



Vidya Vikas Education Trust's

# Universal College of Engineering

Accredited with B+ Grade by NAAC

(Permanently Unaided | Approved by AICTE, DTE & Affiliated to University of Mumbai)

*The Official Newsletter of Dept. of ETRX,  
UCOE*

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- *8-inch GaN-on-Si Wafers Manufacturing Technology*
- *Multi-Cell Front-End Increases Battery Lifetime and Safety*
- *PCB sockets with right-angled design*

## **College Profile:**

*Everything you need to know about us:*

Embraced by lush greenery and scenic beauty, Universal College of Engineering is a treasured place for aspiring engineers to leave their imprints on success.

As a college within the wider network frame, we are one of the fastest-growing institutions in India. Our institute has been accredited by the National Assessment and Accreditation Council (NAAC) with a B+ grade in the first cycle of accreditation. Times of India Survey Ranked No. 1 in India among Top Emerging Private Engineering Institutes for 6 consecutive years 2015, 2016, 2017, 2018, 2019, and 2020 and the saga of accolades still continues.

In response to the expectations of quality technical education, our college is approved by the All-India Council for Technical Education (AICTE), New Delhi; Recognized by the Directorate of Technical Education (DTE), Government of Maharashtra; affiliated to Mumbai University. Our college is also associated with professional bodies like IEEE, IETE, ISA, and CSI to update the revolutionary technological advancements.

*We offer 4 years of full-time Bachelor of Engineering in Computer Engineering, Civil Engineering, Artificial Intelligence & Machine Learning, Information Technology Engineering, and Data Engineering.*

The unique state-of-the-art facility of the institute has been carefully designed to accommodate the needs of the students. Laboratories are equipped with world-class facilities based on the latest technology of different sectors. Our smart classrooms are well ventilated, spacious, and equipped with overhead and LCD projectors along with the public address system. The College library provides a rich collection of specialist library resources and services to support student's academic work and enrich their research skills.



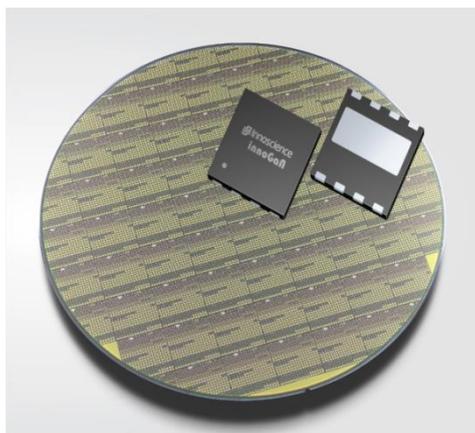
We are obliged to equip our students to get placed in highly reputed companies by mentoring their necessary skill set for cutting-edge technologies. The core highlighted areas are helping students with their technical competency, communication skills along with career guidance and counseling.

Universal College of Engineering has produced a large number of successful alumni who are working in reputed organizations in India and abroad and have contributed immensely to the cause of nation- building and society. We welcome all engineering aspirants to create an incredible legacy in the field of engineering.





## 8-inch GaN-on-Si Wafers Manufacturing Technology



Gallium nitride (GaN) is a wide-bandgap semiconductor material with exceptional features and performance when compared to silicon, including high efficiency, rapid switching rate, great thermal management, and a compact footprint and weight. Some challenges, mostly related to large-volume production and price reduction, must be addressed before GaN-based devices can be widely adopted in power applications.

Founded in December 2015, Innoscience is focusing on gallium nitride technology. With two fabs dedicated to 8-inch GaN-on-Si device manufacturing, Innoscience produces normally-off (e-mode) GaN devices for a wide range of applications and voltages — low voltages (down to 30V) and high voltages (up to 650V).

“GaN-based devices are mainly fabricated on (old) 6-inch lines. By having our brand new 8-inch silicon wafer manufacturing line and big capacity, we can get a great throughput which, together with the economies of scale, allows us to have very cost-effective devices,” said Denis Marcon, general manager of Innoscience Europe.

