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Faculty of Engineering

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VARIOSYSTEMS (PVT) LTD

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PREFACE

This report documents my industrial training experience at Variosystems (Pvt) Ltd., spanning 24 weeks from December 5th, 2023, to May 22nd, 2024. As an In plant trainee in the test engineering department at the EMS plant, I embarked on a journey of exploration and learning within one of the world's leading PCB assembly companies.

Variosystems' Sri Lanka facility served as the backdrop for my training, offering a rich environment for immersing myself in the intricacies of electronic manufacturing. Throughout this period, I had the privilege of gaining hands-on experience in various facets of the industry, ranging from PCB assembly technologies and cable harnessing to testing methods and electronic components.

This report aims to encapsulate the wealth of knowledge acquired during my time at Variosystems. It reflects on the challenges faced, the projects undertaken, and the new skills honed, all of which have contributed to my professional growth and development. Furthermore, it highlights the invaluable opportunity provided by Variosystems to bridge the gap between theoretical knowledge and practical application, fostering a deeper understanding of electronic engineering in an industrial context.

Through this report, I hope to convey the significance of my industrial training experience at Variosystems, not only in terms of personal development but also in preparing me for the challenges and opportunities that lie ahead in the dynamic field of electronic manufacturing.

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ACKNOWLEDGMENT

I extend my heartfelt gratitude to all those who have contributed to the successful completion of my industrial training program at Variosystems (Pvt) Ltd. This journey has been made possible through the unwavering support and guidance of numerous individuals.

Firstly, I express my sincere appreciation to Dr. Suboda Charles, the department coordinator of industrial training for Electronic & Telecommunication Engineering, whose guidance has been instrumental in shaping my learning experience. I am immensely thankful to the industrial training division at the Faculty of Engineering, University of Moratuwa, and NAITA (National Apprentice of Industrial Training Authority) for providing me with this invaluable opportunity to gain practical insights into the field of electronic engineering.

A special note of gratitude goes to Variosystems (Pvt) Ltd. for extending this valuable opportunity to sharpen my skills. I am deeply grateful to Mr. Roshan Perera and Mr. Muditha Prasanna, the Executive trainers, for their unwavering support and mentorship throughout my training journey.

I am indebted to Mr. Sanira Karunarathne, Head of the Test Engineering department, and Mr. Moditha Lakshan Silva, Senior engineer and my supervisor, for their guidance and encouragement. Additionally, I express my appreciation to all the test engineers, leaders, and technicians who have provided assistance and direction, ensuring that I navigated my responsibilities with proficiency and confidence.

Furthermore, I would like to thank the entire team at Variosystems (Pvt) Ltd. for fostering a conducive learning environment and for their willingness to share knowledge and expertise. Their collective efforts have not only enriched my technical skills but have also bolstered my communication abilities and overall confidence in overcoming challenges. I am deeply grateful for their support, which has been instrumental in shaping my growth and development during this industrial training period.

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List of Abbreviations

HR – Human Resource

VS - Variosystems

PPS – Production planning system

EMS - Electronics manufacturing services

WHA – Wire harness assembly

CST – Customer success team

IT – Information technology

EPF - Employees' Provident Fund

ETF – Employee Trust Fund

ISO - International Organization for Standardization

MSD - Moisture sensitive devices

IATF - International Automotive Task Force

PCB – Printed Circuit Board

SMT – Surface Mount Technology

THT – Through-Hole Technology

ESD – Electro Static Discharge

ROHS – Restriction of Hazardous Substances

SMD – Surface Mount Device

GUI – Graphical User Interface

ICT – In-Circuit Test

IC - Integrated Circuit

VSFT – Variosystems Function Test

DC – Direct Current

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1 Description of the organization

Variosystems (Pvt) Ltd, established in 1993 by Peter Germann, Norbert Bachstein, and Peter Ermish, has grown into a global electronics services partner known for its commitment to customer-centric innovation. The company operates with a vision of co-creating leading innovators by leveraging its extensive expertise to help customers succeed. This foundational ethos has driven Variosystems' expansion and success over the decades.

