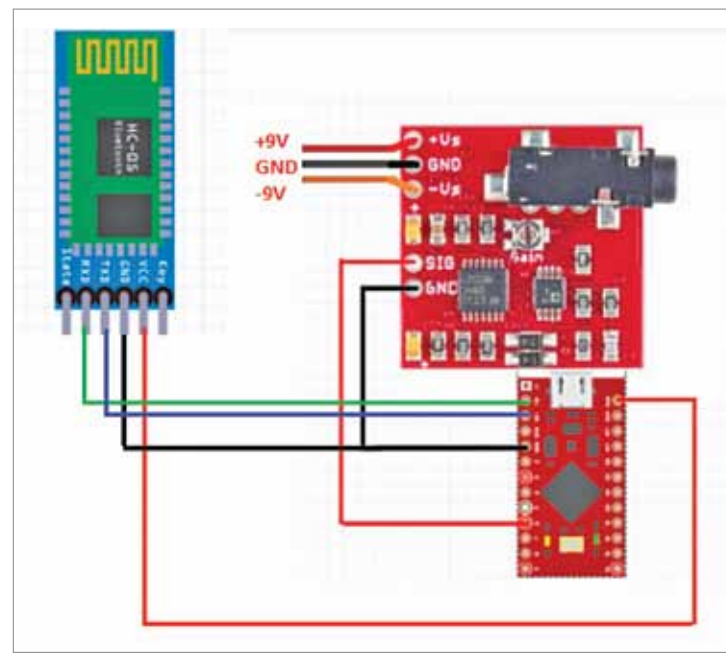


Fig. 10: Transmitter circuit connections

prosthetic hand data transmitter and a prosthetic hand data receiver with servo move mechanism. For each of them we need to create separate codes.

The code for transmitter is required for EMG data transmission to the prosthetic hand. For that we first define the pin numbers for the sensor and variables to store the EMG sensor data. Then we create a setup function where the baud rate is set for the Bluetooth and serial port communication.

The Arduino Pro Micro offers two hardware serial ports—one for USB and the other for receiver and transmitter pins. Use Serial1 for Bluetooth communication by setting its baud rate to 9600, which is the default for Bluetooth HC-05. Then create a loop function (see Fig. 6) for sending updated EMG sensor values to the Bluetooth in a regular interval of time.

For receiver, include the servo library servo.h in the code to control it. Then create a setup function to set the pin number for connecting the PWM signal wire of servo to control it.

Arduino Pro Micro has several PWM pins; we will use pin number 9 for servo PWM control. Start the serial to read the transmitter device value and then create a loop function to get the EMG sensor value over serial. Apply the EMG value to the servo degree rotation range,

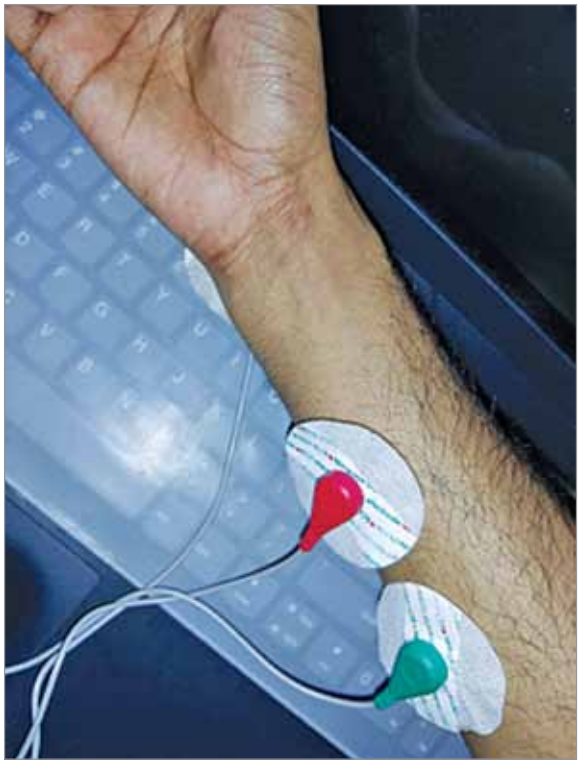


Fig. 11: Electrodes connection for EMG

which is 0 degree to 180 degrees for servo and has values 60 to 800 for the EMG sensor.

Write the mapped value to the servo move position to move the prosthetic hand finger as per signals generated from muscle movement.

Connection

Connect the components for both transmitter and receiver as shown in Fig. 10 and Fig. 9, respectively. For the EMG transmitter circuit, you need to add the Bluetooth module in the receiver circuit as well.

Please note, you need to configure both the Bluetooth modules for them to pair with each other and transmit/receive data accordingly. To do that, you can follow the instructions available online for setting up master and slave mode of HC05.

To test, attach all fingers to the servo pulley for the prosthetic arm and power the transmitter and receiver-cum-controller for the prosthetic arm. Attach the electrodes to your controlling arm as shown in Fig. 11. The prosthetic arm will mimic your hand's finger movements whenever you close and open your palm.

Congrats! You have just made an extra hand, which can be controlled wirelessly. EFY

Ashwini Kumar Sinha is a technology enthusiast at EFY



EFY TESTED Sani Theo

Introduction To RASPBERRY Pi PICO By Making NOISE GENERATOR

T.K. HAREENDRAN

Raspberry Pi's first board based on a single microcontroller chip, the Raspberry Pi Pico (Fig. 1), is designed for physical computing—similar in concept to an Arduino—rather than perform the role of a general-purpose computer (like the others in the range). The Raspberry Pi Pico has 264kB RAM and 2MB flash memory, and it is programmable in MicroPython, CircuitPython, and C (*https://en.wikipedia.org/wiki/Raspberry_Pi*).

The purpose of this article is to introduce Raspberry Pi Pico (RPi Pico), which operates at 133MHz with dual cores. Because it can run MicroPython, even a novice can start coding in a short amount of time. So, here is a project that can be done easily.

However, before jumping into the experiment/project, it would be a good idea to get acquainted with the RPi Pico microcontroller board. The following links would help you to ensure a great start:

- *https://projects.raspberrypi.org/en/projects/getting-started-with-the-pico*
- *https://www.electroschematics.com/raspberry-pi-pico-first-look-part-1/*
- *https://www.codrey.com/raspberry-pi/raspberry-pi-pico-quick-start/*

Firmware for Raspberry Pi Pico can be gathered from the following link:

https://micropython.org/download/rp2-pico/

You can download Thonny – Python IDE for beginners – from:

https://thonny.org/

The following link helps you learn how to program Raspberry Pi Pico using MicroPython:

https://www.makeuseof.com/getting-started-micropython-raspberry-pi-pico/



Fig. 1: Raspberry Pi Pico board

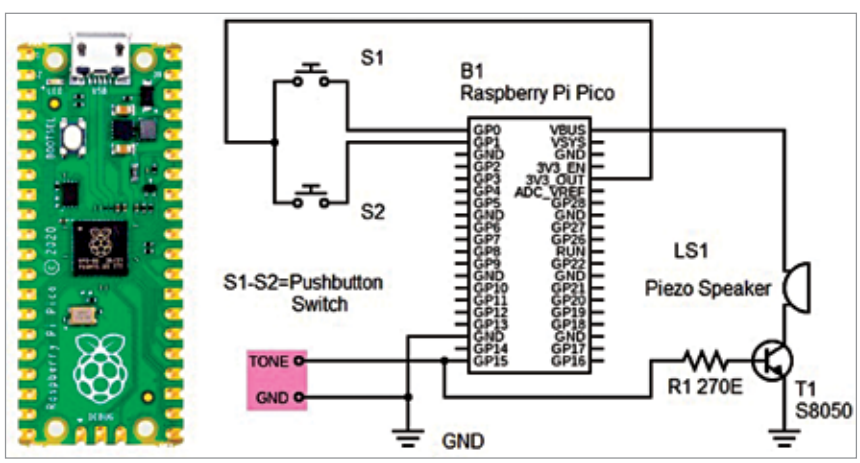


Fig. 2: Circuit diagram

Making a noise generator

The Raspberry Pi Pico based noise generator project described here is in fact a simple tone generator setup realised with the help of a few external parts. Its schematic diagram is shown in Fig. 2.

As you can see, the setup delivers an analogue output through GP15 of Raspberry Pi Pico to drive a piezo speaker. The pushbutton switches S1 and S2 are wired to GP0 and GP1 to control the tone generation.

The element used here for sound is not a common piezo buzzer; it is a piezo speaker that is also called 'motherboard speaker.' This piezo speaker (Fig. 3) is usually employed to obtain beep sound from computer



Fig. 3: Piezo speaker

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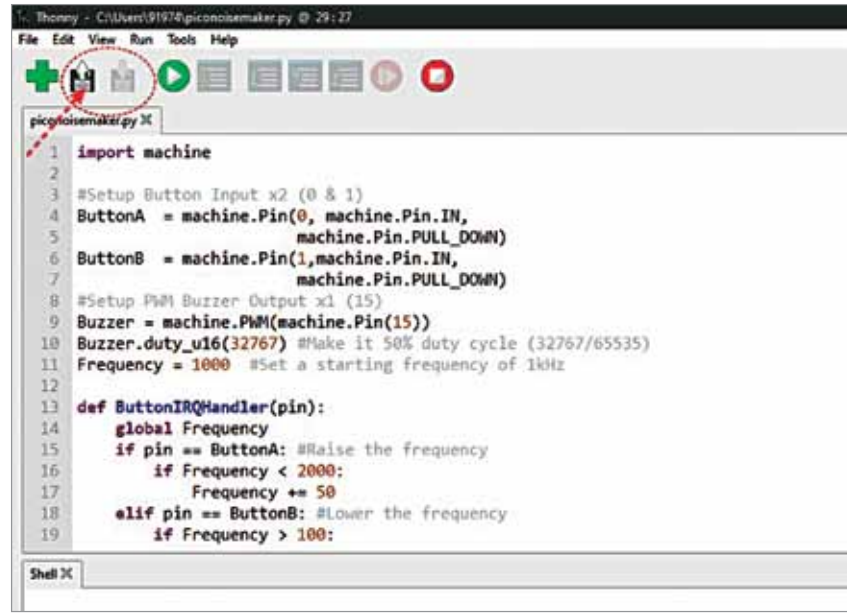


Fig. 4: Thonny editor window

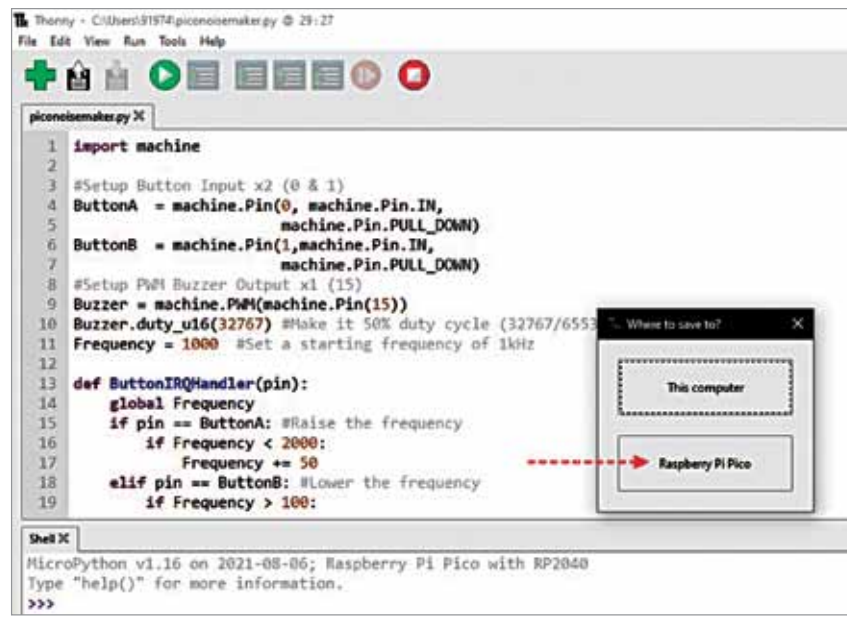


Fig. 5: Saving the Python code

motherboards, alarm systems, and other electronic devices. The tone output from the Raspberry Pi Pico board (TONE and GND) is quite low, so transistor S8050 is used to drive the 16-ohm sounder element (LS1).

The entire hardware setup can be operated from a stable 5V DC/USB power source. The simplest way is to plug the external USB power source into the onboard micro-USB connector, which will power V_{SYS} and therefore the system from the USB 5V (V_{BUS}).

Software

Instead of looping fast to read the value of a pushbutton switch, the microcontroller can also be notified of a change through an interrupt request (IRQ). An IRQ lets the processor be interrupted from its main loop to do a thing before returning to the task it was doing earlier.

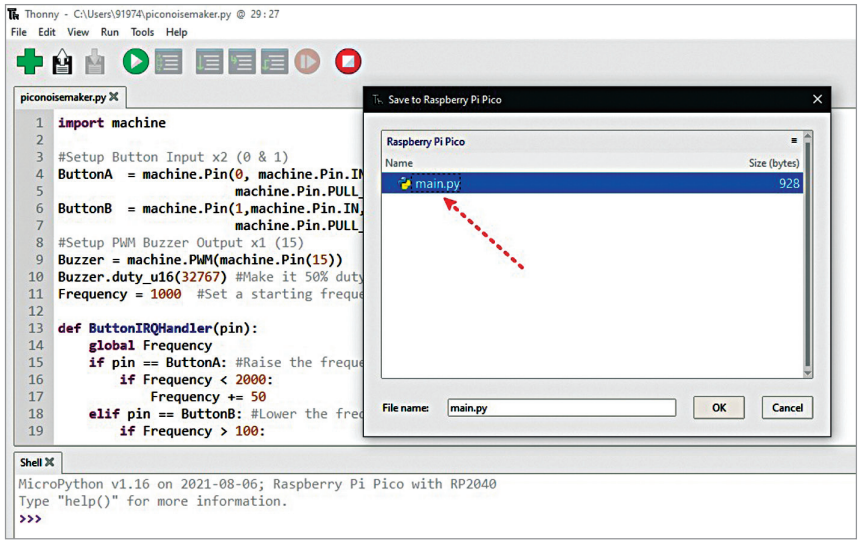


Fig. 6: Naming the Python code

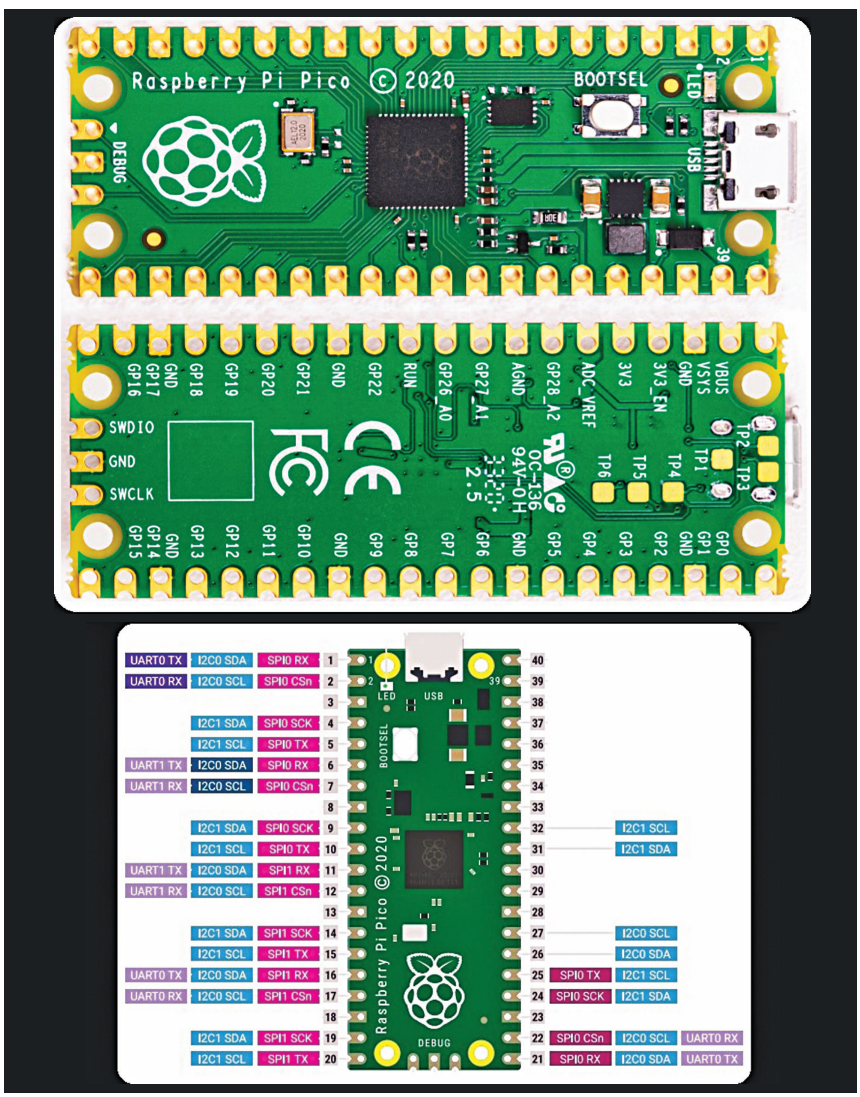


Fig. 7: Pin details of Raspberry Pi Pico

The simplistic code prepared for the above hardware setup to control the IRQ using two buttons (S1 and S2) and then generate an analogue output to drive the sounder element is given alongside (source of inspiration *https://kitronik.co.uk/*). The source code (*piconoisemaker.py*) is listed below:

```
import machine

#Setup Button Input x2 (0 & 1)
ButtonA = machine.Pin(0, machine.Pin.IN,
          machine.Pin.PULL_DOWN)
ButtonB = machine.Pin(1,machine.Pin.IN,
          machine.Pin.PULL_DOWN)
#Setup PWM Buzzer Output x1 (15)
Buzzer = machine.PWM(machine.Pin(15))
Buzzer.duty_u16(32767) #Make it 50% duty
cycle (32767/65535)
Frequency = 1000 #Set a starting
frequency of 1kHz

def ButtonIRQHandler(pin):
 global Frequency
 if pin == ButtonA: #Raise the frequency
   if Frequency < 2000:
      Frequency += 50
 elif pin == ButtonB: #Lower the
             frequency
   if Frequency > 100:
     Frequency -= 50

#Setup the IRQ and hook it to the handler
ButtonA.irq(trigger = machine.Pin.IRQ_
RISING,
 handler = ButtonIRQHandler)
ButtonB.irq(trigger = machine.Pin.IRQ_
RISING,
 handler = ButtonIRQHandler)

while True:
  Buzzer.freq(Frequency)
```

While on the subject, a PY file is a program file (or script) written in Python, which is an interpreted object-oriented programming language. It can be created and edited with a text editor but requires a Python interpreter to run. Simply go for Thonny!

Thonny IDE

Thonny comes with Python 3.7

built in, so you do not need to install Python separately. Just install Thonny in your computer and you are ready to go!

Once you have installed Thonny IDE, connect your Raspberry Pi Pico board with your computer through an appropriate USB data cable. You need to press and hold the BOOTSEL button on the Raspberry Pi Pico board (B1) while connecting it to your computer using a USB-A to micro-USB data cable.

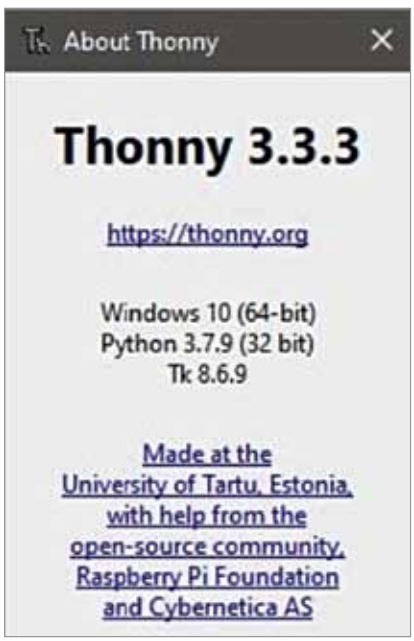


Fig. 8: Thonny IDE

After successfully connecting to PC, you can see your Raspberry Pi Pico as USB mass storage device.

Now you can open Thonny IDE and there will be a popup that shows some information regarding Raspberry Pi Pico. Just proceed to install the MicroPython firmware. Your Raspberry Pi Pico board is now updated with MicroPython firmware and is ready to execute Python codes.

(Actually, there is also a drag and drop way to do this. Check *https://www.twilio.com/blog/programming-raspberry-pi-pico-microcontroller-micropython*)

Copy-paste the above Python code in Thonny editor window (Fig. 4) and save the code before you run it. See there are two floppy disc buttons—open and save.

Choose Raspberry Pi Pico in the "where to save to" popup window, as shown in Fig. 5, assign a name for your Python file with an extension 'py' and click OK.

Once the code is saved, the green Play button on top can be used to execute the code in Raspberry Pi Pico. To stop the code's execution, use the red Stop button.

Remember, the noise generation code should be run automatically to power the standalone Raspberry Pi Pico setup. So, when saving the code file on the Raspberry Pi Pico board, name it *main.py* (Fig. 6).

Awesome? Well, just do it your own way!

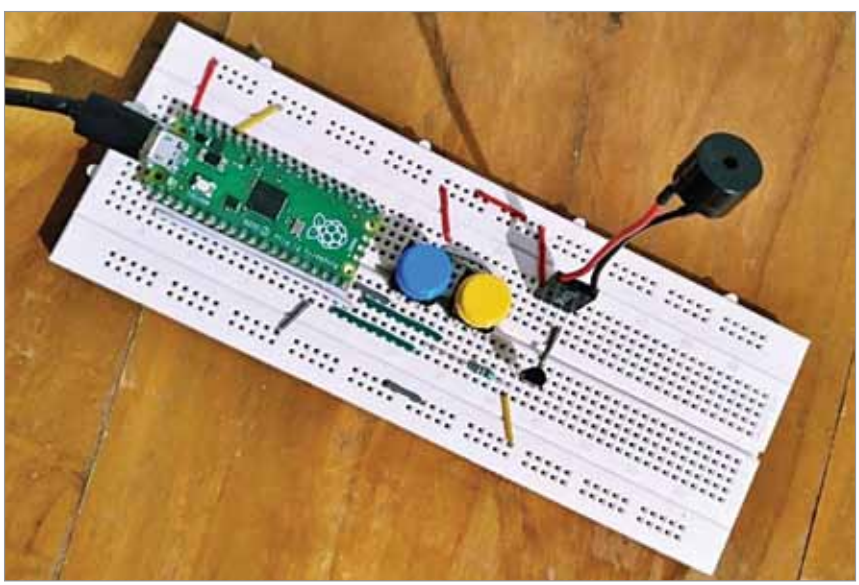


Fig. 9: Author's prototype on breadboard

EFY Note
The source code of this project is available for free download at *source.efymag.com*

Testing

Testing of this project is simple if you know what you are going to do! After successful construction, just run the prototype with a USB power bank or a similar USB power source. If all goes well, the tone signal would be heard. The pushbuttons S1 and S2 can be used to increase or decrease the tone frequency.

The author has been playing with Raspberry Pi Pico a lot lately. He has written on some online channels about Raspberry Pi Pico, which is an awesome minuscule microcontroller board capable of running code to control physical hardware. Pin details of the Pico board are shown in Fig. 7.

The Raspberry Pi Pico used for this project already had headers soldered on, and the author had previously put MicroPython on it. He is using Thonny 3.3.3 (Fig. 8) on his Windows 10 (64-bit) computer.

The author's prototype wired on the breadboard is shown in Fig. 9.

This tutorial is presented by the author for you to try and learn. You may improve the code for better application. You may even take this further into the realm of professional electronic tone generators. It is hoped you will find more interesting ways to play with audio on the Raspberry Pi Pico! EFY



T.K. Hareendran is an electronics designer, hardware beta tester, technical author, and product reviewer

EFY TESTED Sani Theo

CIRCUIT TO PROTECT APPLIANCES From High/Low Voltages

S.C. DWIVEDI

Voltage fluctuations and power cuts can damage electrical equipment and goods like submersible pumps, air-conditioners, television sets, and refrigerators. The circuit presented here (see Fig. 1) will protect the costly electrical items from high as well as low voltages.

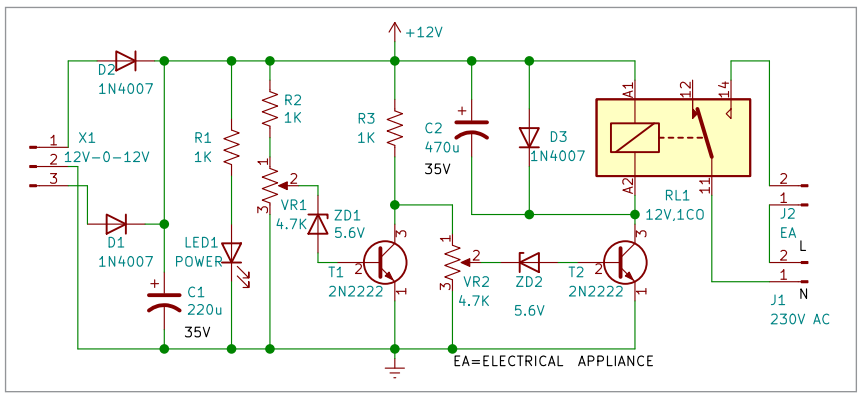


Fig. 1: Circuit diagram

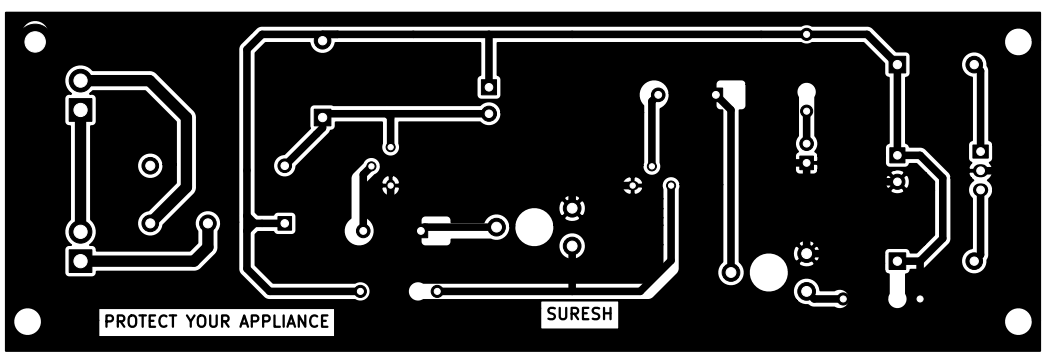


Fig. 2: Actual-size PCB layout

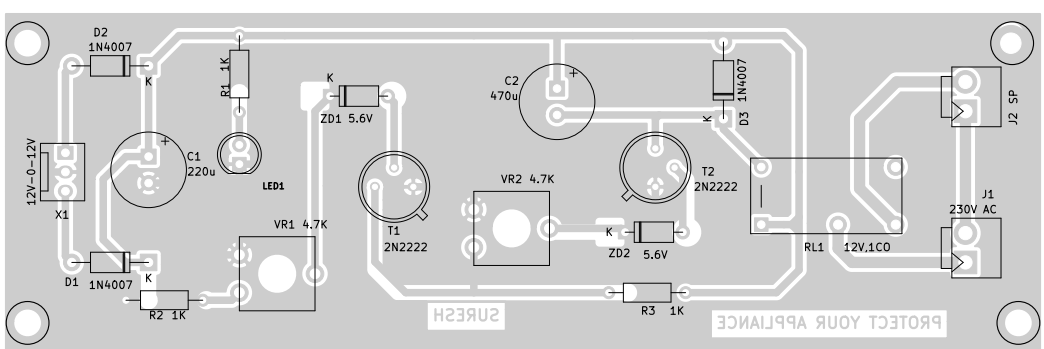


Fig. 3: Component layout of the PCB

The circuit comprises step-down transformer X1, 2N2222 transistors T1 and T2, 1N4007 rectifier diodes D1-D3, a 5mm LED (LED1), 5.6V Zener diodes ZD1 and ZD2, 4.7k potmeters VR1 and VR2, 12V single-changeover relay RL1, and a few other components.

The circuit works on 12V power supply derived from 230V AC primary to 12V-0-12V, 500mA secondary step-down transformer X1. Diodes D1 and D2 rectify the AC into pulsating DC, which is smoothened by the 220µF, 35V filter capacitor C1 to produce a regulated 12V DC voltage to operate the circuit. This 12V voltage increases or decreases slightly based on higher or lower than the normal 230V supply of AC mains input received through transformer X1.

When the AC mains voltage is between the normally-acceptable range of 190V and 230V, the DC voltage at cathode of Zener diode ZD1 is less than 5.6V. As a result, transistor T1 is non-conductive. At the same time, DC voltage at the cathode of Zener

diode ZD2 is more than 5.6V. So, transistor T2 is in conduction mode. Consequently, relay RL1 energies and electrical appliance connected at its contacts gets the AC power supply.

When mains voltage goes high, say more than 230V AC, transistor T1 conducts because voltage at cathode of Zener diode ZD1 becomes greater than 5.6V, and transistor T2 does not conduct. As a result, relay RL1 de-energises and electrical appliance gets disconnected from the AC mains power supply to protect the appliance.

If the mains voltage becomes low, say less than 190V AC, transistor T1 does not conduct because voltage at cathode of Zener diode ZD1 is less than 5.6V. So, transistor T2 also does not conduct. As a result, relay RL1 de-energises and electrical appliance once again gets disconnected from the mains power supply.

To avoid chattering of relay RL1, especially during high/low voltage threshold level settings, capacitor C2 is connected across the relay coil.

Construction and testing

An actual-size PCB layout for the circuit is shown in Fig. 2 and its component layout in Fig. 3. After assembling the circuit on PCB, enclose it in a suitable plastic box.

Connect the electrical appliance to connector J2 and 230V AC mains to connector/socket J1. The AC mains socket should be fixed at the back side of the cabinet to connect the electrical appliance.

Connect LED1 and potmeters VR1 and VR2 on the front of the cabinet. VR1 and VR2 are used to set the low and high voltages, respectively, to trigger the circuit for protection of appliances. EFY

PARTS LIST

Semiconductors:	
T1, T2	- 2N2222 NPN transistor
D1-D3	- 1N4007 rectifier diode
LED1	- 5mm LED
ZD1, ZD2	- 5.6V Zener diode
Resistors (all 1/4-watt, ±5% carbon):	
R1-R3	- 1-kilo-ohm
VR1, VR2	- 4.7-kilo-ohm potmeter
Capacitors:	
C1	- 220µF, 35V electrolytic
C2	- 470µF, 35V electrolytic
Miscellaneous:	
X1	- 230V AC primary to 12V-0-12V, 500mA secondary transformer
EA	- AC mains operated appliance
J1, J2	- 2-pin terminal connector
RL1	- 12V SPDT Finder relay

S.C. Dwivedi is an electronics enthusiast, circuit designer and technical article writer



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AUTOMATIC LIGHT
For Scooter Storage Compartment

A. SAMIUDDHIN

The storage compartment under the seat in scooters does not usually have a light, which makes it difficult to find small items in it at night. This circuit turns on a light automatically when the compartment is opened.

Circuit diagram of the light shown in Fig. 1 comprises NCP3066 monolithic constant-current switching regulator IC1, inductor L1, LED1 an LED that emits bright white light, Schottky barrier diode D1, micro lever limit switch S1, and a few other components. IC1 is configured as constant-current driver in buck topology to drive LED1. IC1, L1, D1, and current-sensing resistor R4 form a constant-current buck driver circuit. While capacitor C1 acts as a buffer, capacitor C2 determines operating frequency of the circuit. The 2.2nF capacitor C2 produces oscillating frequency of about 150kHz.

Limit switch S1 (see Fig. 2) should be fixed on the seat compartment's wall in such a way that its switch lever remains pressed when the seat is in its normal position. This disconnects NC pin of switch S1 and no voltage is available at pin 8 of IC1, which keeps LED1 off.

When the seat is opened, S1's lever is released and disconnects NO pin and connects NC pin with Common. Thus pin 8 of IC1 gets positive supply, which enables it and LED1 glows. Zener diode ZD1 and resistor R3 protect the circuit from open circuit fault condition.

Traditional buck topology

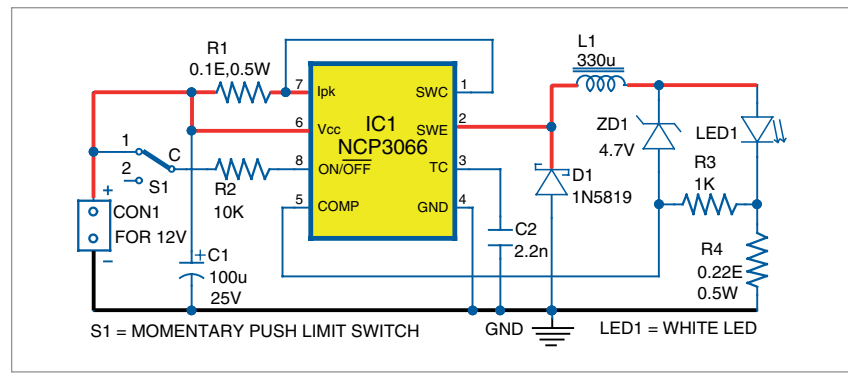


Fig. 1: Circuit diagram of the automatic light



Fig. 2: Micro lever limit switch (S1)

requires an output capacitor on load end to filter the ripples. The capacitor is placed in parallel with LED1, or an array of LEDs, to lower the ripple current. IC NCP3066 controls the current through the load and not the voltage across it. Switching frequency of the IC is 100 to 250kHz, much higher than what a human eye can detect, so there is no ripple in the light. Since the IC is configured in continuous conduction buck mode with low p-p ripple, there is no need for an output filter capacitor.

IC NCP3066 has been used here instead of MC34063A DC-DC converter as it has following advantages:

- MC34063A is designed for voltage conversion while NCP3066 is designed for current regulation.
- The frequency of operation of NCP3066 is up to 250kHz whereas it is limited to 100kHz in MC34063A.
- MC34063A does not have logic switching input pin whereas

PARTS LIST

Semiconductors:	
IC1	- NCP3066 constant-current switching regulator
D1	- 1N5819 Schottky diode
ZD1	- 4.7V Zener diode
LED1	- 1W white-light LED with heat-sink
Resistors (all 1/4-watt, ±5% carbon), unless stated otherwise:	
R1	- 0.1-ohm, 0.5W
R2	- 10-kilo-ohm
R3	- 1-kilo-ohm
R4	- 0.22-ohm, 0.5W
Capacitors:	
C1	- 100µF, 25V electrolytic
C2	- 2.2nF ceramic
Miscellaneous:	
S1	- Micro lever/push limit switch
L1	- 330µH inductor
CON1	- 2pin connector
	- 12V DC supply

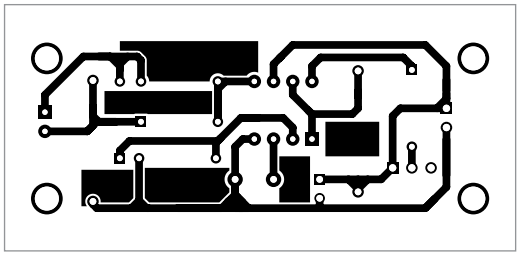


Fig. 3: Actual-size PCB layout of the circuit

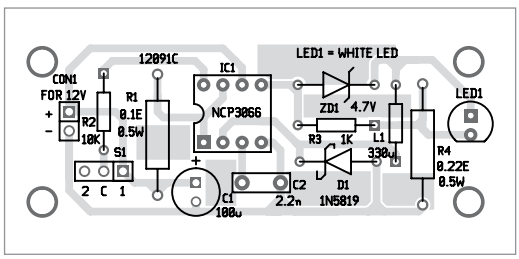


Fig. 4: Component layout of the PCB

NCP3066 has logic-level shutdown capability.

• The feedback voltage of MC34063A is 1.25V whereas NCP3066 has low feedback of about 235mV.

• Constant-current regulation, cycle-by-cycle current limit, internal thermal shutdown with hysteresis, analogue and digital PWM dimming capabilities are additional advantages of IC NCP3066.

An actual-size PCB layout for the automatic light switch for scooter-storage compartment is shown in Fig. 3 and its component layout in Fig. 4. You may assemble the components on this PCB as per the component layout diagram or carefully on a general-purpose PCB. Keep the PCB in the seat compartment and fix switch S1 such that its lever remains pressed when the seat is in its normal horizontal position.

You may check the link *https://www.onsemi.com/pub/Collateral/NCP3066-D.PDF* for datasheet and some other information and *https://www.onsemi.com/pub/Collateral/NCP3066%20DESIGN%20TOOL.XLS* for easy and time saving designs, and worksheet file of NCP3066. EFY

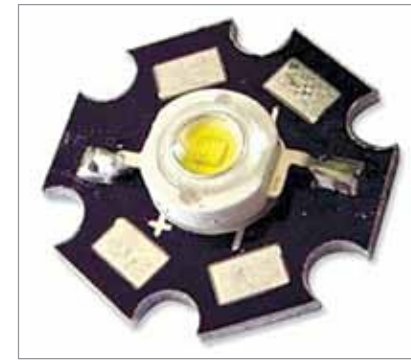


Fig. 5: White-light LED used for the project



A. Samiuddhin, a circuit designer, is B.Tech in electrical and electronics engineering. His interests include LED lighting, power electronics, microcontrollers, and Arduino programming

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1-Watt Single-Channel AUDIO AMPLIFIER

RAJ K. GORKHALI

This simple single-channel audio power amplifier is built around 8-pin IC TDA 7052 and uses only a few other components. Two of these can be used as a stereo amplifier. The amplifier gives 1W output with a power supply of 6V and an 8-ohm speaker.

As shown in its circuit diagram in Fig. 1, pin 1 of TDA7052A (IC1) is connected to four 1.5V batteries to get 6V supply. Electrolytic capacitor C1 (100µF, 25V) and a ceramic capacitor C3 (0.01µF) are used as noise filters.

Pin 2 of TDA7052A is the audio signal input pin that is connected to 5k potentiometer (pot) VR1. Audio input is given at pin 2 of IC1 through 2-pin connector J1 and pot VR1, which is used as volume control. Output pins 5 and 8 of the IC are connected to 8-ohm, 1W speaker LS1.

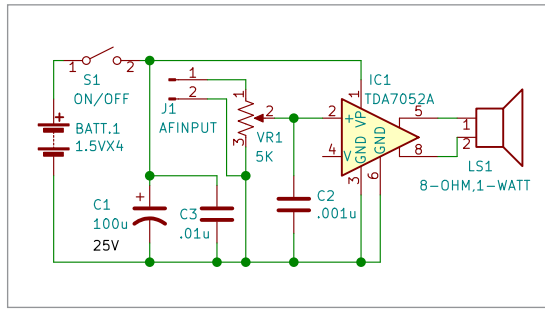


Fig. 1: Circuit diagram

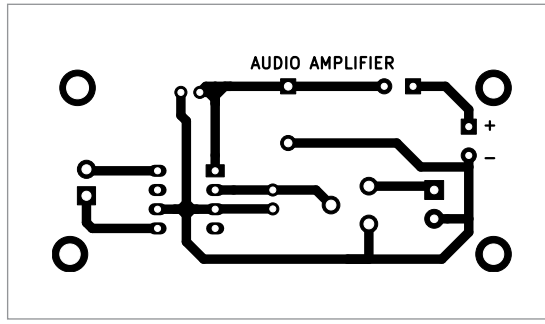


Fig. 2: Actual-size PCB layout

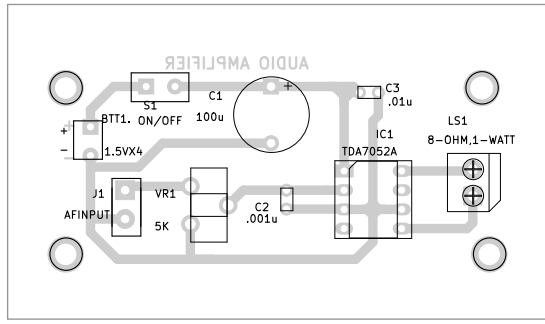


Fig. 3: Component layout of the PCB

Construction and testing

An actual-size PCB layout for the audio amplifier is shown in Fig. 2 and its component layout in Fig. 3. After assembling the circuit on PCB, or on a small Veroboard of about 5x7cm, enclose it in a suitable plastic box. Use an 8-pin socket for the IC, which may be placed in the middle of Veroboard and gently soldered using a small 15W soldering iron.

Solder two 2-pin connectors, one for audio input and another for loudspeaker connections. Solder the remaining components on the PCB or Veroboard as per circuit diagram. Mount the IC on the 8-pin socket last of all. Connect the 6V battery and speaker LS1 as shown in Fig. 1.

After switching on the circuit, take a small metal screwdriver and gently touch at the 2-pin AF input connector terminal J1. You should hear a humming sound from the speaker. Connect one end of mono audio jack to terminal J1 on the PCB and the other end to a headphone output of your mobile or laptop/computer or MP3 audio source.

Move the shaft of potentiometer VR1 to middle position. If you hear a noise-free sound from the speaker, it means the amplifier is working and ready to use. EFY

PARTS LIST

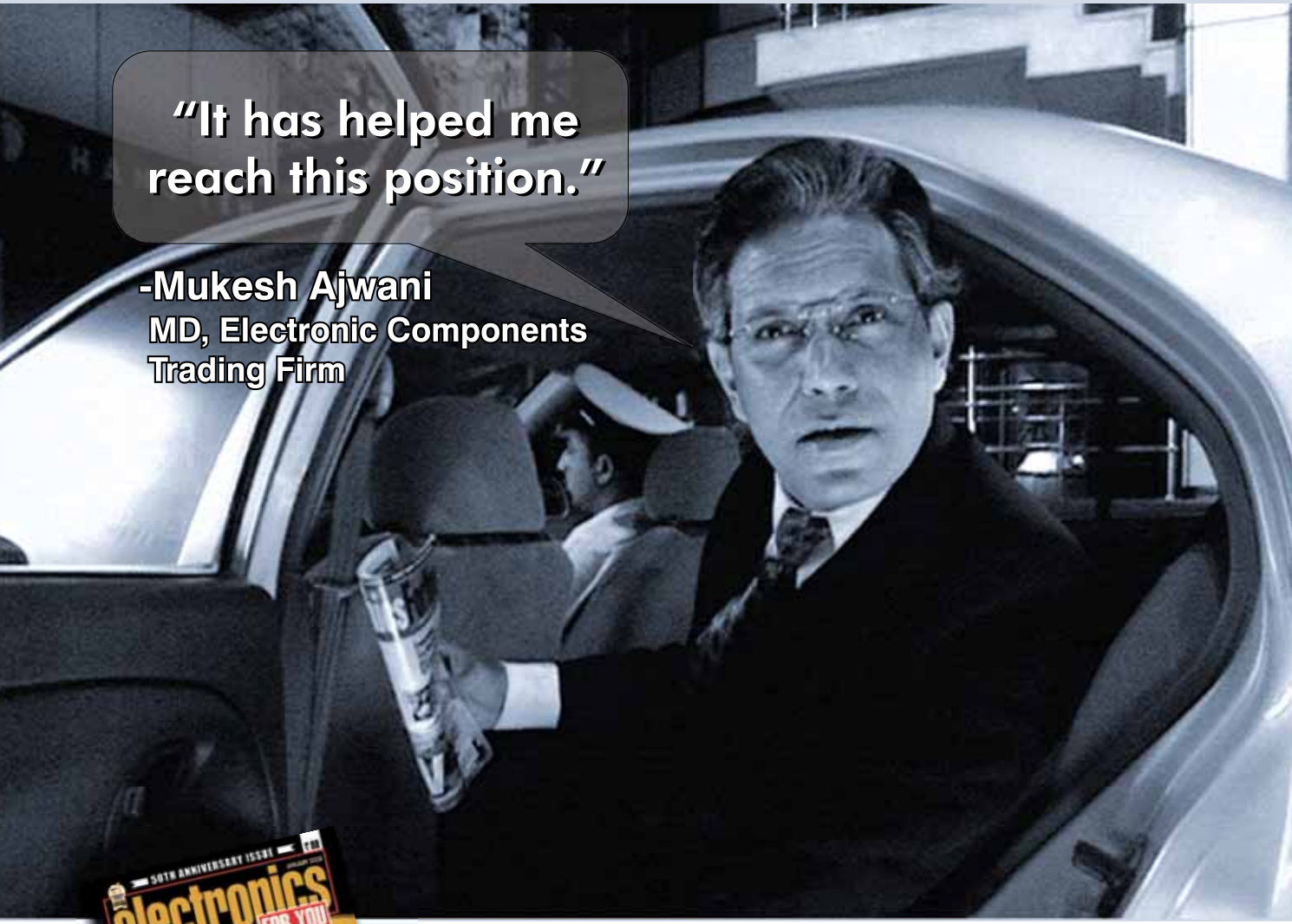
Semiconductors:
IC1 - TDA7052A low-power audio amplifier
Resistors (all 1/4-watt, ±5% carbon):
VR1 - 5-kilo-ohm potentiometer
Capacitors:
C1 - 100µF, 25V electrolytic
C2 - 0.001µF ceramic disk
C3 - 0.01µF ceramic disk
Miscellaneous:
LS1 - 8-ohm, 1-watt speaker
BATT.1 - 1.5Vx4 battery
S1 - On/off switch
J1 - 2-pin audio jack/connector
- 8-pin IC socket



Raj K. Gorkhali is an electronics hobbyist and a regular contributor to EFY

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Bluetooth Controlled DATA LOGGER ROBOT For Soil Testing

ASHUTOSH M. BHATT

This robot can be controlled with a smartphone using Bluetooth through an Android app. Its three sensors can measure four parameters: temperature, humidity, soil moisture, and ambient light intensity in greenhouses, farms, gardens, parks, etc.

Usually robots like robotic hand, agriculture robot, fire-fighting robot, spy robot, snake robot, humanoid, bomb (or mine) diffusing robot operate automatically without any human intervention or are remote-controlled. Remote-controlled robots are mostly wireless.

There are different types of wireless remote-controlled robots like:

1. Fire-fighting robots, which are used as fire extinguishers for spraying water or cardon-dioxide on fire.

2. Bomb (mine) diffusing robots, which are used to diffuse live bombs or mines in a battlefield.

3. Snake robots, which can enter small tunnels or pipelines for search and rescue operations or to find out any problem like leakage in pipelines

This robot monitors the ambient parameters in a field. The operator can manoeuvre the robot in a radius of 10 to 30 metres and take measurements to select the best place for plantation. And if plantation is already done, the above-mentioned four parameters can be checked to see whether these are within the threshold levels or not for taking any corrective actions.

This project can be modified for some other applications also by just changing the sensors. For example, by equipping the robot with MQ2, MQ3 or similar gas sensors, it can be used to detect leakage of any gas like cardon-dioxide, methane, or LPG.

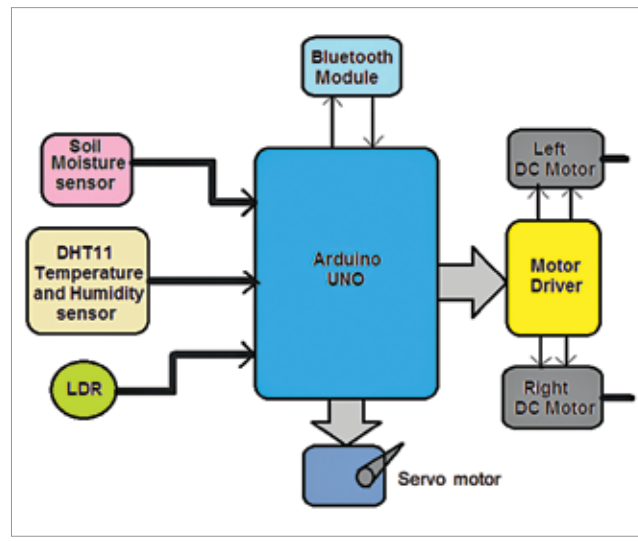


Fig. 1: Block diagram of Bluetooth-controlled data logger robot

Working

Before building the robot, let us first understand its working through the system block diagram shown in Fig. 1 and the circuit diagram in Fig. 2. The major building blocks of the system include the three sensors (soil moisture, DHT11 temperature and humidity sensor, and LDR), an Arduino Uno development board, Bluetooth module HC-05, DC servo motor, two DC gear motors, and motor driver chip L293D. Let us first understand the role of the major components used in the project.