He added, “The fact that we use 8-inch and advanced [ASML] scanners, allows us to shrink the gate length and other dimensions of GaN devices beyond what other players can do with a conventional 6-inch line. This is particularly important for LV devices (<100V) to obtain low on-resistance. And by leveraging 8-inch silicon manufacturing technology, we can get high yield too.”

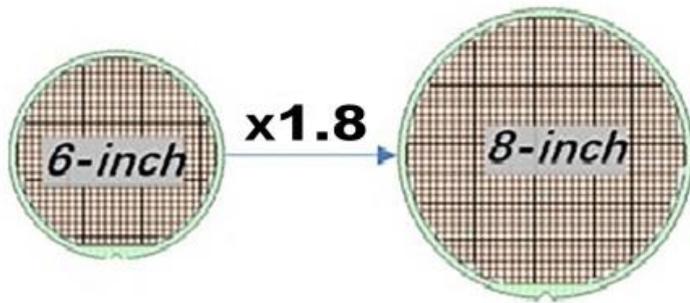
According to Innoscience, production today stands at 10,000 wafers per month, but it will reach 14,000 wafers per month by the end of this year, and 70,000 wafers per month by 2025. Because it owns and controls two fabs, the company can support very large volume production, even with a big increase in the market demand of GaN.

“We started building up our second fab in 2018, thinking ahead that the market would be there. Several other players are still on 6-inch, and it will take some time for them to move to 8-inch, which is not trivial, and/or increase capacity to the level that we already have today,” said Marcon.

### *GaN technology*

By simultaneously processing more devices per wafer, overall cost can be lowered. From the very beginning, Innoscience has strategically adopted 8-inch wafer size, obtaining 80% more devices per wafer with respect to what would be possible with a 6-inch wafer (see **Figures 1 and 2**). This decision has inevitably had a direct impact on the device cost, allowing Innoscience to make GaN device technology much more affordable.

According to Marcon, Innoscience can offer GaN technology at a very competitive price thanks to the optimization they did and the economies of scale they were using. They are offering this technology at a reasonable price in order to penetrate many different markets and applications.



Since its foundation at the end of 2015, Innoscience has enrolled 1,400 people, out of which 300+ are in the R&D department. The company holds, has a license or has submitted over 500+ patents. Innoscience has a sales and application engineering team in Shenzhen, which supports customers making evaluation boards and similar products.

“We really want to collaborate with customers and partners to enable system solutions based on GaN technology. We

really want to be a good partner for any company that wants to widespread the GaN technology and we are here to offer our capacity and technology to them,” said Marcon.

By nature, Innoscience is an IDM, meaning it is a fully integrated company. It does its own epitaxy, device design, wafer processing, and also failure and reliability testing. The only thing that Innoscience is currently outsourcing is packaging. According to Marcon, standard package technology is highly appreciated by the customers, because they are very familiar with it. That’s the reason why Innoscience does not use exotic packages, but rather standard DFN for the high voltage 650V devices, and FCSP, WLCSP, or LGA for low voltage devices.

According to Innoscience, other GaN chipmakers are using a very specific package, trying to make the device as small as possible in order to reduce costs. Innoscience is also working in that direction, but using standard packages and keeping an eye on the thermal dissipation. “What we see as an evolution, and we are supporting, serving several design houses in China, is the co-packaging of our device together with the (Si) driver, the controller, the temperature protection, everything embedded into one package, a system-in-package basically,” said Marcon.

According to Innoscience, GaN-based devices are normally-on (d-mode), but market demand normally-off (e-mode) devices. There are basically two ways to solve this apparent issue. The first one is based on the Cascode solution, consisting in the co-packaging of a d-mode GaN device with a LV Si MOS. The second one consists in developing a normally-off device, which is what Innoscience has done – developing a normally-off/enhancement-mode (e-mode) technology based on p-GaN.

In order to reduce the price, Innoscience leverages two key factors. The first one is to use facilities optimized for large manufacturing capabilities, taking advantage of the optimization achieved by silicon over the past 30 years to squeeze the fab throughput to the maximum. The second one is to use a larger wafer size. By using 8-inch wafer, you can get many more dice per wafer than you can get with a 6-inch wafer.