Figure 1 : Global Variosystems Footprint

Globally headquartered in Steinach, Switzerland, Variosystems employs around 2,500 people and generates annual sales of 300 million Swiss francs. The company provides comprehensive electronics solutions, including development, industrialization, production, and life-cycle management. Its global footprint extends to multiple countries, with a significant presence in Badalgama, Sri Lanka.In Sri Lanka, Variosystems has significantly expanded its operations. The Sri Lankan facility has recently doubled its production capacity to 30,000 square meters, emphasizing sustainability and cutting-edge technology. This state-of-the-art facility is powered entirely by renewable energy and includes advanced waste management systems, water conservation techniques, and energy-efficient lighting. These enhancements underscore the company’s commitment to environmental stewardship and operational excellence.

Figure 2 : Variosystems (Pvt) Ltd , Sri Lanka

Historically, Variosystems has focused on maintaining high standards of quality and fostering a collaborative approach with its customers. This strategy has built a strong reputation in the industry and driven steady growth. The company's approach integrates lean manufacturing principles and a solution-oriented mindset, ensuring efficient processes and superior product quality.

Looking to the future, Variosystems aims to sustain its growth by continuing to innovate and expand its capabilities. The recent facility upgrades in Sri Lanka are part of a broader strategy to support international customers with local supply chains and competitive pricing, while maintaining global quality standards. The company plans to create 600 new jobs in the next three years in Sri Lanka, further solidifying its role as a key player in the global electronics market.

Variosystems' dedication to quality, innovation, and sustainability positions it well for future growth, ensuring it remains a trusted partner in the global electronics services industry.

1.1 Logo

Figure 3 : Variosystems Logo

1.2 Vision

Variosystems' overriding objective is to build long-term strategic partnerships by providing customers with reliable electronics solutions and meeting their requirements in the best possible way, thereby enabling them and their products to succeed in the market. To achieve this, Variosystems focuses on innovation, continuous process optimization, and the use of state-of-the-art technologies. In doing so, Variosystems aims to use resources responsibly and earn the confidence of its customers.

"To be the most trusted and sustainable electronics services partner."

1.3 Mission

The mission of Variosystems is to:

1) Enable Customer Success: They believe their success is closely tied to that of their customers and do their utmost to make their customers' good ideas succeed.
2) Deliver High-Quality Solutions: From development to life-cycle management, Variosystems focuses on maintaining the highest standards of quality in all their services.
3) Sustain Growth with Innovation and Sustainability: They aim to grow sustainably by investing in advanced technology, renewable energy, and efficient manufacturing processes.

This customer-centric approach has been a cornerstone since the company's founding in 1993 and continues to drive its growth and reputation in the industry. By focusing on innovation, quality, and sustainability, Variosystems is well-positioned to maintain its role as a trusted partner in the global electronics market.