Soil moisture sensor (SM1) is used to measure moisture content in soil and give analogue voltage output as per the moisture level. Its output voltage decreases as moisture content increases.

DHT11 temperature and humidity sensor (SM2) is a smart sensor that measures atmospheric temperature and humidity and gives direct digital values for temperature in °C and for humidity in % RH.

The light dependant resistor (LDR1) is a photo-conductive device whose resistance decreases as light intensity increases, and vice versa.

Bluetooth module (HC-05) is used to command (to move forward, reverse, left, and right) the robot from a smartphone with the help of Arduino Uno microcontroller.

The Arduino Uno board (Board1) performs following tasks:

- Reads analogue output voltage from soil moisture sensor and converts it into digital value. Then it calibrates it between 0 and 100% moisture level
- Reads temperature and humidity values from DHT11 sensor
- Reads analogue voltage output from LDR1 and calibrates light intensity between 0 and 100%
- Gets different commands from Bluetooth module and rotates two DC motors to move the robot forward, reverse, left, right, or stop it.
- Sends (transmits) readings of

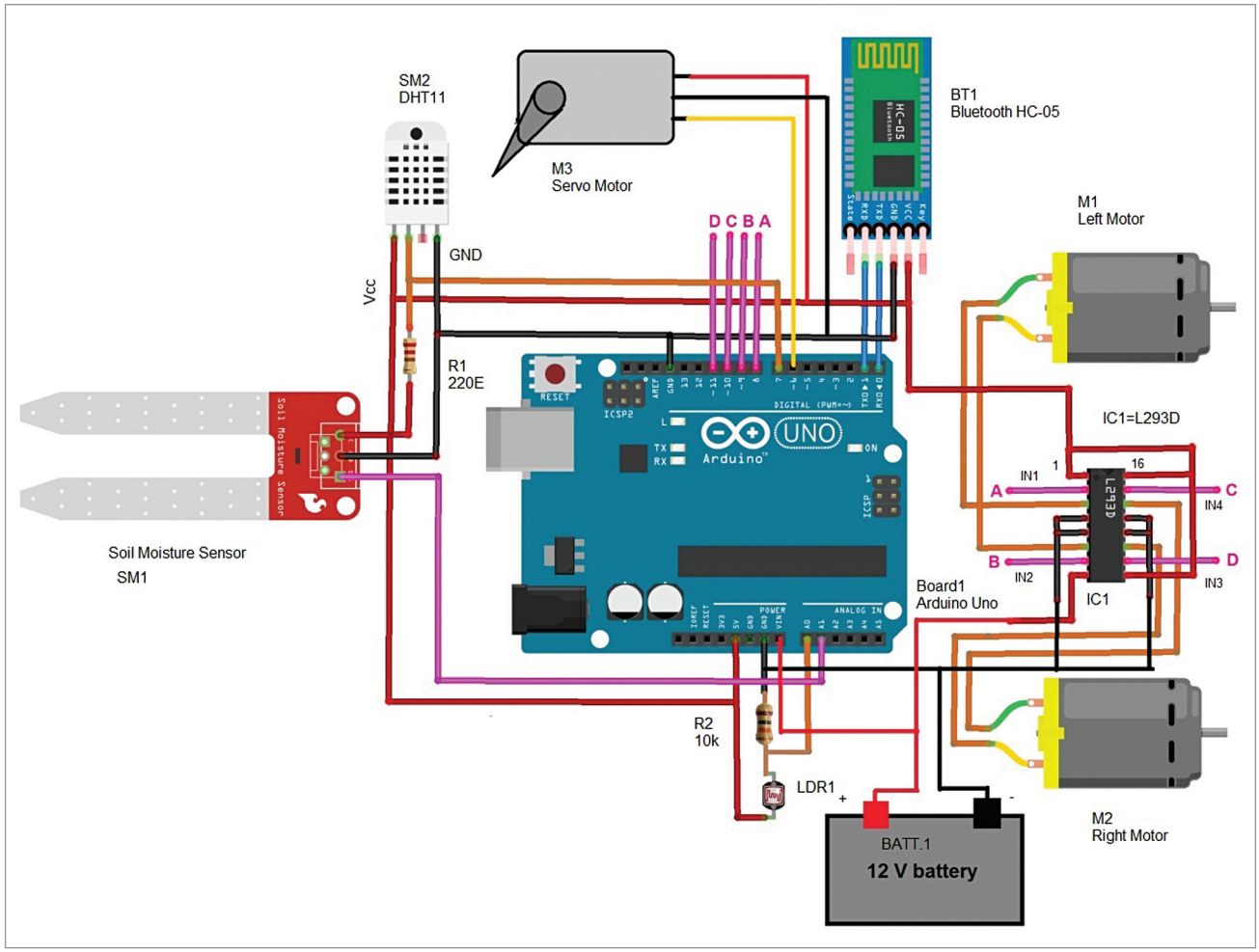


Fig. 2: Circuit diagram

all three sensors to Android smartphone through Bluetooth module

Motor driver L293D (IC1) provides sufficient voltage and current to both the motors to rotate them. It amplifies the output of Arduino board (Board1) and drives the motors.

The DC motors (M1 and M2) drive left and right wheels of the robot and move it forward, backward, left, and right.

Soil moisture sensor (SM1) is attached to servo motor (M3) shaft. This motor moves the sensor up and down to insert it into the soil to check soil moisture content.

HC-05 module operates on 5V received from the Arduino board. It communicates with Arduino board with USART pins Tx (D1) – Rx (D0). So, its Tx pin is connected to Rx pin of Arduino board and vice versa.

DHT11 sensor also gets its 5V supply from Arduino board. Its digital output is connected to digital pin D7 of Arduino.

The analogue output of soil moisture sensor (SM1) is connected to analogue input pin A1 of Arduino board. Its 5V supply also comes from Arduino board.

LDR1 is configured in pulled-down mode with 10-kilo-ohm pull-down resistor. Its analogue output is given to analogue input pin A0 of Arduino board.

Digital pins D8, D9, D10, D11 of Arduino board drive DC motors M1 and M2 using L293D chip. These pins are connected to inputs of L293D, and two motors are connected to output of the chip. Servo motor signal (sig) input is connected to PWM output pin D6 of Arduino board. The motor gets 5V supply from Arduino board.

The motor supply pin Vss of L293D (pin 8) gets 12V from battery. The Arduino board also gets 12V input at its Vin pin from battery. That is, Vin pin gets 12V input and gives 5V output to all other components.

Circuit and operation

The circuit operation starts when 12V battery is connected to Arduino Uno board and L293D chip. Initially, both motors (M1 and M2) are at rest and so the robot is also at rest. The servo motor (M3) is at 0° position and soil moisture sensor is in upward position.

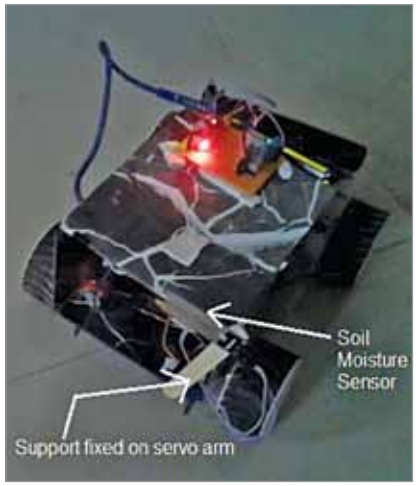


Fig. 3: Author's prototype



Fig. 5: Dry soil status



Fig. 4: Various sensors' data captured on mobile phone

To move the robot in any direction, command is required from smartphone through Bluetooth based Android application, called Bluetooth Terminal HC-05 by mightyIT. To do this, open (start) Bluetooth Android application in smartphone and search for HC-05 Bluetooth module. Once the phone detects HC-05 module, pair it with the smartphone's Bluetooth app. Enter passkey 1234 or 0000 the first time to pair with HC-05 module.

Now you can send commands from the smartphone to robot to move using the app. Following commands given in the table are used to move the robot (all these commands are already set in Android application):

Command	Robot movement
'F'	Move forward
'R'	Turn right
'L'	Turn left
'B'	Move backward
'S'	Stop moving

When any of the above commands is sent (by sending the character in capital letter), it is received by HC-05 module. The module further gives this command to Arduino serially through its Tx-Rx pins. Arduino gets this command and compares it with set commands. If they match, the robot moves in the desired direction.

Once robot is in motion, it keeps moving (within the range) until command 'S' is sent to stop it. When robot stops, it moves the servo motor by 90° so that soil moisture sensor can go down into the soil to capture soil moisture value. At the same time, it starts reading sensor values from DHT11 and LDR. It reads analogue voltage output from soil moisture sensor and LDR and converts it to the range of 0-100%. It also reads digital values of temperature and humidity from DHT11 sensor.

Robot transmits all four values of these sensors to the smartphone through Bluetooth module. It keeps transmitting these values every three seconds till it is stopped by pressing 'S' command. When any of the commands (F,B,R,L) is given, the corresponding servo motor moves from 90° to 0° and the soil moisture sensor moves up. The robot stops transmitting sensor readings and starts moving. Thus it gives an idea of ambient temperature, humidity, soil moisture, and light intensity in the area.

Operation of the circuit is controlled by the program embedded in Arduino Uno microcontroller ATMega328.

Software

The program code (BT_controlled_robot.ino) is written in Arduino programming language. It was tested using Arduino IDE version 1.8.18. Before compiling and uploading the code, make sure you include the relevant libraries, such as

EFY Note
The source code of this project is available for free download at *source.efymag.com*

DHT_sensor_library-1.4.2 and DHT sensor library version 1.4.3. During testing it was found that without these libraries the code could not be compiled.

Construction and testing

The circuit can be assembled on a breadboard or general-purpose PCB. The author's prototype is shown in Fig. 3. On connecting the circuit to a 12V DC supply, the onboard LED on Bluetooth HC-05 will start blinking at a fast rate. When you pair it successfully with your Bluetooth app in your mobile phone, the LED will blink at a slower rate (two blinks per second). Open the Bluetooth Terminal HC-05 app from the mobile phone, select HC-05 again.

If everything's fine, you can enter control commands (F,B,R,L) in the app to move the robot. On entering 'S' command, the robot will stop and all the sensor data can be seen on your mobile phone, as shown in Fig. 4.

Soil moisture sensor SM1 should be properly fixed to the servo arm/horn using either glue gun or screws. When servo motor pulls out soil moisture sensor from the soil, you can see the moisture level drastically reduces to 5, as shown in Fig. 5, indicating that the sensor is out of the soil. EFY

PARTS LIST

Semiconductors:
Board1 - Arduino Uno board
BT1 - HC-05 Bluetooth module
SM1 - Soil moisture sensor
SM2 - DHT11 temperature and humidity sensor
LDR1 - 10-kilo-ohm LDR
IC1 - L293D motor driver

Resistors (all 1/4-watt, ±5% carbon):
R1 - 220-ohm
R2 - 10-kilo-ohm

Miscellaneous:
M1, M2 - 12V DC motor
M3 - Servo motor (Tower Pro)
BATT.1 - 12V Battery
- Robot chassis
- Wheels for the robot
- Jumper wires



Ashutosh M. Bhatt is M.Tech in embedded systems. Currently, he is lecturer of electronics and radio engineering at Government Polytechnic, Jamnagar, Gujarat

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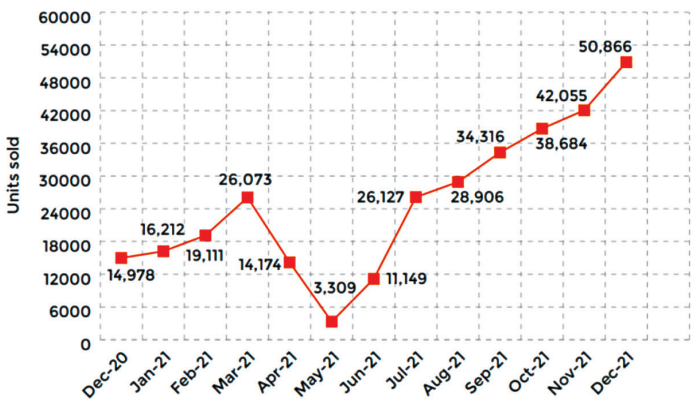
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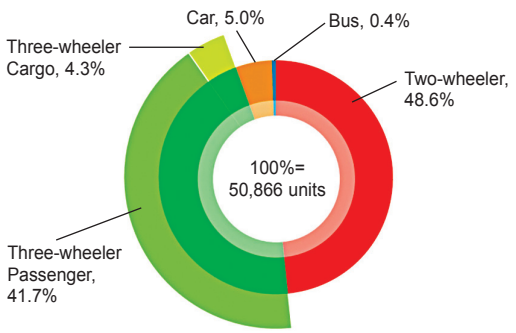
EV Registrations Crossed Over 50,000 Units In December 2021

Overall EV sales in December 2021 clocked 50,866 units, recording a 240% YoY jump from the number recorded in December 2020. Electric two-wheelers alone contributed 48.6% to the total EV registration. Electric cars contributed 5% and the electric cargo three-wheelers contributed 4.3%. Uttar Pradesh was the state where the maximum number of electric vehicles were registered.

Registered EV Sales Trend in India (Dec 2020-Dec 2021)



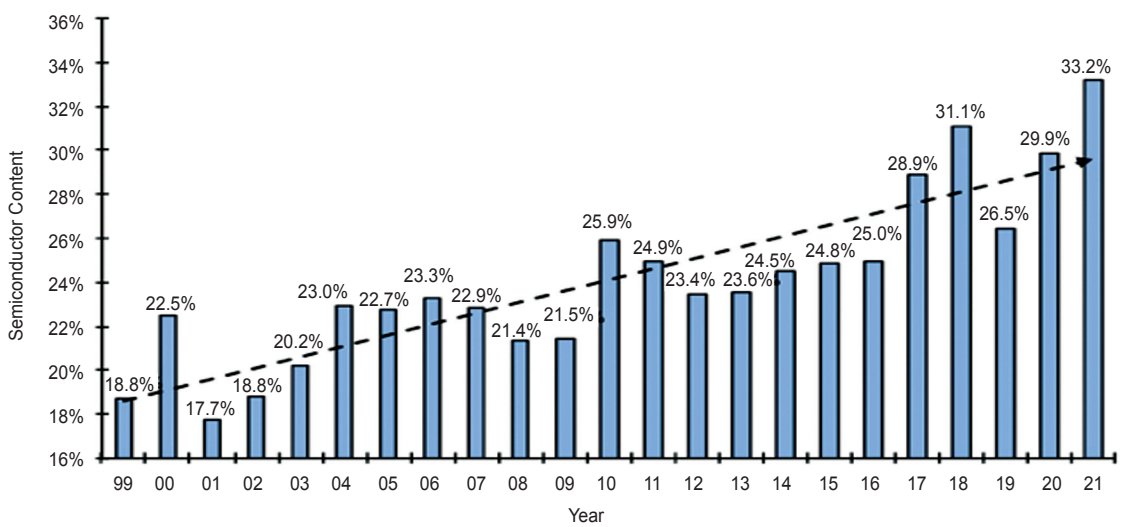
Category-wise EV Sales in December 2021



Source: Vahan Dashboard, JMK Research

Semiconductor Content in Electronic Systems Reached Record High in 2021

The value of semiconductor content in electronic systems reached 33.2% last year, surpassing the previous record high set in 2018. With global unit shipment growth rates of cellphones, automobiles, and PCs showing maturity and slowing over the past 10 years, the disparity between the 3.5% 2011-2021 CAGR registered in the electronic systems market and 6.5% 2011-2021 CAGR displayed by the semiconductor market is directly due to the increasing content/value of semiconductors in electronic systems.

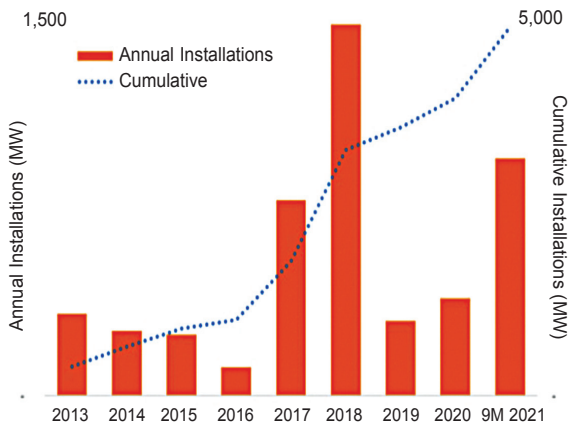


Source: IC Insights

At-a-glance view of key industry trends that can shape the future of your business…

Open-Access Solar Installations Saw An Uptick of 85% YoY in Q3 2021

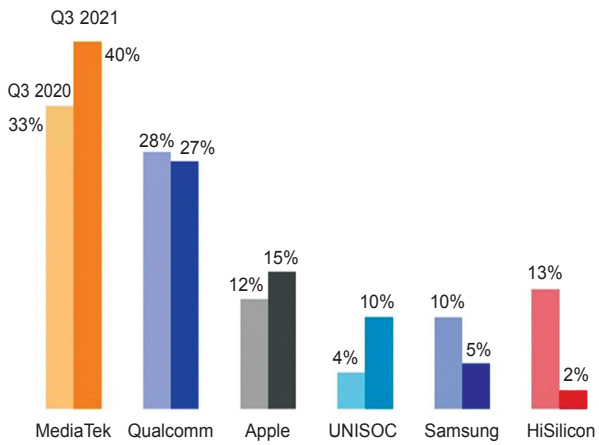
Open access solar installations in India totaled 307 MW in the third quarter (Q3) of 2021, an 85% year-over-year (YoY) increase compared to 166 MW in the same period last year. Karnataka led the way in cumulative installations, with Tamil Nadu, Uttar Pradesh, Rajasthan, and Maharashtra making up the top five.



Source: Mercom India Research

MediaTek Dominates Global Smartphone AP Shipments in Q3 2021

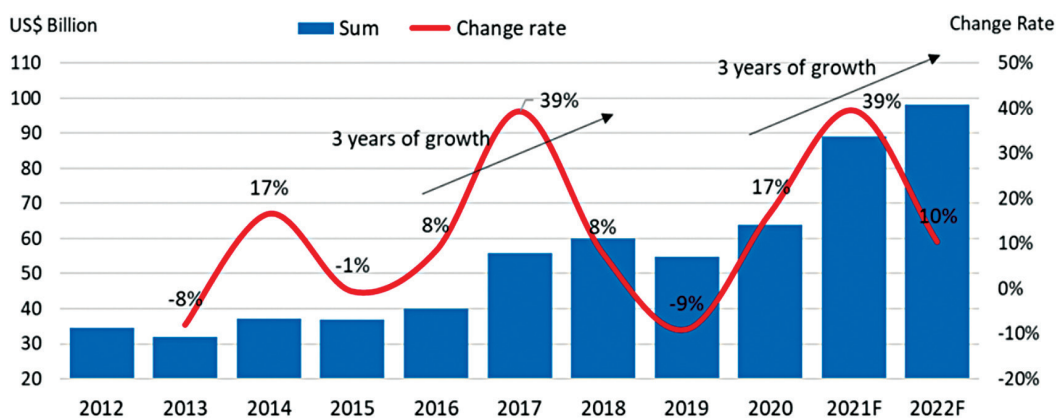
The global smartphone AP/SoC chipset shipments grew 6% YoY in Q3 2021. 5G smartphone SoC shipments grew almost two times compared to the same period a year ago. MediaTek led the smartphone SoC market with a 40% share in Q3 2021. It gained share in the low-mid segment 5G portfolio. Qualcomm grew 9% sequentially due to dual sourcing from foundries.



Source: counterpointresearch.com

Global Fab Equipment Spending Projected to Log Record High in 2022

Global fab equipment spending for front-end facilities is expected to rise 10% YoY in 2022 to a new all-time high of over US$98 billion, marking a third consecutive year of growth. Microcontroller spending is expected to register a staggering 47% surge in 2022. Power related devices are also projected to show strong growth of 33%. Korea is expected to rank at the top of equipment spending, followed by Taiwan and China.



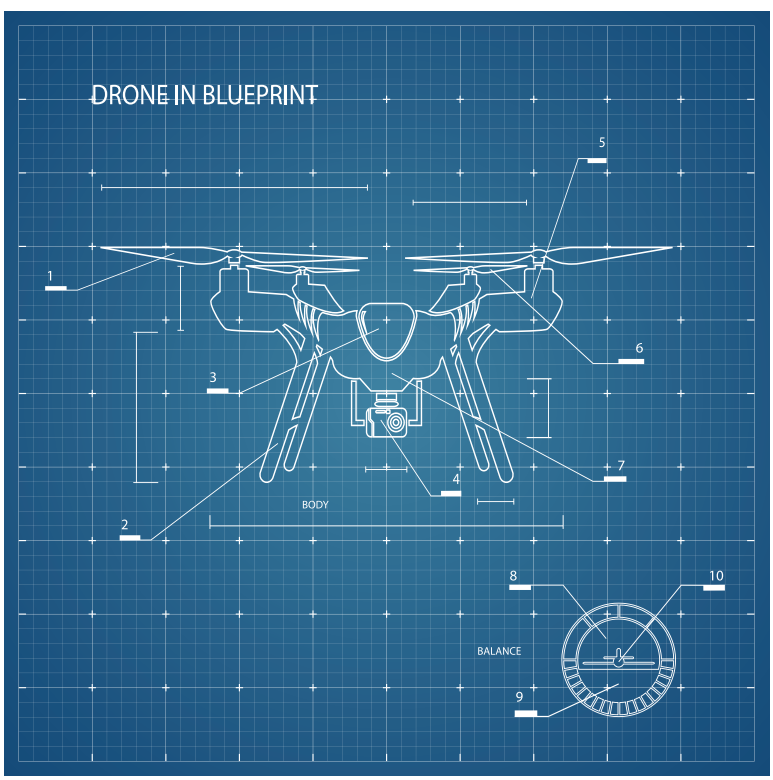
Source: World Fab Forecast Report, 4Q 21 Update, Published by SEMI

DRONES MANUFACTURE IN INDIA: Does PLI Make It Attractive Enough?

The government of India has introduced a production linked incentive (PLI) for manufacturing drones and their components in the country. Should startups, SMEs, MSMEs, and bigger organisations invest in the sector that is still at a nascent stage? What is the future of drones, and what are the business challenges and opportunities offered by the sector? Let us have a look

MUKUL YUDHVEER SINGH

"After the introduction of the new drone policy on August 25, many foreign and domestic investors have invested in drone startups. Many companies are setting up manufacturing units. Army, navy, and air force have given orders worth much more than ₹500 crore (five billion rupees) to Indian drone companies. This is just the beginning, and we don't have to stop here," says India's Prime Minister Modi in his address to the nation via his monthly radio programme *Mann Ki Baat*.



In one of the episodes, he adds, "Drones are a topic which is dominating the imagination of our country, especially the youth, and India is the first country in the world that is preparing digital land records in its villages with the help of drones."

As such, this probably might be the first time in history where the government has taken a proactive approach towards a sector that is considered to be still in its nascent stage. Of course, the Civil Aviation Ministry has estimated India's drone sector to achieve a total turnover of ₹120 to 150 billion (US$1.63 to 2.04 billion) by 2026, from its current turnover of about ₹800 million (US$10.88 million). However, the opportunities and challenges are not just for India, the whole world is experiencing them!

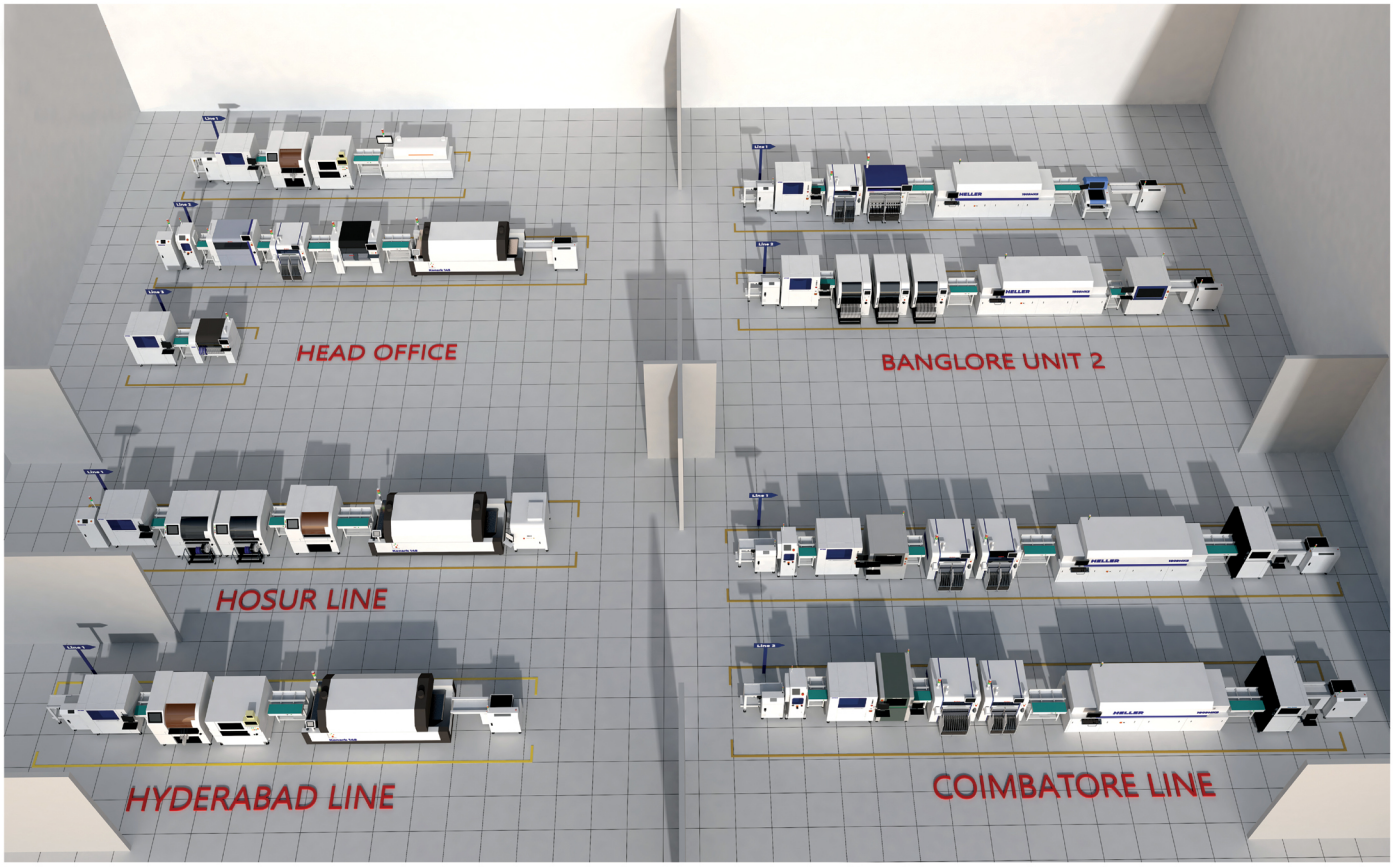
The global market for drones is estimated to reach US$28.47 billion in FY 21-22, and the Bureau of Indian Standards (BIS) research suggests that India will account for roughly 4.25% of this market, even though countries like China, Israel, and the US are currently dominating the market.

Notable in case of India is the government's PLI scheme for promoting manufacture of drones in the country. Offering incentives worth ₹1.2 billion (US$16.06 million), the policy covers almost every critical component required in a drone and envisages to build an ecosystem that fosters drone manufacturing. The opportunities present are not just for big established organisations, but also for startups.

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Some facts

Sectors being revolutionised by drones:

Agriculture • Mapping • Defence • Transportation • Mining • Logistics • Delivery Services • Healthcare • Infrastructure • Surveillance • Photography • Emergency Response • Law Enforcement

Total addressable market potential for drones in India:

- Defence : ₹1,01,000 crore
- Commercial : ₹75,000 crore
- Exports : ₹47,000 crore
- C UAS : ₹49,000 crore
- HLS : ₹23,000 crore

Market forecast figures:

- Total manufacturing potential of more than ₹180,000 crore for drones in India by 2030
- Investment worth ₹5,000 crore for manufacturing drones
- Drones service market to be worth $40.7 billion by 2026
- Drones' camera market to reach $40.7 billion by 2026

Drones PLI at a glance:

- Total amount allocated: ₹120 crore
- Tenure: 3 years, PLI rate constant every year
- Incentive as high as 20% of value addition
- Minimum value addition norm: 40%
- Developers of drone-related IT products also included

Opportunities beyond PLI, being fuelled by PLI:

- Drone pilot training schools
- Drone jobs in AI and ML sector
- Data scientists in the drone sector

*(**Note:** 100 crore=1 billion)*

"We have estimated the total manufacturing potential to be more than ₹180,000 crores (1,800 billion rupees) for drones in India by 2030. This is not just an opportunity for the larger companies but also for the hundreds of startups which are operating in this space," says Rajan Luthra, Head-Special Projects, Reliance Industries Ltd, and Chair, FICCI Committee on Drones and Chairman's Office.

Sampathkumaran S.T., Vice President-Defence & Aerospace, Adani Group, also has a similar view. He notes, "Size does not matter in the drone vertical. The industry as a whole is at a very nascent stage. Everyone is going through learning, that is, the startup phase, and the field is open for everybody to come and play."

Vikram Singh Meena, Founder & CEO-TechEagle adds, "The world will see more than two million Indian made drones flying in airspace by 2030 because of initiatives like liberalised drone policy and PLI scheme."

Let's talk about the PLI first

The graph on last page makes it evident that drones are not just here to stay but to rule every segment they are used in. Moreover, the deployment of drones for mapping villages in India is a clear indicator of the trust and confidence the government of India has in the sector. As a matter of fact, the government itself has admitted that drones can benefit sectors including but not limited to agriculture, mining, infrastructure, surveillance, emergency response, transportation, geo-spatial mapping, defence, and law enforcement.

It is clear that this scheme is a follow-through of the liberalised Drone Rules, 2021 released by the Central government on 25th August 2021. The PLI scheme and new drone rules, as per the government, are intended to catalyse supernormal growth in the upcoming drone sector.

Jyotiraditya M. Scindia, Union Minister of Civil Aviation, while informing about the incentives worth 1.2 billion rupees (₹120 crore), notes the amount would be 1.5 times the combined size of the manufacturing drone sector. He also mentions the objective of establishing India as a global drone hub by 2030 and says that the Ministry of Civil Aviation is committed to facilitate industry, service delivery, and consumers in achieving the aforesaid target.

"Over a period of three years, estimated investment worth ₹5,000 crore (₹50 billion) for manufacturing sector drones will be done, which in turn will bring a turnover of ₹900 crore (₹9 billion), along with 10,000 job opportunities being created," he explains.

The government has kept the eligibility norm for micro, small, and medium enterprises (MSMEs) and startups in terms of annual sales turnover, at a nominal level of ₹20 million for drones and ₹5 million for drone components. Whereas the eligibility norm for non-MSME

Drone components

- Airframe, propulsion systems (engine and electric), power systems, batteries and associated components, launch and recovery systems
- Inertial measurement unit, inertial navigation system, flight control module, ground control station and associated components
- Communications systems (radio frequency, transponders, satellite based, etc)
- Cameras, sensors, spraying systems and related payload, etc
- 'Detect and Avoid' system, emergency recovery system, trackers etc, and other components critical for safety and security

companies in terms of annual sales turnover has been kept twice that at ₹40 million for drones and ₹10 million for drone components.

"We are all starting at the same point and should look towards collaborating and complementing each other. The big companies, small and medium sized enterprises (SMEs), and the startups need to come together and work towards making India the global hub of drones manufacturing," says Lt Col. Ravi Bandreddi (Retd), Senior General Manager, Homeland Security, Dynamatic Technologies Ltd.

What's special

The PLI for drones stands out on a lot of fronts, when compared to PLIs for various other sectors. Like other PLI schemes, the government, via this, is aiming to give incentives to drone and its component manufacturers based on the incremental production achieved by the latter. It stands out from other PLIs in the form that there is no threshold year set by the government to calculate incremental production. Instead, there is a threshold mentioned by the government, and anyone who crosses that threshold can apply for availing benefits.

The method of computing incentives around the PLI is also unique when compared to other sectors. It is based around the amount of local value addition in drones and drone components. In nutshell, the government is aiming to provide 20% of the total local value addition (capped amount) back to the manufacturer. This clause stands true for drones and drone components.

"It is my strong belief that this PLI scheme will drive a lot of companies to look towards manufacturing drones in the years to come," says Sampathkumaran.

What makes the PLI for drones extraordinarily special is the way it has been crafted. Though the amount involved in the PLI is about ₹1.2 billion for three years, it restricts a handful of companies to qualify for the incentives. Two or three big companies, as per Sampathkumaran, coming and taking away all the benefits is not at all possible, and there's enough room for SMEs, MSMEs, and startups to participate in the scheme.

Speaking of equal opportunity for all the players, the PLI for drones has also taken into account IT developers of drone-related IT products. As a matter of fact, the scheme also covers software development for drones, which is probably the first PLI that takes both IT developers as well as software for drones into consideration. As they both are more or less connected to the way drones are deployed, the highlight here is the drone services market size. As per a report by Markets & Markets, it is expected to reach $40.7 billion by 2026 from $13.9 billion in 2021, and the Asia Pacific market is forecast to register the highest CAGR in terms of growth during the forecast period.

On the same page

Yes, the biggest opportunity is in manufacturing drones and their related components, but an equal (maybe bigger) opportunity for startups, SMEs, and MSMEs lies in being successfully able to collaborate with bigger organisations. It is clear that the likes of Adani and Reliance are serious about the drone vertical. The proof of the pudding also lies in announcements made over the last few months.

DCM Shriram Industries, during August 2021, announced that it had

Drones Sector: Why it is India's shining lighthouse



"We have estimated the total manufacturing potential to be more than ₹180,000 crore for drones in India by 2030. This is not just an opportunity for the larger companies but also for the hundreds of startups which are operating in this space," says **Rajan Luthra, Head-Special Projects, Reliance Industries Ltd**, during the Drone World Event organised by Electronics For You and FICCI.



"The only way for India to get a large part of value from the drones sector is by staying ahead in terms of innovation, which resonates with the term startups. The drone industry will benefit a lot from the contributions of the startup industry," says **Ankit Mehta, co-founder & CEO, ideaForge**.



"Drones are one opportunity that is equally available to larger companies as well as startups. It is how fast one can run and compete in the race. The drones' race is open for all," says **Sanjeev Sehgal, Founder & MD, Sparsh Securitech**.



"Size does not matter in the drone vertical. The industry as a whole is at a very nascent stage. Everyone is going through learning, that is, the startup phase and the field is open for everybody to come and play," adds **Sampathkumaran S.T., Vice President-Defence & Aerospace, Adani Group**.



"We are all starting at the same point and should look towards collaborating and complementing each other. The big companies, SMEs and the startups need to come together and work towards making India the global hub for drones manufacturing," says **Lt Col. Ravi Bandreddi (Retd) Senior General Manager-Homeland Security, Dynamatic Technologies Ltd**.



"PLI Scheme also covers software development for drones as a big opportunity, which I think the startups can gain a lot from," opines **Neel Mehta, Director & Cofounder, Asteria Aerospace Pvt Ltd**.

What do startups think about the drones sector in India?



Ankit Mehta, co-founder & CEO, ideaForge: My expectation is that the drone manufacturing industry will jump to over ₹300 crore in a year, from around ₹60 crore today, and will subsequently be much bigger over the coming years.



Prem Kumar Vislawath, Founder & CEO, Marut Drones: The drone industry in India will be more like the IT industry, where we will have a huge base of engineers, developers, design firms, manufacturing firms working inside the drone ecosystem.



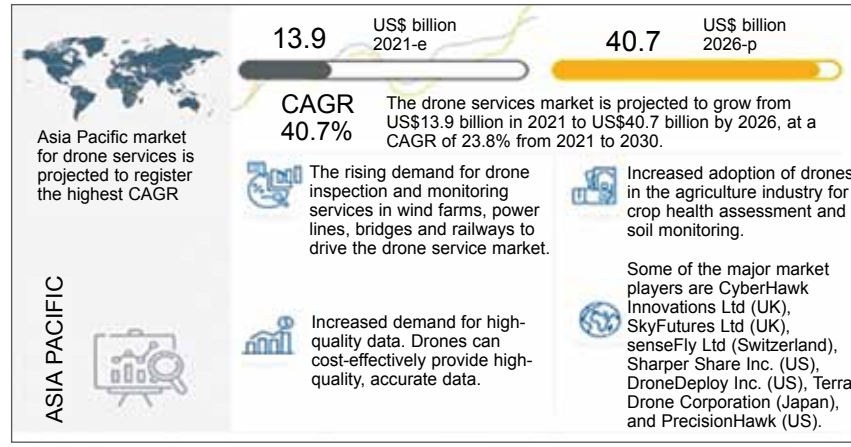
Vikram Singh Meena, CEO & Founder, TechEagle Innovations Pvt Ltd: The drone industry will grow 5x plus during the next 12 months.



Mrinal Pai, Co-founder, Skylark Drones: The drone sector will become an opportunity for creation in India and providing it to the rest of the world. The opening of the sector coupled with the PLI scheme will open the door for tremendous growth and opportunities.



Govind Balakrishna Raju, Founder CEO, 10Infinite: The drone sector would grow just like the IT sector that grew and still continues to grow in India.



Attractive growth opportunities in drone services market

bought 30% stake in Turkish drone manufacturer Zyrone Dynamics Havacilik Danismanlik. The duo plans to work towards marketing drones in India and the rest of the world. It was also in the same month that RattanIndia Enterprises had announced investment in Matternet. The latter is known as the world's most extensive urban drone logistics platform.

However, to make sure that this PLI for drones is successful in not only enabling a local ecosystem of drone manufacturing in India but also in making India the go-to destination for drone manufacturing, service providers, drone component manufacturers, and startups, we will have to be on the same page. The easiest way to do so for the larger companies is to rely on startups for sourcing software and components. And for the SMEs, MSMEs, and startups, the key to success lies in crafting products that do not just appeal to India but to drone companies outside the borders of the country as well.

Dynamatics is setting an example by collaborating with Indian startups in terms of developing and sourcing critical components like sensors, communication systems, and more. Along with Adani group it has already started welcoming startups who wish to work with them.

"The opportunities are present equally in all the verticals of drones, be it components, system integration, data analytics, or services. The intent of the government is very clear, the drone sector is of strategic importance and the government wants to make India the global hub of manufacturing drones," feels Neel.

Sparsh Securitech, credited for making CCTVs in India, is thinking of getting into manufacturing camera technology for drones. It is of the view that the segment is a quite promising one, especially for camera and imagery solution providers. A drone that is not enabled with vision (cameras) is quite difficult to even imagine. The global drone camera market, which was valued at $3.33 billion in 2019, is projected by Allied Market Research to reach $25.39 billion by 2027, registering a CAGR of 29.9%. Asia Pacific, once again, is projected to exhibit the highest CAGR of 31.3% during 2020-27.

"Cameras for drones are the key components that enable photos and video feeds via drones. We believe what was done for CCTVs in 2008, we can do the same for drone camera manufacturing in the coming years," says Sanjeev.

The point to be noted, in terms of components like cameras, communication systems, radars and more, is the opportunity that would arise from the anti-drone sector. This, in addition to the drone sector, also spells chances to cash-in for companies on both the drone as well as anti-drone systems. EFY

This article has been prepared by Mukul Yudhveer Singh, Business Editor, Electronics For You, based on a panel discussion held during the Drone World Event in October 2021 on Tech World Congress platform.

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AUTOMATIC OPTICAL INSPECTION: A Game Changer For PCB Manufacture

Increase in the complexity of electronic boards shows manual inspection may not be a viable option. With the marketplace now requiring high quality, no-error products, there is a strict need for reliable fast methods. One of the effective solutions is to integrate AOI in your electronics test strategy

ZISHANI MISHRA AND
ABBINAYA KUZHANTHAIVEL

Automatic optical inspection (AOI) is a key technique used in manufacturing and testing of electronics printed circuit boards (PCBs). It enables fast and accurate inspection of electronic assemblies, thus ensuring production of high quality of boards without defects. This technique usually comes at the stage just after the soldering process to find and fix faults, especially in the solder and assembly area. In this way of rapid response, defects are recognised quickly and rectified before too many boards are built with the same errors.

Not only identifying errors and pausing production of defective boards, AOI provides data needed to improve the performance of the entire SMT process. AOI uses various techniques like template matching or pattern matching to check the quality of a board. It compares the captured image with the image of a 'golden board'—an ideal board that is of acceptable quality and standard, stored in the database. It can be used to adjust and improve the quality of manufacturing without stopping the process. The need for a dynamic SMT inspection equipment has driven manufacturers to connect their equipment and process data to enable smart, adaptable functioning of AOI machines.

What an AOI machine does

These inspection systems use visual methods to monitor PCBs to detect various surface defects like nodules, scratches, and stains and other dimensional defects by in-circuit testing (ICT), such as open circuits, shorts, discontinuity, and thinning of the solder. They can also detect incorrect components, missing components, and incorrectly placed components.

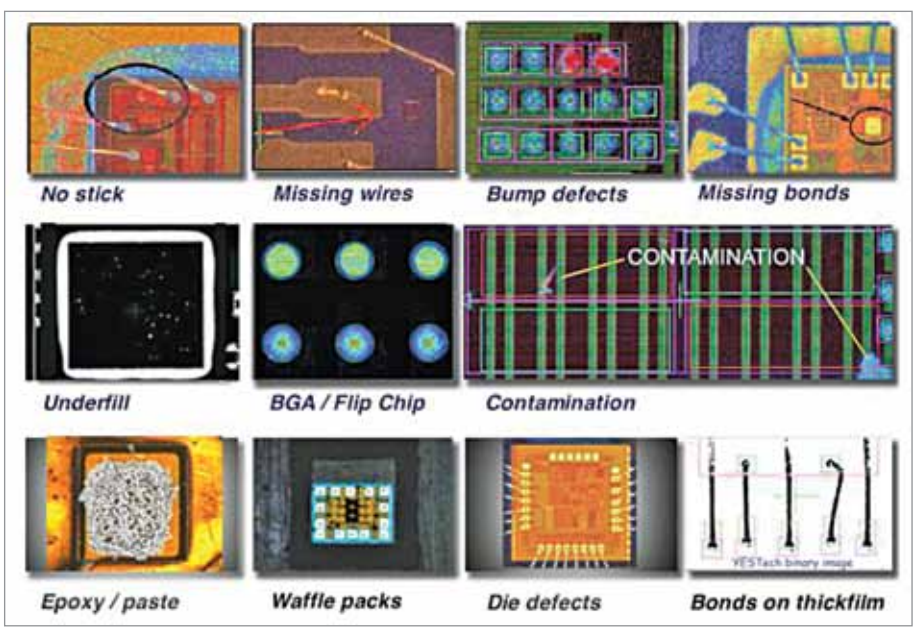


Fig. 1: Optical Inspection (Source: Nordson YESTECH)

An AOI machine uses optical light energy to capture and analyse images of PCBs to verify the assembled electronic components, including presence and position, soldering (solder joints and bridges), polarity, marking (like inscription, signs, colour), flux deposits, microcracks, and subsurface defects. It performs with the help of illumination, CCD image system and processing software, machine vision



Fig. 2: Koh Young's 8-way projection to overcome shadow problem

camera, AC servo control, XY workbench, image processing system, and other actuating parts.

Illumination system

While older AOI machines used fluorescent, incandescent, ultraviolet, or infrared lights, today's machines use smart red, green, white, or blue coloured light emitting diodes (LEDs). LEDs are preferred for their ability to provide a stable form of lighting. With efficient control over the light, LEDs provide uniform illumination.

Along with the type of lighting, the orientation of the light source is also important. Machine vision camera systems assist the illumination system with effective lighting control and intensity adjustments to capture the entire PCB in audit.

CCD image system

CCD is a charge coupled device, a semiconductor element that converts images into digital signals. An AOI system uses a CCD camera for imaging. The system consists of a lens, an image sensor, and image processing tools.

The image sensor forms the heart of the camera. The photon energy captured by the camera lens and the individual pixel information is absorbed by the respective photocells in the sensor. The camera sensor converts incoming photon energy into electrical charges, which are further processed to generate images. The image processing system is the key for extracting the information through images in any application.

In AOI, the processing of images takes place externally through the PC based system supported by various processing tools. The AOI machine's imaging resolution defines the amount of detail it can identify and capture, and hence it is a key factor that affects the inspection accuracy and inspection speed.

Machine vision camera

The image capture takes pictures for analysis. This is assisted by one or more high-definition cameras installed within the AOI to focus or move under the software command. Recently, these cameras have been featured with higher frame rate to support faster scanning and generate more data. An efficient processing software is hence required to manage huge amount of data.

Resolution turns out to be an important aspect as it defines the field of view (FOV) that specifically shows the section in an image. A wider FOV would typically allow the product to be examined with lesser images. However, it takes more time to capture each image as the camera with more pixels leads to a lower frame rate. On the other hand, cameras with a narrow FOV have bigger pixels with higher frame rate.

Processing software

For an AOI machine to inspect a product, the data of an acceptable product must already be fed to the system. There are primarily two ways in which AOI machines are programmed. Image based programming uses scanned images of 'golden board' where references are created and accordingly automated. Algorithm based programming is the other method where the system generates its profile for the product by feeding product data to it.

Now, with all the elements working together, systematic outputs are obtained. Depending on the results, corrections are either made automatically or by human interference.

AOI challenges

While there have been great developments in the manufacturing of AOI machines over the years, many challenges still persist. Manufacturers are coming up with various solutions that are described below to tackle them.

Optical inspection. AOI systems were earlier based on 2D inspection technology where different grey levels for solder paste, solder joint, and component detection were inspected. Today, the 2D technology is being overtaken by 3D measurement solutions.

While many 2D AOI systems remain in use, the effort needed to keep this technology at a low level of escape and false-call rates is tremendously high. This is because the 2D systems work by comparing reference images. To help, some equipment manufacturers have added additional cameras and projectors to create quasi 3D or 2.5D technology, but it is still based on the same antiquated, inadequate comparison, or colour assessment.

AOI machines enabling both 2D and 3D imaging features along with other capabilities are being developed to provide extensive precision in the inspection process. Today, most AOI equipment has the capability to perform multiple tasks, reducing the time and expenses in the SMT process.

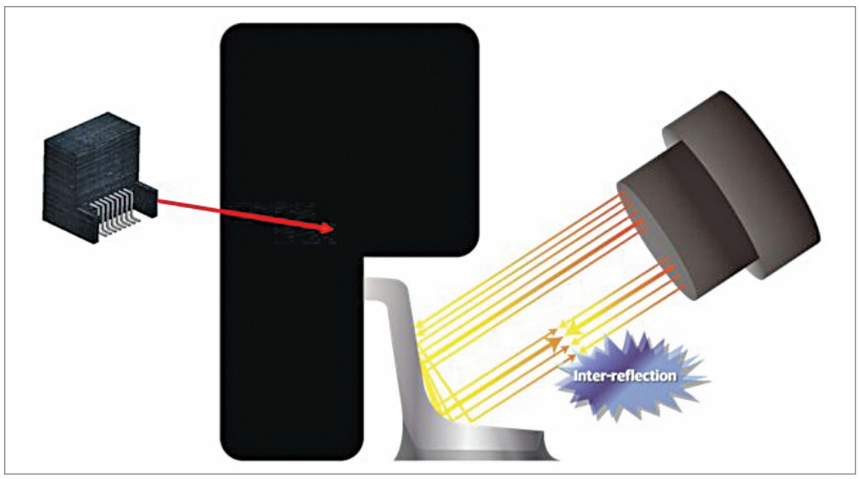


Fig. 3: Single projection's problem with specular areas (Source: Koh Young Technology)

"To avoid faulty solder joints, defects, false calls, and costly rework, we may need easier 3D solder paste inspection as well as 3D AOI inspection," says Olivier Pirou, Head, Product Management and Marketing at Mycronic, an AOI manufacturing company.