“What we have developed on top of the GaN technology is the introduction of a strain enhancement layer, which is basically a layer that we deposit after the gate formation in order to increase the 2DEG density. And by doing so, we are able to reduce the specific resistance of the device, without impacting other parameters, such as threshold voltage and leakage current,” said Marcon.

One of Innoscience’s fab is already certified for automotive part production, and the company is working with an automotive customer to have automotive-qualified devices ready in the next months. Automotive GaN applications include DC/DC high-voltage converters (650 V/950 V), DC/DC 48-V/12-V converters, onboard chargers, and LiDAR.



## *Multi-Cell Front-End Increases Battery Lifetime and Safety*

Battery Management System (BMS) plays an essential role in energy storage and mobility applications, ensuring the safety of the batteries and prolonging their lifetime. Among the different parts which compose a BMS, the Battery Front End (BFE) is one of the most critical: It has to periodically scan the battery status and the operating environment to optimize the battery lifetime and prevent catastrophic failures. This component is becoming more and more important as the voltage and the number of cells of Li-ion batteries increase. A typical BFE is in charge of several key capabilities, including accurate monitoring, cell balancing, and extensive system diagnostics functions.

### **Renesas RAA489204:**

Renesas' battery management ICs group has been reinforced and widened thanks to the acquisition of some companies operating in the automotive sector. Last November, Renesas released a BMS analog front end, a device they call a stacked battery front end. This analog part is basically a Li-ion battery manager IC that supervises up to 14 series-connected cells. The RAA489204 provides all the capabilities required by the battery management system, such as accurate cell voltage and temperature monitoring, cell balancing, and extensive system diagnostics.

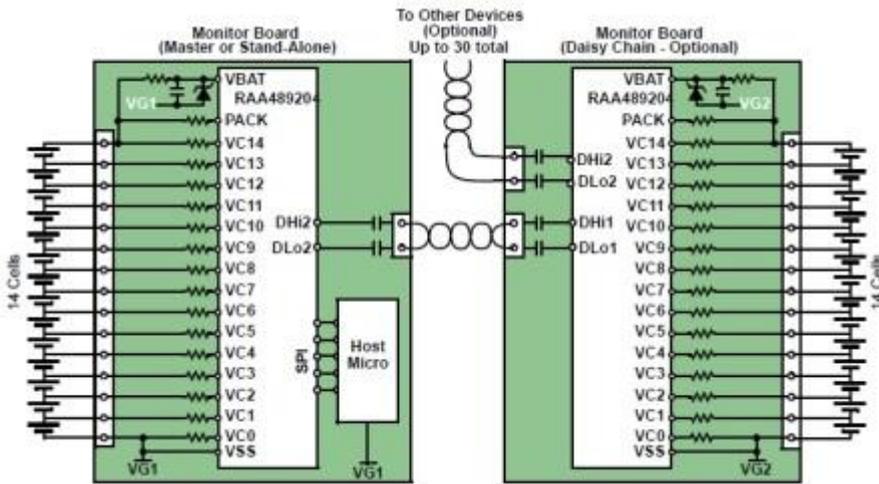
A relevant feature of this device is its integrated communication channel, which enables it to communicate up and down with a stack of batteries with just simple filtering and isolation and without having a controller or a separate communication chip at each level of the stack. The typical configuration includes a Master RAA489204 which communicates to a host microcontroller through an SPI port, and up to 29 additional RAA489204 devices connected together with a robust, proprietary, two-wire Daisy Chain. The total number of cells that can be managed in this case is 420. This communication system is highly flexible and can be implemented with capacitor isolation, transformer isolation, or a combination of both.

Stacked batteries have the same format which can be found in electric vehicles, and exactly as these, they require high voltage batteries. The target applications for this device include energy and storage applications, such as UPS, battery-based generators, e-mobility, e-bikes, and energy storage systems. That allows Renesas to simplify the test process for energy storage, as this device doesn't need to meet the full automotive qualifications.

In an interview with *EE Times Europe*, Renesas said, "One of the things we learned from our past experience is that the firmware for these devices is very complex. Writing the firmware to manage communications up and down a stack of analog parts is not an easy task."