1.4 Country Organization Variosystems Sri Lanka

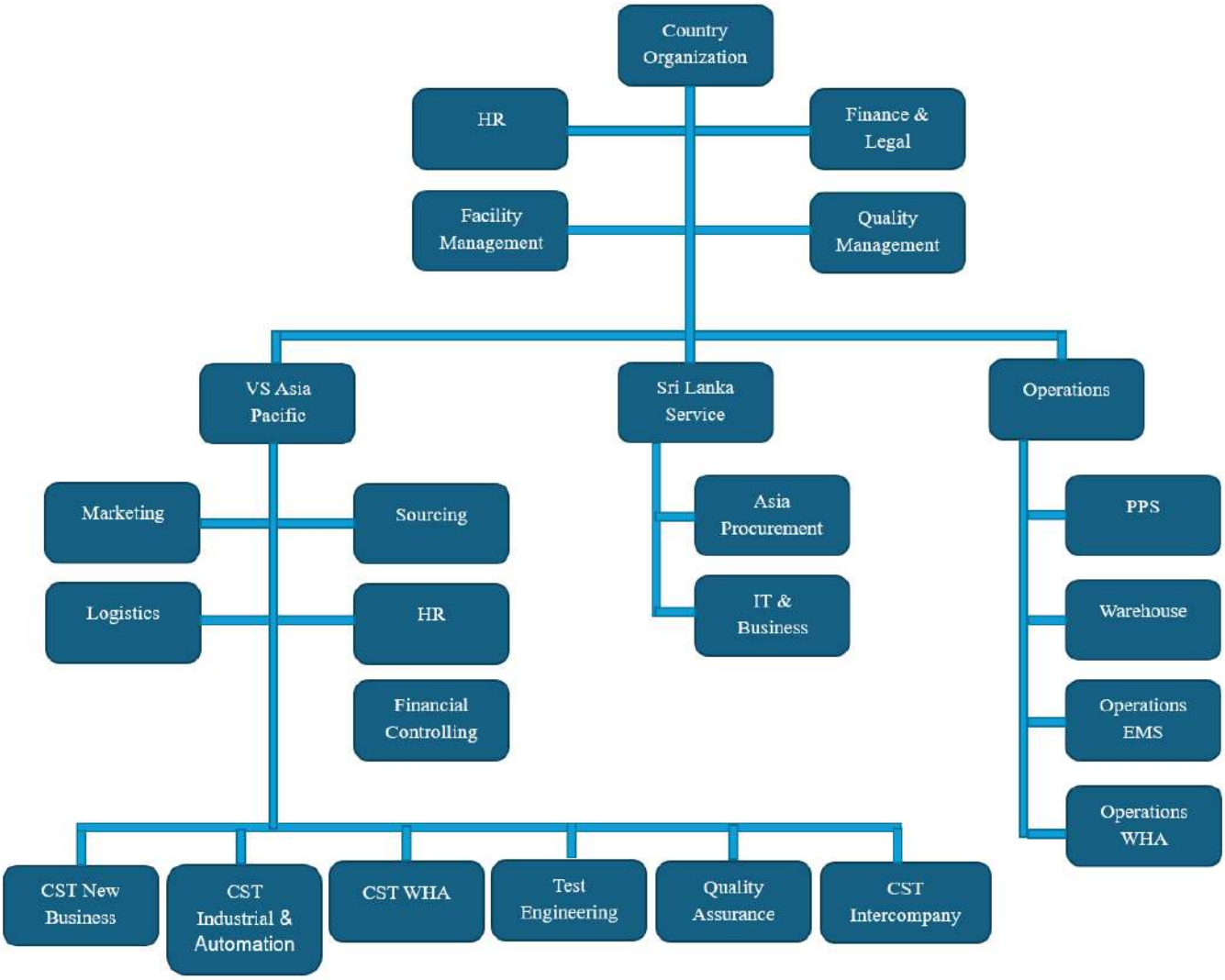

Figure 4 : Organizational structure

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1.5 Services provided by Variosystems.