Most of the AOI solutions still offer a limited level of 3D coverage for components and solder joints. But a full 3D coverage is needed to identify defects. These full-coverage 3D AOI systems not only inspect common defects, such as missing or wrong components, but accurately provide true volumetric height, identify coplanarity, and lead-bridging issues.

Some 3D AOI solutions have used the multi-frequency shadow moiré technology. Unlike 3D AOI systems using a brightness threshold, the moiré technology uses the height threshold to extract critical body and the lead tip information. This data allows the AOI to provide reliable body and joint measurements with CAD dimensions. It can locate the body properly in the first stage of the inspection process.

However, 3D inspection systems also have disadvantages. This approach cannot check for printed part nomenclature, polarity marks, or colour. Even after using multiple digital projectors, shadowing may occur. Therefore, some additional programming may be required to train inspection components. Using 3D inspection can increase cycle times as projectors may need more time to project multiple fringe patterns needed for image processing. And lastly, machine costs are comparatively high as the technique is not yet mature.

Shadow problems

The shadow problem is inevitable even in 3D inspection machines. When various components are assembled on a board, some short parts like resistors may be shadowed by tall neighbouring components like connectors. This may lead to inaccurate 3D measurement results.

Many manufacturers use an 8-way projection mechanism shown in Fig. 1 that could possibly eliminate blind spots and construct a true 3D image by using multiple projectors.

Board warpage

Sometimes, on a warped board, pad positions defined by board CAD or Gerber files appear distorted. This may confuse conventional inspection systems and generate incorrect data. The board warp becomes a prominent issue during the reflow process because of high temperatures.

Creating new advanced algorithms can possibly address this challenge.

Inter-reflection and solder joint problems

Inter-reflection is a common issue in most optical systems, where light itself becomes the source of information. In the PCBs, soldered and tinned components on assembled boards may have specular surfaces, which reflect some lighting back to the camera while creating strong inter-reflection with other lighting reflections. In such a case, some reflected light does not reach the camera and generates false signals that provide incorrect measurement details.

Some AOI systems today overcome this with the use of superior multi-view sensors. Using these multi-view sensors and advanced 3D image fusion algorithms, it is possible to obtain error-free measurements.

Measuring a solder joint is a complicated task as each solder deposit may vary according to the design and printing conditions. Specular reflections in these will not allow to detect solder defects.

Regular challenges in AOI

- Greater need for programming, which is complicated and cumbersome
- Capacitance values are different and the specifications and colours are the same, which can easily lead to missed judgment
- Different character processing methods cause large differences in polarity judgment accuracy
- Most of the AOIs' understanding of virtual welding is ambiguous, resulting in missed judgment
- There is a problem in detection of Pingyang, shielding cover, and shielding point
- It is impossible to detect solder joints where BGA, FC, and other flip-chip components are not visible
- The detection speed of most AOI products is slow. Speed of a few AOI using scanning methods is faster, but the rate of misjudgment is higher

Apart from these challenges, more overlooked problems that lead to misjudgment and missed judgment are usually inevitable.

State-of-the-art inspection machines

With all that said about AOIs, let us have a look at some of the latest AOI machines.

Omron's S10 series. It is a full colour system, offering a unique mix of general-purpose and application-specific solutions. S10 series enables flexible manufacturing, responds to shortages in manpower, and demands for higher quality production. Elimination of shadow and secondary reflection with 4-direction MPS projectors allows stable inspection of fine parts and enables visibility even at the connector solder joint. (*https://industrial.omron.eu/en/news-events/news/introducing-the-worlds-most-advanced-3d-aoi-system*)

Mycronic's MYPro series 3D AOI system. This newly designed user interface with intuitive programming guidance and self-optimising process control algorithms ensures easy implementation of high-performance 3D AOI for any type of production mix or class by operators of any experience level.

Saki Corporation's 3Di-LS2-CASE. It significantly reduces the number of false calls in the inspection of solder defects (non-wetting) that is difficult to achieve with conventional 3D-AOI technology, and dramatically improves the speed and accuracy of solder defect detection. (*https://metrology.news/next-generation-3d-aoi-system-with-artificial-intelligence-selected-by-denso*)

CyberOptics's SQ3000+ multi-function system. The SQ3000+ multi-function system for inspection and metrology not only conducts AOI and SPI but claims to deliver in-line, full coordinate measurement (CMM) data in seconds. The new SQ3000+ offers a combination of high accuracy and high speed with an even higher resolution multi-reflection suppression sensor that inhibits reflection based distortions caused by shiny components and surfaces. (*https://www.businesswire.com/news/home/20211103005180/en/CyberOptics-Receives-Two-Awards-for-New-SQ3000%E2%84%A2-Multi-Function-and-WX3000%E2%84%A2-Systems-during-SMTAI*)

TABLE 1
COMPARISON OF INSPECTION SYSTEMS

Defect type	AOI	AXI	ICT
Soldering defects			
Open circuits	Yes	Yes	Yes
Solder bridges	Yes	Yes	Yes
Solder shorts	Yes	Yes	Yes
Insufficient solder	Yes (not heel of joint)	Yes	No
Solder void	No	Yes	No
Excess solder	Yes	Yes	No
Solder quality	No	Yes	No
Component defects			
Lifted lead	Yes	Yes	Yes
Missing component	Yes	Yes	Yes
Misaligned or misplaced component	Yes	Yes	Yes
Incorrect component value	No	No	Yes
Faulty component	No	No	Yes
BGA and CSP defects			
BGA shorts	No	Yes	Yes
BGA open circuit connections	No	Yes	Yes

(Source: Rayming PCB & Assembly)

Can AOI do it alone?

Automatic optical inspection works well in PCBs with clearly visible solder joints. However, many PCBs today are using other technologies, such as ball grid array (BGA) integrated circuits or chip scale packages (CSPs), where the solder joints are not visible. Such cases may need extended support with automated X-ray inspection (AXI) equipment that can check solder joints under components.

Manufacturers can consider ways to combine the inspection technologies rather than choosing between them, depending on the complexity of the PCB. Each of their advantages can be carefully balanced against cost to suit a particular production environment.

"AOI and AXI have been following the trend of most recent technologies to provide more performance for less cost. Another recent development is the portability of data between AXI and AOI systems from some suppliers. The ability to share libraries, inspection programs and statistical process control (SPC) data between AOI and AXI systems can greatly enhance machine usage and defect coverage. In addition, programming the systems of today is fast and intuitive. Operators are now able to quickly and easily create inspection programs and manage daily runtime operations with very little intervention. As a result, both high-mix and high-volume manufacturing lines can recognise immediate yield improvement and automated inspection results," says Kevin Garcia, Applications Engineering Manager, Nordson YESTECH, an inspection equipment manufacturing company.

The advantages of current-day inspection systems over price and performance are becoming the driving force to handle dynamic manufacturing environments in giving successful yields. EFY

THE SEASON OF IPOs: Are You Thinking Of Going Public Too?

More and more organisations in India are filing to go public and raise funds. But why aren't they taking the foreign investment route instead? Should you, as an electronics company, file for an IPO? If yes, what are the checkpoints, and what are the challenges?

MUKUL YUDHVEER SINGH

The years 2020 and 2021 have been important for electronics. The government of India has launched numerous production-linked incentive (PLI) schemes for promoting indigenous manufacture of electronics within the country. Recent announcement for promoting manufacture of semiconductors and displays in the country is promising incentives of ₹760 billion.

What makes the previous two years more important for the electronics sector is the number of Indian electronics companies that have filed for Initial Public Offering (IPO), the most recent addition being Foxconn's India subsidiary. Foxconn, being the giant it is, could have easily invested in its Indian subsidiary, but it chose to take the IPO route. There is Data Patterns and Paras Defence from the strategic electronics sector, Lava Mobile from the smartphones and feature phones segment, Waaree from the solar segment, Elin Electronics and Syrma SGS from the EMS segment, and more!

The ones that have already listed themselves are witnessing a strong response from the market as well. For instance, aerospace electronics solutions provider Data Patterns' IPO saw massive interest from investors as the issue was subscribed 119.62 times on the last day of bidding. What makes these IPO filings more interesting is the fact that there was a gap of more than six years between two electronics component contract manufacturers filing IPOs in India.

PG Electroplast had floated a ₹1.21 billion IPO in September 2011, while Dixon Technologies filed for IPO in May 2017. The latter's share price, as of December 28, 2021, was ₹5,645, and it was originally subscribed by the market at a price upwards of ₹2,200 in 2017. Similarly, the shares of PG Electroplast are being bought and sold at around ₹790 today, whereas these were being traded in the range of ₹100 to 150 during the year 2015.

"While many of the IPOs are still in the draft stage, the overall electronics industry presents a strong growth opportunity for investors. A large end-user industry, scalability of companies, availability of labour, capital, and a robust policy ecosystem have created a long runway of growth opportunity for these companies, and this is already being noticed and rewarded by markets from the kind of returns delivered by Dixon Technologies, one of our top holdings," says Abhay Agarwal, Founder, Piper Serica, SEBI registered PMS.

ELECTRONICS COMPANIES THAT HAVE FILED IPO PAPERS RECENTLY

Name of Organisation	Origin Year	Expectations
Bharat FIH (Foxconn)	2015	>₹50 billion
Syrma SGS Technology	Merged in 2020	>₹10 billionr
Elin Electronics	1969	>₹7.6 billion
Data Patterns	1998	>₹6 billion
Paras Defence and Space Technologies	2009	>₹1.5 billion
Maini Precision Products Limited	1973	>₹8.5 billion
Lava International	2009	>₹14 billion

Organisations rumored to be filing IPOs soon: 1. Boat, 2. VVDN, 3. Alpha Design

Why so many IPOs

The way the India based electronics companies are filing IPOs one after another is something that has surprised not one but many share market gurus.

"There are several factors motivating electronics company IPOs, including a stronger-than-expected recovery in the economy after the second wave, continued FPIs and domestic flows in the markets, an increase in retail participation in the stock market, and policy ecosystem which is favouring electronics companies and creating growth opportunities at a level playing field with most global companies," explains Agarwal.

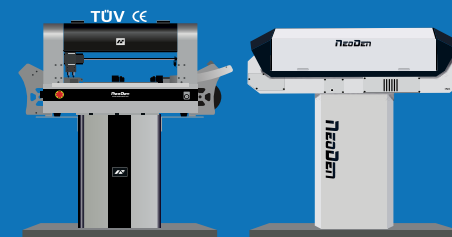
The first and foremost reason encouraging Indian electronics companies to go public seems to be the increased size of the electronics manufacturing market. India's domestic electronics manufacturing industry, as per a MeitY official, is expected to be worth nearly ₹7 trillion. These figures represent 30% growth in the coming fiscal. Then there are heavy-weights like

NeoDen Auto SMT Pick and Place Assembly Line



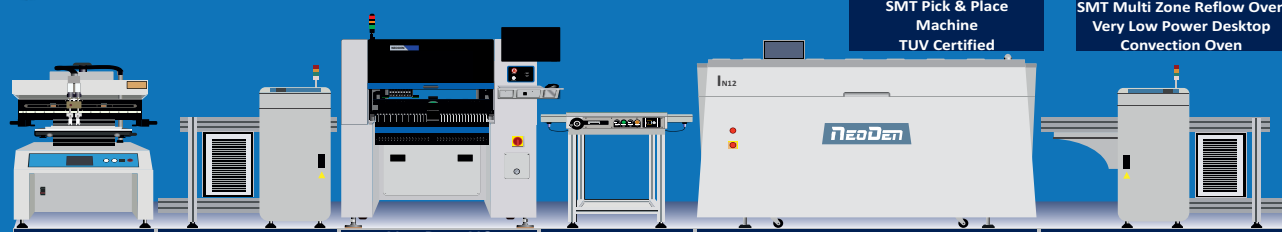
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TUV Certified

NeoDen IN6
SMT Multi Zone Reflow Oven
Very Low Power Desktop Convection Oven



CM-2535
Semi Auto SMT Printer
0.8 Meter

CM-L300
SMT PCB Auto Loader Machine
1.1 Meter

NeoDen N8
SMT Pick & Place Machine
1.5 Meter

J15
External Linkage Conveyor
1.5 Meter

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Samsung announcing big plans for the Indian market. Apple's suppliers, including Wistron and Foxconn, are also investing millions of dollars in the Indian market.

"It's obvious that big names coming and setting up shop in India would mean mammoth business opportunities for Indian companies, and to grab a hold of these opportunities the companies will need a lot of investment. IPOs are one of the best ways to gather this investment for the future," says K. Krishna Moorthy, CEO, India Electronics and Semiconductor Association (IESA).

Second, the incentives on offer by the government of India are more than ₹900 billion. The PLI schemes include IT hardware, telecom, white goods, solar cells, battery cells, healthcare devices. Add ₹760 billion for semiconductor manufacturing, and India's electronics sector starts looking as the most attractive out there.

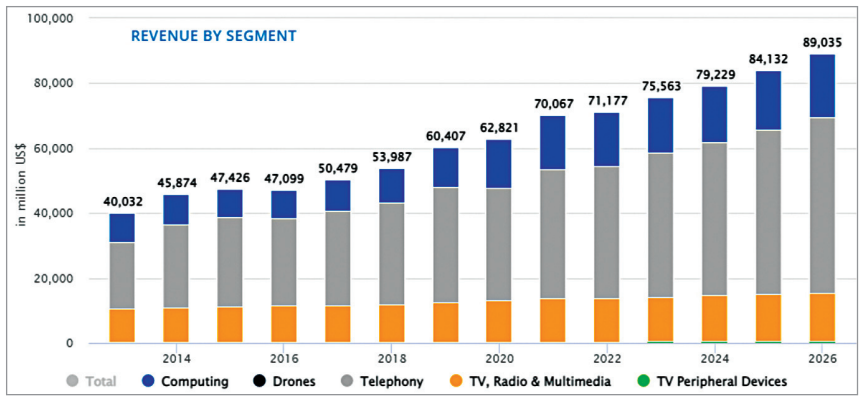
"The quantum change in the mindset has primarily come from the push for local manufacturing. Earlier it was always easy to import and sell, rather than manufacturing here in India. The policies being driven by the government during the last five-six years are the biggest encouraging factors for companies to invest in manufacturing. There is a predictability to the whole world of electronics now," says Krishna.

He adds, "Earlier there were instances of duty being reduced in a year and then increasing it again. It used to go back and forth. The number two reason is the market. Not only are we trying to develop self-sufficiency for the Indian market, but we have also started exporting to many international markets."

The biggest examples of India being a wealth-generation opportunity for electronics companies are smart energy meters and smartphones. Companies manufacturing and supplying these in India, from India, as per Krishna, do not need to look beyond the local markets for generating wealth. The proposed Power Distribution Reforms Scheme envisages to install 250 million smart meters, 10,000 feeders, and 400,000km low-tension overhead lines, while about 2,470,325 smart meters have already been installed in India.

"Forget about export, such verticals of the industry can be sustained from business in India itself. The market, in terms of local consumption, is becoming bigger and better. People now think that the new policies are worth giving a thought and chance," he says.

Moreover, a lot of the companies filing IPO recently have existed for over five years. Faisal Kawoosa, Founder & Chief Analyst, TechArc, believes that it is natural for these companies to file IPOs. Though Foxconn's Bharat FIH was established in the year 2021.



Revenue from consumer electronics segment (Statista)

"It is but natural for such companies to file IPO as they need massive funding. The kind of funds these companies will require can only be raised by going public. The scale at which these companies are today requires them to go public. Otherwise, they will not be adequately resourced, and they will not be able to expand the way they want to," explains Kawoosa.

He adds, "The recent developments like the announcement of PLI schemes have shown a much bigger scale for electronics to such companies. Their potential addressable market, with PLIs, has now stretched beyond India." He explains that to meet the expectations the new scale has put, electronics companies will need a lot of funding, and the best possible way to source that funding is the public route.

Talking about the new scale and then taking an example from the consumer electronics vertical makes things a lot clear about the future of electronics in India. The country is already among the top markets for consumer electronics despite the fact that the penetration rates are still south of 30 to 35%. A report by Statista mentions that revenue in the consumer electronics market (India) has already amounted to US$70,067 million in 2021. The same is forecast to be worth $89,035 million in 2026.

"The market is so vast that even the smartphone companies have started offering consumer electronics beyond smartphones," shares Kawoosa.

Why IPO and not foreign investment

A close look at the factors mentioned above and it becomes easier to guess that all of these are interconnected. Whether it is the increasing market size, the rising geo-polititacl tensions, or the recent PLIs announced by the government of India, all appear to be placed there in a definite pattern.

But why aren't these companies instead of filing for IPO choosing to partner with MNCs for investment?

"Going public majorly means that the controls of the company will majorly remain in the country. People do realise that once they go for a foreign collaboration, most of the foreign partners go for 51:49 kind of partnership, where the 51% belongs to them and the rest belongs to Indian entities. This 51% gives them the decision-making powers. I do not think any Indian company would want that, keeping in mind the way opportunities in the country are growing," explains Kawoosa.

Foxconn's India subsidiary presents a good example of an Indian company trying to raise funds via the public route. The technology group posted revenues of around $178 billion in the year 2019, and in India it is looking to raise around 50 billion rupees through the IPO. The company's IPO will be offered with a 75% reservation for Qualified Institutional Buyers (QIBs), 15% non-institutional investors (NIIs), leaving a meager 10% for retail investors. Would it have been difficult for Foxconn to infuse money in its Indian subsidiary?

"There is no doubt that foreign companies are also investing in India. Dixon had multiple partners who could have invested a lot of money, but they preferred to go with the IPO route. What would you pick when it comes to servicing international debt versus equity? At some point of time equity is going to look better," explains Krishna.

He adds, "The pure-play Indian companies will not prefer foreign investment unless they have subsidiaries already established in and outside of India."

Then comes the 'vocal for local factor.' It is but natural that individuals investing in IPOs will have a lot of confidence in the companies they are putting their money in. The scenario is somewhat like investors funding startups. A good investor in a startup attracts others to put their money in.

Moreover, the likes of Rakesh Jhunjhunwala and others putting their money in electronics companies' stocks has already proved what the move can do. As a matter of fact, what's happening in India now has already happened in countries like the United States, China, Germany, and others.

Should you consider filing for an IPO?

The electronics firms thinking of taking the public route should keep in consideration that filing for an IPO is one thing but being able to generate good market response is another. Right now, the market looks a lot favourable for the electronics companies, but success in the long term depends a lot on not only the company's performance

but the continuation of the right set of policies, and a lot of other things.

"The companies looking to file IPOs should have been in the business for at least five to eight years. Companies which started two to three years back should refrain from investing in filing IPOs. Instead, they should be more focussed on building their dominance in what they are doing," Kirshna opines.

Further, the returns that a company filing or thinking to file an IPO expects should always be kept in mind. The company looking to raise funds via the IPO route should be clear in formulating and conveying what it intends to use the funds for. The checklist also contains owning IPs and product development.

"Whatever kind of investment is a responsibility for the company. If my company does not own an IP or does not have any kind of product development under my belt, then I am just a contract manufacturer. Yes, I do have scales of production, but it will never be seen as long-term by the market or the investors," says Kawoosa.

He adds, "It's important to calculate whether the expected returns will be lucrative enough or not. Will these be as lucrative as returns garnered by BFSI, services, or IT companies. You have every breed of investors. The shares may not be high retuning ones but fundamentally these will be the strong ones."

Trade wars and global disenfranchisement with China has also led to shifts in global manufacturing to alternate locations like India. India with a large and growing domestic electronics market (US$110 billion) and affordable labour is attracting high-ticket investments.

"The development of a robust electronics component ecosystem in India is expected to increase domestic value addition from present levels of 34% to more than 50% by 2025. We believe all these factors converging together will provide a good wealth creation opportunity for investors," says Agarwal.

The global scenario in terms of electronics manufacturing is changing. OEMs and ODMs are resorting to automated processes, whereas the Indian companies are still majorly dependent on human labour. For instance, there were reports of Foxconn's India plant being shut for more than two weeks in the month of December 2021 due to protests by workers.

"There is smart manufacturing, robotics manufacturing, and implementation of IIoT already taking place. A lot of the countries that were not so open for manufacturing will now also think of manufacturing. The decentralisation of manufacturing has begun in China. How are the Indian companies filing for IPO going to address the challenge of automated manufacturing three years down the line?" asks Kawoosa. EFY

The author, Mukul Yudhveer Singh, is a technology enthusiast

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EXNOVATION: Another Side Of INNOVATION

Once a product has been developed well and accepted by the consumers, do we need to keep tinkering with it and try improving it further? Well, the principle of exnovation advises against doing so. And there are, obviously, valid reasons for that





ANAND TAMBOLI is a serial entrepreneur, speaker, award-winning author, and an emerging-technology thought leader

Too much of anything is bad; for business and for anything else as such. Innovation is not an exception. Obviously, you cannot keep innovating the same product or process repeatedly. Not for the extended period. Therefore, we need to talk about the other side of the innovation coin—exnovation!

You may have barely heard of the word exnovation. The earliest usage of this term was observed in 1981 when John Kimberly referred to "removal of innovation from an organization." In 1996, A. Sandeep provided the modern definition of exnovation as the philosophy of not innovating. In other words, ensuring that best-in-class entities are not innovated further.

However, exnovation still has not become common parlance, at least in the intended way.

Why exnovation

The basic definition of exnovation is self-explanatory and quite simple *per se*. However, why do we need it is still a question. Especially if we are comparing it with the continuous innovation paradigm.

When should you call it a day and stop continuous innovation? And, of course, this itself demands a balanced strategy.

But, let me assure you that exnovation is not about refusing innovation in the company. It is about channeling it and narrowing the process down over a period. For example, you may be soliciting innovative ideas from almost everyone initially. It is the phase of exploration where quantity over quality matters. This is when you want everyone to think innovatively and contribute their ideas.

Exnovation is not about refusing innovation in the company. It is about channeling it and narrowing the process down over a period.

However, once you shortlist a few ideas to implement and the execution starts, there is no need to get more of the same ideas again. Moreover, once the changes are made, a new product or process is introduced, and the innovation has been implemented, it is time to reap its benefits. At this stage, colluding tried and tested outcomes with some more new ideas does not make any sense. It only delays the payback.

This is the stage when the focus must shift to exnovation. Earlier, you may have encouraged people for being more in-

novative. However, you must also encourage them to comply with the newly established product or service process. Then only the innovation that you implemented will result in profitable returns.

When and where to use it

Interestingly, in his book, "The Myths of Innovation," author Scott Berkun writes, "Competence trumps innovation. If you suck at what you do, being innovative will not help you. Business is driven by providing value to customers. Often, that can be done without innovation; make a good and needed thing, sell it at a good price, and advertise confidently. If you need innovations to achieve those three things, great, have a go at it. If not, your lack of innovation isn't your biggest problem."

This thinking highlights an important principle of exnovation. For a multinational company with a presence in different geographies, you often face region-wise challenges. These challenges result from apparent differences in consumer behaviours compared to the parent market of the company. So, how do you manage such matters?

In my experience, a set process and structure of innovation and strategy are important. Additionally, specialised teams with vested authority make a good fit here. They can study the local market's needs and see how they could be fulfilled within the existing system. Then, if any changes are to be made, they can tailor the existing process, products, or system. I wrote about these special-purpose teams in a previous article in this series.

Special-purpose teams play a crucial role in innovation as well as exnovation.

During my tenure with LG Electronics in India, each LG factory had its own R&D and TDR (special-purpose tear down re-engineering) teams. So, we would work on joining and separating innovative projects all the time. But when it came to feedback from the local market and adapting the products, each team had a degree of freedom to work on it for making necessary changes that suited the local market and implemented them at scale. And for those improvements that were nationally or globally applied, the company made sure that these improvements got adopted by all.

The point is, if changes in established design and processes are to be made to suit geographic needs, teams need to be empowered to experiment with those changes first. Then, once validated, there must be a process to recommend them to other units and have them formally introduced or regularised for all, when applicable. Once done, it becomes a standard process again, which need not be tampered with any further.

> EXNOVATION IS ABOUT HAMMERING OUT A PROCESS AND STRUCTURE TO IMPLEMENT IT AT SCALE. ONCE ESTABLISHED, EVERYBODY NEED NOT INNOVATE BUT IMPLEMENT IT TO THE 'T.'

Important piece in innovation puzzle

Exnovation is not about saying no to innovation. It is about hammering out a process and structure to implement it at scale. Once established, everybody need not innovate but implement it to the 'T.'

Counterintuitive but true. You can then put a team in charge that will check processes and structures throughout the organisation and improve them when the need arises. Exnovation means the opposite of innovation only to an extent. Mainly, it is about keeping a check on the innovation process in your company.

Once a process, product, or system is evaluated, validated, and almost mastered by the special-purpose team in the organisation, the next step is to put in place a critical system. A system that will ensure this new change is replicated across branches, departments, units, factories, or similar groups within your organisation.

Ensuring the process is implemented without any alteration is highly important. No one within the organisation should be allowed to tailor the process further for whatever reason.

Innovation can give an organisation the much-needed big leap, but only if favourable processes and systems are passed on and repeated seamlessly by all involved. A strict check on customisation by anyone at random must be kept. Let the special-purpose teams take that call. Give them the liberty and latitude to manage it.

The point is

In defense, not everyone is a commanding officer. In orchestra, not everyone is a conductor. In an organisation, not everyone can be an innovator.

If you want to be an innovative company, you cannot be one without the process and structure around it. Whether it is around innovation activity or the downstream delivery mechanism to deliver it, innovation and process within a company must coexist and feed off each other.

Innovation, in its true sense, includes creating culture and systems that help in effectively sustaining innovation. Your people and innovation teams are central to promoting internal and external collaboration. However, for innovation to be really nurtured, you need to establish a solid process with clear communication and appropriate employee training.

It is not just the effort that we put into innovation that decides success. It is how we go about innovating, its structure and its process. EFY

Policy

How GOVERNMENT DRAFTS POLICIES, And How YOU CAN CONTRIBUTE



Are policies and schemes the same thing? What's the process that the government follows to make new policies and schemes? What are the ways an individual can contribute to government policies? The government of India has introduced production linked incentive (PLI) schemes around electronics manufacturing worth more than ₹900 billion. Do you know how you can contribute to the making of such policies, or schemes? We got in touch with Amit Kumar Jha, a former advisor to the Ministry of Electronics and IT (MeitY), to understand the process and bring out the stages where individuals can contribute to the process of policy making.

Can you explain the process of policy making followed by the government?

Policies are made by every organisation, be it government or industry. Policies are a set of rules that an organisation adopts to achieve a certain outcome or a goal. The key objective of government policies is public good.

Policy formulation is usually taken care of by the bureaucrats, the civil servants or IAS officers, as we call them. They are the backbone of public administration in India. The group of civil servants makes a policy, or a scheme, as diverse as it can be. This is because a group of bureaucrats usually consists of civil servants coming from different locations and parts

AMIT KUMAR JHA
A FORMER ADVISOR TO THE MINISTRY OF ELECTRONICS AND IT (MeitY)

of a society. You have engineers, doctors, and a lot more types of civil servants working on the same policy.

They think through each part of a policy and reach the final stages through hierarchical levels. They work through local stages, then move to a state before finally moving to the Centre.

Do you think there are any weaknesses in the current policy process?

Yes, any system cannot be perfect. Please take whatever I am saying with a pinch of salt but there are times when the government is not able to segregate policy formation from policy implementation. However, things have started to improve. For example, the PLI schemes in question were formulated by the government, but the implementation is in the hands of some other agency.

Another problem that I see is the amount of fragmentation in the current system. It's more like blindmen and elephant syndrome where we all perceive it in a different way. There are many times when subject matter experts are not there, and the policies end up missing wood for the trees.

The good part is that a lot of reforms are taking place. Prime Minister Narendra Modi recently announced Mission KarmYogi where the civil servants will undergo training to think constructively using the best technology available today. The government has also started hiring lateral entries at joint director and secretary levels. The best part is that these people are hired directly from the industries. Then there are think tanks and media groups like EFY which are constantly helping the government of India in formulating new policies.

Can you explain policy making in terms of the electronics sector?

The government starts with identifying a problem. For example, the absence of electronics manufacturing in India is a problem. Then come questions like why electronics goods are not getting manufactured in India; what are the issues vis-a-vis other countries? The government then analyses the choices it has in terms of helping the industry start electronics manufacturing in the country. These choices might be in the form of starting mobile assembling in the country before moving on to manufacturing. Then comes the question whether we should start with mobile assembling, or with component manufacturing and assembling?

The government usually checks a lot of alternative choices before finalising a scheme, or a policy. This is because the decision taken in one situation may or may not be true for other situations. All the alternatives are then discussed, and the final decision taken.

Where does the trigger for a new policy come from?

There are various mediums that trigger the initial stages of a policy. The trigger could come from a media report, from a meeting with an industry association or an individual. It can come from an announcement made by a country like China in terms of electronics manufacturing. There could be a trigger from a think tank or an NGO as well. The trigger can be from an election manifesto as well.

You won't hear about some public policies in the media because of their sensitive nature. Then a lot of policies are not highlighted as they cater to only niche areas. The journey of a policy starts with a wider consultation. For example, when we worked on the NPE 2019, we identified all types of electronics with the help of committees and subcommittees, and also through consultation with industry associations.

Once formulated, these policies become the Bible for ministries. The NPE 2019 is a Bible for MeitY. Further, to accomplish the objectives of the policy, various schemes and programmes are made and launched. PLI was formulated to help achieve objectives laid down by the NPE 2019.

How can someone, not a part of any industry association, contribute to such policies and schemes?

It is important to understand that industry associations have a major role to play. They consolidate the views of a particular industry and present them to the government. Industry associations, many a times, co-create a lot of the things with the government of India.

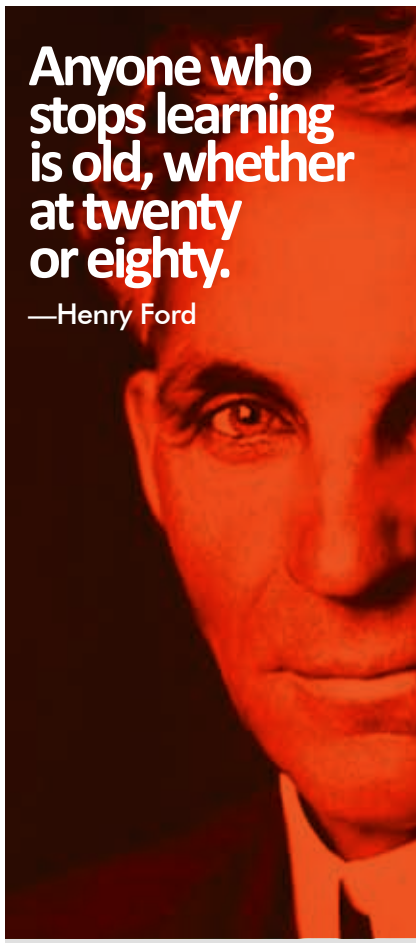
It is usually not possible for a private organisation, because of the bandwidth, to reach out and try and help the government in policy making. This is where the associations have a bigger bandwidth. The associations are the eyes and ears of the government in many cases, and it makes sense for associations to play a bigger role in policy and scheme matters.

For an individual, it is important to channelise his voice and thoughts through an organisation or any other medium. It is not just about making your voice heard, it is also about making sure that your voice is genuine. Going to the government via an organisation, or an association, is the easy way for an individual, according to me.

Otherwise, one can directly write to the government. There are portals like MyGov where the government itself invites views from individuals. The MeitY startup hub is giving opportunities to students, entrepreneurs, and individuals in policy making.

Your suggestion to individuals, SMEs, MSMEs would be to join industry associations?

Not necessarily. Associations might have their own objectives and understanding of the subject matter. Individuals can contribute to policy making as subject matter specialists also. The government also looks for such individuals in the policy making process.



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The easier way is to be part of a like-minded group, work on something together, and then present it to the government.

What if an organisation cannot afford to be a member of an association? What would help then?

It is all about relationship building. The government bodies operate around their structure and codes of conduct. Once you get into relationship building with the government, there will come a time when your voice will be heard. It might take some time, but you would have to prove your worth to the government in terms of what you can do and help the government achieve.

Even for an individual, if there is a strong business case, you will be heard. I, in my tenure with the government, have found that the government does take cognizance of the issues raised by an individual, provided the issues are genuine. It is not difficult for an individual to contribute to a policy. However, never go to the government with a problem, but with a solution as well.

What is the best way for an individual to get heard, as different ministries must be receiving an infinite number of emails?

If you have good intent, you will never miss out is something I always say. Advocacy is with everyone. If the objective is good and the intent is strong enough, it will always get heard. Writing to ask is an art that you should master before reaching out to the government.

Your proposal should be backed by solid research. If you tick all the boxes, then it would not matter whether you are an association or an individual; all that would matter is your research and intent. If you have researched well, and you know exactly what you are presenting, and the kind of impact it can make, there is no way you will go unheard.

Is there a stage where the government extends its arm and consults associations and individuals?

Consulting is done at almost all the stages of policy making. A policy never comes from the dream of a government officer. It is only from the industry that they get some hint, or some trigger. The first draft is prepared after rigorous consultation with the industry. The consultative process happens at the beginning, it happens at the mid-level, and also at the last stages of policy drafting.

The key word here is engage, and one has to engage with the government. Government does not run a "May I help you?" kind of a counter where you go and tell them about your research about a particular matter. There are several events hosted by the government where you can engage in a conversation with it. My two cents for individuals and associations include constant engagement with the government and developing a habit of co-creating with the same. All the policies have a tangible as well as a non-tangible aspect.

What do you mean by relationship building?

One should always be in a consultative process with the government. Though companies cannot reveal everything about them to the government within the first meeting. There are a lot of portals now being used by the government to invite feedback. One should always keep an eye on these portals as the policies are uploaded on these for consultation. Relationship building, as per my understanding, is more of participation. It is not a government policy; it is your policy.

Some of the portals I remember are InvestIndia, PIB, and MyGov. One can also log into the websites of different ministries. However, there is no one-stop shop for getting what you need. What you need to do is a combination of hard and smart work. EFY



AMRIT MANWANI
MANAGING DIRECTOR,
SAHASRA GROUP

KEEP THINGS SIMPLE And SUCCESS Will Come KNOCKING At Your DOOR

He hails from a humble background. His parents had migrated from Pakistan to India (Udaipur, Rajasthan) during partition. His elder sister was born on a railway platform. He quit as vice president of one of the biggest companies on the face of the Earth to start a venture. Today, he has invested almost everything to become the first company in India to package semiconductors and ICs. This is Amrit Manwani's story as told to Mukul Yudhveer Singh from EFY

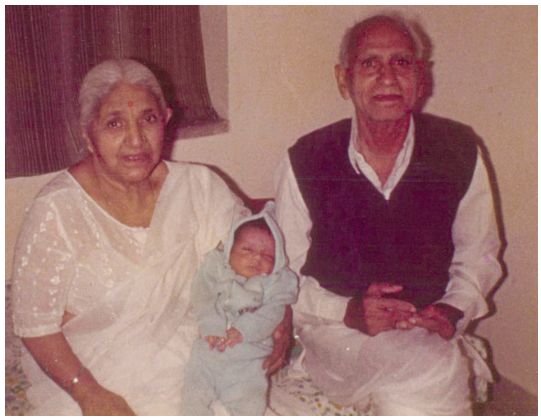
"I consider myself very lucky in terms of what I have been able to accomplish in my life. Nothing I have built would have been possible without the support of my parents, my school mates, my teachers, and the two jobs I had. I consider that every person I have met in my life has been instrumental in making me a man as I am today," says Amrit Manwani, MD, Sahasra Group.

Not have among the haves

Born in Udaipur, Rajasthan, Amrit was born into a family which had recently moved from Pakistan to India. Amrit's father, Narayan Das Manwani, as described by him, was the hardest working man he has seen in his entire life. The family had to leave back everything it owned in Pakistan and start a new life in India. Amrit's father started a sweets shop in Udaipur. The first story that Amrit heard from his parents was probably that of how his elder sister came into being, a story that can send chills down anyone's bones!

"My elder sister was born on a railway platform. This was the time when my parents were migrating to seek refuge in India from Pakistan. I still get goosebumps remembering that story. That incident, though I was not in the world till then, has left a big impact on my mind. I still can't picture how my mom and dad managed to go through that, and still give each one of us brothers and sisters a good life," he shares.

Amrit continues, "My father was visionary enough to put me in a missionary school despite all the difficulties we faced in Udaipur." Amrit completed his primary schooling from St Mary's and secondary from St Paul's. These two schools were known to have students originating from financially strong backgrounds. Getting a chance to study with the



Amrit's parents with his son Akshay

elite of a city proved to be one of the biggest encouragements in the life of Amrit.

"I always felt like I was not a have among the haves. That formed my determination to do well in life. I wanted to become one of them as life progressed. My schoolmates made my determination strong to succeed in life," he explains.

Amrit's biggest inspiration is his father. He would spend hours preparing the finest of sweets to make sure that business was good, so he could afford good education for his children. The population of Udaipur, as Amrit shares, was only about 25,000 people back then. The competition between the sweet shops was cut-throat and anybody who compromised on quantity or quality immediately witnessed a dip in sales.

The financial condition of the family was so weak that Amrit's elder brother had to leave education and help his father at the sweets shop. It was Amrit's father who backed the decision of Amrit preparing for the IIT exams. Most of his other family members did not know about IIT and hence did not back him for taking the exam.

"He told me to prepare for the exams with complete focus and determination. He would tell me that even if I am not able to make it to IIT, I would always have a sweets shop to run and earn from," Amrit recalls. There were only two students who made it to IIT from Udaipur at that time. How did Amrit learn that working hard is the key to success?

He answers, "I remember my father cycling 10 to 12 kilometres every day at 4am in the morning to get milk from a nearby village for our sweets shop. He would put milk containers on both sides of the bicycle. I took it from him to always work hard."

Amrit was so encouraged by his father that he would come back from school and immediately finish homework and start reading for the next day. Amrit was found solving math more often than not. The amount of time that Amrit was spending on books can be gauged from the fact that his mother scolded him to stop studying as she believed that spending that amount of time would ruin his son's eyesight.

"I used to study in the light of earthen lamps before electricity came to our house. My mother would always become anxious as she saw me continuing to do math for hours in the light of the earthen lamp. The attitude of doing hard work came from my father," he says. Amrit was so good at studies his school principal gave him a double promotion and he was promoted to fourth standard straight from second standard.

First business lessons

Amrit, known to have a sharp brain when it comes to business, had his first business classes at his father's sweets shop. These business lessons not only included selling to end consumers but also manufacturing products to be sold. He would also sit on the counter at times and manage the cash inflow. Amrit started helping his father at the shop when he was seven, and the first job his father gave him was that of sourcing ingredients used in preparing sweets. Any incident that he still remembers from those days?

"There was this time when I had lost money that my father had given to buy some ingredients. I was so scared that I didn't go to my shop and my father started searching for me. When he finally found me, he hugged me and told me not to worry as he saw me crying. Those were the golden days of life," recalls an emotional Manwani.

This incident, as he shares, was the one which taught him the opposite of what was taught in a lot of business schools. He got certain that day that people who are emotionally attached to their profession, and other people who work with them, are the ones that can accomplish anything.

"I was never fond of eating sweets. In fact, I also quit cooking a long time back. And I must tell you that I was a master at preparing sev namkeen at a very early age. I was also good at making rabdi, gulab jamuns, and kulfi. If my father were to listen to this statement today, he would twist my ear and tell me that I could have prepared sweets (at the shop)," he shares with a smile and eyes full of light. Amrit, who quit cooking a long time ago, never missed a chance to cook rabadi or prepare kulfi for his father. He also often cooked for his children when they were young.

Amrit found his slot when time came to select subjects for the ninth class and start focusing on them. "I was a good student but I also used to feel a little bit inferior in front of the other kids. There was a time when I

Facts about Amrit Manwani you do not know

1. Amrit Manwani's parents migrated to India from Pakistan during the partition
2. Amrit Manwani's sister was born on a railway platform
3. Amrit Manwani's father owned a sweet shop. Amrit knows how to prepare sweets like rabaddi, kulfi, jalebi, sev, gulab jamun, and more
4. Amrit Manwani met his wife at a job interview
5. Amrit Manwani had invested almost everything in Sahasra's semiconductor initiative

was sitting in the same class as the son of the district magistrate and other influential people. That was the time which was a big challenge for me. Studies, no matter how tough they were, were never a challenge for me," he recalls talking about the challenges he faced in his childhood.

How did he overcome the challenges?

"My goal was to study hard enough to be the best not only in the class but the whole country. I never minded anyone who saw me as inferior and I made friends with kids who were humble. I wanted to study and that was the only thing that mattered to me," he answers. Then there was a time when fellow students were lining up to learn mathematics from Manwani.

Amrit adds, "There came a time when all my fellow students started saying that if anybody would make it to an IIT from their school, it would be Amrit." His rank in the IIT entrance exam was 345 PAN India. IITs were only taking 2,000 students in its five colleges at that time, and the better the rank meant not only bettering the chances of getting into an IIT but also a chance to choose the stream of one's choice.

"The exposure to IIT, the exposure to people coming to study with you from all over the country, is extremely brilliant. Being exposed to the absolute freedom that you get at the college and hostel, and nobody to look after you is one of the biggest challenges. This is a challenge that can teach you the best of time management lessons with on-job experience," he shares.

Amrit, who refers to himself as an average IIT student, was clear from the beginning about not leaving his parents in India in pursuit of a job offer or further studies outside the country. IIT Kanpur was also affiliated to the United States situated universities such as MIT, and it was easy for students to pursue a higher degree in such universities. Amrit, who passed IIT with 7.6 CGI, got a campus placement job offer from Larsen and Toubro. Today, he also holds an MBA degree from Delhi University, which he had completed while working with GE.



Amrit with US Ambassador's wife at a party arranged by General Electric

"More than 50% of the students were hell bent on going overseas for higher studies and then a job offer. I didn't have that kind of a dream or a desire. I wanted to be around my parents as much as I could. My father wanted me to start a business while I always wanted to work in the corporate world," he shares.

Father knew, Amrit realised later

As Amrit started inching towards completing an engineering degree from IIT Kanpur, the financial situation of the family started getting better. Amrit's father then asked him to start a new business in the city of Udaipur and got ready to finance the whole business for his younger son. Amrit, however, wanted to expose himself to the corporate world and learn more about business practically. He also had an offer from Larsen and Toubro (in 1972) awaiting his reply.

"My father was disappointed to hear that I was joining a job instead of starting my own business. I convinced him by telling him that to build a successful business I will need to have exposure to working in an MNC. I joined Larsen and Toubro's Bombay office and worked there for five years. My father never missed a chance to call me and tell me to move back to Udaipur to start a business of my own," he shares.

L&T had offered Amrit to join the company as a graduate engineering trainee. Amrit joined L&T Powai facility, the only manufacturing facility that L&T operated around 1972. Joining L&T as a graduate engineering trainee meant rotation into different departments every six months. Amrit has undergone on-job training in the electrical maintenance department, the switch-gear manufacturing department, the electronics division, vendor development, and the sales & marketing division.

"I finished the two-year graduate engineer trainee programme and was promoted to the designation of a sales & marketing engineer. The HR and training department told me that I had more flair for sales than anything else," recalls Amrit.

Here was Amrit working in the sales & marketing team of L&T, the same Amrit that was helping his father in sales at an early age of ten at the sweets shop! Amrit moved from L&T Mumbai's office to its Delhi office and worked there for around eight months before making up his mind to start looking for a change. GE, at that time, was looking to expand their base in India and Asia. The company, in the process to re-invest in India, had hired only two people from the country, and Amrit was one of them.

"My father started asking me to start my own business once again when he came to know that I was leaving L&T to join GE. It was as if my father knew that I was more of a business guy and less of a corporate job guy. I did realise the same later on," he shares.

Amrit's reason behind joining GE was to explore the international markets and the marketing side of busi-



Amrit with his father Narayan Das, wife Varsha, and first born son Akshay

ness. He joined GE in the company's international marketing programme and also stayed in the USA for a while. He rose through the ranks in GE rapidly and went on to become vice president of such a big company at the age of 35. He was trained in advanced modern marketing at the Crotonville facility of GE.

"GE gave a wonderful engineering, market, and international exposure. I was fortunate to meet Jack Welsh, the CEO of GE. It was him, after my father, who ignited the fire of being an entrepreneur in me. He told all of us to be the entrepreneurs for the GE units we were heading," he recalls.

Amrit adds, "I owe learning the art of starting a business to L&T. From selling a new product to identifying the need for a new product to everything around a business, it's L&T where I learnt it all."

Both L&T and GE have been clients of the Sahasra Group. GE was one of the first companies that Sahasra had onboraded as clients. Amrit shares that being on the other side with GE was a unique experience as Amrit had already worked with a lot of people from GE, the ones that he was selling solutions to under the Sahasra brand. Amrit recalls how he pitched a solution to one of his previous bosses, who said "Amrit it will be a lot easier for you to sell to us as you know all the processes."

Amrit credits learning to do hard work and perseverance to his father, analytics ability to his math teacher, Mr Sisodiya, and the art of keeping things simple yet effective from GE's former CEO, Jack Welch." Jack used to stammer, and yet he headed one of the biggest companies on the face of the Earth. The way he simplified things was out of this world. The direction that he gave to GE is still one of the biggest learnings of my life," he says.

Bungalow to flat

It was in 1990 that Amrit submitted his papers and told his family, friends, and colleagues about the entrepreneurial journey he was heading towards. The first hint that made Amrit look in the direction of entrepreneurship included GE's joint venture with Fanuk of Japan. He is still of the view that the person heading him during this venture was below par. Your expectations are always on the higher side when you have worked with the likes of legendary Jack Welch.

"I thought I was working with somebody who had no vision. It's always good to take directions even as president of a company, but this individual was not somebody I wanted to work with or for. Moreover, I knew that I would not be given a free hand as there will be people from GE and Fanuk trying to control and influence my decisions. I was not really willing to do that," he shares.

"Second, I was no longer able to picture myself working for any other company for the next 24 years. I was 36, with at least 24 more years left in me. Third, we wanted to source PCBs from within India for a GE project, and we could find none! We reached out to a couple of companies and requested them to quote prices for PCBs. The lead time these companies were saying was six months. The same PCBs were available from the United States within two to three weeks," recalls Amrit.

This was the moment when Amrit realised there was a big challenge available to be solved in the market, a challenge that was worth the opportunity of building something of his own in India. "Why don't we set up a PCB plant was a question I asked myself. There is a market, the prices look good. I said all the right ingredients are there. I have identified the business potential," explains Amrit.

Amrit explains all the research and groundwork was done unconsciously while he was working on projects for other companies. Amrit and his partners were able to raise money from a bank consortium. Amrit explains that financial engineering is the first thing that you learn when you start pursuing an entrepreneurial life.

"The office that I started on my own, which employed around eight people, was smaller than my GE cabin. We didn't even have chairs for the vendors who came to visit us the first time. You realise cutting corners is a must when you are an entrepreneur. Sometimes you will have to be the peon and close the office doors at the end of the day. Then there is dealing with the government. How you navigate through tough waters does not come as a part of any research, it starts setting up in your mind unconsciously the day you start working," he explains.