For this reason, Renesas did several design actions to simplify the new part. A lot of the protection functions, for instance, are performed within the device without having to communicate down to the controller. That allows the RAA489204 to independently react to certain fault conditions, such as an open wire. Also, the communication protocol was simplified and provided with high-security features. **Figure 1** shows the device block diagram. It is able to perform measurement and read-back on all voltages, temperatures, and diagnostics for 112 cells in less than 10ms.





“Over the years, one of the things people have been complaining about is quiescent current,” Renesas said. “So, we’ve lowered the quiescent current quite a bit, improving at the same time the accuracy over the ADC and the functional safety capability.”

Everything that concerns consumers involves many requirements in terms of fault detection and ensuring the accuracy of the measurement unit. To meet some functional safety requirements, it may be necessary to have a sort of two-level protection. In

this configuration, the primary battery management device will be the main source for detecting and correcting faults, while the second layer of fault protection provides basically standard requirements for functional safety.

The new device features a high level of integration, including voltage and temperature detection and a high-security communication protocol. A relevant feature for this kind of device is Li-ion cell balancing. When the cells are charged and discharged, the differences in the ability of each cell to collect and release charge can lead to cells with different states of charge. The problem is that Li-ion cells have a maximum voltage above which it should not be charged, and a minimum voltage below which it should not be discharged. The worst-case occurs when one cell in the stack is at the maximum voltage, while another one is at the minimum voltage, resulting in a nonfunctional battery stack, which cannot be charged or discharged. The RAA489204 offers both internal and external balancing since it activates external cell balancing FETs via the CB1 to CB14 outputs (see **Figure 1**), or alternatively can use internal balancing FETs for a more measured balancing current.

## *PCB sockets with right-angled design*



The right-angled design reduces strain between the PCB and the lead, increasing reliability and product lifetime.

The sockets are suitable for a range of applications including automotive diagnostic, industrial, medical, music industry, instrumentation, education, and bench and hand-held electrical testing equipment.

The Cliff range of 4mm test sockets are designed for mating with industry standard 4mm plugs and available in black, red, green, blue, brown and yellow. Contacts are gold plated socket and rated at 1000V, 24A, CAT III.

Cliff Electronics can supply jack sockets, DC power connectors, terminal binding posts, test connectors and leads, optical jacks and leads and waterproof connectors and design and manufacture

standard and FeedThrough connectors which mount into an industry standard XLR, 23mm cutout.



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## *ENGINEERING QUOTES*

1. **“As engineers, we were going to be in a position to change the world – not just study it.”**  
—Henry Petroski, American engineer and author specializing in failure analysis
2. **“The scientist discovers a new type of material or energy and the engineer discovers a new use for it.”**  
—Gordon Lindsay Glegg, British engineer and author
3. **“This job is a great scientific adventure. But it’s also a great human adventure.”**  
—Fabiola Gianotti, Higgs Boson physicist
4. **“Science can amuse and fascinate us all, but it is engineering that changes the world.”**  
—Isaac Asimov, American writer, professor of biochemistry
5. **“The engineer has been, and is, a maker of history.”**  
— James Kip Finch, American engineer and educator
6. **“Scientists study the world as it is; engineers create the world that has never been.”**  
—Theodore von Karman, Hungarian-American mathematician, aerospace engineer, and physicist
7. **“The way to succeed is to double your failure rate.”**  
—Thomas J. Watson, pioneer in the development computing equipment for IBM
8. **“Strive for perfection in everything you do. Take the best that exists and make it better. When it does not exist, design it.”**  
—Sir Henry Royce, English engineer and car designer
9. **“We are continually faced by great opportunities brilliantly disguised as insoluble problems.”**  
—Lee Iacocca, American engineer and automobile executive
10. **“The ideal engineer is a composite ... He is not a scientist, he is not a mathematician, he is not a sociologist or a writer; but he may use the knowledge and techniques of any or all of these disciplines in solving engineering problems.”**  
—Nathan W. Dougherty, American civil engineer



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