1.5.1 PCB Assembly

Figure 5 : PCB Assembly

1.5.2 Wire harness manufacturing

Figure 6 : Wire harness

1.5.3 Testing

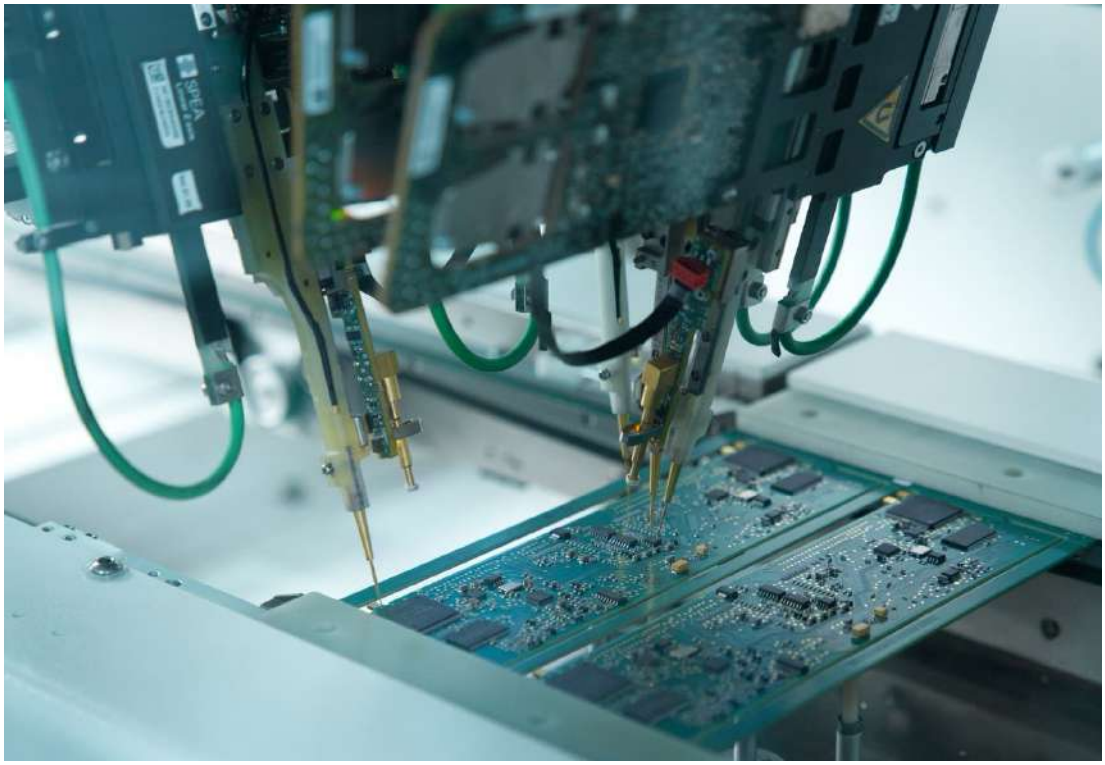

Figure 7 : Flying Probe Testing

1.5.4 Engineering

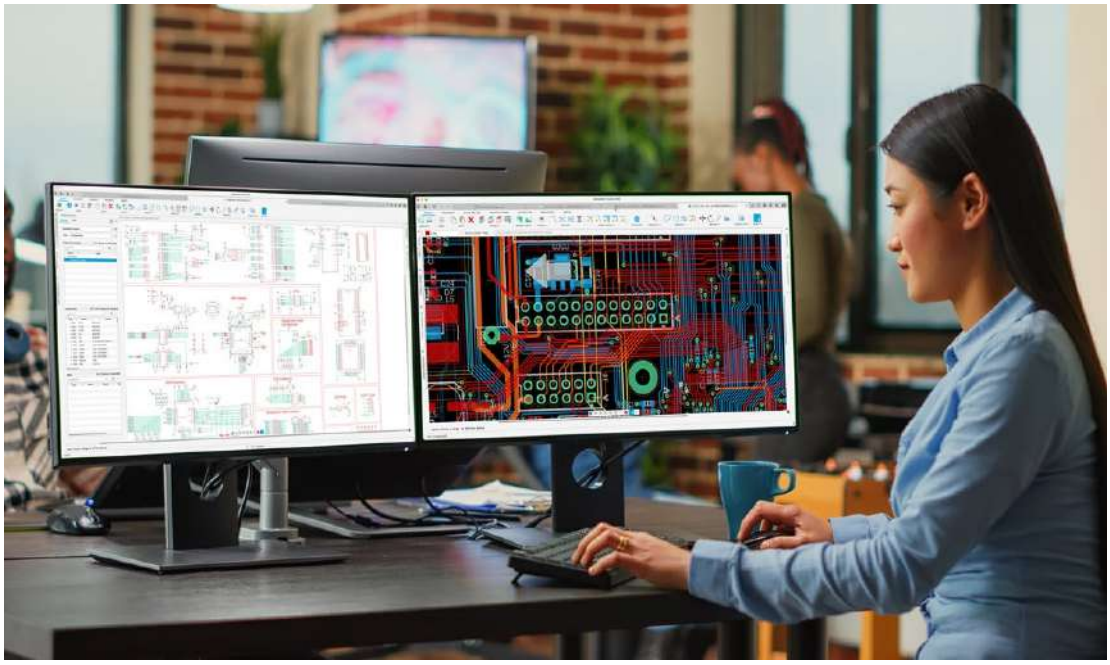

Figure 8 : Engineering Services

2 Description of familiarization work carried out

2.1 ESD protection

Figure 10 : - ESD susceptibility symbol

Figure 9 : ESD protective symbol

ESD stands for Electro static discharge. Electro static discharge is the rapid transfer of a static electric charge from one object to another. The components in the circuit can be damage due to this ESD. So, because of this cause, the company happens to pay additional cost for remove and place the new components.