But how does it feel leaving behind a secure job to start something of your own?

"I was not afraid but there were other things that we, as a family, had to compromise upon. For example, I was living in a posh house in Nehru Enclave when working for GE. But as soon as I started my venture my whole family had to shift to a rented small two-bedroom house in Greater Kailash. The first three years of our venture were very good. We were able to capture a good amount of market share. The business was booming," he explains.

What's a business journey with all the ups in it? The government of India opened up the country's doors to imports and the prices of PCBs

dropped by almost 50% (from 90 paise per square centimetre to 50 paise per square centimetre for double side PCB). The effect was such that a lot of PCB units operating in India decided to shut and bear significant losses.

"That was the first time when I asked myself if I had made a mistake by leaving my corporate job for entrepreneurship. Those were the toughest five years of my life. We looked at PCB assembly. I do not regret leaving my corporate job, and I do not think I ever will," says Amrit.

The Sahasra Group, led by Amrit, has an average annual turnover of more than 2.5 billion rupees. It also has a company in the United States. The group also has a unit in Rwanda. The net worth of the group is said to be 1.5 billion rupees. The group is operational in PCBs, memory products, motherboards for data servers, all-in-one PCs, and DVRs for automobiles. The group has recently forayed into the semiconductor packaging arena, and is investing close to 1.5 billion rupees in the same. It has also been selected for PLI for the same by the government of India.

"We will be working on ICs at our new semiconductor facility, and we will be the first in India to do so. The only regret that I have is, I do not have my father and mother to see their son becoming the businessman they always wanted," he says.

Love at job interview

How Amrit met his wife and the duo started dating is also an interesting story. Amrit's boss was scheduled to interview candidates for the position of a secretary. As the day came, Amrit's boss had to travel outstation for a project and Amrit was told to take these interviews.

"He guided me to test the candidates by giving them dictation. My future-to-be-wife came for an interview. Believe you me, I rejected her because of the way she handled the dictation notes. She wrote telephones in place of tenders and made other mistakes as well," explains Amrit.



4th of July 2006, life almost came a full circle for Amrit with his two sons getting betrothed

Amrit informed his boss about the interviews. He was not looking to recommend any of the candidates for the position, but his boss told him that if the candidate's (Amrit's wife to be) English was good, it was easier for them to help her with the dictations. However, this lady joined L&T with a different team. But who proposed whom?

"She lived very close to where I lived, and one thing led to another. I was the one who proposed first," says Amrit with a cute smile on his face. The journey from love to marriage wasn't easy at all. Amrit's parents were strictly against marrying their son out-of-caste. Amrit and Varsha stood firm on their ground and made it clear that they were marrying each other or not getting married at all.

"My wife has always been on my side. She doesn't see wealth as a necessity, but she never discouraged me from taking the decision to quit my job and starting a venture of my own. Yes, I have seen her worried but, despite all that, she encouraged me to start the business. If she had not been in my life, I would not have been able to reach where I am today," shares a proud Amrit.

He continues, "There used to be days when we used to have rejections worth lakhs of rupees. I would return home sad and dejected and she would sit by my side, cheer me up and assure me that everything will be alright."

The couple has been blessed with two boys - Varun and Akshay. Varun is currently helping his father at the Sahasra Group whereas Akshay, the elder son, is a writer and a sports journalist, and has also given cricket commentaries for BCCI.

What's Amrit's plan for the future?

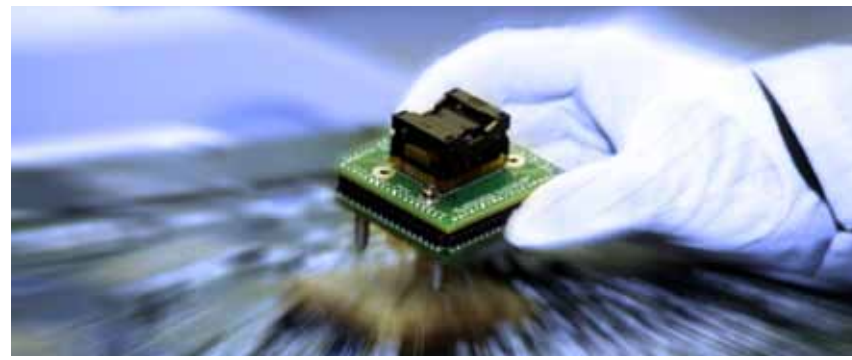
"I love enjoying single malts. On the official side I would definitely like to see the semiconductor industry grow. We have put in all we had in the semiconductor project. It is a big challenge. My dream is not just to be the first company to do semiconductor and IC packaging but also help India in exporting semiconductors. Besides that, I am also the vice-chairman in the Electronic Sector Skill Council of India (India), and I would like to see skill in the youth of India so that they can make India electronics manufacturing hub of the world," concludes Amrit. EFY

Less known facts about Amrit Manwani

- **A dish that he always requested his mother to prepare** – Lotus stem (Kamal Kakdi)
- **Favourite cuisine** – Chinese
- **Vegetarian/Non-vegetarian** – Mutton is his favourite but had to give up because of health issues
- **Cars/Bikes** – Now cars
- **Car I drive today** – Mercedes
- **Favourite Actress** – Sadhana, Alia Bhatt
- **Favourite Actor** – Amitabh Bachan, Gregory Peck
- **All-time favourite movie** – Deewar
- **A book he can read again and again** – Good Earth, Atlas Shrugged
- **One advice he could give to your younger self** – Don't follow the beaten path

Applications invited under Chips to Startup plan

MeitY has sought applications from hundred academia, R&D organisations, start-ups, and MSMEs under its Chips to Startup (C2S) Programme. The programme aims to train 85,000 high-quality and qualified engineers in the area of VLSI and embedded system design. This is expected to result in development of 175 ASICs, working prototypes of 20 SoC and IP core repository over a period of five years.



Representational image

Centre invites applications for semiconductor DLI scheme

The Union Cabinet has approved a comprehensive ₹760 billion plan for the development of chip ecosystem in the country. Support will be provided to a hundred domestic companies for semiconductor design of ICs, chipsets, SoCs, systems and IP cores and semiconductor linked design. Growth of not less than twenty such companies will be facilitated to achieve turnover of over ₹15 billion in the coming five years. MeitY has begun inviting applications.

PEOPLE (on the move)

Satish N.S. to takes over Haier India as President



Satish N.S. will now lead consumer electronics company Haier India as President of the company following the retirement of current President, Eric Braganza, effective 1st January. However, Eric will continue to mentor the team as a consultant. Satish N.S. was earlier company's Senior Vice President of sales and marketing.

EESL appoints IAS Radhika Jha as CEO



Energy Efficiency Services (EESL) has appointed Radhika Jha as its Chief Executive Officer. Jha, a 2002 Uttarakhand IAS officer, is known to have been the brains behind Centre's Integrated Power Development Scheme as Executive Director in Power Finance Corp, before moving to the state.



Silicon Labs appoints Sumit Sadana as Lead Director

Silicon Labs announced that Sumit Sadana has been appointed Lead Director of the company's board of directors. Sadana has been a director on the Silicon Labs board since 2015 and is a member of the nominating and governance committee.

Vicor appoints Chinmaya Joshi as Global Automotive Segment Director



Vicor Corporation announced the appointment of Chinmaya Joshi as the Global Automotive Segment Director. His primary role at Vicor will be to support the expansion of the OEM customer base, tier-one suppliers, and automotive system partners through high-density modular solutions for electrification.

Shinyoung Park named CFO of Magnachip Semiconductor

Magnachip Semiconductor Corporation announced that Shinyoung Park has been promoted to the rank of Chief Financial Officer from 1st January. Park succeeds Dr Young Soo Woo, who stepped down from the position at the end of December. Park joined Magnachip in 2014 and served as Chief Accounting Officer from March 2020 to December 2021.

CORPORATE news

Vedanta to invest in semiconductor industry

Vendanta group has committed to invest ₹600 billion in India's semiconductor industry. They will use the investment to set up a sophisticated chip and glass manufacturing ecosystem in India over the next three years through Japanese glass substrate manufacturer, AvanStrate. The group is eyeing Haryana, Gujarat, Maharashtra, Telangana, Tamil Nadu, and Karnataka as one of the potential states for setting up shop.

CMI to partner with chip makers to enter the market

Indian cable maker CMI Ltd is planning to make its entry into the hot semiconductor market and is looking for partners to do the same. The company is ready to enter into an alliance with prospective manufacturers of semiconductors by leasing out the Baddi plant acquired from US based Fortune 500 company General Cables in 2016.

Ruttonsha International acquires Visicon Power

Power chip firm Ruttonsha International Rectifier Ltd has acquired 100% stake in Visicon Power Electronics Private Limited. Visicon Power is in the business of manufacturing silicon carbide (SiC) wafers and power electronic devices through the epitaxial process. It is in the process of setting up its plant near Baska, Halol in Gujarat.

Foxconn's India subsidiary files for IPO with SEBI

Foxconn's India subsidiary Bharat FIH Ltd is joining the IPO bandwagon, looking to raise ₹50.04 bilion. The IPO will consist of a fresh issue of up to 25.02 billion shares. In addition, a Foxconn unit holding shares of Bharat FIH will divest a portion of its stake to raise an equal amount.



Representational image

EMS company Syrma SGS Technology files for IPO

Syrma SGS Technology has filed its DRHP with market regulator SEBI for an IPO. The company is looking to raise between ₹10 and ₹12 billion. The issue comprises fresh shares worth ₹9.26 billion and an offer for sale (OFS) up to 3,369,360 equity shares by Veena Kumari Tandon. The EMS company may also consider raising ₹1.8 billion via a pre-IPO placement before filing its red herring prospectus. If that happens, the issue size will be altered accordingly.

SNIPPETS

- Centre wants Apple to raise local production to $50 billion over next 5-6 years and make India a global sourcing base
- Attero to invest ₹3 billion to increase Li-ion battery recycling capacity 11x by 2022-end
- Optiemus Electronics looking to invest ₹1.5 billion to ramp up production of laptops, wearables and hearables
- Dixon Technologies to set up ₹3 billion electronics manufacturing plant in Ludhiana
- HFCL appoints three new executives to grow international business
- Ather Energy ropes in two former Ola executives to strengthen senior management team
- Adani Green Energy signs world's largest green PPA with SECI to supply 4667MW solar power
- India's import bill for medical electronic equipment was over $6.24 billion in FY21

VVDN evaluating IPO to start making tablets indigenously

Homegrown VVDN is evaluating taking the IPO route. The company might file for the same within one to two years, sources close to the developments told EFY. Meanwhile, it has already started design, development, and manufacture of tablets for domestic and global OEMs under 'Make in India' campaign. The company said that it will do complete tablet architecture, hardware, software, mechanical design, PCB assembly, tooling and mould making, tablet assembly, testing and validation, and certification.

Waaree Energies gets approval for ₹15 billion IPO

Solar module maker Waaree Energies has received approval from SEBI to launch its IPO with an issue size of ₹15 billion. The IPO comprises fresh issue of shares worth ₹13.5 billion and an offer for sale up to 4,007,500 equity shares by the company's promoters and existing shareholders.

Zypp Electric forays into drone space

Zypp Electric has forayed into the drone logistics segment. The company has said that it plans to deploy 200 drones in four



Representational image

cities in the first phase and has partnered with TSAW Drones for the same. These services are planned in all the cities where Zypp Electric is operational, such as Delhi-NCR, Bengaluru, Hyderabad, Mumbai, and Pune.

Xiaomi India fined for evasion of customs duty

Following an intensive raid by the Income Tax department, Chinese electronics giant Xiaomi has been sent a notice for ₹6.53 billion fine for alleged evasion of import duty. Evidence gathered during investigations by the DRI indicated that neither Xiaomi India nor its contract manufacturers were including the amount of royalty paid by the firm in the assessable value of the goods imported by the company and its contract manufacturers, which is in violation of the customs law.

Bajaj Auto to manufacture EVs at new Pune unit

Bajaj Auto will be spending ₹3 billion for manufacturing electric vehicles at its new unit at Akurdi, Pune. The unit will have a production capacity of 500,000 EVs a year and employ nearly 800 people. The first vehicle from the unit is expected to roll out by June 2022.



Representational image

Tata Motors forms EV subsidiary TPEML

Tata Motors has announced that it will be forming a separate subsidiary for its electric vehicle business, which will be called Tata Passenger Electric Mobility Limited (TPEML). The wholly-owned EV company has been formed with an initial investment of ₹7 billion and will be responsible for manufacturing electric vehicles for the automaker.

Amara Raja Batteries to invest in InoBat Auto

Looking to enter the European battery market, Amara Raja Batteries is investing 10 million euros (about ₹845 million) in European EV battery maker InoBat Auto. This will give the company access to advanced battery technology for e-mobility applications and will open new R&D avenues.

Reliance acquiring Faradion and becomes Sterling & Wilson promoter

Reliance has announced that it will wholly acquire sodium-ion battery technology firm Faradion Limited for an enterprise value of 100 million pounds. Reliance will use Faradion's technology at its proposed fully integrated energy storage giga-factory as part of the Dhirubhai AmbGreen Energy Giga Complex project at Jamnagar. It has also become a promoter in Sterling and Wilson for 40% stake in the company post payment of balance ₹15.83 billion for acquisition of 25.9% equity in it.

Applications received under Auto & EV PLI Scheme

A total of 115 automotive OEM and ancillary companies have applied for the PLI scheme for automobile and auto component industry. The Champion OEM Incentive is a 'sales value linked' scheme applicable on battery electric vehicles and hydrogen fuel cell vehicles of all segments.

Portal for India Semiconductor Mission launched

The government of India has launched a new portal dedicated to the India Semiconductor Mission. This portal will serve as one window for all the works related to applications for the recently announced semiconductors mission in the country.

Companies bid for ACC battery storage PLI scheme

A total of ten companies listed below have bid for ACC battery storage manufacture under the new PLI scheme with their total capacity of about 130GWh: Reliance New Energy Solar Limited, Hyundai Global Motors Company Limited, Ola Electric Mobility Private Limited, Lucas-TVS Limited, Mahindra & Mahindra Limited, Amara Raja Batteries Limited, Exide Industries Limited, Larsen & Toubro Limited, and India Power Corporation Limited.

Telecom equipment worth ₹60 billion produced under PLI scheme

Telecom equipment makers have produced equipment worth over ₹60 billion since the launch of the PLI



Representational image

INTERNATIONAL news

Intel sells SSD business and Dalian facility

Intel Corporation has completed the first closing of the sale of its NAND and SSD business, selling its SSD business and the Dalian NAND memory manufacturing facility to SK hynix. In exchange, SK hynix will pay Intel US$7 billion in consideration. Intel will continue to manufacture NAND wafers at SK hynix's Dalian memory manufacturing facility.



Representational image

China's Luxshare building iPhone mega-plant to challenge Foxconn

China's Apple supplier Luxshare Precision Industry is building a massive manufacturing complex in eastern China worth $1.72 billion as it aims to overtake rivals Foxconn and Pegatron for iPhone assembly.

Toyota Motor to introduce 30 BEVs by 2030

Toyota Motor Corp has revealed its plans to introduce a full lineup of 30 battery electric vehicles by 2030. The Japanese auto giant will also invest 4 trillion yen (US$ 35 billion) to boost battery production. It is aiming for battery EVs to make up 100% of its global vehicles sales in 2035.

Tesla's 2021 vehicle deliveries surge over 87%

As the EV manufacturer Tesla expands production, the number of delivered vehicles is also expected to hit record levels in 2022. Data acquired by Finbold indicates that Tesla's 2021 deliveries stood at 936,172, growing 87.4% from 2020's figure of 499,550. In 2019, the company delivered 367,500 vehicles under different models.

Navitas Semiconductor opens first-ever GaN IC EV design centre

Looking to further expand into higher-power GaN markets, US based Navitas Semiconductor has announced the opening of a new electric vehicle (EV) design centre based in Shanghai, China. EV customers will be supported worldwide by the new team, from concept to prototype, through full qualification and mass production.

Samsung Electronics sees 52% jump in Q4 profits

Samsung Electronics reported a 52% jump in its operating profit in the fourth quarter of 2021. The surge was helped by solid demand for server memory chips and higher margins in chip contract manufacturing. This is the highest jump it has recorded for the quarter in four years. Samsung estimated October-December profit at 13.8 trillion won ($11.5 billion).

Synapse Design now part of TSMC Design Center Alliance

Synapse Design, a QuEST Global company, has joined the Design Center Alliance (DCA) of TSMC Open Innovation Platform (OIP). The TSMC DCA focuses on chip-implementation services and system-level design solutions to help lower design barriers for customers adopting TSMC technology.

Delta to acquire Universal Instruments

Delta Electronics, a provider of smart energy-saving solutions, is acquiring, through its subsidiary Delta International Holding Limited B.V., UI Acquisition Holding Co., the owner of Universal Instruments Corporation and its worldwide branches and subsidiaries, for an estimated amount of $88.9 million.

Honeywell to acquire US Digital Designs

Honeywell has agreed to acquire privately-held US Digital Designs for a purchase multiple of ~14x EBITDA in an all-cash transaction. The company delivers alerting and dispatch communications solutions, which enhance first responders' efficacy and enable faster emergency response times.

scheme for telecom products. This feat was achieved with an investment of ₹2.47 billion from these manufacturers. These investments include ₹97 million from MSMEs, ₹860 million from large Indian manufacturers, and a mammoth ₹1,510 million investment from MNCs.

MeitY seeking another $3 billion for IT Hardware PLI

An expansion of the IT Hardware and Wearables and Hearables PLI seems to be on the cards as MeitY is seeking an additional $3 billion for increasing the incentive budget. Officials added that MeitY has sent the proposal to expand the incentives to the empowered group of secretaries. A series of meetings are planned to assess progress of various PLIs to see which ones have more potential and need more inputs.

India's electronics manufacture to reach ₹7 trillion this year

India's domestic electronics manufacturing industry is expected to be worth nearly ₹7 trillion with 30% growth expected this year. The value addition from local manufacturing units is expected to go up to 25% in 2022 from 18% in 2021.

India's engineering goods sent to China doubled in November

India's engineering goods exports to China more than doubled in November with $434.6 million worth of shipments from the $205.3 million in the same period in 2020. The top importer of Indian engineering goods was still the US, with $1196 million during this period, registering a growth of 36.6% over $875 million in November 2020.

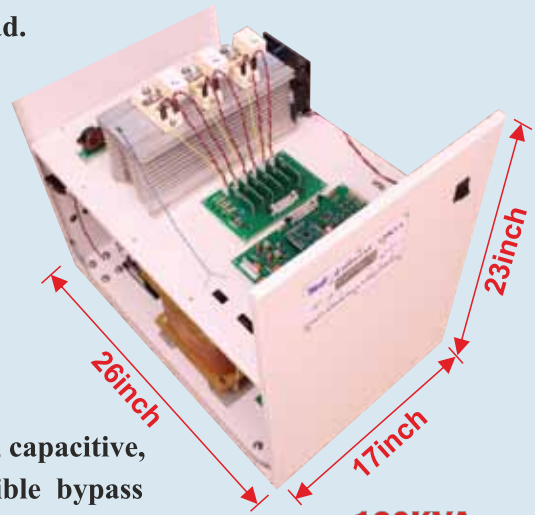
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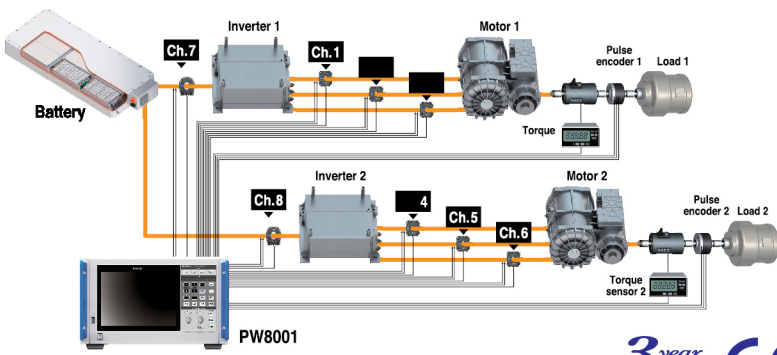
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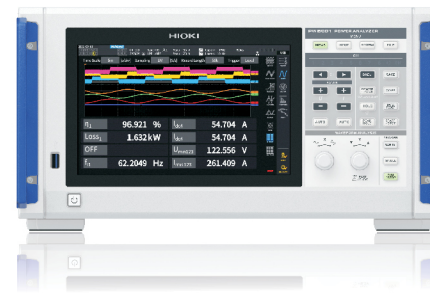
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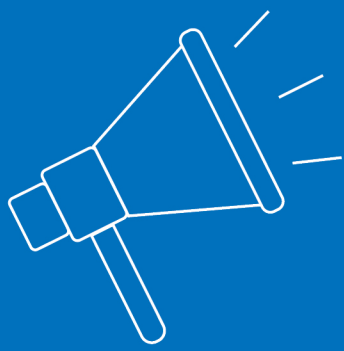


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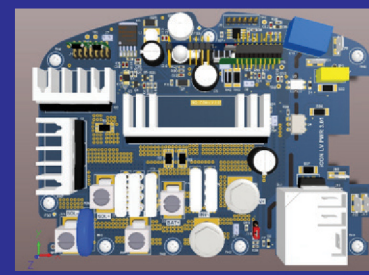
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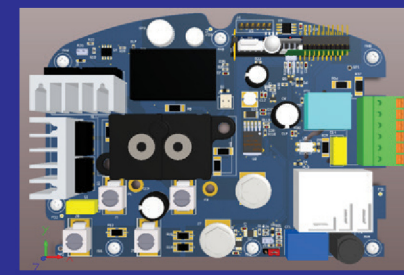
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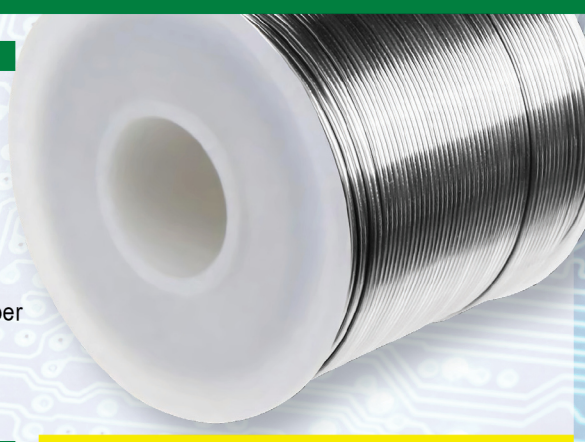
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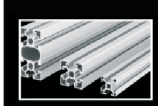
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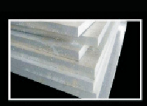
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Does Your Antivirus Solution Provide You With Complete Protection?

Don't RELY on 20 years old technology to FIGHT current date viruses



TOP 10 things that your Antivirus solution should provide to tackle today's threat...

Ransomware File Protection	ATP- Advance Threat Protection	EDR- Endpoint Detection And Response	
Application Blocking	Deep Learning Malware Analysis	Exploit Prevention	URL Blocking
Disk and Boot Record Protection	Peripheral Control	Respond Investigate Remove (Root Cause Analysis)	

If it doesn't, contact us for a solution which can

Contact: Santosh on 9971696319 or Email at santosh.gupta@itsipl.com

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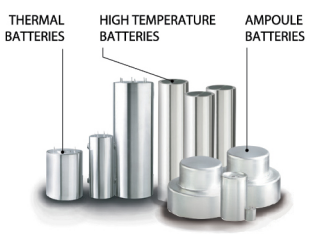
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The Season Of IPOs: Are You Thinking Of Going Public Too?

Automatic Optical Inspection: A Game Changer For PCB Manufacture

Exnovation: Another Side Of Innovation

MY STORY:

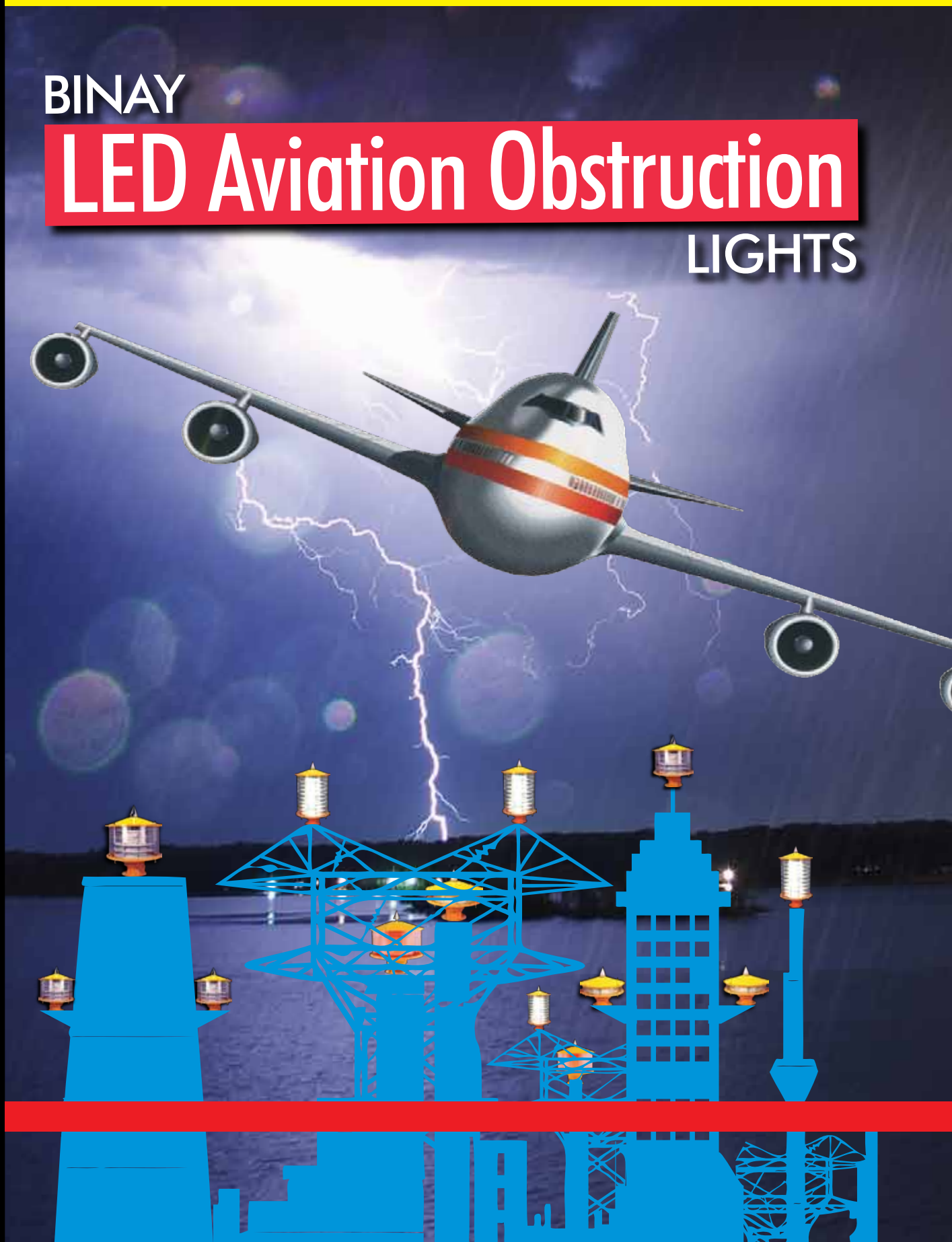
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BINAY LED-based HIGH, MEDIUM and LOW Intensity Aviation Obstruction Light Beacons

As per International Civil Aviation Organisation (ICAO) requirements
Available in Low Intensity, Medium Intensity and High Intensity versions (as per International Civil Aviation Organization guidelines), BINAY's patented LED Aviation Lights come with 5-year/3-year warranties



High Intensity
200,000 candela
(Flashing White LEDs)



Medium Intensity
20,000 candela
(Flashing White LEDs)



Medium Intensity
2,000 candela
(Flashing Red OR Fixed Red LEDs)



All BINAY Aviation Lights are based on Non-switching passive type circuitry (NO SMPS)

The circuitry incorporated inside the LED Aviation Obstruction Lights is passive electronic (solid-state) in nature, and does not use internal SMPS driver switching units to control the light unit. Internal LED current control is by non-switching electronic means only. No electrolytic capacitors are used inside the Aviation Obstruction Light unit.

The above is necessary to ensure reliability of the LED Aviation Obstruction Light. This system design effectively eliminates any active components and circuits inside the aviation light itself, and enhances the solid-state passive reliability of the LEDs (mounted in relatively inaccessible locations at the height of tall structures). This drastically reduces the possibility of component failure - and hence possibility of any maintenance requirement – in the LED Aviation Obstruction Lights themselves (which are mounted at extreme heights in the system).

The BINAY LED Aviation Obstruction Light offers the following advantages:

- Fit-and-forget maintenance-free operation
- A long life of 100,000 hours (20 years at 12 hours daily burning)
- Pays for itself within a short period of operation in the form of reduced installation, maintenance and servicing costs
- Quick Installation; Reliable operation 365 days per year
- Shock-proof and vibration-resistant
- Over-Designed Intensity to allow for natural LED intensity degradation over its operating lifetime

LED Obstruction Lighting for:

- Industrial chimneys and smokestacks
- Transmission, microwave and cellular towers
- Radio, TV and similar structural towers
- High-rise buildings and structures
- Airports and airfields

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

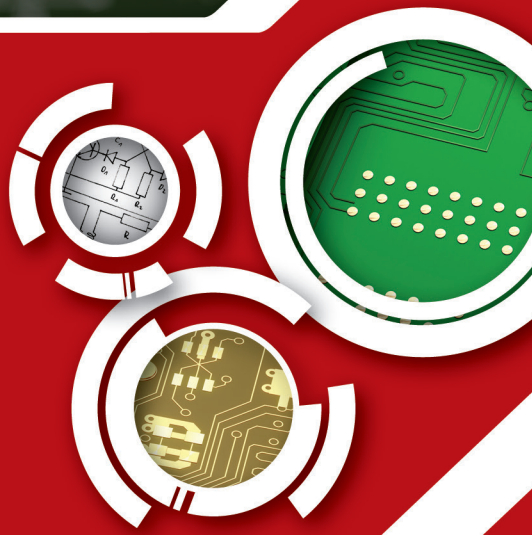
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Dr Er P. Venkatesan

• • •

NON-STANDARD GPS RECEIVER

The 'Nonstandard GPS Receiver Using ESP32' DIY project published in August 2021 issue (also available on your website at *https://www.electronicsforu.com/electronics-projects/nonstandard-gps-receiver-using-esp32*) is a good one.

Aturnomkawi

EFY. Thanks for the feedback!

❑ Please send me the complete sketch of 'Nonstandard GPS Receiver Using ESP32' DIY project. I tried to compile it and got errors such as RXD1 not defined. Please help.

Ian Carruthers

EFY. The link to download the complete sketch of the project is given in the article itself. Regarding the error message you are getting while compiling, please make sure that you use the original source code and correct libraries. RXD1 is not used in original code. If you have installed ESP32 board and correct libraries, selected the correct board in Arduino IDE and used the original code with RXD2 defined, such error message should not show up.

• • •

AUTO WATER DISPENSER

This is regarding 'Auto Water Dispenser For Pets' DIY project published in September 2021 issue (also available on your website at *https://www.electronicsforu.com/electronics-projects/auto-water-dispenser-for-pets*). I am interested in this project. Please give an estimation to construct this project.

Archie

EFY. You can assemble the circuit for less than ₹2,000. If you want the complete project kit (including components, project descriptions, PCB, etc), please visit kitsnspares.com website or write to *info@kitsnspares.com*

• • •

FM BASED PROJECTS

I am interested in FM projects. I have seen such projects on your website and want to build some of them. I used to talk about this website with my friends and teachers in my college. Please send me all FM related projects or a collection of the FM projects in PDF files with schematic and PCB layouts (top and bottom views), so that I can reproduce them on copper boards.

Vishnu

EFY. Thanks! Most FM projects published in EFY are available on EFY website. Please download the projects including the schematics and PCB layouts from there. If you have query/doubt on any specific FM circuit please do let us know, we will try to help you. Right now we do not have a collection of the FM related projects in PDF files.

• • •

UV ROBOTS' APPLICATIONS

What are some applications of UV robots? Please let me know as I am deeply interested in the subject.

Varsha

EFY. Ultraviolet (UV) robots or UV-disinfection (UVD)robots are used as part of the regular cleaning cycle to prevent and reduce the spread of infectious diseases, viruses, bacteria, and other types of harmful organic microorganisms in the environment. UVD robots employ non-touch technique to deliver disinfection by irradiation to kill microorganisms.

There are generally two types of UV robots: remote controlled and autonomous. Both of these are commonly found in hospitals and targetted areas.



Fig. 1: Typical UVD robot (Credit: www.mobile-industrial-robots.com)

Remote controlled UV robot is controlled by a human operator and sent to various places in hospitals wherever disinfection is required by manually pressing a button to emit ultravoilet rays to kill microorganisms and sterilise the area. An autonomous UV robot, after setting the parameters like surface distance and UV exposure time for each area, moves on its own and emits UV-C irradiation in the targetted areas.

UV radiation spectrum is divided into three categories called UV-A, UV-B and UV-C. The UV robots use UV-C light for sterilisation, which is used as a key element to fight the novel Corona virus.

Most UV robots work in an unmanned fashion, without the need for human presence at the disinfection site. This considerably helps avoid exposure of healthcare workers to harmful UV radiation. Many UV mobile robots are used to disinfect risky contagion areas in hospitals, such as surgical operating rooms, toilets, patient rooms, bathrooms, etc.

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: **onedit@efy.in**)

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Microbots powered by soft actuators can fly like insects



MIT researchers have pioneered a new fabrication technique that enables them to produce low-voltage, power-dense, high-endurance soft actuators for an aerial microrobot (Credit: https://news.mit.edu)

MIT researchers have demonstrated diminutive drones that can zip around with bug-like agility and resilience, which could eventually perform tasks such as pollinating a field of crops or searching for survivors amid the rubble of a collapsed building. The soft actuators that propel these microrobots are very durable and operate with 75% lower voltage than their earlier versions while carrying 80% more payload. The actuators are like artificial muscles that rapidly flap the robot's wings. The artificial muscles with fewer defects dramatically extend the lifespan of the components and increase the robot's performance and payload.

Multi-sensor system for more accurate knee implant fitting

CEA-Leti has developed a smart, multi-sensor system for knee implants, thus allowing surgeons to position the implant with high accuracy, significantly reduce the risk of follow-up surgery, and enhance rehabilitation. Called FollowKnee, the system integrates a deformation sensor, a pH sensor, a temperature sensor, and an accelerometer in a titanium tibial baseplate. A more accurate implant fitting is achieved via the deformation sensor and accelerometer that guide the surgeon during the operation. The pH sensor with living tissue, the system's pH, and temperature sensors detect infection early, while the deformation sensor and accelerometer also trigger an alert if they detect mechanical problems, such as loosening of the implant.



Clear acrylic column and tablet for demonstrating FollowKnee. The green device shows comparative size of the system (Credit: www.leti-cea.com)



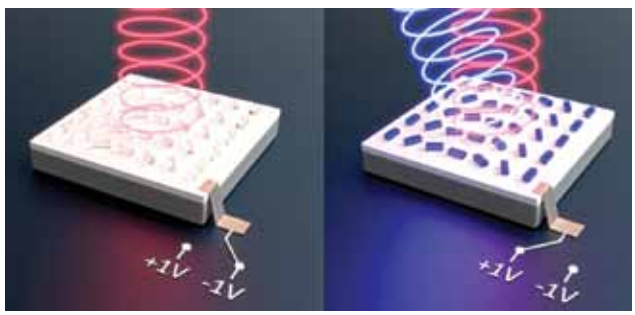
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Nanoantennas enable holograms for virtual conferences

Researchers at the University of Stuttgart have succeeded in breaking the constraints related to liquid-crystal technology by developing electrically switchable plasmonic nanoantennas with dimensions of only a few hundred nanometers and made from conductive polymers. This will help in

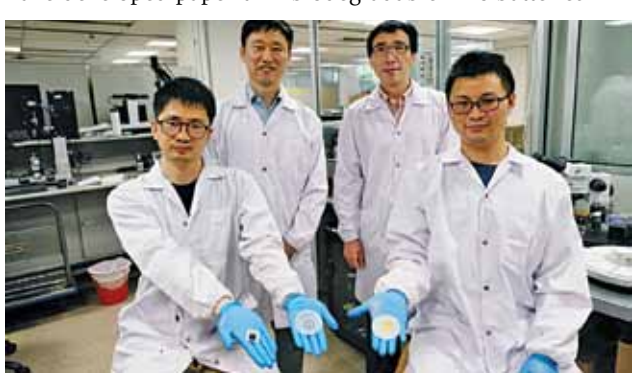


Left: Image displaying the plasmonic polymer nanoantenna, switched into the dielectric (glassy) state. The light beam from the bottom just passes through to the top without being deflected. Right: Image displaying the plasmonic polymer nanoantenna, switched into the metallic state. The light beam from the bottom is deflected to the side when passing through the sample. The light also changes its handedness when travelling to the top (Credit: www.uni-stuttgart.de/en)

realising dynamic holographic displays, which can enable virtual conferences with a 'real-life feeling. It was demonstrated that the optical appearance of the nanoantennas could be switched between that of a shiny metal and a transparent material by applying a voltage between minus and plus 1V at video rates of 30Hz. Despite being only a few tens of nanometers thick and less than 400 nanometers in size, the nanoantennas do the same job as the much larger and thicker liquid crystals used in current state-of-the-art technology.

Flexible, paper-thin biodegradable printed batteries

Nanyang Technological University, Singapore scientists have developed paper-thin biodegradable zinc batteries



Batteries of the future could be paper-thin and biodegradable (Credit: www.ntu.edu.sg)

that could one day become an environmentally sustainable option for powering flexible and wearable electronic systems. These zinc batteries are made up of electrodes screen-printed on to both sides of a piece of cellulose paper that has been reinforced with hydrogel. Once the battery has been expended, it can be buried in soil, where it breaks down completely within a month. The scientists think their printed battery could be integrated into flexible electronics, such as foldable smartphones or biomedical sensors, for health monitoring.

Non-invasive device can treat stroke and diabetes patients

A silicon device that can change skin tissue into blood vessels and nerve cells has been developed by researchers at the Indiana University School of Medicine, bringing us closer to potential use as a treatment for people with a variety of health concerns. The technology, called tissue

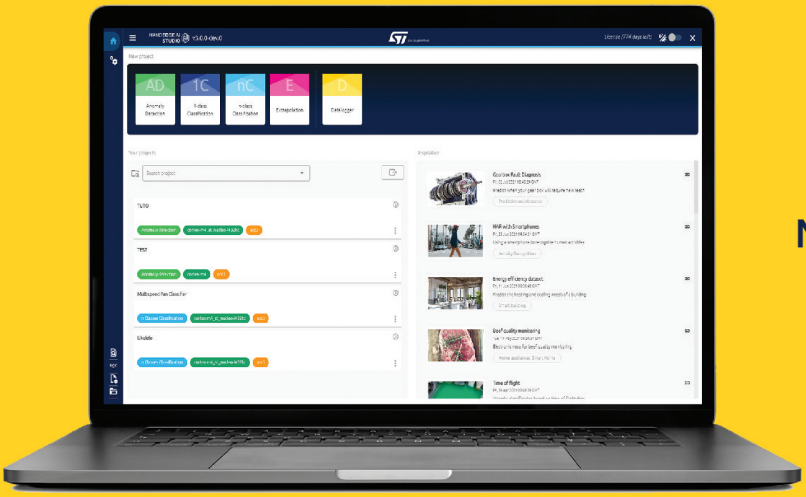


Silicon nanochip can reprogram biological tissue in living body (Credit: https://news.iu.edu)

nanotransfection, uses a non-invasive nanochip device that can reprogram tissue function by applying a harmless electric spark to deliver specific genes in a fraction of a second. It is suitable for reprogramming tissue for different kinds of therapies, such as repairing brain damage caused by stroke or preventing and reversing nerve damage caused by diabetes.

Smart bandage for onsite chronic wound monitoring

The research team from the National University of Singapore's (NUS) Department of Biomedical Engineering, in collaboration with Singapore General Hospital, has developed a smart wearable sensor that can conduct real-time, point-of-care assessment of chronic wounds wirelessly via an app. A world's first, the novel sensor technology can detect temperature, pH, bacteria type, and inflammatory factors specific to chronic wounds within fifteen minutes,



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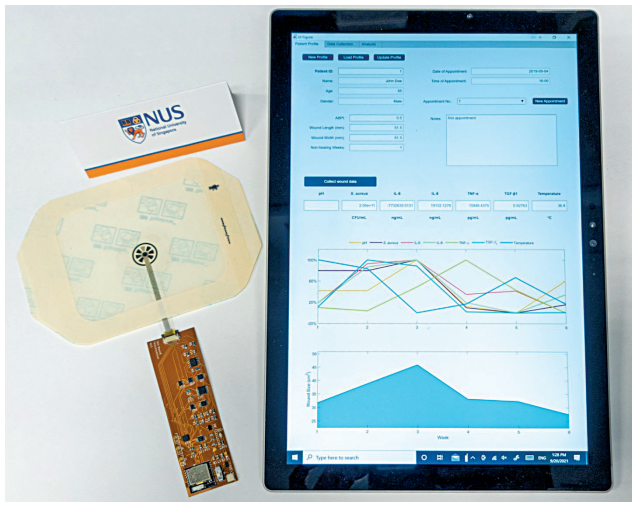
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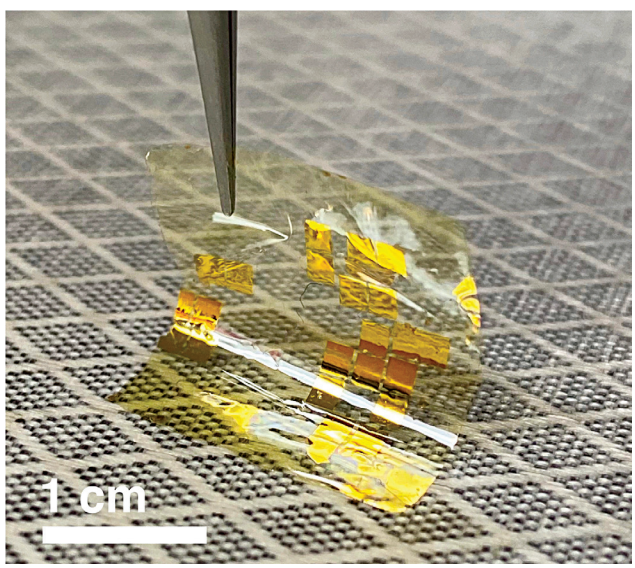


The VeCare platform comprises (clockwise from bottom left) a chip, wound sensor, bandage and app for real-time, point-of-care chronic wound monitoring (Credit: https://news.nus.edu.sg)

hence enabling fast and accurate wound assessment. Called VeCare, the point-of-care wound assessment platform consists of an innovative wound sensing bandage, an electronic chip, and a mobile app. The bandage comprises a wound contact layer, a breathable outer barrier, a microfluidic wound fluid collector, and a flexible immunosensor.

New material for ultrathin, lightweight solar panels

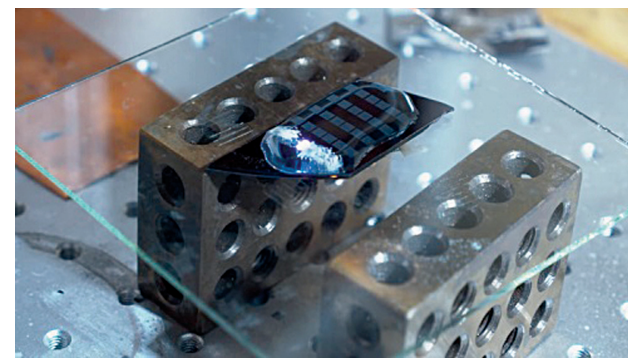
Researchers at Stanford University have a new group of photovoltaic materials that can be used in applications ranging from self-powered wearable devices and sensors to lightweight aircraft and electric vehicles. Chief among the benefits of these transition metal dichalcogenides—or TMDs—is that they absorb ultrahigh levels of the sunlight that strikes their surface compared to other solar materials. The prototype achieves 5.1% power conversion efficiency and could practically reach 27% efficiency upon optical and electrical optimisations. The biggest benefit, however, is the remarkable thinness, which not only minimises the material usage and cost but also makes TMD solar cells lightweight and flexible, and capable of being moulded to irregular shapes.



Transition metal dichalcogenide solar cells on a flexible polyimide substrate (Credit: https://news.stanford.edu)

Low-cost, self-fabrication of silicon wafers made possible

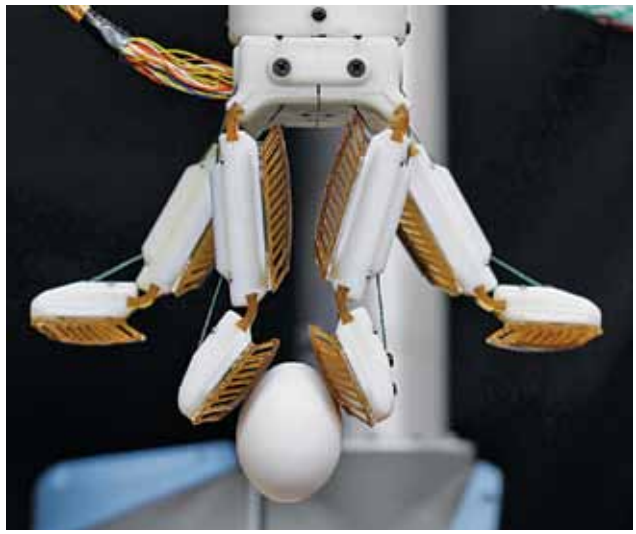
Zachary Tong on his YouTube channel Breaking Taps recently experimented doping a silicon wafer with phosphoric acid and a fibre laser that's near-infrared using a process called thermal diffusion to fabricate a silicon wafer at home. He used some advanced equipment—including a laser, a powerful electron microscope, and high-end software—for scanning probe microscopy purposes, etc, to accomplish the feat. UV laser was preferred over infrared laser while doping as the former tends to have less optical penetration, thereby damaging less silicon wafer. The aim of the experiment was to inspire others to fabricate their own semiconductors at low cost.



Doping liquid phosphoric acid on top of the silicon wafer and embedding it with precise laser pulses (Credit: Breaking Taps)

Robotic hand picks up fruits and veggies delicately but firmly

Engineers at Stanford University have developed a robotic hand, called farmhand, capable of handling various items from raw eggs and grape bunches to jugs and basketballs. The robotic hand has gecko-like adhesive on the inner surface of its grippers that creates a strong grip via microscopic flaps, thus applying no extra inward force to hold an object. On coming in contact with an object's exterior surface, the flaps create Van der Waals forces, allowing the

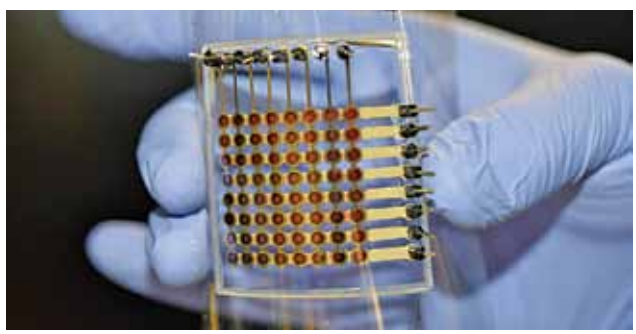


A close-up of the hand performing a highly hyperextended pinch on only the top surface of an egg (Credit: https://news.stanford.edu)

adhesive to grip strongly with only adequate pressure. The development helps in delicately yet firmly clamping and picking up objects having a soft composition, including fruits and vegetables, without causing any damage.

First fully 3D-printed, low-cost flexible OLED display

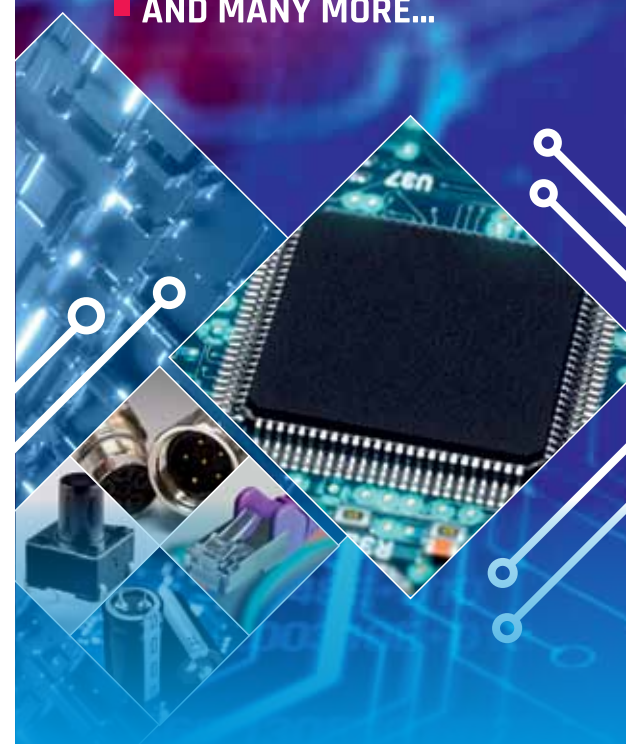
Researchers at the University of Minnesota used a customised printer to fully 3D-print a flexible organic light-emitting diode (OLED) display. The discovery could result in low-cost OLED displays in the future that could be widely produced using 3D printers by anyone at home, instead of by technicians in expensive microfabrication facilities. Two different



The fully 3D-printed flexible organic light-emitting diode (OLED) display prototype is about 3.8cm on each side and has 64 pixels. Every pixel works and displays light. The 3D-printed display is also flexible, which could make it useful for a wide variety of applications, such as foldable smartphone displays (Credit: https://twin-cities.umn.edu)

modes of printing were combined to print the six device layers that resulted in a fully 3D-printed, flexible OLED display. The electrodes, interconnects, insulation, and encapsulation were all extrusion printed, while the active layers were spray printed using the same 3D printer at room temperature.

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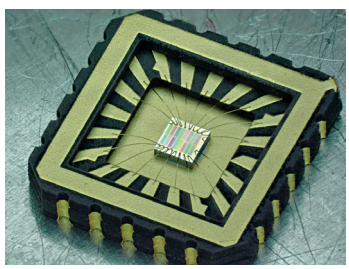
TRULY INNOVATIVE ELECTRONICS

INNOVATION UPDATES

Amongst numerous press releases of new products received by us, these are the ones we found worthy of the title *Truly Innovative Electronics*

Classifying and quantifying sensor

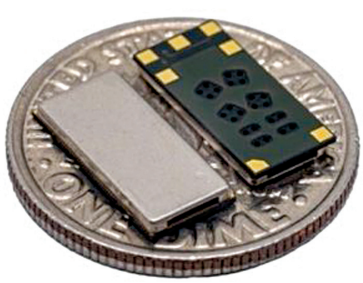
ChipSense, a tiny spectral chip containing sixteen detectors, is based on an array of resonant-enhanced photodetectors comprising an absorbing layer that has selective wavelengths in the near-infrared region (850-1700nm). It can classify different materials and quantify their composition, such as chemical content of milk and plastics. It relies on fully integrated technology based on the indium phosphide platform. Features include miniature size to fit in a smartphone, no moving parts, high signal-to-noise ratio (~ 10000 SNR), multi-pixel read-out in less than a few seconds, and scalability. Applications include smart farming, smart industry, and smart home.



MantiSpectra
www.mantispectra.com

MEMS speaker with vent

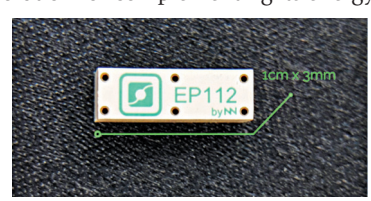
The Montara Pro is the world's first monolithic MEMS µspeaker with integrated DynamicVent that enables smart TWS earbuds and hearing aids to create unique listening experiences by combining the benefits of closed-fit (occluded) and open-fit earbuds. The DynamicVent technology can be intelligently opened or closed by the earbud system DSP based on ambient noise levels. With the vent closed, Montara Pro creates a listening environment with the best passive isolation for music and media consumption or for improved focus in the presence of background noise. With the vent open, Montara Pro enables improved spatial awareness, increased listening comfort, and reduced occlusion effects, such as the perception of the user's own voice as too loud or 'hollow.'



xMEMS
www.xmems.com

Energy harvesting mini antenna

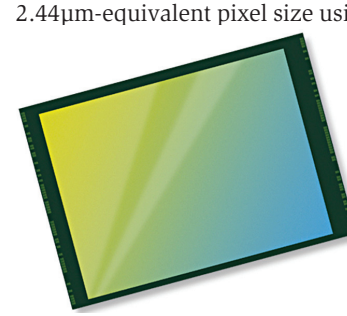
With the goal of providing a complete set of all the essential components required for RF energy harvesting, e-peas has now added an antenna solution for complementing its energy harvesting dedicated power management ICs (AEM family). The e-peas energy harvesting antenna is ten times smaller than a standard off-the-shelf component, providing more space for customers' designs. It is well suited to a wide variety of industrial applications including building automation, smart metering, asset tracking, and other logistics applications. The same antenna can be used for any band and for any device form factor with a proper matching network design. Through use of this antenna, it will be possible to harvest energy at all frequencies within the 0.4GHz to 10.6GHz range.



e-peas Semiconductors
www.e-peas.com

Tiny sensor for smartphones

The OVB0B is the world's smallest 200MP image sensor with pixel size at just 0.61µm for smartphone cameras. The unique 16-cell binning of the OVB0B delivers 4K2K video and preview quality in 12.5MP mode with 2.44µm-equivalent pixel size using near pixel 4 × 4 binning, especially in low light. It also offers 100% quad phase detection technology for excellent fast autofocus performance. An on-chip remosaic enables 50MP at 24 frames per second (fps) and 8k video at 30fps with 1.22µm-equivalent performance. The OVB0B can also output 12.5MP at 30fps with 3-exposure staggered HDR timing. The OVB0B supports CPHY, DPHY, and dual DOVDD (1.8V and 1.2V).



OMNIVISION
www.ovt.com

RF-to-DC converter chips

The Powerharvester RF-to-DC converter chips PCC114 and PCC110 are the core components which convert RF energy to DC power. When paired with tuning components and an antenna, these chips can harvest RF energy from 10MHz to 6GHz. They have an extremely small profile: 1mm x 0.6mm x 0.3mm (PCC114)

Electronics For You's Top 10 Thought Leaders on LinkedIn

Only if we are aware of what out readers should know but don't know–can we get them to know. That represents one of the key challenges faced by our journalists, and the question that we often find ourselves asking…

"How can we get all the updates that are important for our audience who represent different facets of the electronics ecosystem?"

The Idea

"Why not identify the most active and influential thought-leaders for electronics in India on LinkedIn, and then follow them?", asked a trainee during one of our recent brain-storming sessions.
"That made sense. But, was anyone aware about these thought-leaders who we should follow?", I asked. Silence. "Are we seeing any of our contacts share such updates?", I asked. Thankfully, few names got shared. "How about we build a system to review those who regularly post, and rate them on a regular basis? Not only will we know whom to follow, but so will our readers?", suggested a senior journalist. "And what if we released this ranking on LinkedIn and our websites and publications?", added a tech journalist. "Wow! We seem to be onto something here. Let's see if we can implement it", I challenged…

The Criterion

Within a couple of days, few of us held another meeting with two clear goals: 1. List all contacts whom we were seeing post actively related to India's electronics ecosystem 2. List all possible parameters that can be used to rank them
Within a few hours, we had a list of 127 contacts who seemed pretty active. Thankfully, while preparing this list, we got to review activities and posts of a large variety of thought-leaders. This helped us identify and freeze key metrics for ranking–pretty quickly.

Here's the list of questions (parameters) we sought data for, to rank them:

1. Did they post updates related to India's electronics industry or ecosystem at large, or were their posts primarily to promote themselves or their firm?
2. Did they post frequently or were they posting in bursts or only once in a while?
3. How many posts did they publish in last 2 months?
4. What was the highest engagement that any of their posts had received in the last one month?

We had listed a few more, but later realised that these four formed the Core. In fact, #1 and #2 acted as filters–that is whether they could be added to the list or not. And, #3 and #4 acted as the key parameters that decided their ranks. Thanks to parameter #1, we also realised that many whom we had considered as leading influencers were only promoting their brands and themselves, and were not sharing any important updates. Hence, we had to drop them.

The Result

It took a couple of meetings to collect and review all the data points. Few more got added to the list too, while we were going through the grind. And then–we had the sheet with all data and parameters updated! The top 10 emerged clearly, and we had our first set of…

Electronics For You's Top Thought Leaders on LinkedIn!

And, the names that emerged along with the data to back their ranks–made us proud…

We're Grateful

By the time we finished with the rankings, we were truly grateful for the original idea, and many that emerged later that enabled us to execute it. The beauty that emerged amongst the Top 10 was the diversity of applications of electronics itself. We have thought leaders representing the government, the consumer electronics and appliances; telecom and mobile; drones & robotics; EVs; solar and renewables; et al.

We believe that this list will surely help us to follow the leaders. Plus, it will motivate many to start leading too. And, we hope this list will expand from Top 10 to Top 20, and hopefully to Top 100 soon.

■ **Author:** Rahul Chopra

RANK #1



SAURABH GAUR
(Joint Secretary, MeitY (IAS), Government of India)

RANK #2



MANU KAPOOR
(Sr VP, Samsung Electronics)

RANK #3



DR. ALOKNATH DE
(Consulting Technologist, Cyber-Physical Systems & ex-CTO, Samsung India)

RANK #4



SMIT SHAH
(President, Drone Federation of India)

RANK #5



AMBER DUBEY
(Joint Secretary at Ministry of Civil Aviation, Government of India)

RANK #6



MANISH SHARMA
(Chairman and CEO, Panasonic India and South Asia)

RANK #7



SANJEEV KESKAR
(CEO, Arvind Consultancy & Ex-MD, Arrow Electronics India)

RANK #8



RAHUL LAMBA
(Co-Founder, The Energy Company)

RANK #9



VIVEK TYAGI
(GM, Rashi Peripherals and Vice Chairman, IESA)

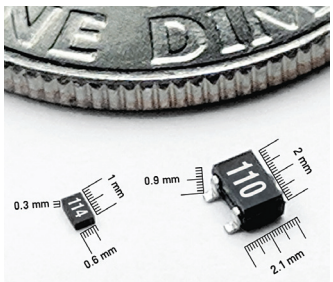
RANK #10



GANESH SHANKAR
(Founder & CEO at FluxGen Technologies)

What to follow these influencers? Visit: https://lnkd.in/g9ZbWVgF

and 2mm x 2.1mm x 0.9mm (PCC110), and have up to 75% conversion efficiency while harvesting energy from all



modulation types, enabling maximum power transfer and range. Due to their small size, they have a low cost of implementation and are RoHS compliant.
Powercast Corporation
www.powercastco.com

DSP and ML coupling chips

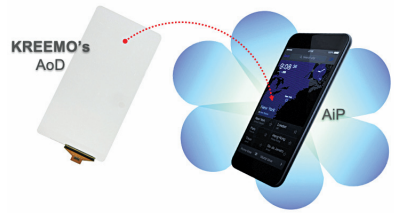
Tyr, a family of three different chips—called Tyr1, Tyr2, and Tyr3—uses a fully programmable and scalable architecture that tightly couples digital signal processing (DSP) cores with machine learning



(ML) accelerators necessary to design L3 through L5 autonomous driving vehicles. Delivering between 258-trillion and 1,032-trillion operations per second and consuming as little as 10 watts, Tyr allows users to implement autonomous driving functions previously not commercially viable. The Tyr companion chip is algorithm and host processor agnostic and can be integrated into new or existing environments without the need to redesign the entire system.
VSORA
www.vsora.com

Transparent built-in display antenna

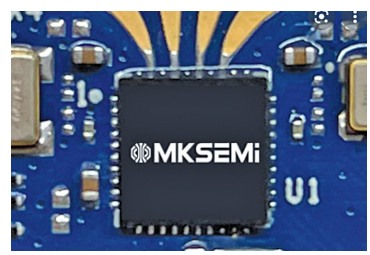
The world's first transparent antenna on display (AOD) is characterised by a smooth 360-degree high-capacity data transmission and reception. By combining an antenna and a display into one, more space can be utilised. The built-in display antenna can be mounted on high-definition screens and glasses in organic light emitting diodes (OLEDs) or liquid crystal displays (LCDs) of



smartphones, augmented reality (AR), and game devices. The antenna technology is expected to become a metaverse antenna platform in a rapidly-growing global market.
KREEMO
www.kreemo.io

Low-power, integrated SoC

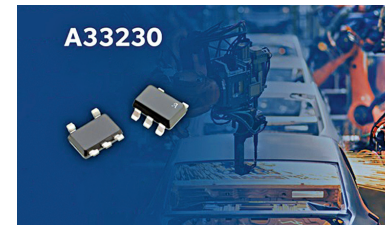
The MK8000 system-on-chip (SoC) is the world's lowest power, highest integrated chip solution that can empower IoT devices with the smallest batteries and size for high-precision sensing. MK8000 also enables OEMs and ODMs to rapidly design, integrate, and deploy



complete location and direction-finding solutions. With a high level of integration and computing power, the MK8000 SoC allows customers to implement UWB ranging products with only a handful of external components, ensuring the smallest possible footprint and lowest power consumption. Its low-power UWB technology significantly extends the battery life of electronics and enables even the smallest wireless devices to have high precision ranging and location capability.
Mauna Kea Semiconductors
www.mk-semi.com

Tiny Hall-effect position sensor

The new A33230 3D sine/cosine Hall-effect position sensor IC is the smallest 3D sine/cosine sensor currently available in the market. It offers system designers a cost-effective solution for



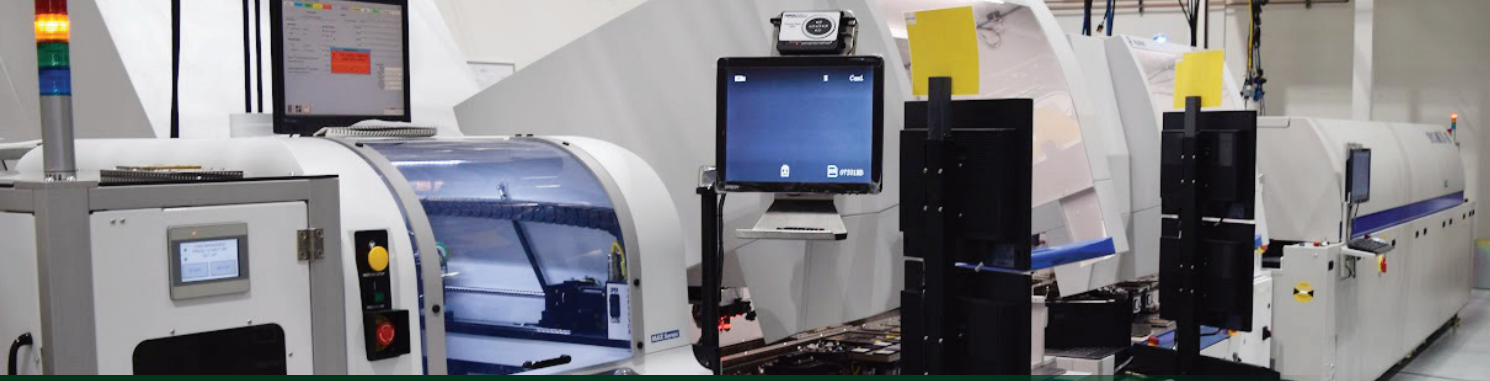
automotive and industrial applications with a quick time to market. The A33230 contains two discrete analogue signal paths for superior high-speed performance, and the tiny SOT23-W package size makes it ideal for situations where PCB space is at a premium. The IC can also be used as an angle sensor, provided the system includes an electronic control unit (ECU) capable of performing CORDIC calculations on the two outputs.
Allegro MicroSystems
www.allegromicro.com

Mini CPC capacitive sensors

Two unique, miniature carbon-nanotube paper composite (CPC) capacitive sensors, SomaControl and SomaSense, bring a better sense to the digital world by creating a new genre of gesture based digital interfaces, wellness monitoring, and safety applications. The SomaControl gesture monitor enables everyday tasks at home or integrated



into gaming devices for a more immersive experience. It also allows users to interact with and control a digital device using hand movements with no contact. The SomaSense 3D floor mat is a flexible sensing mat that observes, monitors, and reports on human wellness factors, including presence, gait, and foot pressure, with applications in health-tech and wellness, assisting individuals with balance, movement, and other challenges.
Somalytics
www.somalytics.com



El Camino Technologies Pvt Ltd

Your Partner for Manufacturing, Assembly and Testing of Semiconductor Devices

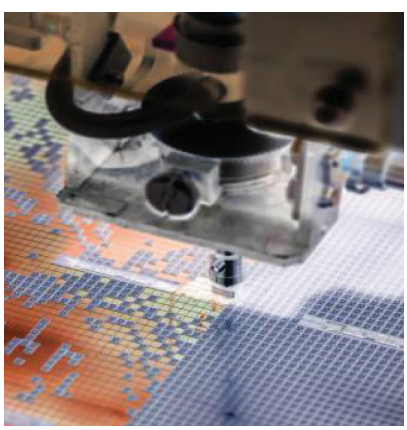
El Camino Technologies has focused on the Indian market for more than three decades. Through this article, we would like to highlight the different stages of Semiconductor device manufacturing and solutions we offer for production, R&D, and prototype development as an introduction to the company.

Front End- Wafer Fabrication Solution

Wafer Fabrication:

The Czochralski technique, named after Polish scientist Jan Czochralski, is used to develop silicon wafers into cylindrical ingots of various diameters. These ingots are then sliced into wafers and polished to achieve a smooth even surface, which are ready for fabrication. El Camino Technologies provides manufacturing solutions for the numerous processing steps involved in wafer fabrication, which include deposition, removal, patterning, and electrical property modification. The company offers front end equipment for different processes, such as wet process tools, Diffusion, Doping, PECVD, LPCVD, Photolithography, Plasma, Annealing, coating, etching, developing, thin film metallisation, Metal Lift-off, baking station, and resist coat and bake systems, among others, with our partners who are world-class leaders in High end Technologies.

Back End- Assembly and Testing



Assembly and Packaging involves mounting the die, connecting the die pads to the pins on the package, and sealing the die. Wires are used then to link the pads to the pins, completing the connection. These wires are gold or aluminium. El Camino Technologies also offers complete turnkey line solution for assembly and testing, Island of automation or individual equipment. We provide both automated, semi-automatic, and manual microelectronic assembly equipment, with a focus on precision die attach, wire bonding, and batch and auto reflow vacuum systems, in collaboration with our international partners from the United States, Europe, and SGP. Wafer dicing, dispensing, bonding, encapsulation, Trim & form, Singulation, and the integration of whole line systems.

Not only does the firm provide and identifies equipment, but it also offers process assistance, material guidance, process for discrete and modules (IGBTs, Diodes, Power MOSFETs), sophisticated packaging solutions for various applications - Power modules, Micro bolometers, GaN RF power amplifiers, and IR sensors, automotive, lasers, LEDs, military/high reliability/MEMS, power semiconductors, RF/microwave/wireless, sensors and telecom/5G/Datacom. The company also undertakes the project management-Support for Assembly services, Package Design, and prototype development to manufacturing solutions. With process/application, expertise and a deep understanding of production needs we can help in setting up a customized turnkey line.

Characterization equipment

The Metrology or Characterisation is intrinsic part of wafer processing required between the various processing steps. These wafer test equipment are used to verify the processing steps up until testing. El Camino Technologies offers several standard testing solutions for both front and back end such as sheet resistance both contact and non-contact, hall mobility, thin film measurement- bow, warp, stress thickness, probe stations, die shear and wire pull testers, sorters, transfer systems apart from electrical testing of finished device in tape and reel system.

FA and RA solutions.

We also provide tools for failure analysis and reliability such as - Mechanical, laser and chemical decap, scanning acoustic, PIND, vibration and BEND testing etc. Help in establishing required quality management system and documentations & certifications for the plant. With our honourable Prime Minister's recent remarks, we look forward to supporting his MAKE IN INDIA goal by offering solutions for the production, packaging, and testing of semiconductor devices in India for a variety of applications.

Please feel free to contact us at:
info@elcamino.in, additional information on our website: www.elcamino.in

Updates on LinkedIn: https://www.linkedin.com/company/elcamino-technologies-pvt-ltd

Feel free to interact with the Team for any queries:
President: Ms. Chetna Mohan
General Manager: Mr. Prashant Kalalabandi
Manager Technical: Mr. Asher Vinod

NEW PRODUCTS

MAKE IN INDIA

COMPONENTS

Automotive microcontroller

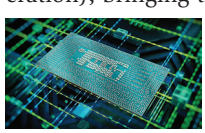
The RL78/F24 and RL78/F23 microcontrollers (MCUs) designed for automotive actuator and sensor control applications support edge evolution in next-generation electronic and electrical architecture. The expanded RL78 family of low-power 16-bit MCUs strengthens the company's automotive portfolio, offering customers highly reliable and high-performance solutions for systems ranging from actuators to zone control. Both MCUs support the CAN FD high-speed communication protocol and EVITA-Light security, delivering up to 70% faster operating frequencies, which can more than double the performance in brushless motor control applications.



Renesas Electronics
www.renesas.com

Mobile processors

The new 12th Gen Intel Core mobile processors are claimed to be the world's fastest mobile processors (40% faster than the previous generation), bringing their performance hybrid architecture to mobile platforms. Intel has introduced 28 such mobile processors that deliver a feature-rich suite of computing capabilities, powering designs across consumer, enterprise, IoT, and other applications. Based on the Intel 7 process, new 12th Gen H-series processors offer up to 5GHz frequencies, 14 cores (6 P-cores and 8 E-cores), and 20 threads. They have nearly three times faster connectivity on exclusive high-speed channels without legacy Wi-Fi interference.



Intel Corporation
www.intel.corporation

ADAS radar sensor

With the new AWR2944 radar sensor, Texas Instruments (TI) has expanded its extensive portfolio of analogue and embedded processing products and technologies that can help automakers improve how advanced driver assistance systems (ADAS) sense objects. The increased ability to quickly detect objects, monitor blind spots, and efficiently navigate turns and corners paves the way for automakers to achieve their vision of a collision-free future. The 77GHz AWR2944 radar sensor offers best-in-class radio frequency performance in a small form factor and provides 33% higher resolution than existing sensors. The sensor's unique hardware supported by Doppler division multiple access based signal processing improves the ability to sense oncoming vehicles at distances up to 40% farther away.



Texas Instruments
www.ti.com

Upgraded GaN ICs

The GaNFast power ICs with GaNSense technology have been upgraded to increase efficiency, power density, and access additional fast-charger markets. GaNFast power ICs integrate GaN power and drive plus protection and control to deliver simple, small, fast, and efficient performance. The voltage rating of NV613x and NV615x GaNFast ICs has been upgraded from 650 to 700V for continuous operation and is rated at 800V for transient conditions. Increased voltage rating enables more efficient power transformer circuit designs and higher capabilities for areas of the world with unreliable, widely-varying power grids with extreme voltage spikes. Autonomous system-level monitoring and reaction ensures 'detect and protect' within 30ns—10x faster than for discrete implementations.



Navitas Semiconductor
www.navitassemi.com

Automotive positioning chip

The STA8135GA is an automotive-qualified GNSS (Global Navigation Satellite System) receiver that integrates a triple-band positioning measurement engine on-chip, in addition to standard multi-band Position-Velocity-Time (PVT) and dead-reckoning. It helps driver-assistance systems make accurate decisions about the road ahead and delivers raw information for running any precise-positioning algorithm. The STA8135GA also enhances the performance of in-dash navigation systems, telematics equipment, smart antennas, and V2X communication systems, as well as marine navigation systems, drones, and other vehicles.



STMicroelectronics
www.st.com

5G smartphone chip

The Dimensity 9000 5G smartphone chip is built on the ultra-efficient TMSC N4 (4nm-class) production process for next-generation flagship smartphones, thus leading the

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Anritsu's new Rubidium™ low-noise RF/microwave signal generator redefines signal purity and stability.

Signal purity and frequency stability are essential distinguishing characteristics of a high-frequency microwave signal generator. The Rubidium MG362x1A signal generator product line is built to deliver outstanding signal purity and frequency stability across a broad frequency range from 9 kHz to 43.5 GHz, even at high output power levels.

Along with AM, FM and PM modulation, Rubidium also features comprehensive pulse generation capabilities for radar signal simulation. Coupled with built in, easy to use, on location frequency and power calibration, the Rubidium MG362x1A offers exceptional overall utility and long-term value for a broad range of measurement applications.

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- Low phase noise and spurious performance unmatched in today's market
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- High output power with low spurious eliminates need for external power amplification
- Low cost of ownership with on-site frequency and power calibration capabilities

FOLLOW THE LEADER
PURITY
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Advancing beyond

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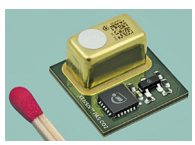
industry in computing performance, gaming, imaging, multimedia, and connectivity innovations. It integrates the cutting-edge Armv9 CPU architecture for a true flagship experience. The octa-core CPU has one ultra-Cortex-X2 core operating at up to 3.05GHz, three performance A710 cores operating at up to 2.85GHz, and four efficiency Cortex-A510 cores. With the integrated LPDDR5X supporting up to 7500Mbps, along with an 8MB L3 cache and 6MB system cache, the chip is built for the massive bandwidth demands of the mobile market.



MediaTek
www.mediatek.com

CO_2 sensor

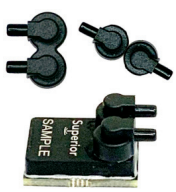
To meet the rising demand for sensors that measure the CO_2 concentration in the air, Infineon Technologies AG is launching an innovative CO_2 sensor known as the XENSIV PAS CO2 that can be used to monitor indoor air quality and reduce energy costs. Suitable applications include ventilation, air-conditioning systems, portable room air monitoring devices, and smart speakers. Based on the innovative PAS (photoacoustic spectroscopy) technology, the sensor has an integrated microcontroller that directly converts the CO_2 measurement into a ppm value, which is available via three interfaces: the serial I²C, UART, and PWM.



Infineon Technologies
www.infineon.com

Pressure sensors

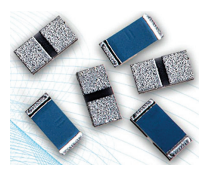
The new ND series absolute mid-pressure sensors and the differential and gauge mid-pressure sensors enable manufacturers to cost-effectively develop more accurate and stable products for numerous industrial equipment applications operating at low- to mid-pressure ranges. The absolute sensors support pressures up to 150psia with market leading accuracy and long-term stability of 0.10%, while the differential/gauge sensors support multi-range pressures from 0.5psi to 150psi with market leading accuracy and long-term stability of 0.05%. These are said to offer manufacturers a 2x advantage over other solutions.



Superior Sensor Technology
www.superiorsensors.com

HPDC resistors

The new high power density chip (HPDC) resistors are optimised for power management, actuator drive, and heating applications which benefit from the enhanced heat transfer from element to terminal. The use of such high power density components saves PCB area and boosts reliability by restricting the temperature rise in the component hotspot. The resistors use an aluminium nitride ceramic substrate and feature large area terminations for improved thermal contact with a PCB. As a result, heat generated in the resistor element is effectively conducted away, reducing the temperature rise and enabling the HPDC resistors to offer a high power density solution with ratings of 2.4W in 1206 and 3.5W in 2512 footprints.



TTElectronics
www.ttelectronics.com

Ultrasonic ToF sensors

The Chirp ICU-10201 and ICU-20201, two new high-performance, ultra-low-power integrated ultrasonic Time-of-Flight (ToF) sensors for short- and long-range detection include a powerful on-chip processor with higher computational power. The enhanced processing capabilities allow a wide range of application algorithms to fit and to run on-chip, completely offloading the system MCU. Compared to the previous generation, the ICU-10201 and ICU-20201 have 10 times faster DSP with HW multiplier for higher calculation power, larger memory, and a fast host interface (SPI). The sensors also support a wide range of IO supply voltages with range measurements to targets up to 5m (for ICU-20201) and 1.2m (for ICU-10201) away.

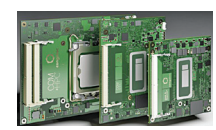


TDK Corporation
www.tdk.com

BOARDS & MODULES

Computer-on-modules

The 10 new COM-HPC and COM Express computer-on-modules feature the latest high-performance cores from Intel. The new modules in COM-HPC Size A and C as well as COM Express Type 6 form factors offer major performance gains and improvements for the world of embedded and edge computing systems. Offering up to 14 cores/20 threads on BGA and 16 cores/24 threads on desktop variants (LGA mounted), 12th Gen Intel Core processors provide a quantum leap in multitasking and scalability levels. Next-gen IoT and edge applications benefit from up to 6 or 8 (BGA/LGA) optimised Performance-cores (P-cores) plus up to 8 low-power Efficient-cores (E-cores) and DDR5 memory support to accelerate multithreaded applications and execute background tasks more efficiently.



congatec
www.congatec.com

IoT module

The AWS IoT ExpressLink module, ESP32-C3-MINI-1-N4-A, is based on the ESP32-C3 SoC and offers Wi-Fi + Bluetooth LE 5.0 connectivity, thus providing any host MCUs with out-of-the-box, seamless, AWS cloud connectivity. The module offers a simple

It's not the survival of the fittest...
...It's the survival of the fastest.

LWI Electronics Inc.

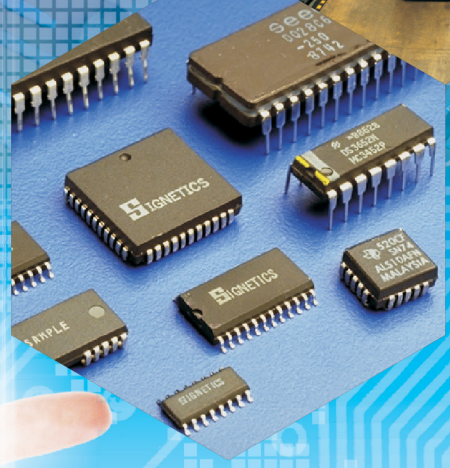
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Live Wire Group: World Sourcing

serial interface which the host MCU uses to get connected to AWS IoT services and transform any offline product into a cloud-connected product. Espressif's AWS IoT ExpressLink module handles complex yet undifferentiated workloads, such as authentication, device management, connectivity, messaging, and OTA. Thus, it relieves developers from developing and maintaining complex firmware, while it provides end-to-end security and fleet management at scale.



Espressif
www.espressif.com

In-circuit emulator

Embedded engineers seeking complete analysis of projects for rapid development can now use the MPLAB ICE 4 next-generation full in-circuit emulator, debugging and programming development tool for Microchip's PIC and AVR microcontrollers (MCUs), dsPIC digital signal controllers (DSCs), and SAM MCUs and microprocessors (MPUs). The MPLAB ICE 4 in-circuit emulator is a fast and feature-rich emulation and programming tool, debugging and programming with a powerful, easy-to-use graphical user interface of MPLAB X integrated development environment (IDE). It provides a flexible development experience including advanced debugging capabilities to write power-efficient code with reduced debugging time.



Microchip Technology
www.microchip.com

System-on-module

Building on the new industry standard 'Open Standard Module (OSM)' defined by SGeT, the iW-RainboW-G40M, the solderable i.MX 8M Plus OSM LGA module, integrates the powerful i.MX 8M Plus processor in the compact OSM 1.0 standard, delivering powerful AI and machine learning capabilities on a compact edge device. Two image signal processors (ISPs) and a dedicated neural network processor at up to 2.3 TOPS makes the i.MX 8M Plus an ideal fit in smart home, smart city, industrial IoT, and beyond with its machine learning, vision, and advanced multimedia capability. Industrial interfaces like CAN-FD, time-sensitive networking, and high-speed interfaces make the processor fit in Industry 4.0 and automation systems.



iWave Systems Technologies
www.iwavesystems.com

Panel kits

The newly launched panel kits can combine with any specification of motherboards and every kind of mechanical design. Based on flexible features of the panel kits, they not only provide high-quality display developing solutions but significantly reduce the product developing time. Primary target markets include smart factories (such as industrial automation, HMI, and package recognition system), smart retail (such as kiosk, interactive digital signage, multimedia kiosk, and public internet), intelligent transportation (such as outdoor payment terminal), and smart home (such as conference system and sports and fitness equipment).



Avalue Technology
www.avalue-tech.com

Location monitoring system

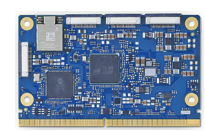
The AL300 LTE-M waterproof tracker with IP67 waterproof and dustproof functions is designed for heavy machinery or transportation equipment that needs to be monitored for a long time and placed outdoors, such as refrigerated trucks, scooters, trailers, and agricultural and construction heavy machinery. In addition to the powerful IP67 enclosure, AL300 can monitor the driving behaviour and the equipment operation data in real time and supports global LTE Cat M1 wireless communication. It allows real-time location monitoring of the machinery and mechanical operation, along with access to engine information to predict failure and maintain it accordingly, thereby avoiding high maintenance costs.



ATrack Technology
www.atrack.com.tw

AI-on-module

The LEC-RB5 SMARC module, a SMARC AI-on-module based on Qualcomm Technologies processor QRB5165, provides on-device artificial intelligence (AI) capabilities, support for up to 6 cameras, and low power consumption. It is capable of powering robots

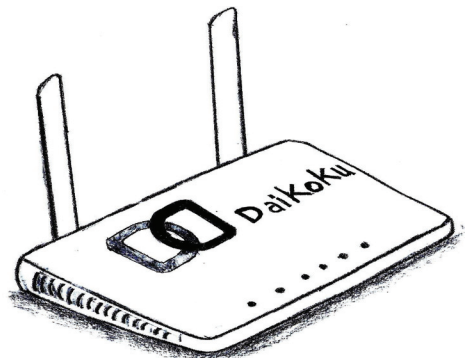




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Daikoku Innovations - Your partner for Passive Optical Networking (PON) products



Daikoku Innovations (Daikoku), a Bangalore headquartered burgeoning product design services company has a strong presence across Communications, Industrial, Consumer, Medical and Automotive segments. Daikoku is now building a strong product portfolio in the passive optical networking (PON) domain.

India's well know dependency on imported communication equipment triggered Daikoku to take a leap into the PON domain in order to make India "Atmanirbhar" (self-reliant). An ecosystem needs to be built based on multiple players so that finally India and the world benefit. With the production linked incentive (PLI) in place and the encouraging push from the Government of India towards building Indian products, there can't be better time than now.

"Daikoku with a strong team of engineers having PON experience is excited to create products with "Made in India" labels ", says Sudarshan NS, Founder, President at Daikoku Innovations.

Why Passive Optical Network (PON) Technology?
The tremendous growth of IP traffic, especially with OTT, work-from-home scenarios, heavy social media usage, cloud infrastructure etc. has made PON technology extremely relevant. The old copper-based networks neither have the bandwidth capacity nor the required transmission distance to efficiently support the current usage patterns of the world, that's where PON technology comes in.

What is Passive Optical Network (PON) Technology?
PON uses point-to-multipoint fiber to the end-points in which optical splitters enable a single optical fiber to connect to multiple end-points. There are three major devices in the network (see FIGURE 1 below): the OLT (optical line terminal), the ONUs (optical network units) or ONTs (optical network terminals) and the splitter. Daikoku is well-positioned to cater to the OLT,ONT and ONU development and deliver complete production-worthy products to their customers.

"We are clearly seeing that multi-gigabit services are going to be commonplace within the next two years' time. Daikoku is gearing up for that by entering the passive optical networking space.", says Sanket Bandyopadhyay, Co-Founder, Vice-President, Worldwide Sales & Marketing at Daikoku Innovations.

Where is Daikoku as far as PON Technology is concerned?
Daikoku is working towards indigenizing the below SKUs and are ready to deliver to customers willing to collaborate.

1. XPON to Ethernet ONU
2. Single-Band XPON ONT (802.11n)
3. Dual-Band XPON ONT (802.11n/ac)
4. Wi-Fi 6 XPON ONT (802.11ax)
5. GPON/EPON OLT
6. XGS-PON OLT



Rajeev Krishnamoorthy, a Bay Area serial entrepreneur, pioneer of 802.11 standard, previously consulting professor at Stanford University's Electrical Engineering department and an advisor to Daikoku Innovations says, **"It is very exciting to see Daikoku driving leading-edge 802.11 solutions. Delivering cost-effective, multi-gigabit services is going to be imperative in the coming future."**

With these in the portfolio, Daikoku can offer its product design services to Indian and overseas companies who want to expeditiously build their product portfolio and cater to the ever-increasing fiber-to-the-home market.

"We are building intelligent networks in the PON domain and implementing customized AI features tuned to our customers' needs.", says Sunil Kumar, Co-Founder, Vice-President, Algorithms Development, AI,ML at Daikoku Innovations.

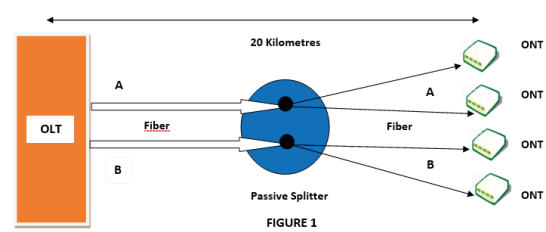


FIGURE 1

Reach Daikoku at: info@daikokuinnovations.com, +91-9343379845 / +91-9845051485

and drones in consumer, enterprise, defence, industrial, and logistics sectors. For robotics and autonomous robot solution providers, the module provides the capability to build powerful robots for use in harsh industrial conditions and in temperatures that range from -30° to +85°C. It provides enhancements for computer vision applications with reduced latencies for real-time image processing decisions, freeing up capacity for other critical AI applications.

ADLINK Technology
www.adlink.tech.com

AC-DC power supply

The Excelsys Xsolo XB1000 series is an ultra-compact single-output AC-DC power supply for Type BF medical



applications featuring market-leading 92% efficiency and user-defined output setpoint voltages. XB1000 power supplies have the safety approvals required to simplify and speed the development and certification of a wide range of applications, including acoustically sensitive laboratory and medical systems requiring Type B (body) and Type BF (body floating) ratings. The XB1000 comes with maximum output power up to 1000W with output voltages of 24 or 48V. Meeting the stringent creepage and clearance requirements for medical applications, the XB1000 provides 4kVAC isolation, 2MOPP, as well as the low leakage currents required for body floating applications.

Advanced Energy
www.advancedenergy.com

AC-DC power supply

The new TPP 40E and TPP 65E families of miniature encapsulated AC-DC



power supplies with safety approvals for both medical and industrial applications consist of 6 models within each wattage family offering single outputs of 5/12/15/24/36/48V with up to 94% efficiency. The small footprint with PCB or chassis-mount versions makes these an attractive solution for a wide range of requirements. The operating temperature range is -40°C to +80°C with derating above 60°C. The EMC characteristic is dedicated for applications in industrial and medical fields. High reliability is provided by use of high-quality components and excellent thermal management, making the TPP 40E and TPP 65E ideal for medical devices and for demanding safety and space-critical applications.

TRACO POWER
www.tracopower.com

Rugged computers

The Karbon 800 series of rugged computers is designed to leverage the advanced features and capabilities of Intel's latest CPUs. It includes



PCIe Gen 4 expansion for the latest GPUs, new I/O options like 10GbE and M12 LAN, and new configurations including a high-capacity RAID array option. The series has been engineered for machine learning, artificial intelligence, advanced manufacturing, automation, and other Industry 4.0 and industrial IoT applications that require powerful computing in commercial and industrial environments. Available in four models, each can be configured with up to a 16-core, Intel Core i9 processor and 64GB DDR4 ECC or non-ECC memory.

OnLogic
www.onlogic.com

T&M SOLUTIONS

Radar scene emulator

Keysight's radar scene emulator enables automakers to lab-test complex, real-world driving scenarios, accelerating the overall speed of the test. Full-scene emulation in the lab is critical to developing the robust radar sensors and algorithms needed to realise ADAS/autonomous driving capabilities. The full-scene emulator combines hundreds of miniature radio frequency



front ends into a scalable emulation screen representing up to 512 objects and distances as close as 1.5 metres. Using full scene rendering that emulates near and far targets across a wide continuous field of view, it enables customers to rapidly test automotive radar sensors integrated in autonomous driving systems with highly complex multi-target scenes.

Keysight Technologies
www.keysight.com

Interposer system

The PCI Express 5.0 EDSFF interposers for analysis of enterprise and datacentre small form factor (EDSFF) E1.S, E1.L, E3.x type solid-state drives (SSDs) and devices work in combination with the Summit family of PCI Express 5.0 protocol analysers to test



product designs that utilise the PCIe 5.0, NVM Express (NVMe), and Compute Express Link (CXL) protocol technologies. The PCIe 5.0 EDSFF interposers allow users to debug enhanced power management and link training equalisation through correlated and time aligned physical and protocol layer views. Based on the PCIe 5.0, NVMe, and CXL specifications, the EDSFF interface can support speeds of up to 32GT/s, enabling design and test engineers to test, identify issues, and optimise EDSFF (E1.S, E1.L, E3.x) type memory systems and solid-state drive performance.

Teledyne LeCroy
www.teledynelecroy.com

SOFTWARE

Machine-learning software

The Version 3 of NanoEdge AI Studio,



RAC05-K/PD3 SERIES: 5W AC/DC WITH OVC III AND PD3-RATING

Board-mount 5W AC/DC for harsh environments

- OVC III and PD3 rating
- Input ranges: 100-277VAC, max 480VAC nominal
- Output ranges: 5V, 12V or 15V
- Operating temp: -40°C to +85°C
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- Suit smart grid, renewable energy, smart metering, IoT systems and food & beverage monitoring process appliances usages



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a software tool for machine-learning applications, offers manufacturers phenomenal potential to fundamentally improve industrial processes, optimise maintenance costs, and deliver innovative functions in equipment that can sense, process data, and act locally to improve latency and information security. Applications include connected devices, household appliances, and industrial automation. NanoEdge AI Studio simplifies the creation of machine learning, anomaly learning, detection and classification on any STM32 microcontroller. This new release also includes prediction capabilities, such as regression and outliers libraries.



STMicroelectronics
www.st.com

CHEMICALS & ADHESIVES

Laminate adhesive system

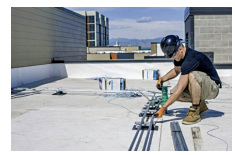
The Pyralux HP laminate adhesive system improves performance of electronic devices and combines best-in-class insertion loss performance with increased functionality and processing. It possesses robust processability while maintaining excellent electrical performance to optimise signal integrity in demanding and extreme-environment PCB applications. This IPC-certified product is available as a sheet adhesive or as a coverlay that is well-suited for a wide variety of multilayer flex and rigid-flex applications. It enables processing at lower temperatures and addresses the needs in high-performance and high-reliability applications in the telecommunications, networking, medical, industrial, military, and aerospace markets.



DuPont
www.dupont.com

Corrosion control solution

The new EcoShield VpCI-386 HT slip coating is a unique high-heat-resistant water based direct-to-metal coating that offers improved surface slip, excellent outdoor weathering, and thermal heat protection. It significantly retards the reaction of metal ionisation and repels water, thus protecting against corrosive electrolytes and aggressive environments. This thixotropic coating resists sagging and running, and is thermally stable when dried in ambient temperatures up to 260°C, depending on colour choice (clear, black, or aluminium). The coating offers extended protection in sheltered, unsheltered, indoor, or outdoor conditions, and is UV-resistant to resist cracking or chipping from prolonged exposure to sunlight.



Cortec Corporation
www.cortecvci.com

MANUFACTURING EQUIPMENT

Soldering system

The VERSAFLOW ONE complements the Ersa world of inline selective soldering systems and features decades of know-how in the form of proven hardware and intuitive software (ERSASOFT 5). Set up, switch on, solder—optimum selective soldering can be this fast and simple. It claims the highest demands on quality, throughput, and ease of maintenance. Features include 3mm pin-chain transport with automatic transport width adjustment, 127µm spray head with 1.8-litre flux tank, IR emitter at the bottom, and one solder pot with electromagnetic pump.



kurtz ersa
www.kurtzersa.com

ENTERPRISE CLASS

Industrial-grade computer

The CMB100 series, an industrial-grade AI-embedded system, is designed for today's artificial intelligence and Internet of Things (IoT) applications. It supports up to Intel 9th generation Core processors and two NVIDIA GeForce RTX 30 series graphics cards. The CMB100 series delivers high performance and responsiveness required to process data in real time at massive scale in deep learning operations. It supports Windows 10 64-bit, Linux Ubuntu 18.0.4, and Windows 7 64-bit (C236 variant only) operating systems.



IBASE Technology
www.ibase.com.tw

Night-vision CCTV

The SeeThru Color NV+ colour night vision CCTV camera not only enhances security but is also dependable and durable owing to its technology. Developed and manufactured in India, the CCTV camera is capable of producing colour images as against the IR camera that gives black & white images. SeeThru Color NV+ comes in two variants—indoor mini dome colour camera and outdoor bullet colour camera. The camera comes with colour night vision, backlight compensation, ultra-low illumination support, and more.

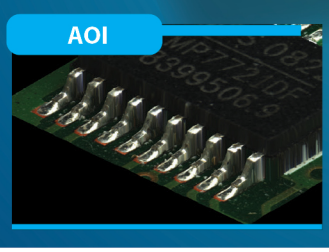


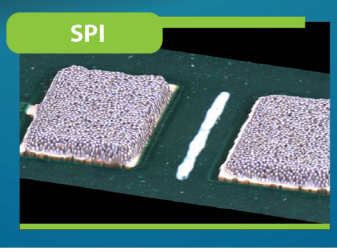
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CYBEROPTICS

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What's So EXCITING About NEUROMORPHIC COMPUTING

The human brain is the most efficient and powerful computer that exists. Even after decades and decades of technological advancements, no computer has managed to beat the brain with respect to efficiency, power consumption, and many other factors. Will neuromorphic computers be able to do it?