And also, this cause damage the reputation of the company. To prevent from this ESD, Variosystems have taken several decisions. They are shown in the below table.

 Wear ESD protected jacket	 Wear ESD protected gloves	 Wear ESD protected slippers
Wear wrist trap 	 Earthing all workstations, chairs and table mats	 Use ESD safe brush for cleaning
 Use ESD safe dividers to store	 Use ESD safe trays to transport the PCB	 Use ESD safe bags to store

Figure 11 : ESD Protection

2.2 Lean Manufacturing

Lean manufacturing is a production process that maximize the productivity while minimizing the waste of manufacturing process. The roots of lean can be found in the Japanese company of Toyota. Importance of lean manufacturing - reduce cost, eliminate waste, increase productivity, increase profit, maintain high quality level.

Figure 12 : Wastes of Lean

According to the lean manufacturing, there are 3 types of wastes.

2.2.1 MUDA

Any activity that consumes resources without creating any values for the customer (Non value adding). There are 8 types of wastes under the MUDA. They are shown below.

Figure 13 : Waste under MUDA

2.2.2 MURA

MURA means unevenness, non-uniformity and irregularity. It is the reason for the existence of any of the 8 wastes.

2.2.3 MURI

MURI means overburden, excessiveness, impossible or unreasonableness, MURI can result from MURA and in some cases be caused by excessive removal of MUDA from the process.

2.3 5S Concept

5S is defined as a methodology that result in a help reduce waste and optimize productivity. It is help to build a quality work environment, both physically and mentally. There are 5 steps of this concept. They are,

- Seiri – Sort
- Seithon – Set in order
- Seiso – Shine
- Seiketso – Standardize
- Shitsuki – Sustain

Figure 14 : 5S Concept

2.4 ISO standards

2.4.1 ISO 9001:2015

It is an international standard for quality management systems, ensuring organizations meet customer and regulatory requirements through continuous improvement, effective process management, and leadership commitment to quality across all operations.

2.4.2 ISO 14001:2015

It is an international standard for environmental management systems, helping organizations enhance environmental performance, comply with regulations, and reduce environmental impact through effective resource management, sustainable practices, and continuous improvement.

2.4.3 ISO 45001:2018

It is an international standard for occupational health and safety management systems, designed to prevent work-related injuries and illnesses by providing a framework to improve safety, reduce risks, and enhance worker well-being through proactive management practices.

2.4.4 ISO 13485:2016

It is an international standard for medical device quality management systems, ensuring that organizations design, produce, and deliver medical devices that meet regulatory requirements and customer needs through effective risk management and consistent quality control processes.

2.4.5 IATF 16949:2019

It is an international standard for automotive quality management systems, aligning with ISO 9001 to ensure consistent quality in the automotive industry by emphasizing defect prevention, waste reduction, and continuous improvement in the supply chain.

2.5 HR Training Program

In an HR program, salary calculations are detailed, including components like basic pay, allowances, bonuses, and deductions, ensuring transparent and fair compensation. The program also covers leave management, explaining various types of leaves such as annual, sick, and maternity leave, their accrual, and application processes. Overtime (OT) calculations are outlined, specifying the rates (e.g., 1.5x or 2x regular pay) and eligibility criteria. Additionally, the program addresses the Employee Provident Fund (EPF) and Employee Trust Fund (ETF) contributions, explaining how these are calculated, their importance for employee savings, and compliance with statutory requirements.

Figure 15 : Human Resources

2.5.1 LEAVES

Annual Leaves – 14 per year, Casual Leaves – 7 per year, Probation Leave – 0.5 per completed month, Lieu leave, Maternity Leaves, Feeding Leaves, Injury Leave, Election Leave, Short Leave, Disaster Leave, Abroad Leave, Training Leave, Critical Illness Leave, Statutory Holiday.

2.5.2 EPF & ETF

- 12% for the EPF is given by the employer and 8% is deducted from the employee salary.
- 3% of the earning is given by the employer as the ETF.