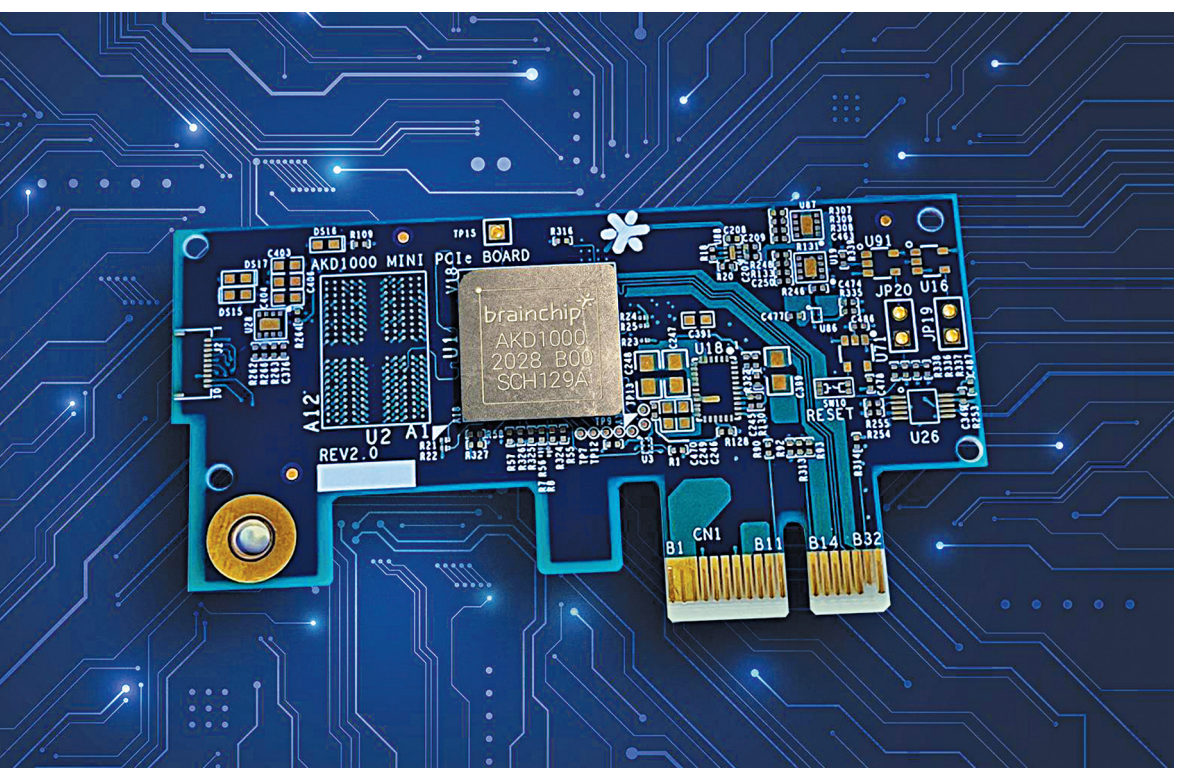
AARYAA PADHYEGURJAR

The exact sequence of events that take place when we do a particular activity on our computer, or on any other device, completely depends on its inherent architecture. It depends on how the various components of the computer like the processor and memory are structured in the solid state.

Almost all modern computers we use today are based on the Von Neumann architecture, a design first introduced in the late 1940s. There, the processor is responsible for executing instructions and programs, while the memory stores those instructions and programs. When you think of your body as an embedded device, your brain is the processor as well as the memory. The architecture of our brain is such that there is no distinction between the two.

Since we know for a fact that the human brain is superior to every single computer that exists, doesn't it make sense to modify computer architecture in a way that it functions more like our brain? This was what many scientists

> In his paper titled 'Neuromorphic Electronic Systems,' American scientist and engineer Carver Mead writes, "Biological information-processing systems operate on completely different principles from those with which engineers are familiar. For many problems, particularly those in which the input data are ill-conditioned, and the computation can be specified in a relative manner, biological solutions are many orders of magnitude more effective than those we have been able to implement using digital methods."



The AKD1000-powered Mini PCIe board (Source: BrainChip Inc.)

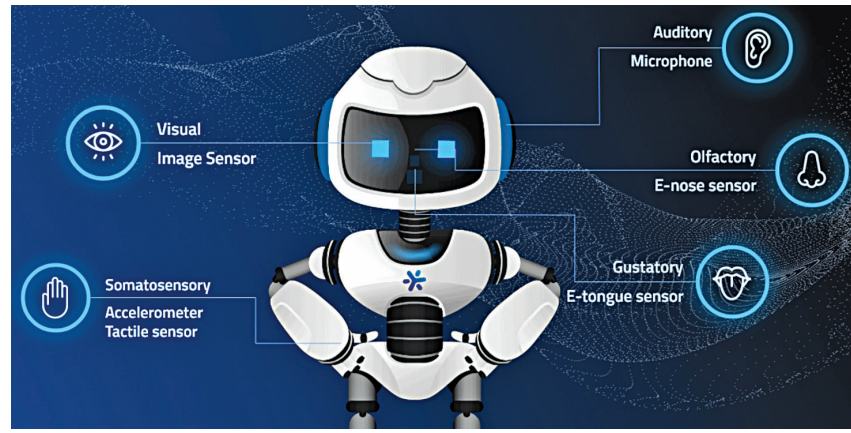
realised in the 1980s, starting with Carver Mead, an American scientist and engineer.

Fast forward to today

Nowadays, almost all companies have dedicated teams working on neuromorphic computing. Groundbreaking research is being done in multiple research organisations and universities. It is safe to say that neuromorphic computing is gaining momentum and will continue to do so as various advancements are being made.

What's interesting to note is that although this is a specialised field with prerequisites from various topics, including solid-state physics, VLSI, neural networks, and computational neurobiology, undergraduate engineering students are extremely curious about this field.

At IIT Kanpur, Dr Shubham Sahay, Assistant Professor at the Department of Electrical Engineering, introduced a course on neuromorphic computing last year. Despite being a post-graduate level course, he saw great participation from undergrads as well. "Throughout the course, they were very interactive. The huge B.Tech participation in my course bears testimony to the fact that undergrads are really interested in this topic. I believe that this (neuromorphic computing) could be introduced as one of the core courses in the UG curriculum in the future," he says.



The 5 sensor modalities (Source: BrainChip Inc.)

Getting it commercial

Until recently, neuromorphic computing was a widely used term only in research and not in the commercial arena. However, as of January 18, 2022, BrainChip, a leading provider of ultra-low-power high-performance AI technology, commercialised its AKD1000 AIOT chip. Developers, system integrators, and engineers can now buy AKD1000-powered Mini PCIe boards and leverage them in their applications, especially those requiring on-edge computing, low power consumption, and high-performance AI.

"It's meant as our entry-level product. We want to proliferate this into as many hands as we can and get people designing in the Akida environment," says Rob Telson, Vice President of WorldWide Sales at BrainChip. Anil Mankar, Co-founder and Chief Development Officer of BrainChip, explains, "We are enabling system integrators to easily use neuromorphic AI in their applications. In India, if some system integrators want to manufacture the board locally, they can take the bill of materials from us (BrainChip) and manufacture it locally."

What's fascinating about Akida is that it enables sensor nodes to compute without depending on the cloud. Further, BrainChip's AI technology not only performs audio and video based learning but even focuses on other sensor modalities like taste, vibration, and smell. You can use it to make a sensor that performs wine tasting! Here is a link to their wine tasting demonstration: *https://youtu.be/RwWTietRioM*

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www.tracopower.com
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- I/O isolation 4000 VAC rated for 250 VAC working voltage
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CE UKCA 2MOPP CSA prepared ErP ready cULus ES 60601-1 UL 62368-1 CB Scheme IEC 60601-1 IEC 62368-1



Here's a small glimpse of what all has been happening in this field

- Intel's Loihi is a neuromorphic AI chip that can implement spiking neural networks (SNNs). Quite recently, Intel announced the next generation of this chip, Loihi 2.
- Accenture, Airbus, GE, and Hitachi have joined forces with the Intel Neuromorphic Research Community (INRC).
- Samsung, along with researchers from Harvard, published a paper titled 'Neuromorphic electronics based on copying and pasting the brain' in Nature Electronics in September 2021. It presented a new way of reverse-engineering how our brain works.
- The US Air Force and IBM are working together to build a neuromorphic supercomputer, probably based on the next generation of IBM's True North chip.
- A team of Chinese researchers has developed an AI chip, called Tianjic, and deployed it in an autonomous cycle.
- TCS collaborated with BrainChip in 2019 for a demonstration on hand gesture recognition featuring the Akida neuromorphic technology.
- IIT Kanpur's NeuroCHaSe research group is actively working on the development of neuromorphic hardware platforms and ensuring their security against adversary attacks. They are also going to tape out (fabricate) a 3D-neuromorphic computing IC soon.
- MemryX Inc., a startup at the University of Michigan, is developing a programmable AI accelerator chip that promises unmatched performance at relatively low power for high-performance applications.

Another major event that occurred this year was when Mercedes implemented BrainChip's Akida technology in its Vision EQXX electric vehicle. This is definitely a big deal since the Akida technology is tried and tested for a smart automotive experience. All features that the Akida provides, including facial recognition, keyword spotting, etc consume extremely low power.

"This is where we get excited. You'll see a lot of these functionalities in vehicles—recognition of voices, faces, and individuals in the vehicle. This allows the vehicles to have customisation and device personalisation according to the drivers or the passengers as well," says Telson. These really are exciting times.

Neuromorphic hardware, neural networks, and AI

The process in which neurons work is eerily similar to an electric process. Neurons communicate with each other via synapses. Whenever they receive input, they produce electrical signals called spikes (also called action potentials), and the event is called neuron spiking. When this happens, chemicals called neurotransmitters are released into hundreds of synapses and activate the respective neurons. That's the reason why this process is super-fast.

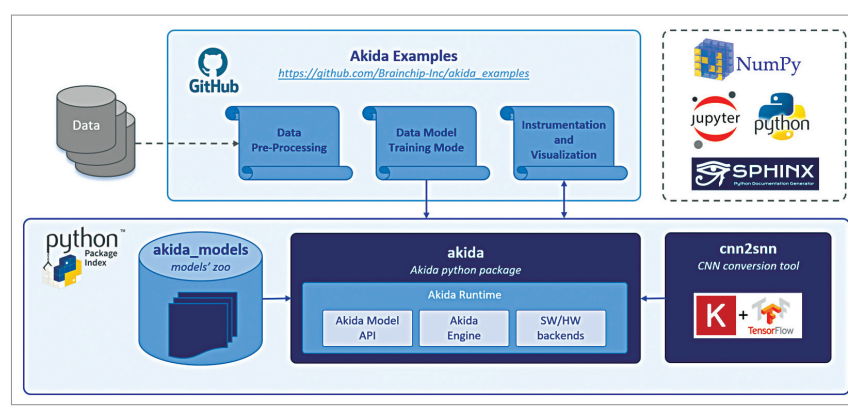
Artificial neural networks mimic the logic of the human brain, but on a regular computer. The thing is, regular computers work on the Von Neumann architecture, which is extremely different from the architecture of our brain and is very power-hungry. We may not be able to deploy CMOS logic on the Von Neumann architecture for long. We will eventually reach a threshold to which we can exploit silicon. We are nearing the end of Moore's Law and there is a need to establish a better computing mechanism. Neuromorphic computing is the solution because neuromorphic hardware realises the structure of the brain in the solid-state.

As we make progress in neuromorphic hardware, we will be able to deploy neural networks on it. Spiking Neural Network (SNN) is a type of artificial neural network that uses time in its model. It transmits information only when triggered—or, in other words, spiked. SNNs used along with neuromorphic chips will transform the way we compute, which is why they are so important for AI.

How to get started with SNNs

Since the entire architecture of neuromorphic AI chips is different, it is only natural to expect the corresponding software framework to be different too. Developers need to be educated on working with SNNs. However, that is not the case with MetaTF, a free software development framework environment that BrainChip launched in April 2021.

"We want to make our environment extremely simple to use. Having people learn a new development environment is not an efficient way to move forward," says Telson. "We had over 4600 unique users start looking at and playing with MetaTF in 2021. There's a community out there that wants to learn."



Akida MetaTF ML Framework (Source: MetaTF)



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Objectives

- To engage unemployed technical manpower with a Diploma/graduate degree in Science, Engineering and Technology
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- To create a pool of such technical manpower trained to meet the need for equipment and maintenance engineers at R&D facilities across the country.
- To enhance the working life of sophisticated instruments by regular maintenance and thereby making (import) capital-expenditure more cost-effective.
- To enable optimal use of the high-end equipment and provide opportunities for host institutions to generate funds by sharing the equipment and by conducting skill development training using in-house experts (faculty members/technical staff/students).
- To fill the void to operate an instrument when trained technical manpower (e.g. Research/PhD candidate) leaves a facility, or promoted to another laboratory of importance, also to reduce dependency of facilities on research students.

Mechanism

- Host Institutions may provide the details of their requirements in prescribed format at the portal
- Advertisement of the internship program/requirement through I-STEM national portal
- Registration and Selection of interns on a regional basis in coordination with I-STEM team
- Interns will be paid a suitable stipend by I-STEM for a limited period
- After being trained, Interns may be offered employment by the host/different institution; or they may seek opportunity through I-STEM portal or practice on their own as Tools Consultant, via the I-STEM, at any of the labs listed on the portal across the country.

How to get engaged with various R&D Labs:

Interested candidates may apply to the internship program throughout the year via the I-STEM portal https://www.istem.gov.in/employment-opportunities.
Suitable candidates will be shortlisted from time to time and be asked to join the program as and when custodian institutions send request for an internship to the I-STEM team. For more details, please visit www.istem.gov.in

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India and the future of neuromorphic computing

When asked about the scope of neuromorphic computing in India, Dr Sahay mentions, "As of now, the knowledge, dissemination, and expertise in this area is limited to the eminent institutes such as IITs and IISc, but with government initiatives such as India Semiconductor Mission (ISM) and NITI Ayog's national strategy for artificial intelligence (#AI-forall), this field would get a major boost. Also, with respect to opportunities in the industry, several MNCs have memory divisions in India—Micron, Sandisk (WesternDigital), etc—that develop the memory elements which will be used for neuromorphic computing." There's a long way to go, but there is absolutely no lack of potential. More companies would eventually have their neuromorphic teams in India.

An overview of Meta TF, BrainChip's software development framework

- MetaTF is a free and easy-to-use ML framework that leverages the TensorFlow framework and PyPI for BrainChip tools installation.
- Since it is built on TensorFlow, deep-learning professionals need not learn a new framework and can start working on Meta TF immediately.
- In-depth documentation with multiple examples is provided on the MetaTF website. (Do check the example section.)
- You can continue to design your CNNs in TensorFlow. Convert them for deployment on the AKIDA neural processor by the following CNN2SNN flow examples.
- The resulting SNN model runs on the AKIDA neural processor MetaTF Runtime.
- All of this in just a few steps!

Check MetaTF out: *https://doc.brainchipinc.com*

BrainChip Inc. is also building its university strategy to make sure students are being educated in this arena. Slowly, the research done in neuromorphic computing is making its way into the commercial world and academia. Someday, we might be able to improve our self-driving cars, create artificial skins and prosthetic limbs that can learn things about their surroundings! Consider your smart devices. All of them are dependent on the internet and the cloud. If equipped with a neuromorphic chip, these devices can compute on their own! This is just the start of the neuromorphic revolution. EFY

The author, Aaryaa Padhyegurjar, is an Industry 4.0 enthusiast with a keen interest in innovation and research.

Ten Industry-Ready COMMUNITY BOARDS Designers Love

Selecting the right development boards for your products is challenging due to the myriad of types and sub-categories. Let's try to understand what industry-ready community boards are before incorporating them into our designs

AARYAA PADHYEGURJAR

Microcontroller boards like Arduino Uno and ESP32 have certainly made it easy for DIYers and hobbyists to implement their fun ideas and projects in a cost-effective way. But in a professional scenario, where commercially viable embedded devices are to be made, most engineers use these boards for just implementing their proof-of-concept. The next stage of the product development process requires developers to finalise their components, create specification sheets, and ensure that their device is capable of working successfully as a product and not a prototype.

While it is a common practice to migrate from a development board to a custom PCB design, one should also consider the possibility of using industry-ready community boards in one or more steps in the product development life cycle.

Most semiconductor manufacturers create a development board for each microcontroller chip they launch. Nearly all can be programmed using open source integrated development environments (IDEs) and are extremely easy to use. But some of the chips like ATMega328P (the one used in Arduino Uno) offer only basic features.

Then there are others like XMC47xx from Infineon that have a larger memory size, more embedded interfaces, more input-output pins, and, in general, better performance. Simply put, industry-level boards are development boards based on these chips. Although these boards are created for an engineer to get familiarised with the chip and for easy firmware development, they are often considered to be production-level boards. Thanks to their comprehensive features and a wide range of desirable attributes, engineers can choose to deploy them directly in their products. Moreover, they are backed by multiple online forums and communities.

According to their specifications, applications, and areas of production, development boards need to be certified by FCC (Federal Communications Commission) or similar organisations. Most of them are also under the scope of RoHS (Restriction of Hazardous Substances) and need to be RoHS compliant.

When to use them

For prototyping. Instead of using a general-purpose development board that is not specifically designed for a particular application, engineers can use an industry-ready development board even at the prototyping stage. Migrating from the Arduino framework to one that is a little advanced might be viewed as a hassle. But it should be considered as an investment for a smoother transition from R&D to production.

For alpha and beta testing. After the proof-of-concept is made, it is time to start testing it. Alpha and beta testing for hardware is very different from its software counterpart. This testing is done in a controlled environment that mimics the environment in which the end product is to be located. A custom PCB takes approximately 7 to 10 revisions before being ready. Since

Pros and Cons

Pros:

- Low time to market
- Application-specific nature
- A smooth transition from prototype to product

Cons:

- A learning curve at the initial stages of development
- There are extra peripherals that are not used in the final product

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hardware development is an iterative process, using industry-ready boards at this stage will definitely save time and money. With a huge variety of boards to select from, engineers can do their due diligence and select one whose microcontroller chip can be used in their PCBs after successful testing. Thus, industry-ready boards can be used as a temporary solution to reduce time to market.

For your minimum viable product (MVP). Although the full form says that it is a product, more often than not companies treat their MVP as a part of their development process. Most hardware startups do not prefer to invest too much money in the first version of anything that launches into the market. In such a scenario, using an industry-ready board will not only benefit the company financially but also ensure a quality product. Similar to the case of alpha and beta testing, engineers can migrate to custom PCBs once they are sure of the product's maturity on the field. In this case, these boards provide an interim solution that allows the R&D team to understand the viability of the technology they have developed.

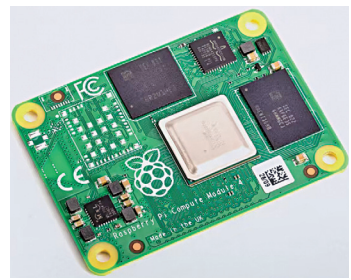
When to use in end products

By definition, development boards contain peripherals and circuitry that allow engineers to experiment and prototype. Generally, development boards are not used in appliances because they contain circuitry that may not be required in the final product. This affects the battery life and efficiency of the device. Hence, a custom PCB is made at this stage.

That being said, almost all industry-ready boards are tailored for a particular application. If selected wisely according to the requirements of the final product, they can even be used as a permanent solution. Using them is easier if the final product is to be stationary and connected to a continuous power supply, like a gateway node in Industrial IoT (IIoT) applications. Nevertheless, rigorous quality assurance must be done based on the environment in which the final product is to be launched.

Ten industry-ready boards

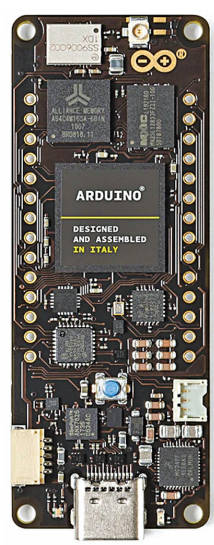
1. Raspberry Pi Compute Module 4 (CM4002008). This module is particularly designed for end applications. It has a powerful compute engine that is far superior to



(Source: Raspberry Pi)

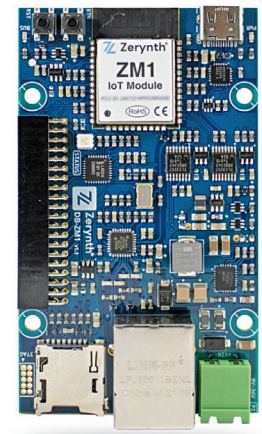
its predecessors. It is also the first to offer an external antenna connector, which is vital in industrial applications. This is because the circuitry is always present in an enclosure, which inhibits Wi-Fi connectivity. But here, we can directly connect a certified antenna (also sold by Raspberry Pi) and enjoy a really good Wi-Fi connection.

2. Portenta H7 (ABX00042). It is Arduino's industry-grade development board that intends to satisfy the needs and demands of Industry 4.0. It has a wide range of pins and can be programmed using high-level languages including C++ (Arduino framework), JavaScript, and MicroPython. An interesting feature is that it can run TensorFlow for machine learning. Considering all its characteristics, the Portenta H7 is well suited for robotics applications.



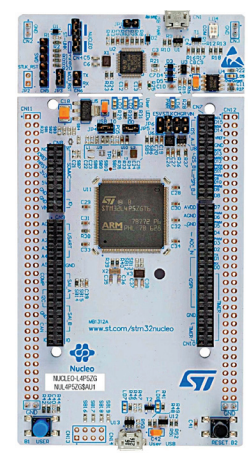
(Source: Arduino)

3. ZM1-DB. This board is a complete package for IoT applications. It contains an ESP based microcontroller, which makes it easy for developers with prior experience in ESP8266 or ESP32 to start using this board. With its industry-grade hardware and IoT cloud platform (Zerynth Cloud), ZM1-DB can be viewed as a useful solution for prototyping as well as direct deployment. It contains an interface standard called zBus, which allows us to easily expand the board's capabilities using various expansion boards provided by Zerynth. Therefore, it is heavily customisable and can be tailored to any end application.



(Source: Zerynth)

4. NUCLEO-L4P5ZG. This board from STMicroelectronics provides a cost-effective and energy-efficient solution to developers. The STM32 ecosystem and communities provide a good platform for understanding this board and learning how to use it. It integrates an on-board debugger/programmer and can be programmed using various IDEs. It is suitable for applications with many peripherals since all STM32 input-output pins are available for use. It



(Source: STMicroelectronics)

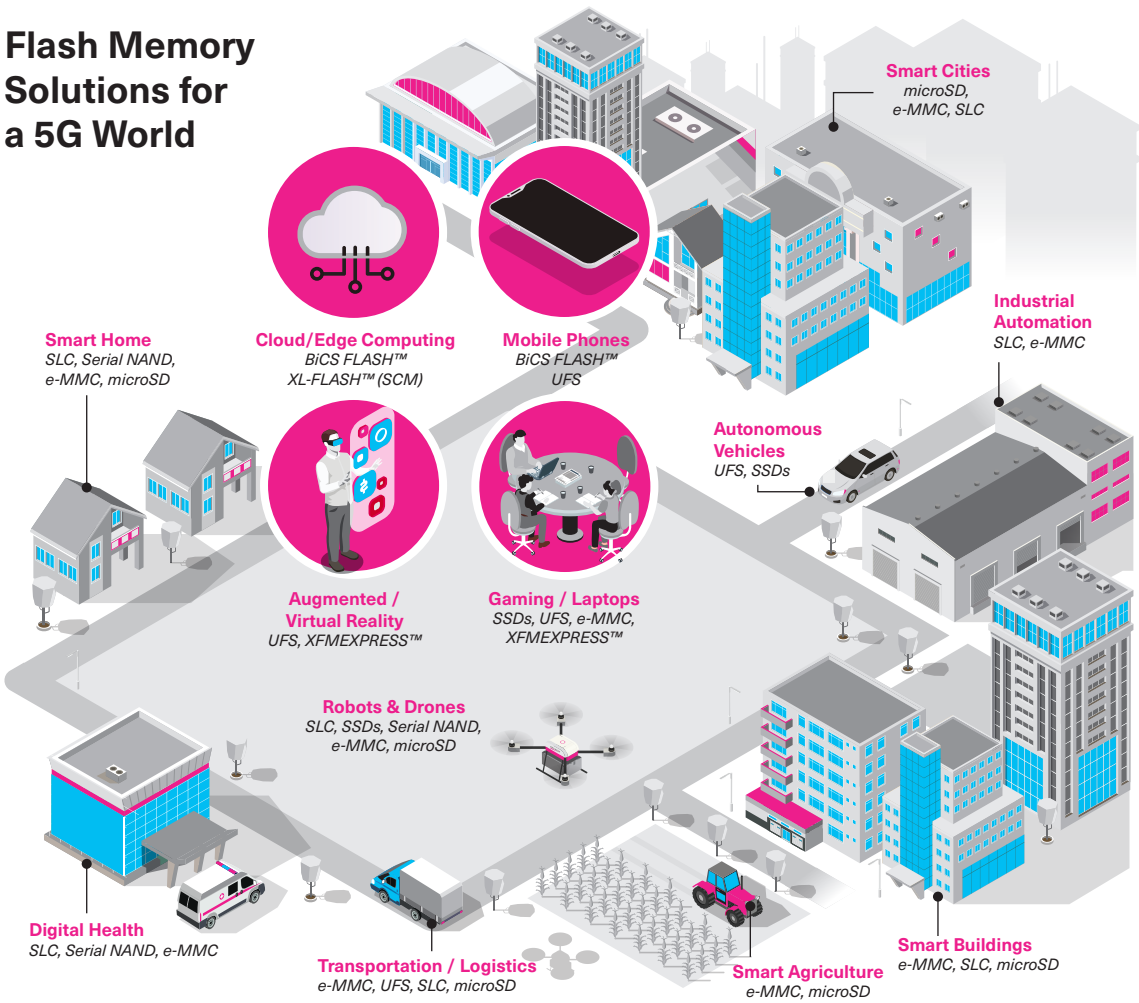
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TABLE 1
COMPARISON OF INDUSTRY-READY COMMUNITY BOARDS

Board Name/ Part Number	Family Name	Board Manufacturer	Silicon Manufacturer	MCU/ Silicon Core Number	Number of Bits	Architecture	Most Notable Feature	Compatibility	IDEs	MRP ($/€)	Use Case	Supported by
Raspberry Pi Compute Module 4 (CM4002008)	BCM2xxx	Raspberry Pi	Broadcom	BCM2711	64	ARM Cortex-A72	Inclusion of U.FL Antenna Connector	Connection with Arduino is possible	-	$25 onwards	Applications involving gaming or networking	Raspberry Pi Community
Portenta H7 (ABX00042)	STM32	Arduino	STMicroelectronics	STM32H747XI	32	ARM Cortex-M4F, Cortex-M7F	Two parallel cores that via a 'Remote Procedure Call' mechanism	Arduino IoT Cloud compatible	Arduino IDE (Desktop), Arduino IDE (Cloud)	$103	Parallel computing and multitasking operations like robotics controllers	Arduino Forum
ZM1-DB	ESP32	ZERYNTH	-	ESP32-D0WD	32	-	Extremely customisable due to the presence of zBus. It also has a crypto IC ATECC608A from Microchip	Connections available with a vast variety of expansion boards	Zerynth SDK (VSCode extension is available)	$127	IIoT applications that involve transfer of sensitive data	Zerynth Community and ESP Community
NUCLEO-L4P5ZG	STM32 Nucleo-144	STMicroelectronics	STMicroelectronics	STM32L4P5ZGT6U	32	ARM Cortex-M4	Low power consumption	Supports Arduino, ST Zio and morpho connectivity	IAR Embedded Workbench, MDK-ARM, and STM32CubeIDE	$19	Applications with I/O management (when there are lots of sensors, actuators and peripherals)	ST Community
FRDM-KE15Z	Kinetis-E	NXP	NXP	MKE15Z256VLL7	32	ARM Cortex-M0+	Has a complete set of analogue/digital features	Compatible with FRDM-TOUCH, FRDM-MC-LVBLDC and Arduino boards	IAR Embedded Workbench	$50	Embedded systems development and prototyping	NXP Community
BBONE-AI	AM57x	BEAGLEBOARD	Texas Instruments	AM5729	32	ARM Cortex-A15	It is possible to run a neural network	Has dual C66 DSP, four PRU and four Embedded Vision engines	-	$127	AI, ML and time-critical tasks like motor drivers	BeagleBoard Forum
SIMBA-DKL	-	SensiEDGE	STMicroelectronics	STM32L476RG	32	ARM Cortex-M4	Has a variety of sensors and peripherals on board	Its development kit, SIMBA-DKL comes with Arduino compatible connectors	Arduino IDE is compatible with its dev kit	$106	Can be used as a sensor node in IoT based data acquisition systems	Partners with many community forms including Arrow.com
KITXMC47RELAXV1TOBO1	XMC4000	Infineon Technologies	Infineon Technologies	XMC4700F144	32	ARM Cortex-M4	MicroSD card slot makes firmware updates easier	Arduino hardware compatible	DAVE IDE by Infineon	€30	IIoT applications, can be used as a node	Infineon Developer Community
Nvidia AGX Xavier Industrial	-	Nvidia	Nvidia	8-core NVIDIA Carmel Armv8.2 64-bit CPU	64	Armv8.2	Contains AI software that can be used 'on the edge'	-	-	$1,449	AI-powered applications like robots, drones and autonomous machines	Jetson Community
Particle Argon	-	Particle IO	-	Espressif ESP32-D0WD, Nordic Semiconductor nRF52840 SoC	32	ARM Cortex-M4F	Allows the creation of MESH networks	Supports parts of the Arduino API	Particle Web IDE, Particle Workbench	$28	Battery operated Mesh networks for IoT applications	Particle Community

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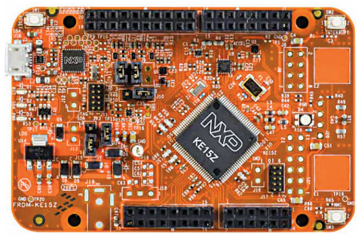
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consumes extremely low power despite having a few components that are in general power-hungry.

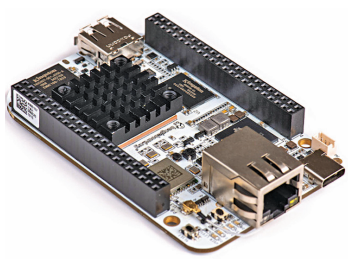
5. FRDM-KE15Z. The Freedom Development board range from NXP is appropriate for embedded hardware and IoT development



(Source: NXP Semiconductors)

and is packed with NXP sensors. Each board has different features, and hence an engineer can select a board according to a particular application. The FRDM-KE15Z board contains an RGB LED, a 3-axis gyroscope, a temperature sensor, and two capacitive touchpads. Also, the NXP community is a good platform for beginners to post their queries and get them solved by experienced developers.

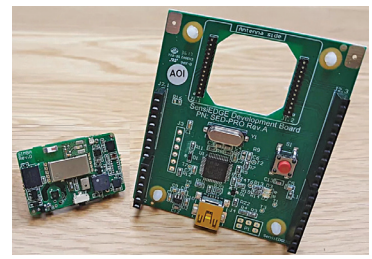
6. BBONE-AI. In several applications, IoT, ML, and AI go hand in hand. The BeagleBone AI is particularly suited for embedded artificial



(Source: BeagleBoard Org)

intelligence and has become popular in the BeagleBoard community. It allows users to implement neural networks and TensorFlow models. Moreover, it has programmable real-time units (PRUs) that can be used for time-sensitive applications while the intense computing tasks are done on its ARM processor.

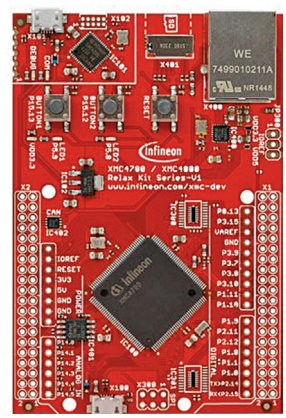
7. SIMBA-DKL. It has all the necessary features needed for IoT prototyping and embedded product development including light sensor, pressure sensor, accelerometer,



(Source: SensiEdge)

gyroscope, and BLE (Bluetooth Low Energy) connectivity. Since it is compatible with Arduino IDE, you can leverage your knowledge in the Arduino framework to make innovative projects.

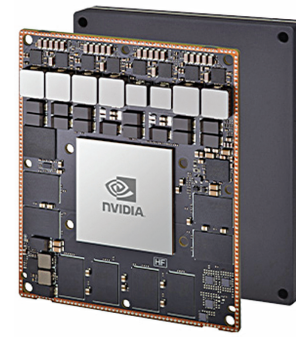
8. KITXMC47RELAXV1TOBO1. Commonly known as the XMC4700 Relax Kit, this board can be used as an Industrial IoT (IIoT) node or as a



(Source: Infineon Technologies)

gateway in commercial applications. It has an onboard micro SD card slot that not just expands the memory but can also be used to ensure that data is stored locally on the device, thus preventing data loss. Infineon has also created several user groups on its community website where developers can participate in discussions and post queries regarding this board, if required.

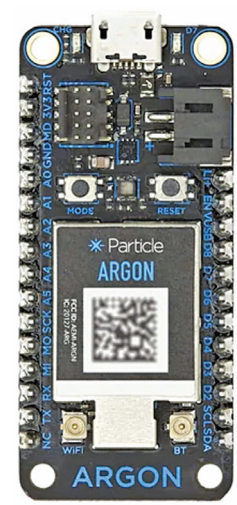
9. Nvidia AGX Xavier Industrial. It promises fast AI development and AI inferencing capabilities on edge devices. It can be useful for applications involving edge computing, which is significant in modern AI devices these days. It has an operating lifetime of ten years



(Source: Nvidia)

and works on extremely low power. Smart cities, logistics, and autonomous robots are desirable application areas for this board. Nvidia also offers AI certifications to those who submit their Jetson based projects to the Jetson developer community.

10. Particle Argon. This board is known for its usage in Wi-Fi applications. It allows the creation of mesh networks. This means that even if one device is connected to the internet, all devices in the network are connected to the internet. You can even power it using a LiPo (lithium-ion polymer) battery. Programming and troubleshooting the board is extremely easy due to the user-friendly Particle Web IDE and the Particle community.



(Source: Particle IO)

Detailed comparison of these boards is given in Table 1. EFY

The author, Aaryaa Padhyegurjar, is an Industry 4.0 enthusiast with a keen interest in innovation and research.

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Wireless EMG Controlled PROSTHETIC HAND

ASHWINI KUMAR SINHA

What if you had an extra pair of hands to carry out tasks somewhere else while you controlled them from another location wirelessly. Seems unrealistic, right? But it's possible.

This project describes how to design a prosthetic hand that can replicate natural hand movements and muscle contractions. Although artificial, it works like a biological hand by following the muscle signals.

To achieve this, the muscle contraction and stress values are captured and then through muscle signals used to wirelessly control the prosthetic arm located somewhere else. The project can be developed further to help the physically challenged and also to grip objects lying in places where you do not want to dirty your own hands.

Assembly

There are various open source prosthetic body parts available in the market. You can also 3D print them at home. In this project the InMoov robotic arm has been used. After getting the required parts comprising fingers and servo, assemble the prosthetic hand as shown in the figures.

Coding

We need to make two devices—a

TABLE 1
MATERIALS

Component name	Quantity	Description
3D Printed prosthetic hand	3	Prosthetic hand
Arduino Pro Micro	2	ATmega32u4
Jumper wires	6	Female to female
9V battery	2	9V DC MN1604 battery
Servo motor	1	12kg/cm^2
EMG sensor	1	EMG sensor
Bluetooth HC 05	2	Bluetooth module



Fig. 1: Inside view of the prosthetic arm



Fig. 3: Outside view of the prosthetic arm



Fig. 2: The prosthetic arm with servo move mechanism



Fig. 4: The prosthetic hand

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```
int senpin=A7;
int senval=0;

void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
Serial1.begin(9600);

}
```

Fig. 5: Transmitter code1

```
void loop() {
  senval=analogRead(senpin);
  Serial.println(senval);
  delay(100);
  // put your main code here, to run repeatedly:

}
```

Fig. 6: Transmitter code for updating value from EMG sensor

```
#include<Servo.h>
Servo arm;

int recvvval=0;

void setup() {
  // put your setup code here, to run once:
arm.attach(9);
Serial1.begin(9600);
}
```

Fig. 7: Connection for receiver

```
void loop() {
recvvval= Serial.parseInt();
// put your main code here, to run repeatedly:
int pos= map(recvval,60,400, 0, 180);
arm.write(pos);
}
```

Fig. 8: Receiver code loop function

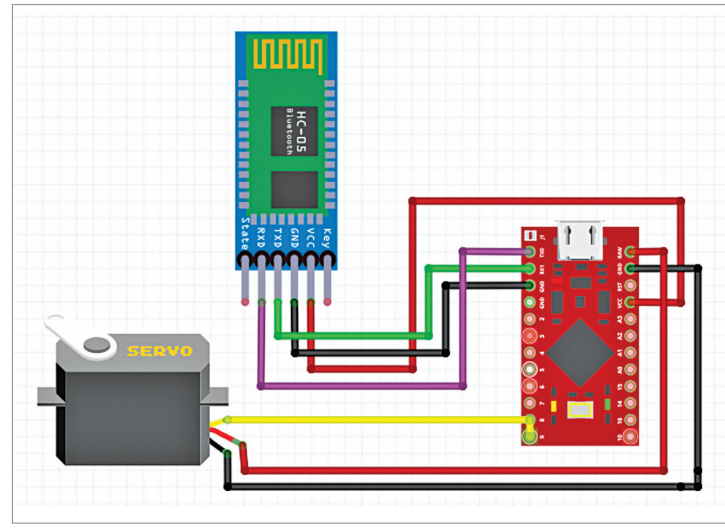


Fig. 9: Receiver circuit connections

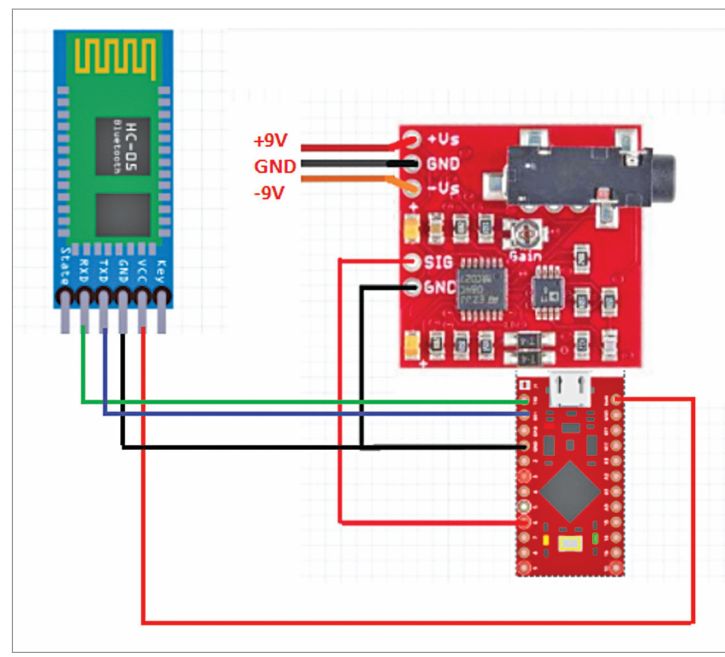


Fig. 10: Transmitter circuit connections

prosthetic hand data transmitter and a prosthetic hand data receiver with servo move mechanism. For each of them we need to create separate codes.

The code for transmitter is required for EMG data transmission to the prosthetic hand. For that we first define the pin numbers for the sensor and variables to store the EMG sensor data. Then we create a setup function where the baud rate is set for the Bluetooth and serial port communication.

The Arduino Pro Micro offers two hardware serial ports—one for USB and the other for receiver and transmitter pins. Use Serial1 for Bluetooth communication by setting its baud rate to 9600, which is the default for Bluetooth HC-05. Then create a loop function (see Fig. 6) for sending updated EMG sensor values to the Bluetooth in a regular interval of time.

For receiver, include the servo library servo.h in the code to control it. Then create a setup function to set the pin number for connecting the PWM signal wire of servo to control it.

Arduino Pro Micro has several PWM pins; we will use pin number 9 for servo PWM control. Start the serial to read the transmitter device value and then create a loop function to get the EMG sensor value over serial. Apply the EMG value to the servo degree rotation range,

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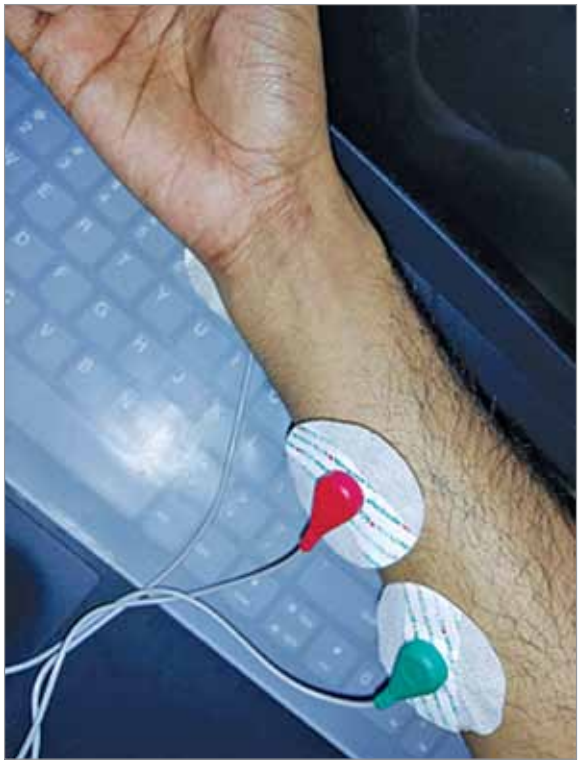


Fig. 11: Electrodes connection for EMG

which is 0 degree to 180 degrees for servo and has values 60 to 800 for the EMG sensor.

Write the mapped value to the servo move position to move the prosthetic hand finger as per signals generated from muscle movement.

Connection

Connect the components for both transmitter and receiver as shown in Fig. 10 and Fig. 9, respectively. For the EMG transmitter circuit, you need to add the Bluetooth module in the receiver circuit as well.

Please note, you need to configure both the Bluetooth modules for them to pair with each other and transmit/receive data accordingly. To do that, you can follow the instructions available online for setting up master and slave mode of HC05.

To test, attach all fingers to the servo pulley for the prosthetic arm and power the transmitter and receiver-cum-controller for the prosthetic arm. Attach the electrodes to your controlling arm as shown in Fig. 11. The prosthetic arm will mimic your hand's finger movements whenever you close and open your palm.

Congrats! You have just made an extra hand, which can be controlled wirelessly. EFY

Ashwini Kumar Sinha is a technology enthusiast at EFY



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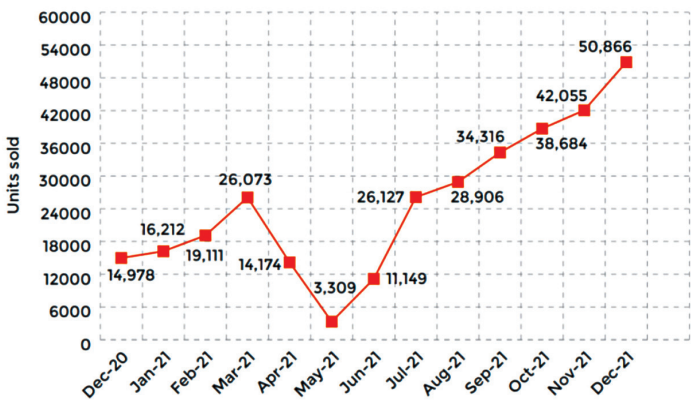
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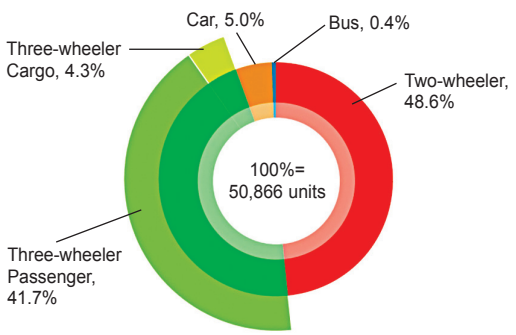
EV Registrations Crossed Over 50,000 Units In December 2021

Overall EV sales in December 2021 clocked 50,866 units, recording a 240% YoY jump from the number recorded in December 2020. Electric two-wheelers alone contributed 48.6% to the total EV registration. Electric cars contributed 5% and the electric cargo three-wheelers contributed 4.3%. Uttar Pradesh was the state where the maximum number of electric vehicles were registered.

Registered EV Sales Trend in India (Dec 2020-Dec 2021)



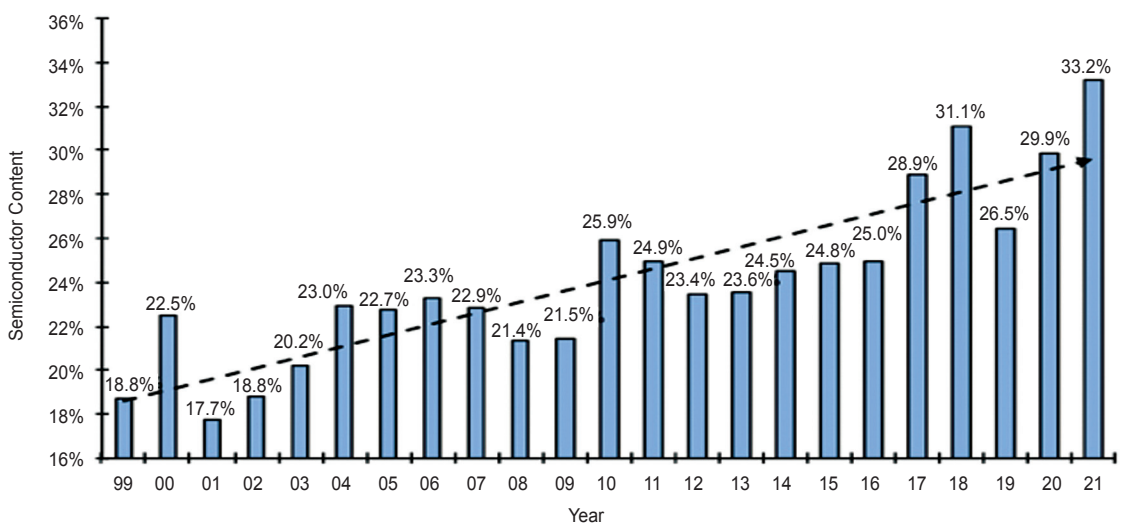
Category-wise EV Sales in December 2021



Source: Vahan Dashboard, JMK Research

Semiconductor Content in Electronic Systems Reached Record High in 2021

The value of semiconductor content in electronic systems reached 33.2% last year, surpassing the previous record high set in 2018. With global unit shipment growth rates of cellphones, automobiles, and PCs showing maturity and slowing over the past 10 years, the disparity between the 3.5% 2011-2021 CAGR registered in the electronic systems market and 6.5% 2011-2021 CAGR displayed by the semiconductor market is directly due to the increasing content/value of semiconductors in electronic systems.

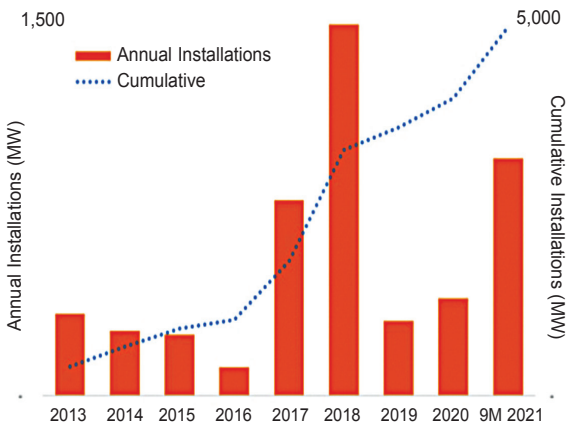


Source: IC Insights

At-a-glance view of key industry trends that can shape the future of your business…

Open-Access Solar Installations Saw An Uptick of 85% YoY in Q3 2021

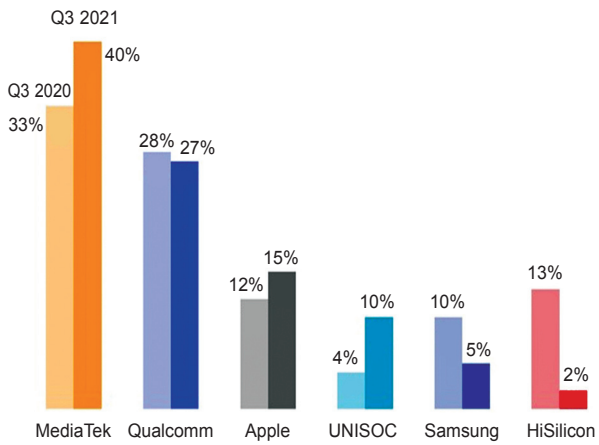
Open access solar installations in India totaled 307 MW in the third quarter (Q3) of 2021, an 85% year-over-year (YoY) increase compared to 166 MW in the same period last year. Karnataka led the way in cumulative installations, with Tamil Nadu, Uttar Pradesh, Rajasthan, and Maharashtra making up the top five.



Source: Mercom India Research

MediaTek Dominates Global Smartphone AP Shipments in Q3 2021

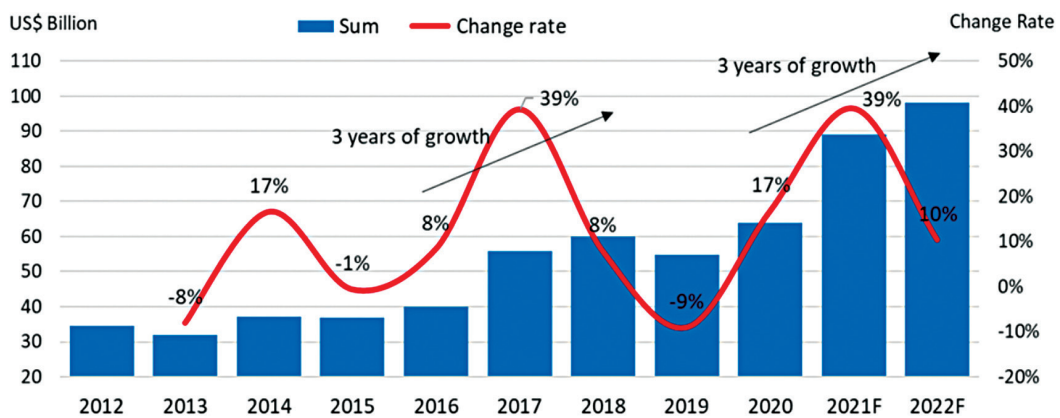
The global smartphone AP/SoC chipset shipments grew 6% YoY in Q3 2021. 5G smartphone SoC shipments grew almost two times compared to the same period a year ago. MediaTek led the smartphone SoC market with a 40% share in Q3 2021. It gained share in the low-mid segment 5G portfolio. Qualcomm grew 9% sequentially due to dual sourcing from foundries.



Source: counterpointresearch.com

Global Fab Equipment Spending Projected to Log Record High in 2022

Global fab equipment spending for front-end facilities is expected to rise 10% YoY in 2022 to a new all-time high of over US$98 billion, marking a third consecutive year of growth. Microcontroller spending is expected to register a staggering 47% surge in 2022. Power related devices are also projected to show strong growth of 33%. Korea is expected to rank at the top of equipment spending, followed by Taiwan and China.



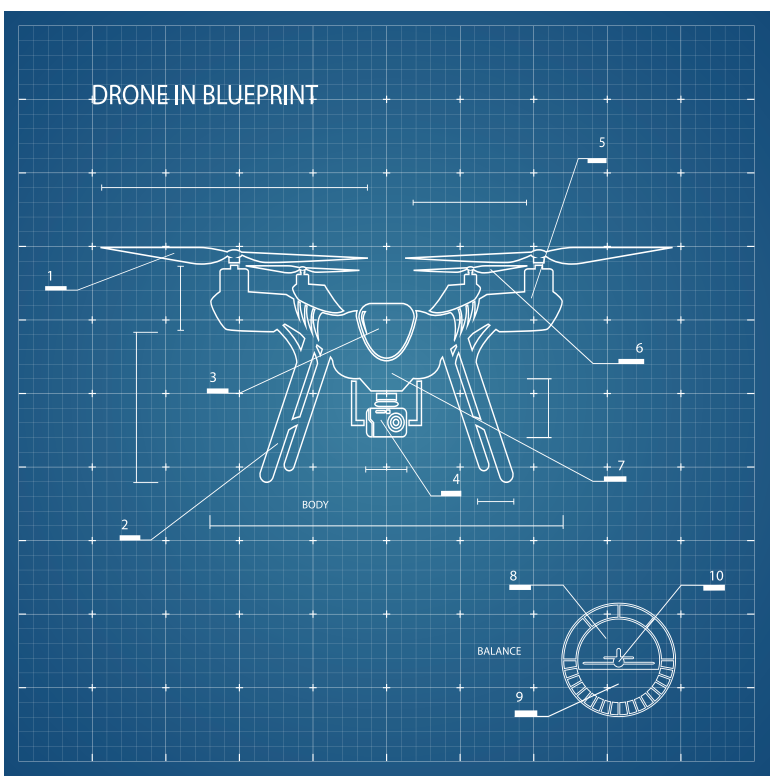
Source: World Fab Forecast Report, 4Q 21 Update, Published by SEMI

DRONES MANUFACTURE IN INDIA: Does PLI Make It Attractive Enough?

The government of India has introduced a production linked incentive (PLI) for manufacturing drones and their components in the country. Should startups, SMEs, MSMEs, and bigger organisations invest in the sector that is still at a nascent stage? What is the future of drones, and what are the business challenges and opportunities offered by the sector? Let us have a look

MUKUL YUDHVEER SINGH

"After the introduction of the new drone policy on August 25, many foreign and domestic investors have invested in drone startups. Many companies are setting up manufacturing units. Army, navy, and air force have given orders worth much more than ₹500 crore (five billion rupees) to Indian drone companies. This is just the beginning, and we don't have to stop here," says India's Prime Minister Modi in his address to the nation via his monthly radio programme *Mann Ki Baat*.



In one of the episodes, he adds, "Drones are a topic which is dominating the imagination of our country, especially the youth, and India is the first country in the world that is preparing digital land records in its villages with the help of drones."

As such, this probably might be the first time in history where the government has taken a proactive approach towards a sector that is considered to be still in its nascent stage. Of course, the Civil Aviation Ministry has estimated India's drone sector to achieve a total turnover of ₹120 to 150 billion (US$1.63 to 2.04 billion) by 2026, from its current turnover of about ₹800 million (US$10.88 million). However, the opportunities and challenges are not just for India, the whole world is experiencing them!

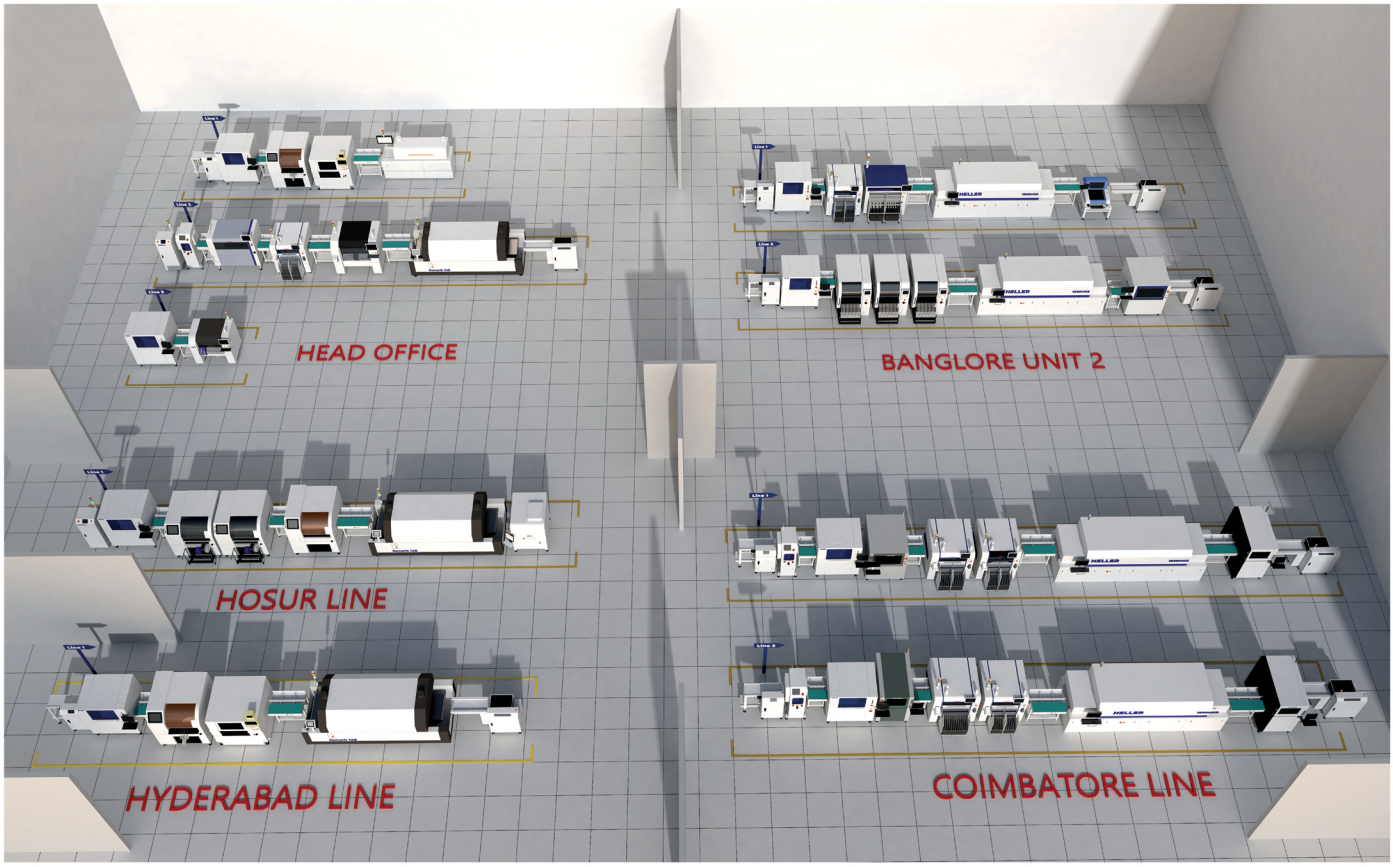
The global market for drones is estimated to reach US$28.47 billion in FY 21-22, and the Bureau of Indian Standards (BIS) research suggests that India will account for roughly 4.25% of this market, even though countries like China, Israel, and the US are currently dominating the market.

Notable in case of India is the government's PLI scheme for promoting manufacture of drones in the country. Offering incentives worth ₹1.2 billion (US$16.06 million), the policy covers almost every critical component required in a drone and envisages to build an ecosystem that fosters drone manufacturing. The opportunities present are not just for big established organisations, but also for startups.

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Some facts

Sectors being revolutionised by drones:

Agriculture • Mapping • Defence • Transportation • Mining • Logistics • Delivery Services • Healthcare • Infrastructure • Surveillance • Photography • Emergency Response • Law Enforcement

Total addressable market potential for drones in India:

- Defence : ₹1,01,000 crore
- Commercial : ₹75,000 crore
- Exports : ₹47,000 crore
- C UAS : ₹49,000 crore
- HLS : ₹23,000 crore

Market forecast figures:

- Total manufacturing potential of more than ₹180,000 crore for drones in India by 2030
- Investment worth ₹5,000 crore for manufacturing drones
- Drones service market to be worth $40.7 billion by 2026
- Drones' camera market to reach $40.7 billion by 2026

Drones PLI at a glance:

- Total amount allocated: ₹120 crore
- Tenure: 3 years, PLI rate constant every year
- Incentive as high as 20% of value addition
- Minimum value addition norm: 40%
- Developers of drone-related IT products also included

Opportunities beyond PLI, being fuelled by PLI:

- Drone pilot training schools
- Drone jobs in AI and ML sector
- Data scientists in the drone sector

*(**Note:** 100 crore=1 billion)*

"We have estimated the total manufacturing potential to be more than ₹180,000 crores (1,800 billion rupees) for drones in India by 2030. This is not just an opportunity for the larger companies but also for the hundreds of startups which are operating in this space," says Rajan Luthra, Head-Special Projects, Reliance Industries Ltd, and Chair, FICCI Committee on Drones and Chairman's Office.

Sampathkumaran S.T., Vice President-Defence & Aerospace, Adani Group, also has a similar view. He notes, "Size does not matter in the drone vertical. The industry as a whole is at a very nascent stage. Everyone is going through learning, that is, the startup phase, and the field is open for everybody to come and play."

Vikram Singh Meena, Founder & CEO-TechEagle adds, "The world will see more than two million Indian made drones flying in airspace by 2030 because of initiatives like liberalised drone policy and PLI scheme."

Let's talk about the PLI first

The graph on last page makes it evident that drones are not just here to stay but to rule every segment they are used in. Moreover, the deployment of drones for mapping villages in India is a clear indicator of the trust and confidence the government of India has in the sector. As a matter of fact, the government itself has admitted that drones can benefit sectors including but not limited to agriculture, mining, infrastructure, surveillance, emergency response, transportation, geo-spatial mapping, defence, and law enforcement.

It is clear that this scheme is a follow-through of the liberalised Drone Rules, 2021 released by the Central government on 25th August 2021. The PLI scheme and new drone rules, as per the government, are intended to catalyse supernormal growth in the upcoming drone sector.

Jyotiraditya M. Scindia, Union Minister of Civil Aviation, while informing about the incentives worth 1.2 billion rupees (₹120 crore), notes the amount would be 1.5 times the combined size of the manufacturing drone sector. He also mentions the objective of establishing India as a global drone hub by 2030 and says that the Ministry of Civil Aviation is committed to facilitate industry, service delivery, and consumers in achieving the aforesaid target.

"Over a period of three years, estimated investment worth ₹5,000 crore (₹50 billion) for manufacturing sector drones will be done, which in turn will bring a turnover of ₹900 crore (₹9 billion), along with 10,000 job opportunities being created," he explains.

The government has kept the eligibility norm for micro, small, and medium enterprises (MSMEs) and startups in terms of annual sales turnover, at a nominal level of ₹20 million for drones and ₹5 million for drone components. Whereas the eligibility norm for non-MSME

Drone components

- Airframe, propulsion systems (engine and electric), power systems, batteries and associated components, launch and recovery systems
- Inertial measurement unit, inertial navigation system, flight control module, ground control station and associated components
- Communications systems (radio frequency, transponders, satellite based, etc)
- Cameras, sensors, spraying systems and related payload, etc
- 'Detect and Avoid' system, emergency recovery system, trackers etc, and other components critical for safety and security

companies in terms of annual sales turnover has been kept twice that at ₹40 million for drones and ₹10 million for drone components.

"We are all starting at the same point and should look towards collaborating and complementing each other. The big companies, small and medium sized enterprises (SMEs), and the startups need to come together and work towards making India the global hub of drones manufacturing," says Lt Col. Ravi Bandreddi (Retd), Senior General Manager, Homeland Security, Dynamatic Technologies Ltd.

What's special

The PLI for drones stands out on a lot of fronts, when compared to PLIs for various other sectors. Like other PLI schemes, the government, via this, is aiming to give incentives to drone and its component manufacturers based on the incremental production achieved by the latter. It stands out from other PLIs in the form that there is no threshold year set by the government to calculate incremental production. Instead, there is a threshold mentioned by the government, and anyone who crosses that threshold can apply for availing benefits.

The method of computing incentives around the PLI is also unique when compared to other sectors. It is based around the amount of local value addition in drones and drone components. In nutshell, the government is aiming to provide 20% of the total local value addition (capped amount) back to the manufacturer. This clause stands true for drones and drone components.

"It is my strong belief that this PLI scheme will drive a lot of companies to look towards manufacturing drones in the years to come," says Sampathkumaran.

What makes the PLI for drones extraordinarily special is the way it has been crafted. Though the amount involved in the PLI is about ₹1.2 billion for three years, it restricts a handful of companies to qualify for the incentives. Two or three big companies, as per Sampathkumaran, coming and taking away all the benefits is not at all possible, and there's enough room for SMEs, MSMEs, and startups to participate in the scheme.

Speaking of equal opportunity for all the players, the PLI for drones has also taken into account IT developers of drone-related IT products. As a matter of fact, the scheme also covers software development for drones, which is probably the first PLI that takes both IT developers as well as software for drones into consideration. As they both are more or less connected to the way drones are deployed, the highlight here is the drone services market size. As per a report by Markets & Markets, it is expected to reach $40.7 billion by 2026 from $13.9 billion in 2021, and the Asia Pacific market is forecast to register the highest CAGR in terms of growth during the forecast period.

On the same page

Yes, the biggest opportunity is in manufacturing drones and their related components, but an equal (maybe bigger) opportunity for startups, SMEs, and MSMEs lies in being successfully able to collaborate with bigger organisations. It is clear that the likes of Adani and Reliance are serious about the drone vertical. The proof of the pudding also lies in announcements made over the last few months.

DCM Shriram Industries, during August 2021, announced that it had

Drones Sector: Why it is India's shining lighthouse



"We have estimated the total manufacturing potential to be more than ₹180,000 crore for drones in India by 2030. This is not just an opportunity for the larger companies but also for the hundreds of startups which are operating in this space," says **Rajan Luthra, Head-Special Projects, Reliance Industries Ltd**, during the Drone World Event organised by Electronics For You and FICCI.



"The only way for India to get a large part of value from the drones sector is by staying ahead in terms of innovation, which resonates with the term startups. The drone industry will benefit a lot from the contributions of the startup industry," says **Ankit Mehta, co-founder & CEO, ideaForge**.



"Drones are one opportunity that is equally available to larger companies as well as startups. It is how fast one can run and compete in the race. The drones' race is open for all," says **Sanjeev Sehgal, Founder & MD, Sparsh Securitech**.



"Size does not matter in the drone vertical. The industry as a whole is at a very nascent stage. Everyone is going through learning, that is, the startup phase and the field is open for everybody to come and play," adds **Sampathkumaran S.T., Vice President-Defence & Aerospace, Adani Group**.



"We are all starting at the same point and should look towards collaborating and complementing each other. The big companies, SMEs and the startups need to come together and work towards making India the global hub for drones manufacturing," says **Lt Col. Ravi Bandreddi (Retd) Senior General Manager-Homeland Security, Dynamatic Technologies Ltd**.



"PLI Scheme also covers software development for drones as a big opportunity, which I think the startups can gain a lot from," opines **Neel Mehta, Director & Cofounder, Asteria Aerospace Pvt Ltd**.

What do startups think about the drones sector in India?



Ankit Mehta, co-founder & CEO, ideaForge: My expectation is that the drone manufacturing industry will jump to over ₹300 crore in a year, from around ₹60 crore today, and will subsequently be much bigger over the coming years.



Prem Kumar Vislawath, Founder & CEO, Marut Drones: The drone industry in India will be more like the IT industry, where we will have a huge base of engineers, developers, design firms, manufacturing firms working inside the drone ecosystem.



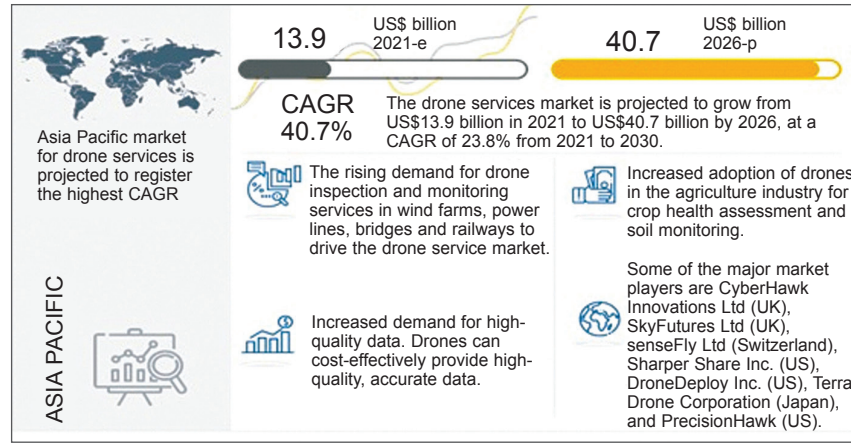
Vikram Singh Meena, CEO & Founder, TechEagle Innovations Pvt Ltd: The drone industry will grow 5x plus during the next 12 months.



Mrinal Pai, Co-founder, Skylark Drones: The drone sector will become an opportunity for creation in India and providing it to the rest of the world. The opening of the sector coupled with the PLI scheme will open the door for tremendous growth and opportunities.



Govind Balakrishna Raju, Founder CEO, 10Infinite: The drone sector would grow just like the IT sector that grew and still continues to grow in India.



Attractive growth opportunities in drone services market

bought 30% stake in Turkish drone manufacturer Zyrone Dynamics Havacilik Danismanlik. The duo plans to work towards marketing drones in India and the rest of the world. It was also in the same month that RattanIndia Enterprises had announced investment in Matternet. The latter is known as the world's most extensive urban drone logistics platform.

However, to make sure that this PLI for drones is successful in not only enabling a local ecosystem of drone manufacturing in India but also in making India the go-to destination for drone manufacturing, service providers, drone component manufacturers, and startups, we will have to be on the same page. The easiest way to do so for the larger companies is to rely on startups for sourcing software and components. And for the SMEs, MSMEs, and startups, the key to success lies in crafting products that do not just appeal to India but to drone companies outside the borders of the country as well.

Dynamatics is setting an example by collaborating with Indian startups in terms of developing and sourcing critical components like sensors, communication systems, and more. Along with Adani group it has already started welcoming startups who wish to work with them.

"The opportunities are present equally in all the verticals of drones, be it components, system integration, data analytics, or services. The intent of the government is very clear, the drone sector is of strategic importance and the government wants to make India the global hub of manufacturing drones," feels Neel.

Sparsh Securitech, credited for making CCTVs in India, is thinking of getting into manufacturing camera technology for drones. It is of the view that the segment is a quite promising one, especially for camera and imagery solution providers. A drone that is not enabled with vision (cameras) is quite difficult to even imagine. The global drone camera market, which was valued at $3.33 billion in 2019, is projected by Allied Market Research to reach $25.39 billion by 2027, registering a CAGR of 29.9%. Asia Pacific, once again, is projected to exhibit the highest CAGR of 31.3% during 2020-27.

"Cameras for drones are the key components that enable photos and video feeds via drones. We believe what was done for CCTVs in 2008, we can do the same for drone camera manufacturing in the coming years," says Sanjeev.

The point to be noted, in terms of components like cameras, communication systems, radars and more, is the opportunity that would arise from the anti-drone sector. This, in addition to the drone sector, also spells chances to cash-in for companies on both the drone as well as anti-drone systems. EFY

This article has been prepared by Mukul Yudhveer Singh, Business Editor, Electronics For You, based on a panel discussion held during the Drone World Event in October 2021 on Tech World Congress platform.

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AUTOMATIC OPTICAL INSPECTION: A Game Changer For PCB Manufacture

Increase in the complexity of electronic boards shows manual inspection may not be a viable option. With the marketplace now requiring high quality, no-error products, there is a strict need for reliable fast methods. One of the effective solutions is to integrate AOI in your electronics test strategy

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ABBINAYA KUZHANTHAIVEL

Automatic optical inspection (AOI) is a key technique used in manufacturing and testing of electronics printed circuit boards (PCBs). It enables fast and accurate inspection of electronic assemblies, thus ensuring production of high quality of boards without defects. This technique usually comes at the stage just after the soldering process to find and fix faults, especially in the solder and assembly area. In this way of rapid response, defects are recognised quickly and rectified before too many boards are built with the same errors.

Not only identifying errors and pausing production of defective boards, AOI provides data needed to improve the performance of the entire SMT process. AOI uses various techniques like template matching or pattern matching to check the quality of a board. It compares the captured image with the image of a 'golden board'—an ideal board that is of acceptable quality and standard, stored in the database. It can be used to adjust and improve the quality of manufacturing without stopping the process. The need for a dynamic SMT inspection equipment has driven manufacturers to connect their equipment and process data to enable smart, adaptable functioning of AOI machines.

What an AOI machine does

These inspection systems use visual methods to monitor PCBs to detect various surface defects like nodules, scratches, and stains and other dimensional defects by in-circuit testing (ICT), such as open circuits, shorts, discontinuity, and thinning of the solder. They can also detect incorrect components, missing components, and incorrectly placed components.

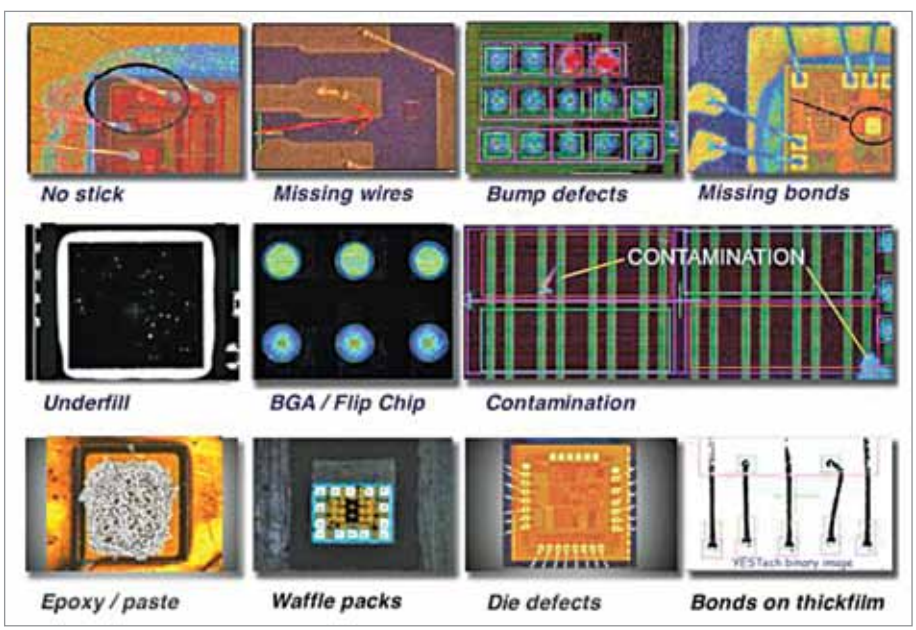


Fig. 1: Optical Inspection (Source: Nordson YESTECH)

An AOI machine uses optical light energy to capture and analyse images of PCBs to verify the assembled electronic components, including presence and position, soldering (solder joints and bridges), polarity, marking (like inscription, signs, colour), flux deposits, microcracks, and subsurface defects. It performs with the help of illumination, CCD image system and processing software, machine vision



Fig. 2: Koh Young's 8-way projection to overcome shadow problem

camera, AC servo control, XY workbench, image processing system, and other actuating parts.

Illumination system

While older AOI machines used fluorescent, incandescent, ultraviolet, or infrared lights, today's machines use smart red, green, white, or blue coloured light emitting diodes (LEDs). LEDs are preferred for their ability to provide a stable form of lighting. With efficient control over the light, LEDs provide uniform illumination.

Along with the type of lighting, the orientation of the light source is also important. Machine vision camera systems assist the illumination system with effective lighting control and intensity adjustments to capture the entire PCB in audit.

CCD image system

CCD is a charge coupled device, a semiconductor element that converts images into digital signals. An AOI system uses a CCD camera for imaging. The system consists of a lens, an image sensor, and image processing tools.

The image sensor forms the heart of the camera. The photon energy captured by the camera lens and the individual pixel information is absorbed by the respective photocells in the sensor. The camera sensor converts incoming photon energy into electrical charges, which are further processed to generate images. The image processing system is the key for extracting the information through images in any application.

In AOI, the processing of images takes place externally through the PC based system supported by various processing tools. The AOI machine's imaging resolution defines the amount of detail it can identify and capture, and hence it is a key factor that affects the inspection accuracy and inspection speed.

Machine vision camera

The image capture takes pictures for analysis. This is assisted by one or more high-definition cameras installed within the AOI to focus or move under the software command. Recently, these cameras have been featured with higher frame rate to support faster scanning and generate more data. An efficient processing software is hence required to manage huge amount of data.

Resolution turns out to be an important aspect as it defines the field of view (FOV) that specifically shows the section in an image. A wider FOV would typically allow the product to be examined with lesser images. However, it takes more time to capture each image as the camera with more pixels leads to a lower frame rate. On the other hand, cameras with a narrow FOV have bigger pixels with higher frame rate.

Processing software

For an AOI machine to inspect a product, the data of an acceptable product must already be fed to the system. There are primarily two ways in which AOI machines are programmed. Image based programming uses scanned images of 'golden board' where references are created and accordingly automated. Algorithm based programming is the other method where the system generates its profile for the product by feeding product data to it.

Now, with all the elements working together, systematic outputs are obtained. Depending on the results, corrections are either made automatically or by human interference.

AOI challenges

While there have been great developments in the manufacturing of AOI machines over the years, many challenges still persist. Manufacturers are coming up with various solutions that are described below to tackle them.

Optical inspection. AOI systems were earlier based on 2D inspection technology where different grey levels for solder paste, solder joint, and component detection were inspected. Today, the 2D technology is being overtaken by 3D measurement solutions.

While many 2D AOI systems remain in use, the effort needed to keep this technology at a low level of escape and false-call rates is tremendously high. This is because the 2D systems work by comparing reference images. To help, some equipment manufacturers have added additional cameras and projectors to create quasi 3D or 2.5D technology, but it is still based on the same antiquated, inadequate comparison, or colour assessment.

AOI machines enabling both 2D and 3D imaging features along with other capabilities are being developed to provide extensive precision in the inspection process. Today, most AOI equipment has the capability to perform multiple tasks, reducing the time and expenses in the SMT process.

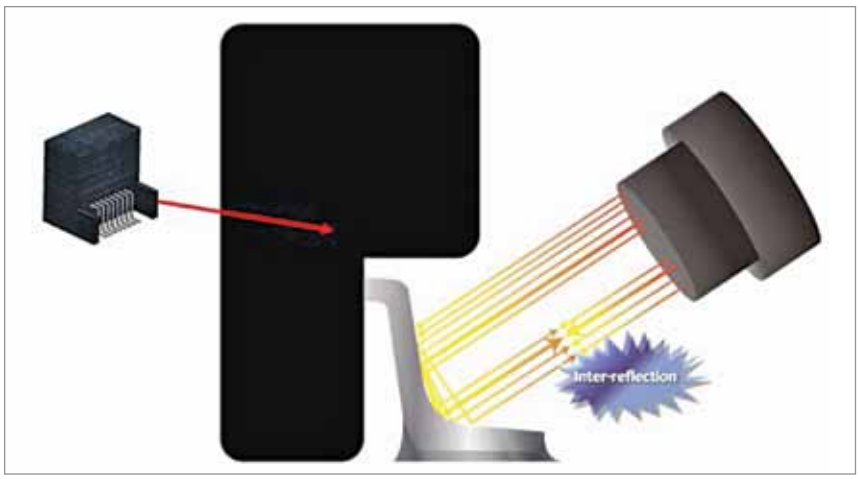


Fig. 3: Single projection's problem with specular areas (Source: Koh Young Technology)

"To avoid faulty solder joints, defects, false calls, and costly rework, we may need easier 3D solder paste inspection as well as 3D AOI inspection," says Olivier Pirou, Head, Product Management and Marketing at Mycronic, an AOI manufacturing company.

Most of the AOI solutions still offer a limited level of 3D coverage for components and solder joints. But a full 3D coverage is needed to identify defects. These full-coverage 3D AOI systems not only inspect common defects, such as missing or wrong components, but accurately provide true volumetric height, identify coplanarity, and lead-bridging issues.

Some 3D AOI solutions have used the multi-frequency shadow moiré technology. Unlike 3D AOI systems using a brightness threshold, the moiré technology uses the height threshold to extract critical body and the lead tip information. This data allows the AOI to provide reliable body and joint measurements with CAD dimensions. It can locate the body properly in the first stage of the inspection process.

However, 3D inspection systems also have disadvantages. This approach cannot check for printed part nomenclature, polarity marks, or colour. Even after using multiple digital projectors, shadowing may occur. Therefore, some additional programming may be required to train inspection components. Using 3D inspection can increase cycle times as projectors may need more time to project multiple fringe patterns needed for image processing. And lastly, machine costs are comparatively high as the technique is not yet mature.

Shadow problems

The shadow problem is inevitable even in 3D inspection machines. When various components are assembled on a board, some short parts like resistors may be shadowed by tall neighbouring components like connectors. This may lead to inaccurate 3D measurement results.

Many manufacturers use an 8-way projection mechanism shown in Fig. 1 that could possibly eliminate blind spots and construct a true 3D image by using multiple projectors.

Board warpage

Sometimes, on a warped board, pad positions defined by board CAD or Gerber files appear distorted. This may confuse conventional inspection systems and generate incorrect data. The board warp becomes a prominent issue during the reflow process because of high temperatures.

Creating new advanced algorithms can possibly address this challenge.

Inter-reflection and solder joint problems

Inter-reflection is a common issue in most optical systems, where light itself becomes the source of information. In the PCBs, soldered and tinned components on assembled boards may have specular surfaces, which reflect some lighting back to the camera while creating strong inter-reflection with other lighting reflections. In such a case, some reflected light does not reach the camera and generates false signals that provide incorrect measurement details.

Some AOI systems today overcome this with the use of superior multi-view sensors. Using these multi-view sensors and advanced 3D image fusion algorithms, it is possible to obtain error-free measurements.

Measuring a solder joint is a complicated task as each solder deposit may vary according to the design and printing conditions. Specular reflections in these will not allow to detect solder defects.

Regular challenges in AOI

- Greater need for programming, which is complicated and cumbersome
- Capacitance values are different and the specifications and colours are the same, which can easily lead to missed judgment
- Different character processing methods cause large differences in polarity judgment accuracy
- Most of the AOIs' understanding of virtual welding is ambiguous, resulting in missed judgment
- There is a problem in detection of Pingyang, shielding cover, and shielding point
- It is impossible to detect solder joints where BGA, FC, and other flip-chip components are not visible
- The detection speed of most AOI products is slow. Speed of a few AOI using scanning methods is faster, but the rate of misjudgment is higher

Apart from these challenges, more overlooked problems that lead to misjudgment and missed judgment are usually inevitable.

State-of-the-art inspection machines

With all that said about AOIs, let us have a look at some of the latest AOI machines.

Omron's S10 series. It is a full colour system, offering a unique mix of general-purpose and application-specific solutions. S10 series enables flexible manufacturing, responds to shortages in manpower, and demands for higher quality production. Elimination of shadow and secondary reflection with 4-direction MPS projectors allows stable inspection of fine parts and enables visibility even at the connector solder joint. (*https://industrial.omron.eu/en/news-events/news/introducing-the-worlds-most-advanced-3d-aoi-system*)

Mycronic's MYPro series 3D AOI system. This newly designed user interface with intuitive programming guidance and self-optimising process control algorithms ensures easy implementation of high-performance 3D AOI for any type of production mix or class by operators of any experience level.

Saki Corporation's 3Di-LS2-CASE. It significantly reduces the number of false calls in the inspection of solder defects (non-wetting) that is difficult to achieve with conventional 3D-AOI technology, and dramatically improves the speed and accuracy of solder defect detection. (*https://metrology.news/next-generation-3d-aoi-system-with-artificial-intelligence-selected-by-denso*)

CyberOptics's SQ3000+ multi-function system. The SQ3000+ multi-function system for inspection and metrology not only conducts AOI and SPI but claims to deliver in-line, full coordinate measurement (CMM) data in seconds. The new SQ3000+ offers a combination of high accuracy and high speed with an even higher resolution multi-reflection suppression sensor that inhibits reflection based distortions caused by shiny components and surfaces. (*https://www.businesswire.com/news/home/20211103005180/en/CyberOptics-Receives-Two-Awards-for-New-SQ3000%E2%84%A2-Multi-Function-and-WX3000%E2%84%A2-Systems-during-SMTAI*)

TABLE 1
COMPARISON OF INSPECTION SYSTEMS

Defect type	AOI	AXI	ICT
Soldering defects			
Open circuits	Yes	Yes	Yes
Solder bridges	Yes	Yes	Yes
Solder shorts	Yes	Yes	Yes
Insufficient solder	Yes (not heel of joint)	Yes	No
Solder void	No	Yes	No
Excess solder	Yes	Yes	No
Solder quality	No	Yes	No
Component defects			
Lifted lead	Yes	Yes	Yes
Missing component	Yes	Yes	Yes
Misaligned or misplaced component	Yes	Yes	Yes
Incorrect component value	No	No	Yes
Faulty component	No	No	Yes
BGA and CSP defects			
BGA shorts	No	Yes	Yes
BGA open circuit connections	No	Yes	Yes

(Source: Rayming PCB & Assembly)

Can AOI do it alone?

Automatic optical inspection works well in PCBs with clearly visible solder joints. However, many PCBs today are using other technologies, such as ball grid array (BGA) integrated circuits or chip scale packages (CSPs), where the solder joints are not visible. Such cases may need extended support with automated X-ray inspection (AXI) equipment that can check solder joints under components.

Manufacturers can consider ways to combine the inspection technologies rather than choosing between them, depending on the complexity of the PCB. Each of their advantages can be carefully balanced against cost to suit a particular production environment.

"AOI and AXI have been following the trend of most recent technologies to provide more performance for less cost. Another recent development is the portability of data between AXI and AOI systems from some suppliers. The ability to share libraries, inspection programs and statistical process control (SPC) data between AOI and AXI systems can greatly enhance machine usage and defect coverage. In addition, programming the systems of today is fast and intuitive. Operators are now able to quickly and easily create inspection programs and manage daily runtime operations with very little intervention. As a result, both high-mix and high-volume manufacturing lines can recognise immediate yield improvement and automated inspection results," says Kevin Garcia, Applications Engineering Manager, Nordson YESTECH, an inspection equipment manufacturing company.

The advantages of current-day inspection systems over price and performance are becoming the driving force to handle dynamic manufacturing environments in giving successful yields. EFY

THE SEASON OF IPOs: Are You Thinking Of Going Public Too?

More and more organisations in India are filing to go public and raise funds. But why aren't they taking the foreign investment route instead? Should you, as an electronics company, file for an IPO? If yes, what are the checkpoints, and what are the challenges?

MUKUL YUDHVEER SINGH

The years 2020 and 2021 have been important for electronics. The government of India has launched numerous production-linked incentive (PLI) schemes for promoting indigenous manufacture of electronics within the country. Recent announcement for promoting manufacture of semiconductors and displays in the country is promising incentives of ₹760 billion.

What makes the previous two years more important for the electronics sector is the number of Indian electronics companies that have filed for Initial Public Offering (IPO), the most recent addition being Foxconn's India subsidiary. Foxconn, being the giant it is, could have easily invested in its Indian subsidiary, but it chose to take the IPO route. There is Data Patterns and Paras Defence from the strategic electronics sector, Lava Mobile from the smartphones and feature phones segment, Waaree from the solar segment, Elin Electronics and Syrma SGS from the EMS segment, and more!

The ones that have already listed themselves are witnessing a strong response from the market as well. For instance, aerospace electronics solutions provider Data Patterns' IPO saw massive interest from investors as the issue was subscribed 119.62 times on the last day of bidding. What makes these IPO filings more interesting is the fact that there was a gap of more than six years between two electronics component contract manufacturers filing IPOs in India.

PG Electroplast had floated a ₹1.21 billion IPO in September 2011, while Dixon Technologies filed for IPO in May 2017. The latter's share price, as of December 28, 2021, was ₹5,645, and it was originally subscribed by the market at a price upwards of ₹2,200 in 2017. Similarly, the shares of PG Electroplast are being bought and sold at around ₹790 today, whereas these were being traded in the range of ₹100 to 150 during the year 2015.

"While many of the IPOs are still in the draft stage, the overall electronics industry presents a strong growth opportunity for investors. A large end-user industry, scalability of companies, availability of labour, capital, and a robust policy ecosystem have created a long runway of growth opportunity for these companies, and this is already being noticed and rewarded by markets from the kind of returns delivered by Dixon Technologies, one of our top holdings," says Abhay Agarwal, Founder, Piper Serica, SEBI registered PMS.

ELECTRONICS COMPANIES THAT HAVE FILED IPO PAPERS RECENTLY

Name of Organisation	Origin Year	Expectations
Bharat FIH (Foxconn)	2015	>₹50 billion
Syrma SGS Technology	Merged in 2020	>₹10 billionr
Elin Electronics	1969	>₹7.6 billion
Data Patterns	1998	>₹6 billion
Paras Defence and Space Technologies	2009	>₹1.5 billion
Maini Precision Products Limited	1973	>₹8.5 billion
Lava International	2009	>₹14 billion

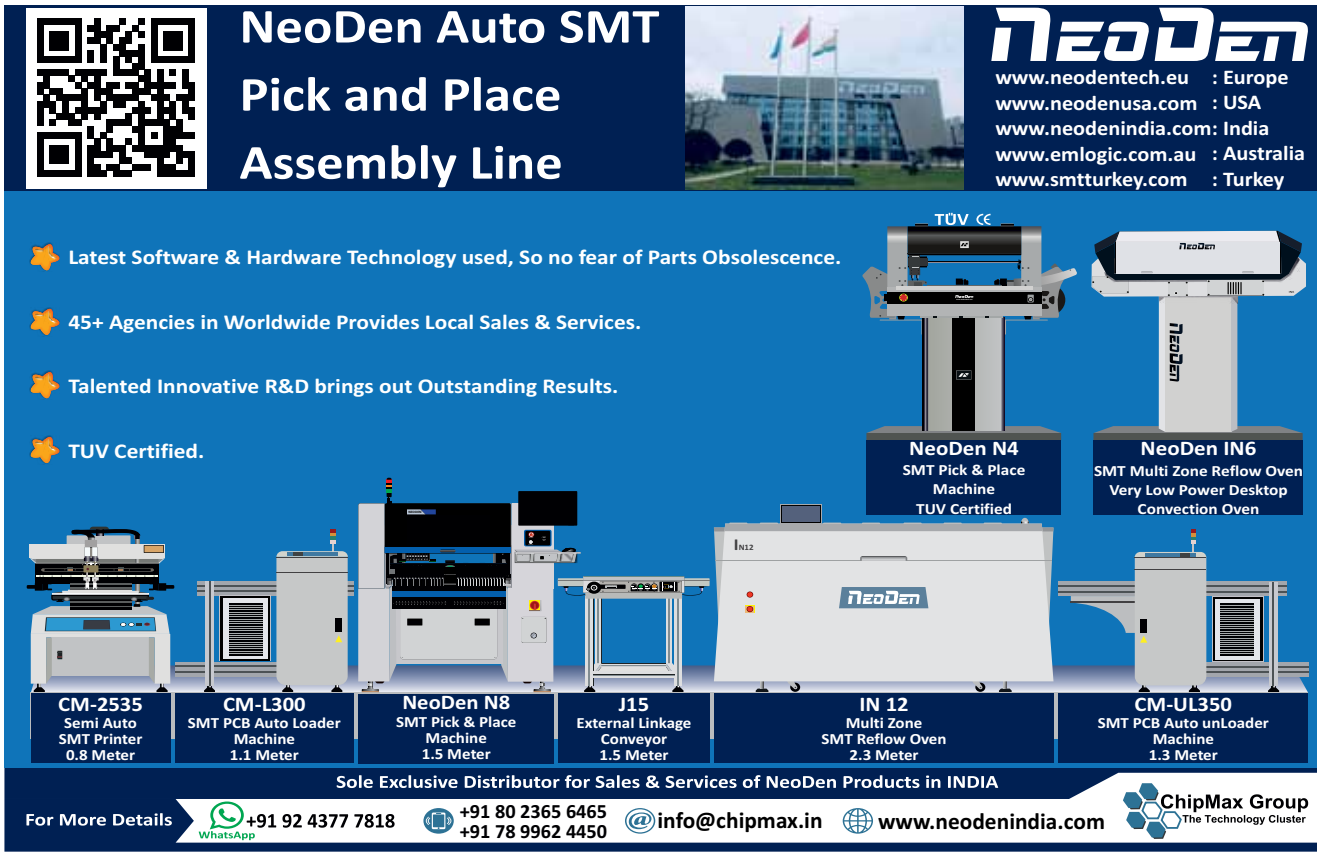
Organisations rumored to be filing IPOs soon: 1. Boat, 2. VVDN, 3. Alpha Design

Why so many IPOs

The way the India based electronics companies are filing IPOs one after another is something that has surprised not one but many share market gurus.

"There are several factors motivating electronics company IPOs, including a stronger-than-expected recovery in the economy after the second wave, continued FPIs and domestic flows in the markets, an increase in retail participation in the stock market, and policy ecosystem which is favouring electronics companies and creating growth opportunities at a level playing field with most global companies," explains Agarwal.

The first and foremost reason encouraging Indian electronics companies to go public seems to be the increased size of the electronics manufacturing market. India's domestic electronics manufacturing industry, as per a MeitY official, is expected to be worth nearly ₹7 trillion. These figures represent 30% growth in the coming fiscal. Then there are heavy-weights like



Samsung announcing big plans for the Indian market. Apple's suppliers, including Wistron and Foxconn, are also investing millions of dollars in the Indian market.

"It's obvious that big names coming and setting up shop in India would mean mammoth business opportunities for Indian companies, and to grab a hold of these opportunities the companies will need a lot of investment. IPOs are one of the best ways to gather this investment for the future," says K. Krishna Moorthy, CEO, India Electronics and Semiconductor Association (IESA).

Second, the incentives on offer by the government of India are more than ₹900 billion. The PLI schemes include IT hardware, telecom, white goods, solar cells, battery cells, healthcare devices. Add ₹760 billion for semiconductor manufacturing, and India's electronics sector starts looking as the most attractive out there.

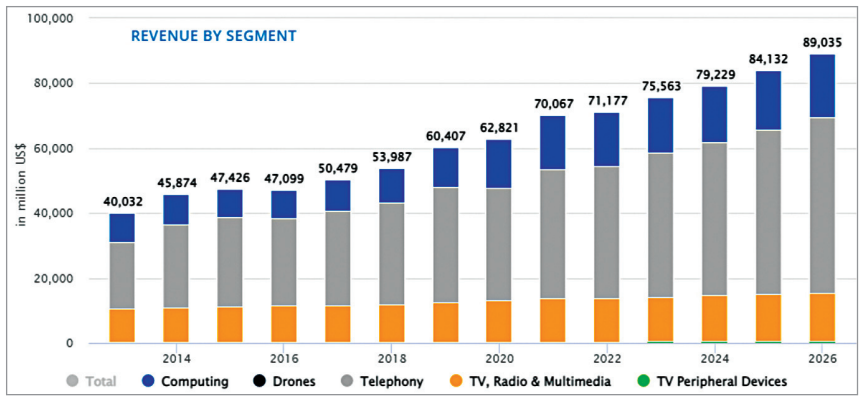
"The quantum change in the mindset has primarily come from the push for local manufacturing. Earlier it was always easy to import and sell, rather than manufacturing here in India. The policies being driven by the government during the last five-six years are the biggest encouraging factors for companies to invest in manufacturing. There is a predictability to the whole world of electronics now," says Krishna.

He adds, "Earlier there were instances of duty being reduced in a year and then increasing it again. It used to go back and forth. The number two reason is the market. Not only are we trying to develop self-sufficiency for the Indian market, but we have also started exporting to many international markets."

The biggest examples of India being a wealth-generation opportunity for electronics companies are smart energy meters and smartphones. Companies manufacturing and supplying these in India, from India, as per Krishna, do not need to look beyond the local markets for generating wealth. The proposed Power Distribution Reforms Scheme envisages to install 250 million smart meters, 10,000 feeders, and 400,000km low-tension overhead lines, while about 2,470,325 smart meters have already been installed in India.

"Forget about export, such verticals of the industry can be sustained from business in India itself. The market, in terms of local consumption, is becoming bigger and better. People now think that the new policies are worth giving a thought and chance," he says.

Moreover, a lot of the companies filing IPO recently have existed for over five years. Faisal Kawoosa, Founder & Chief Analyst, TechArc, believes that it is natural for these companies to file IPOs. Though Foxconn's Bharat FIH was established in the year 2021.



Revenue from consumer electronics segment (Statista)

"It is but natural for such companies to file IPO as they need massive funding. The kind of funds these companies will require can only be raised by going public. The scale at which these companies are today requires them to go public. Otherwise, they will not be adequately resourced, and they will not be able to expand the way they want to," explains Kawoosa.

He adds, "The recent developments like the announcement of PLI schemes have shown a much bigger scale for electronics to such companies. Their potential addressable market, with PLIs, has now stretched beyond India." He explains that to meet the expectations the new scale has put, electronics companies will need a lot of funding, and the best possible way to source that funding is the public route.

Talking about the new scale and then taking an example from the consumer electronics vertical makes things a lot clear about the future of electronics in India. The country is already among the top markets for consumer electronics despite the fact that the penetration rates are still south of 30 to 35%. A report by Statista mentions that revenue in the consumer electronics market (India) has already amounted to US$70,067 million in 2021. The same is forecast to be worth $89,035 million in 2026.

"The market is so vast that even the smartphone companies have started offering consumer electronics beyond smartphones," shares Kawoosa.

Why IPO and not foreign investment

A close look at the factors mentioned above and it becomes easier to guess that all of these are interconnected. Whether it is the increasing market size, the rising geo-polititacl tensions, or the recent PLIs announced by the government of India, all appear to be placed there in a definite pattern.

But why aren't these companies instead of filing for IPO choosing to partner with MNCs for investment?

"Going public majorly means that the controls of the company will majorly remain in the country. People do realise that once they go for a foreign collaboration, most of the foreign partners go for 51:49 kind of partnership, where the 51% belongs to them and the rest belongs to Indian entities. This 51% gives them the decision-making powers. I do not think any Indian company would want that, keeping in mind the way opportunities in the country are growing," explains Kawoosa.

Foxconn's India subsidiary presents a good example of an Indian company trying to raise funds via the public route. The technology group posted revenues of around $178 billion in the year 2019, and in India it is looking to raise around 50 billion rupees through the IPO. The company's IPO will be offered with a 75% reservation for Qualified Institutional Buyers (QIBs), 15% non-institutional investors (NIIs), leaving a meager 10% for retail investors. Would it have been difficult for Foxconn to infuse money in its Indian subsidiary?

"There is no doubt that foreign companies are also investing in India. Dixon had multiple partners who could have invested a lot of money, but they preferred to go with the IPO route. What would you pick when it comes to servicing international debt versus equity? At some point of time equity is going to look better," explains Krishna.

He adds, "The pure-play Indian companies will not prefer foreign investment unless they have subsidiaries already established in and outside of India."

Then comes the 'vocal for local factor.' It is but natural that individuals investing in IPOs will have a lot of confidence in the companies they are putting their money in. The scenario is somewhat like investors funding startups. A good investor in a startup attracts others to put their money in.

Moreover, the likes of Rakesh Jhunjhunwala and others putting their money in electronics companies' stocks has already proved what the move can do. As a matter of fact, what's happening in India now has already happened in countries like the United States, China, Germany, and others.

Should you consider filing for an IPO?

The electronics firms thinking of taking the public route should keep in consideration that filing for an IPO is one thing but being able to generate good market response is another. Right now, the market looks a lot favourable for the electronics companies, but success in the long term depends a lot on not only the company's performance

but the continuation of the right set of policies, and a lot of other things.

"The companies looking to file IPOs should have been in the business for at least five to eight years. Companies which started two to three years back should refrain from investing in filing IPOs. Instead, they should be more focussed on building their dominance in what they are doing," Kirshna opines.

Further, the returns that a company filing or thinking to file an IPO expects should always be kept in mind. The company looking to raise funds via the IPO route should be clear in formulating and conveying what it intends to use the funds for. The checklist also contains owning IPs and product development.

"Whatever kind of investment is a responsibility for the company. If my company does not own an IP or does not have any kind of product development under my belt, then I am just a contract manufacturer. Yes, I do have scales of production, but it will never be seen as long-term by the market or the investors," says Kawoosa.

He adds, "It's important to calculate whether the expected returns will be lucrative enough or not. Will these be as lucrative as returns garnered by BFSI, services, or IT companies. You have every breed of investors. The shares may not be high retuning ones but fundamentally these will be the strong ones."

Trade wars and global disenfranchisement with China has also led to shifts in global manufacturing to alternate locations like India. India with a large and growing domestic electronics market (US$110 billion) and affordable labour is attracting high-ticket investments.

"The development of a robust electronics component ecosystem in India is expected to increase domestic value addition from present levels of 34% to more than 50% by 2025. We believe all these factors converging together will provide a good wealth creation opportunity for investors," says Agarwal.

The global scenario in terms of electronics manufacturing is changing. OEMs and ODMs are resorting to automated processes, whereas the Indian companies are still majorly dependent on human labour. For instance, there were reports of Foxconn's India plant being shut for more than two weeks in the month of December 2021 due to protests by workers.

"There is smart manufacturing, robotics manufacturing, and implementation of IIoT already taking place. A lot of the countries that were not so open for manufacturing will now also think of manufacturing. The decentralisation of manufacturing has begun in China. How are the Indian companies filing for IPO going to address the challenge of automated manufacturing three years down the line?" asks Kawoosa. EFY

The author, Mukul Yudhveer Singh, is a technology enthusiast

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EXNOVATION: Another Side Of INNOVATION

Once a product has been developed well and accepted by the consumers, do we need to keep tinkering with it and try improving it further? Well, the principle of exnovation advises against doing so. And there are, obviously, valid reasons for that





ANAND TAMBOLI is a serial entrepreneur, speaker, award-winning author, and an emerging-technology thought leader

Too much of anything is bad; for business and for anything else as such. Innovation is not an exception. Obviously, you cannot keep innovating the same product or process repeatedly. Not for the extended period. Therefore, we need to talk about the other side of the innovation coin—exnovation!

You may have barely heard of the word exnovation. The earliest usage of this term was observed in 1981 when John Kimberly referred to "removal of innovation from an organization." In 1996, A. Sandeep provided the modern definition of exnovation as the philosophy of not innovating. In other words, ensuring that best-in-class entities are not innovated further.

However, exnovation still has not become common parlance, at least in the intended way.

Why exnovation

The basic definition of exnovation is self-explanatory and quite simple *per se*. However, why do we need it is still a question. Especially if we are comparing it with the continuous innovation paradigm.

When should you call it a day and stop continuous innovation? And, of course, this itself demands a balanced strategy.

But, let me assure you that exnovation is not about refusing innovation in the company. It is about channeling it and narrowing the process down over a period. For example, you may be soliciting innovative ideas from almost everyone initially. It is the phase of exploration where quantity over quality matters. This is when you want everyone to think innovatively and contribute their ideas.

Exnovation is not about refusing innovation in the company. It is about channeling it and narrowing the process down over a period.

However, once you shortlist a few ideas to implement and the execution starts, there is no need to get more of the same ideas again. Moreover, once the changes are made, a new product or process is introduced, and the innovation has been implemented, it is time to reap its benefits. At this stage, colluding tried and tested outcomes with some more new ideas does not make any sense. It only delays the payback.

This is the stage when the focus must shift to exnovation. Earlier, you may have encouraged people for being more in-

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novative. However, you must also encourage them to comply with the newly established product or service process. Then only the innovation that you implemented will result in profitable returns.

When and where to use it

Interestingly, in his book, "The Myths of Innovation," author Scott Berkun writes, "Competence trumps innovation. If you suck at what you do, being innovative will not help you. Business is driven by providing value to customers. Often, that can be done without innovation; make a good and needed thing, sell it at a good price, and advertise confidently. If you need innovations to achieve those three things, great, have a go at it. If not, your lack of innovation isn't your biggest problem."

This thinking highlights an important principle of exnovation. For a multinational company with a presence in different geographies, you often face region-wise challenges. These challenges result from apparent differences in consumer behaviours compared to the parent market of the company. So, how do you manage such matters?

In my experience, a set process and structure of innovation and strategy are important. Additionally, specialised teams with vested authority make a good fit here. They can study the local market's needs and see how they could be fulfilled within the existing system. Then, if any changes are to be made, they can tailor the existing process, products, or system. I wrote about these special-purpose teams in a previous article in this series.

Special-purpose teams play a crucial role in innovation as well as exnovation.

During my tenure with LG Electronics in India, each LG factory had its own R&D and TDR (special-purpose tear down re-engineering) teams. So, we would work on joining and separating innovative projects all the time. But when it came to feedback from the local market and adapting the products, each team had a degree of freedom to work on it for making necessary changes that suited the local market and implemented them at scale. And for those improvements that were nationally or globally applied, the company made sure that these improvements got adopted by all.

The point is, if changes in established design and processes are to be made to suit geographic needs, teams need to be empowered to experiment with those changes first. Then, once validated, there must be a process to recommend them to other units and have them formally introduced or regularised for all, when applicable. Once done, it becomes a standard process again, which need not be tampered with any further.

> EXNOVATION IS ABOUT HAMMERING OUT A PROCESS AND STRUCTURE TO IMPLEMENT IT AT SCALE. ONCE ESTABLISHED, EVERYBODY NEED NOT INNOVATE BUT IMPLEMENT IT TO THE 'T.'

Important piece in innovation puzzle

Exnovation is not about saying no to innovation. It is about hammering out a process and structure to implement it at scale. Once established, everybody need not innovate but implement it to the 'T.'

Counterintuitive but true. You can then put a team in charge that will check processes and structures throughout the organisation and improve them when the need arises. Exnovation means the opposite of innovation only to an extent. Mainly, it is about keeping a check on the innovation process in your company.

Once a process, product, or system is evaluated, validated, and almost mastered by the special-purpose team in the organisation, the next step is to put in place a critical system. A system that will ensure this new change is replicated across branches, departments, units, factories, or similar groups within your organisation.

Ensuring the process is implemented without any alteration is highly important. No one within the organisation should be allowed to tailor the process further for whatever reason.

Innovation can give an organisation the much-needed big leap, but only if favourable processes and systems are passed on and repeated seamlessly by all involved. A strict check on customisation by anyone at random must be kept. Let the special-purpose teams take that call. Give them the liberty and latitude to manage it.

The point is

In defense, not everyone is a commanding officer. In orchestra, not everyone is a conductor. In an organisation, not everyone can be an innovator.

If you want to be an innovative company, you cannot be one without the process and structure around it. Whether it is around innovation activity or the downstream delivery mechanism to deliver it, innovation and process within a company must coexist and feed off each other.

Innovation, in its true sense, includes creating culture and systems that help in effectively sustaining innovation. Your people and innovation teams are central to promoting internal and external collaboration. However, for innovation to be really nurtured, you need to establish a solid process with clear communication and appropriate employee training.

It is not just the effort that we put into innovation that decides success. It is how we go about innovating, its structure and its process. EFY



AMRIT MANWANI
MANAGING DIRECTOR,
SAHASRA GROUP

KEEP THINGS SIMPLE And SUCCESS Will Come KNOCKING At Your DOOR

He hails from a humble background. His parents had migrated from Pakistan to India (Udaipur, Rajasthan) during partition. His elder sister was born on a railway platform. He quit as vice president of one of the biggest companies on the face of the Earth to start a venture. Today, he has invested almost everything to become the first company in India to package semiconductors and ICs. This is Amrit Manwani's story as told to Mukul Yudhveer Singh from EFY

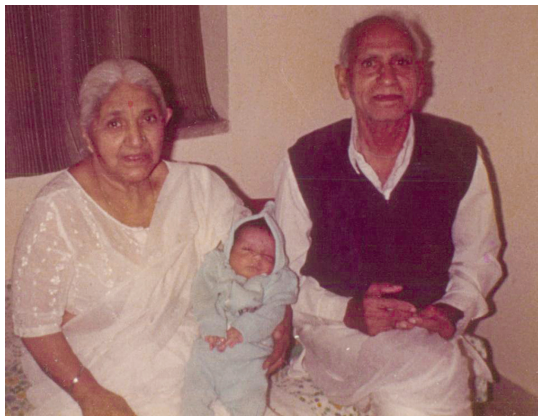
"I consider myself very lucky in terms of what I have been able to accomplish in my life. Nothing I have built would have been possible without the support of my parents, my school mates, my teachers, and the two jobs I had. I consider that every person I have met in my life has been instrumental in making me a man as I am today," says Amrit Manwani, MD, Sahasra Group.

Not have among the haves

Born in Udaipur, Rajasthan, Amrit was born into a family which had recently moved from Pakistan to India. Amrit's father, Narayan Das Manwani, as described by him, was the hardest working man he has seen in his entire life. The family had to leave back everything it owned in Pakistan and start a new life in India. Amrit's father started a sweets shop in Udaipur. The first story that Amrit heard from his parents was probably that of how his elder sister came into being, a story that can send chills down anyone's bones!

"My elder sister was born on a railway platform. This was the time when my parents were migrating to seek refuge in India from Pakistan. I still get goosebumps remembering that story. That incident, though I was not in the world till then, has left a big impact on my mind. I still can't picture how my mom and dad managed to go through that, and still give each one of us brothers and sisters a good life," he shares.

Amrit continues, "My father was visionary enough to put me in a missionary school despite all the difficulties we faced in Udaipur." Amrit completed his primary schooling from St Mary's and secondary from St Paul's. These two schools were known to have students originating from financially strong backgrounds. Getting a chance to study with the



Amrit's parents with his son Akshay

elite of a city proved to be one of the biggest encouragements in the life of Amrit.

"I always felt like I was not a have among the haves. That formed my determination to do well in life. I wanted to become one of them as life progressed. My schoolmates made my determination strong to succeed in life," he explains.

Amrit's biggest inspiration is his father. He would spend hours preparing the finest of sweets to make sure that business was good, so he could afford good education for his children. The population of Udaipur, as Amrit shares, was only about 25,000 people back then. The competition between the sweet shops was cut-throat and anybody who compromised on quantity or quality immediately witnessed a dip in sales.

The financial condition of the family was so weak that Amrit's elder brother had to leave education and help his father at the sweets shop. It was Amrit's father who backed the decision of Amrit preparing for the IIT exams. Most of his other family members did not know about IIT and hence did not back him for taking the exam.

"He told me to prepare for the exams with complete focus and determination. He would tell me that even if I am not able to make it to IIT, I would always have a sweets shop to run and earn from," Amrit recalls. There were only two students who made it to IIT from Udaipur at that time. How did Amrit learn that working hard is the key to success?

He answers, "I remember my father cycling 10 to 12 kilometres every day at 4am in the morning to get milk from a nearby village for our sweets shop. He would put milk containers on both sides of the bicycle. I took it from him to always work hard."

Amrit was so encouraged by his father that he would come back from school and immediately finish homework and start reading for the next day. Amrit was found solving math more often than not. The amount of time that Amrit was spending on books can be gauged from the fact that his mother scolded him to stop studying as she believed that spending that amount of time would ruin his son's eyesight.

"I used to study in the light of earthen lamps before electricity came to our house. My mother would always become anxious as she saw me continuing to do math for hours in the light of the earthen lamp. The attitude of doing hard work came from my father," he says. Amrit was so good at studies his school principal gave him a double promotion and he was promoted to fourth standard straight from second standard.

First business lessons

Amrit, known to have a sharp brain when it comes to business, had his first business classes at his father's sweets shop. These business lessons not only included selling to end consumers but also manufacturing products to be sold. He would also sit on the counter at times and manage the cash inflow. Amrit started helping his father at the shop when he was seven, and the first job his father gave him was that of sourcing ingredients used in preparing sweets. Any incident that he still remembers from those days?

"There was this time when I had lost money that my father had given to buy some ingredients. I was so scared that I didn't go to my shop and my father started searching for me. When he finally found me, he hugged me and told me not to worry as he saw me crying. Those were the golden days of life," recalls an emotional Manwani.

This incident, as he shares, was the one which taught him the opposite of what was taught in a lot of business schools. He got certain that day that people who are emotionally attached to their profession, and other people who work with them, are the ones that can accomplish anything.

"I was never fond of eating sweets. In fact, I also quit cooking a long time back. And I must tell you that I was a master at preparing sev namkeen at a very early age. I was also good at making rabdi, gulab jamuns, and kulfi. If my father were to listen to this statement today, he would twist my ear and tell me that I could have prepared sweets (at the shop)," he shares with a smile and eyes full of light. Amrit, who quit cooking a long time ago, never missed a chance to cook rabadi or prepare kulfi for his father. He also often cooked for his children when they were young.

Amrit found his slot when time came to select subjects for the ninth class and start focusing on them. "I was a good student but I also used to feel a little bit inferior in front of the other kids. There was a time when I

Facts about Amrit Manwani you do not know

1. Amrit Manwani's parents migrated to India from Pakistan during the partition
2. Amrit Manwani's sister was born on a railway platform
3. Amrit Manwani's father owned a sweet shop. Amrit knows how to prepare sweets like rabaddi, kulfi, jalebi, sev, gulab jamun, and more
4. Amrit Manwani met his wife at a job interview
5. Amrit Manwani had invested almost everything in Sahasra's semiconductor initiative

was sitting in the same class as the son of the district magistrate and other influential people. That was the time which was a big challenge for me. Studies, no matter how tough they were, were never a challenge for me," he recalls talking about the challenges he faced in his childhood.

How did he overcome the challenges?

"My goal was to study hard enough to be the best not only in the class but the whole country. I never minded anyone who saw me as inferior and I made friends with kids who were humble. I wanted to study and that was the only thing that mattered to me," he answers. Then there was a time when fellow students were lining up to learn mathematics from Manwani.

Amrit adds, "There came a time when all my fellow students started saying that if anybody would make it to an IIT from their school, it would be Amrit." His rank in the IIT entrance exam was 345 PAN India. IITs were only taking 2,000 students in its five colleges at that time, and the better the rank meant not only bettering the chances of getting into an IIT but also a chance to choose the stream of one's choice.

"The exposure to IIT, the exposure to people coming to study with you from all over the country, is extremely brilliant. Being exposed to the absolute freedom that you get at the college and hostel, and nobody to look after you is one of the biggest challenges. This is a challenge that can teach you the best of time management lessons with on-job experience," he shares.

Amrit, who refers to himself as an average IIT student, was clear from the beginning about not leaving his parents in India in pursuit of a job offer or further studies outside the country. IIT Kanpur was also affiliated to the United States situated universities such as MIT, and it was easy for students to pursue a higher degree in such universities. Amrit, who passed IIT with 7.6 CGI, got a campus placement job offer from Larsen and Toubro. Today, he also holds an MBA degree from Delhi University, which he had completed while working with GE.



Amrit with US Ambassador's wife at a party arranged by General Electric

"More than 50% of the students were hell bent on going overseas for higher studies and then a job offer. I didn't have that kind of a dream or a desire. I wanted to be around my parents as much as I could. My father wanted me to start a business while I always wanted to work in the corporate world," he shares.

Father knew, Amrit realised later

As Amrit started inching towards completing an engineering degree from IIT Kanpur, the financial situation of the family started getting better. Amrit's father then asked him to start a new business in the city of Udaipur and got ready to finance the whole business for his younger son. Amrit, however, wanted to expose himself to the corporate world and learn more about business practically. He also had an offer from Larsen and Toubro (in 1972) awaiting his reply.

"My father was disappointed to hear that I was joining a job instead of starting my own business. I convinced him by telling him that to build a successful business I will need to have exposure to working in an MNC. I joined Larsen and Toubro's Bombay office and worked there for five years. My father never missed a chance to call me and tell me to move back to Udaipur to start a business of my own," he shares.

L&T had offered Amrit to join the company as a graduate engineering trainee. Amrit joined L&T Powai facility, the only manufacturing facility that L&T operated around 1972. Joining L&T as a graduate engineering trainee meant rotation into different departments every six months. Amrit has undergone on-job training in the electrical maintenance department, the switch-gear manufacturing department, the electronics division, vendor development, and the sales & marketing division.

"I finished the two-year graduate engineer trainee programme and was promoted to the designation of a sales & marketing engineer. The HR and training department told me that I had more flair for sales than anything else," recalls Amrit.

Here was Amrit working in the sales & marketing team of L&T, the same Amrit that was helping his father in sales at an early age of ten at the sweets shop! Amrit moved from L&T Mumbai's office to its Delhi office and worked there for around eight months before making up his mind to start looking for a change. GE, at that time, was looking to expand their base in India and Asia. The company, in the process to re-invest in India, had hired only two people from the country, and Amrit was one of them.

"My father started asking me to start my own business once again when he came to know that I was leaving L&T to join GE. It was as if my father knew that I was more of a business guy and less of a corporate job guy. I did realise the same later on," he shares.

Amrit's reason behind joining GE was to explore the international markets and the marketing side of busi-



Amrit with his father Narayan Das, wife Varsha, and first born son Akshay

ness. He joined GE in the company's international marketing programme and also stayed in the USA for a while. He rose through the ranks in GE rapidly and went on to become vice president of such a big company at the age of 35. He was trained in advanced modern marketing at the Crotonville facility of GE.

"GE gave a wonderful engineering, market, and international exposure. I was fortunate to meet Jack Welsh, the CEO of GE. It was him, after my father, who ignited the fire of being an entrepreneur in me. He told all of us to be the entrepreneurs for the GE units we were heading," he recalls.

Amrit adds, "I owe learning the art of starting a business to L&T. From selling a new product to identifying the need for a new product to everything around a business, it's L&T where I learnt it all."

Both L&T and GE have been clients of the Sahasra Group. GE was one of the first companies that Sahasra had onboraded as clients. Amrit shares that being on the other side with GE was a unique experience as Amrit had already worked with a lot of people from GE, the ones that he was selling solutions to under the Sahasra brand. Amrit recalls how he pitched a solution to one of his previous bosses, who said "Amrit it will be a lot easier for you to sell to us as you know all the processes."

Amrit credits learning to do hard work and perseverance to his father, analytics ability to his math teacher, Mr Sisodiya, and the art of keeping things simple yet effective from GE's former CEO, Jack Welch." Jack used to stammer, and yet he headed one of the biggest companies on the face of the Earth. The way he simplified things was out of this world. The direction that he gave to GE is still one of the biggest learnings of my life," he says.

Bungalow to flat

It was in 1990 that Amrit submitted his papers and told his family, friends, and colleagues about the entrepreneurial journey he was heading towards. The first hint that made Amrit look in the direction of entrepreneurship included GE's joint venture with Fanuk of Japan. He is still of the view that the person heading him during this venture was below par. Your expectations are always on the higher side when you have worked with the likes of legendary Jack Welch.

"I thought I was working with somebody who had no vision. It's always good to take directions even as president of a company, but this individual was not somebody I wanted to work with or for. Moreover, I knew that I would not be given a free hand as there will be people from GE and Fanuk trying to control and influence my decisions. I was not really willing to do that," he shares.

"Second, I was no longer able to picture myself working for any other company for the next 24 years. I was 36, with at least 24 more years left in me. Third, we wanted to source PCBs from within India for a GE project, and we could find none! We reached out to a couple of companies and requested them to quote prices for PCBs. The lead time these companies were saying was six months. The same PCBs were available from the United States within two to three weeks," recalls Amrit.

This was the moment when Amrit realised there was a big challenge available to be solved in the market, a challenge that was worth the opportunity of building something of his own in India. "Why don't we set up a PCB plant was a question I asked myself. There is a market, the prices look good. I said all the right ingredients are there. I have identified the business potential," explains Amrit.

Amrit explains all the research and groundwork was done unconsciously while he was working on projects for other companies. Amrit and his partners were able to raise money from a bank consortium. Amrit explains that financial engineering is the first thing that you learn when you start pursuing an entrepreneurial life.

"The office that I started on my own, which employed around eight people, was smaller than my GE cabin. We didn't even have chairs for the vendors who came to visit us the first time. You realise cutting corners is a must when you are an entrepreneur. Sometimes you will have to be the peon and close the office doors at the end of the day. Then there is dealing with the government. How you navigate through tough waters does not come as a part of any research, it starts setting up in your mind unconsciously the day you start working," he explains.

But how does it feel leaving behind a secure job to start something of your own?

"I was not afraid but there were other things that we, as a family, had to compromise upon. For example, I was living in a posh house in Nehru Enclave when working for GE. But as soon as I started my venture my whole family had to shift to a rented small two-bedroom house in Greater Kailash. The first three years of our venture were very good. We were able to capture a good amount of market share. The business was booming," he explains.

What's a business journey with all the ups in it? The government of India opened up the country's doors to imports and the prices of PCBs

dropped by almost 50% (from 90 paise per square centimetre to 50 paise per square centimetre for double side PCB). The effect was such that a lot of PCB units operating in India decided to shut and bear significant losses.

"That was the first time when I asked myself if I had made a mistake by leaving my corporate job for entrepreneurship. Those were the toughest five years of my life. We looked at PCB assembly. I do not regret leaving my corporate job, and I do not think I ever will," says Amrit.

The Sahasra Group, led by Amrit, has an average annual turnover of more than 2.5 billion rupees. It also has a company in the United States. The group also has a unit in Rwanda. The net worth of the group is said to be 1.5 billion rupees. The group is operational in PCBs, memory products, motherboards for data servers, all-in-one PCs, and DVRs for automobiles. The group has recently forayed into the semiconductor packaging arena, and is investing close to 1.5 billion rupees in the same. It has also been selected for PLI for the same by the government of India.

"We will be working on ICs at our new semiconductor facility, and we will be the first in India to do so. The only regret that I have is, I do not have my father and mother to see their son becoming the businessman they always wanted," he says.

Love at job interview

How Amrit met his wife and the duo started dating is also an interesting story. Amrit's boss was scheduled to interview candidates for the position of a secretary. As the day came, Amrit's boss had to travel outstation for a project and Amrit was told to take these interviews.

"He guided me to test the candidates by giving them dictation. My future-to-be-wife came for an interview. Believe you me, I rejected her because of the way she handled the dictation notes. She wrote telephones in place of tenders and made other mistakes as well," explains Amrit.



4th of July 2006, life almost came a full circle for Amrit with his two sons getting betrothed

Amrit informed his boss about the interviews. He was not looking to recommend any of the candidates for the position, but his boss told him that if the candidate's (Amrit's wife to be) English was good, it was easier for them to help her with the dictations. However, this lady joined L&T with a different team. But who proposed whom?

"She lived very close to where I lived, and one thing led to another. I was the one who proposed first," says Amrit with a cute smile on his face. The journey from love to marriage wasn't easy at all. Amrit's parents were strictly against marrying their son out-of-caste. Amrit and Varsha stood firm on their ground and made it clear that they were marrying each other or not getting married at all.

"My wife has always been on my side. She doesn't see wealth as a necessity, but she never discouraged me from taking the decision to quit my job and starting a venture of my own. Yes, I have seen her worried but, despite all that, she encouraged me to start the business. If she had not been in my life, I would not have been able to reach where I am today," shares a proud Amrit.

He continues, "There used to be days when we used to have rejections worth lakhs of rupees. I would return home sad and dejected and she would sit by my side, cheer me up and assure me that everything will be alright."

The couple has been blessed with two boys - Varun and Akshay. Varun is currently helping his father at the Sahasra Group whereas Akshay, the elder son, is a writer and a sports journalist, and has also given cricket commentaries for BCCI.

What's Amrit's plan for the future?

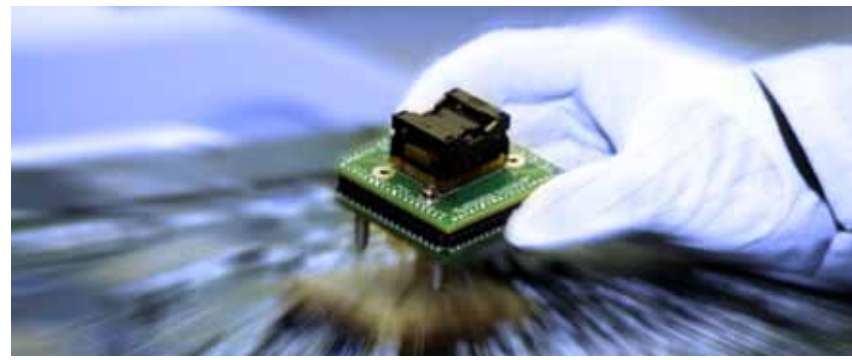
"I love enjoying single malts. On the official side I would definitely like to see the semiconductor industry grow. We have put in all we had in the semiconductor project. It is a big challenge. My dream is not just to be the first company to do semiconductor and IC packaging but also help India in exporting semiconductors. Besides that, I am also the vice-chairman in the Electronic Sector Skill Council of India (India), and I would like to see skill in the youth of India so that they can make India electronics manufacturing hub of the world," concludes Amrit. EFY

Less known facts about Amrit Manwani

- **A dish that he always requested his mother to prepare** – Lotus stem (Kamal Kakdi)
- **Favourite cuisine** – Chinese
- **Vegetarian/Non-vegetarian** – Mutton is his favourite but had to give up because of health issues
- **Cars/Bikes** – Now cars
- **Car I drive today** – Mercedes
- **Favourite Actress** – Sadhana, Alia Bhatt
- **Favourite Actor** – Amitabh Bachan, Gregory Peck
- **All-time favourite movie** – Deewar
- **A book he can read again and again** – Good Earth, Atlas Shrugged
- **One advice he could give to your younger self** – Don't follow the beaten path

Applications invited under Chips to Startup plan

MeitY has sought applications from hundred academia, R&D organisations, start-ups, and MSMEs under its Chips to Startup (C2S) Programme. The programme aims to train 85,000 high-quality and qualified engineers in the area of VLSI and embedded system design. This is expected to result in development of 175 ASICs, working prototypes of 20 SoC and IP core repository over a period of five years.



Representational image

Centre invites applications for semiconductor DLI scheme

The Union Cabinet has approved a comprehensive ₹760 billion plan for the development of chip ecosystem in the country. Support will be provided to a hundred domestic companies for semiconductor design of ICs, chipsets, SoCs, systems and IP cores and semiconductor linked design. Growth of not less than twenty such companies will be facilitated to achieve turnover of over ₹15 billion in the coming five years. MeitY has begun inviting applications.

PEOPLE (on the move)

Satish N.S. to takes over Haier India as President



Satish N.S. will now lead consumer electronics company Haier India as President of the company following the retirement of current President, Eric Braganza, effective 1st January. However, Eric will continue to mentor the team as a consultant. Satish N.S. was earlier company's Senior Vice President of sales and marketing.

EESL appoints IAS Radhika Jha as CEO



Energy Efficiency Services (EESL) has appointed Radhika Jha as its Chief Executive Officer. Jha, a 2002 Uttarakhand IAS officer, is known to have been the brains behind Centre's Integrated Power Development Scheme as Executive Director in Power Finance Corp, before moving to the state.



Silicon Labs appoints Sumit Sadana as Lead Director

Silicon Labs announced that Sumit Sadana has been appointed Lead Director of the company's board of directors. Sadana has been a director on the Silicon Labs board since 2015 and is a member of the nominating and governance committee.

Vicor appoints Chinmaya Joshi as Global Automotive Segment Director



Vicor Corporation announced the appointment of Chinmaya Joshi as the Global Automotive Segment Director. His primary role at Vicor will be to support the expansion of the OEM customer base, tier-one suppliers, and automotive system partners through high-density modular solutions for electrification.

Shinyoung Park named CFO of Magnachip Semiconductor

Magnachip Semiconductor Corporation announced that Shinyoung Park has been promoted to the rank of Chief Financial Officer from 1st January. Park succeeds Dr Young Soo Woo, who stepped down from the position at the end of December. Park joined Magnachip in 2014 and served as Chief Accounting Officer from March 2020 to December 2021.

CORPORATE news

Vedanta to invest in semiconductor industry

Vendanta group has committed to invest ₹600 billion in India's semiconductor industry. They will use the investment to set up a sophisticated chip and glass manufacturing ecosystem in India over the next three years through Japanese glass substrate manufacturer, AvanStrate. The group is eyeing Haryana, Gujarat, Maharashtra, Telangana, Tamil Nadu, and Karnataka as one of the potential states for setting up shop.

CMI to partner with chip makers to enter the market

Indian cable maker CMI Ltd is planning to make its entry into the hot semiconductor market and is looking for partners to do the same. The company is ready to enter into an alliance with prospective manufacturers of semiconductors by leasing out the Baddi plant acquired from US based Fortune 500 company General Cables in 2016.

Ruttonsha International acquires Visicon Power

Power chip firm Ruttonsha International Rectifier Ltd has acquired 100% stake in Visicon Power Electronics Private Limited. Visicon Power is in the business of manufacturing silicon carbide (SiC) wafers and power electronic devices through the epitaxial process. It is in the process of setting up its plant near Baska, Halol in Gujarat.

Foxconn's India subsidiary files for IPO with SEBI

Foxconn's India subsidiary Bharat FIH Ltd is joining the IPO bandwagon, looking to raise ₹50.04 bilion. The IPO will consist of a fresh issue of up to 25.02 billion shares. In addition, a Foxconn unit holding shares of Bharat FIH will divest a portion of its stake to raise an equal amount.



Representational image

EMS company Syrma SGS Technology files for IPO

Syrma SGS Technology has filed its DRHP with market regulator SEBI for an IPO. The company is looking to raise between ₹10 and ₹12 billion. The issue comprises fresh shares worth ₹9.26 billion and an offer for sale (OFS) up to 3,369,360 equity shares by Veena Kumari Tandon. The EMS company may also consider raising ₹1.8 billion via a pre-IPO placement before filing its red herring prospectus. If that happens, the issue size will be altered accordingly.

SNIPPETS

- Centre wants Apple to raise local production to $50 billion over next 5-6 years and make India a global sourcing base
- Attero to invest ₹3 billion to increase Li-ion battery recycling capacity 11x by 2022-end
- Optiemus Electronics looking to invest ₹1.5 billion to ramp up production of laptops, wearables and hearables
- Dixon Technologies to set up ₹3 billion electronics manufacturing plant in Ludhiana
- HFCL appoints three new executives to grow international business
- Ather Energy ropes in two former Ola executives to strengthen senior management team
- Adani Green Energy signs world's largest green PPA with SECI to supply 4667MW solar power
- India's import bill for medical electronic equipment was over $6.24 billion in FY21

VVDN evaluating IPO to start making tablets indigenously

Homegrown VVDN is evaluating taking the IPO route. The company might file for the same within one to two years, sources close to the developments told EFY. Meanwhile, it has already started design, development, and manufacture of tablets for domestic and global OEMs under 'Make in India' campaign. The company said that it will do complete tablet architecture, hardware, software, mechanical design, PCB assembly, tooling and mould making, tablet assembly, testing and validation, and certification.

Waaree Energies gets approval for ₹15 billion IPO

Solar module maker Waaree Energies has received approval from SEBI to launch its IPO with an issue size of ₹15 billion. The IPO comprises fresh issue of shares worth ₹13.5 billion and an offer for sale up to 4,007,500 equity shares by the company's promoters and existing shareholders.

Zypp Electric forays into drone space

Zypp Electric has forayed into the drone logistics segment. The company has said that it plans to deploy 200 drones in four



Representational image

cities in the first phase and has partnered with TSAW Drones for the same. These services are planned in all the cities where Zypp Electric is operational, such as Delhi-NCR, Bengaluru, Hyderabad, Mumbai, and Pune.

Xiaomi India fined for evasion of customs duty

Following an intensive raid by the Income Tax department, Chinese electronics giant Xiaomi has been sent a notice for ₹6.53 billion fine for alleged evasion of import duty. Evidence gathered during investigations by the DRI indicated that neither Xiaomi India nor its contract manufacturers were including the amount of royalty paid by the firm in the assessable value of the goods imported by the company and its contract manufacturers, which is in violation of the customs law.

Bajaj Auto to manufacture EVs at new Pune unit

Bajaj Auto will be spending ₹3 billion for manufacturing electric vehicles at its new unit at Akurdi, Pune. The unit will have a production capacity of 500,000 EVs a year and employ nearly 800 people. The first vehicle from the unit is expected to roll out by June 2022.



Representational image

Tata Motors forms EV subsidiary TPEML

Tata Motors has announced that it will be forming a separate subsidiary for its electric vehicle business, which will be called Tata Passenger Electric Mobility Limited (TPEML). The wholly-owned EV company has been formed with an initial investment of ₹7 billion and will be responsible for manufacturing electric vehicles for the automaker.

Amara Raja Batteries to invest in InoBat Auto

Looking to enter the European battery market, Amara Raja Batteries is investing 10 million euros (about ₹845 million) in European EV battery maker InoBat Auto. This will give the company access to advanced battery technology for e-mobility applications and will open new R&D avenues.

Reliance acquiring Faradion and becomes Sterling & Wilson promoter

Reliance has announced that it will wholly acquire sodium-ion battery technology firm Faradion Limited for an enterprise value of 100 million pounds. Reliance will use Faradion's technology at its proposed fully integrated energy storage giga-factory as part of the Dhirubhai AmbGreen Energy Giga Complex project at Jamnagar. It has also become a promoter in Sterling and Wilson for 40% stake in the company post payment of balance ₹15.83 billion for acquisition of 25.9% equity in it.

Applications received under Auto & EV PLI Scheme

A total of 115 automotive OEM and ancillary companies have applied for the PLI scheme for automobile and auto component industry. The Champion OEM Incentive is a 'sales value linked' scheme applicable on battery electric vehicles and hydrogen fuel cell vehicles of all segments.

Portal for India Semiconductor Mission launched

The government of India has launched a new portal dedicated to the India Semiconductor Mission. This portal will serve as one window for all the works related to applications for the recently announced semiconductors mission in the country.

Companies bid for ACC battery storage PLI scheme

A total of ten companies listed below have bid for ACC battery storage manufacture under the new PLI scheme with their total capacity of about 130GWh: Reliance New Energy Solar Limited, Hyundai Global Motors Company Limited, Ola Electric Mobility Private Limited, Lucas-TVS Limited, Mahindra & Mahindra Limited, Amara Raja Batteries Limited, Exide Industries Limited, Larsen & Toubro Limited, and India Power Corporation Limited.

Telecom equipment worth ₹60 billion produced under PLI scheme

Telecom equipment makers have produced equipment worth over ₹60 billion since the launch of the PLI



Representational image

INTERNATIONAL news

Intel sells SSD business and Dalian facility

Intel Corporation has completed the first closing of the sale of its NAND and SSD business, selling its SSD business and the Dalian NAND memory manufacturing facility to SK hynix. In exchange, SK hynix will pay Intel US$7 billion in consideration. Intel will continue to manufacture NAND wafers at SK hynix's Dalian memory manufacturing facility.



Representational image

China's Luxshare building iPhone mega-plant to challenge Foxconn

China's Apple supplier Luxshare Precision Industry is building a massive manufacturing complex in eastern China worth $1.72 billion as it aims to overtake rivals Foxconn and Pegatron for iPhone assembly.

Toyota Motor to introduce 30 BEVs by 2030

Toyota Motor Corp has revealed its plans to introduce a full lineup of 30 battery electric vehicles by 2030. The Japanese auto giant will also invest 4 trillion yen (US$ 35 billion) to boost battery production. It is aiming for battery EVs to make up 100% of its global vehicles sales in 2035.

Tesla's 2021 vehicle deliveries surge over 87%

As the EV manufacturer Tesla expands production, the number of delivered vehicles is also expected to hit record levels in 2022. Data acquired by Finbold indicates that Tesla's 2021 deliveries stood at 936,172, growing 87.4% from 2020's figure of 499,550. In 2019, the company delivered 367,500 vehicles under different models.

Navitas Semiconductor opens first-ever GaN IC EV design centre

Looking to further expand into higher-power GaN markets, US based Navitas Semiconductor has announced the opening of a new electric vehicle (EV) design centre based in Shanghai, China. EV customers will be supported worldwide by the new team, from concept to prototype, through full qualification and mass production.

Samsung Electronics sees 52% jump in Q4 profits

Samsung Electronics reported a 52% jump in its operating profit in the fourth quarter of 2021. The surge was helped by solid demand for server memory chips and higher margins in chip contract manufacturing. This is the highest jump it has recorded for the quarter in four years. Samsung estimated October-December profit at 13.8 trillion won ($11.5 billion).

Synapse Design now part of TSMC Design Center Alliance

Synapse Design, a QuEST Global company, has joined the Design Center Alliance (DCA) of TSMC Open Innovation Platform (OIP). The TSMC DCA focuses on chip-implementation services and system-level design solutions to help lower design barriers for customers adopting TSMC technology.

Delta to acquire Universal Instruments

Delta Electronics, a provider of smart energy-saving solutions, is acquiring, through its subsidiary Delta International Holding Limited B.V., UI Acquisition Holding Co., the owner of Universal Instruments Corporation and its worldwide branches and subsidiaries, for an estimated amount of $88.9 million.

Honeywell to acquire US Digital Designs

Honeywell has agreed to acquire privately-held US Digital Designs for a purchase multiple of ~14x EBITDA in an all-cash transaction. The company delivers alerting and dispatch communications solutions, which enhance first responders' efficacy and enable faster emergency response times.

scheme for telecom products. This feat was achieved with an investment of ₹2.47 billion from these manufacturers. These investments include ₹97 million from MSMEs, ₹860 million from large Indian manufacturers, and a mammoth ₹1,510 million investment from MNCs.

MeitY seeking another $3 billion for IT Hardware PLI

An expansion of the IT Hardware and Wearables and Hearables PLI seems to be on the cards as MeitY is seeking an additional $3 billion for increasing the incentive budget. Officials added that MeitY has sent the proposal to expand the incentives to the empowered group of secretaries. A series of meetings are planned to assess progress of various PLIs to see which ones have more potential and need more inputs.

India's electronics manufacture to reach ₹7 trillion this year

India's domestic electronics manufacturing industry is expected to be worth nearly ₹7 trillion with 30% growth expected this year. The value addition from local manufacturing units is expected to go up to 25% in 2022 from 18% in 2021.

India's engineering goods sent to China doubled in November

India's engineering goods exports to China more than doubled in November with $434.6 million worth of shipments from the $205.3 million in the same period in 2020. The top importer of Indian engineering goods was still the US, with $1196 million during this period, registering a growth of 36.6% over $875 million in November 2020.

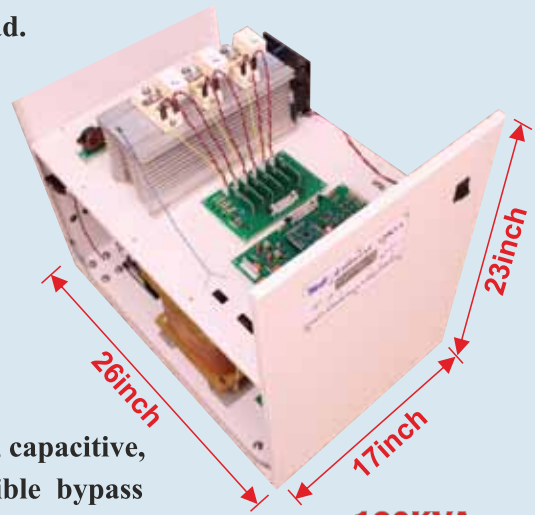
TrioSTAT Static Voltage Stabilizer

Technology transfer up to 200KVA 3-phase

Lesser BOM than a mechanical servo stabilizer

BOM of a 3phase 75KVA TrioSTAT = Rs. 35000, 3phase 150KVA = Rs. 60000

- Excellent surge handling capacity - 50KVA unit can handle 500KVA surge without going to bypass. Above this, it will go to uninterrupted bypass if input range is within the set limit.
- Because of phase to phase regulation TrioSTAT will function without neutral input, Output neutral created for single phase load if any. Created neutral can be connected to earth. So no problem with incoming neutral failure and neutral shift due to neutral in contact with any phase.
- TrioSTAT is designed to handle regenerative energy from load.
- TrioSTAT is bidirectional, grid tied inverter connect at the output of TrioSTAT will feed energy back to grid.
- Because of delta PWM technology no current harmonic or voltage harmonic and no reduction in power factor.
- Only 3 IGBT modules for a 3-phase system. Very low BOM
- Imbalanced load can also be connected. • Three phase input 400V ±20%(320V to 480V) output will be 400V ±1%.
- Works in 110V L to N (190V L to L) 60Hz USA standard.
- The system can handle all types of loads –inductive, resistive, capacitive, non - linear or any mixed loads. • Automatic uninterruptible bypass in case of hazard. • Only the difference power is processed through the system resulting in small size buck-boost transformer and higher efficiency > 98%.



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3-Phase TrioSTAT

- Protections - high / low voltage cut, high temperature, overload/surge and short circuit protection, incorrect phase sequence protection. • Earth Voltage protection (settable) – the system will sense the Earth Neutral voltage and will go to cut-off incase of excess voltage. • System has built-in data logger. All parameters are periodically saved to flash memory with date and time stamp.
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For video demo of the product, go to Youtube and search "TrioSTAT"

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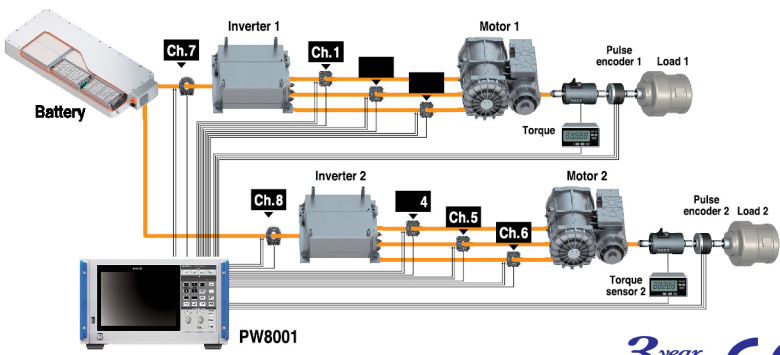
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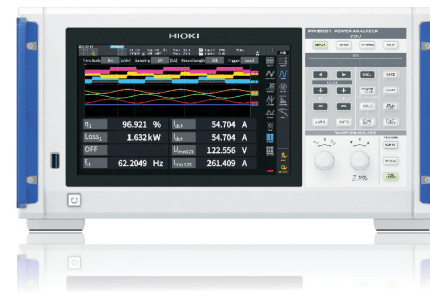
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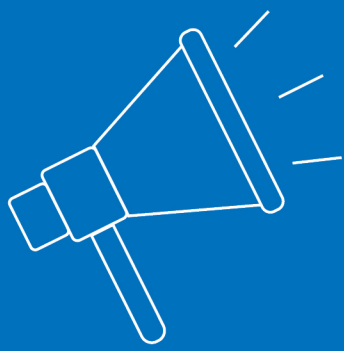


Large packs for xEVs, Large packs of up to 300 V Voltage measurement ranges: 6 V/60 V/300 V Resistance measurement ranges: 3 mΩ/30 mΩ/300 mΩ/3 Ω/30 Ω/300 Ω/3 kΩ





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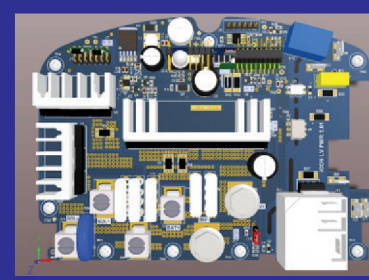
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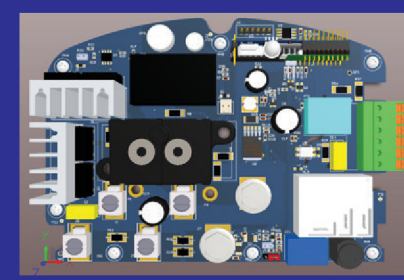
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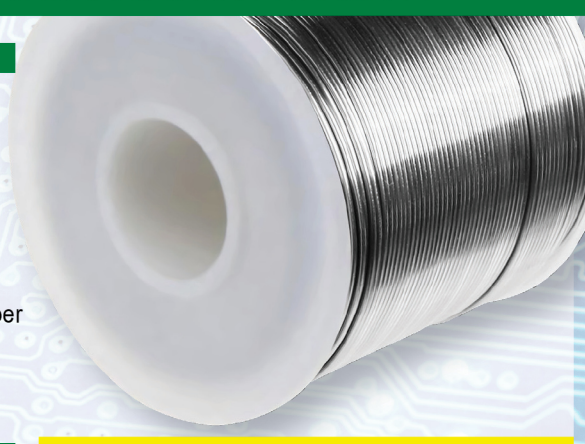
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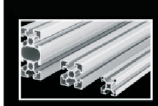
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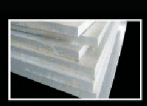
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