2.6 Medical Training Program

In a medical program, training includes chemical safety protocols to protect against hazardous substances, workplace safety measures to prevent injuries, and comprehensive approaches to physical and mental therapies. These components ensure healthcare professionals can safely handle chemicals, navigate working environments, and provide holistic care that addresses both physical and mental health needs of patients.

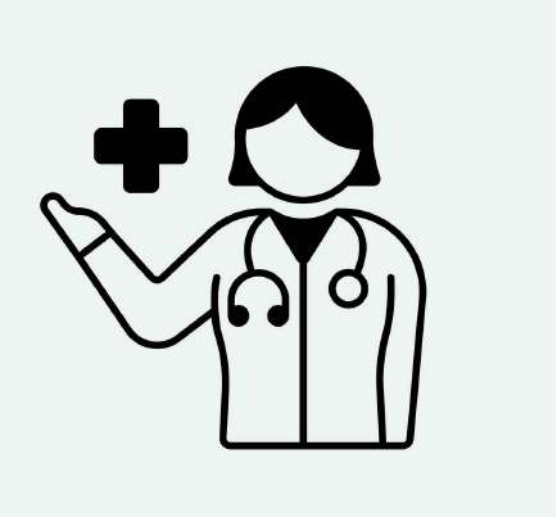

Figure 16 : Medical Centre symbol

2.7 IT Training Program

In IT training programs, employees are educated on the risks posed by hackers to companies that possess valuable data. Training covers how to identify and mitigate these threats by recognizing spam emails and suspicious websites, which are common methods used by hackers to gain unauthorized access. Employees learn to spot phishing attempts, fake links, and malicious attachments. Additionally, safe practices for using company internet and computers are emphasized to prevent data breaches, including guidelines on password security, software updates, and secure browsing habits. Advanced modules might focus on how large companies can proactively defend against cyber attacks through the implementation of robust cybersecurity measures, incident response plans, and the use of specialized software to detect and neutralize threats. This comprehensive training helps protect the company's digital assets and maintain operational integrity.

Figure 17 : Cyber Security

3 Exposure to Systems

3.1 Training Centre

During our first week of training, we learned how to solder stuff by hand. We made sure to do it safely, using the right tools and being careful not to mess up. We also learned about protecting electronics from getting messed up by static electricity, which can happen when we're soldering.

Another important thing we learned was about keeping our workplace neat and tidy using the 5S method. This helps us find things easily and makes our work area safer. We also talked about how to handle waste properly, like recycling stuff instead of just throwing it away.

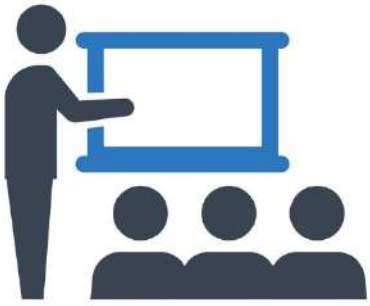

Figure 18 : Training Centre symbol

Overall, the training gave us a good start and helped us understand what the company is all about. Now we feel ready to do our jobs well and be part of the team.

3.2 HR Department

The HR department serves as the backbone of employee management within an organization. Their responsibilities encompass a wide range of essential functions, starting with recruitment, where they identify talent, conduct interviews, and facilitate the hiring process to onboard new employees effectively.

Moreover, HR oversees logistical aspects such as transportation arrangements and food services, ensuring employees have convenient commuting options and access to nourishing meals during work hours.

Figure 19 : HR department services

They also prioritize employee welfare by organizing recreational activities, addressing grievances, and managing accommodation arrangements when necessary.

Training programs are another critical area managed by HR, ensuring employees receive continuous skill development and stay updated with industry advancements. Additionally, HR administers salary administration, including payroll processing and benefits management, while also conducting performance evaluations to assess employee productivity and potential for promotions.

Ultimately, the HR department plays a pivotal role in fostering a supportive work environment conducive to employee growth, satisfaction, and organizational success.

3.3 IT Department

The IT department oversees a comprehensive array of responsibilities critical to an organization's digital infrastructure. They manage data servers, ensuring the secure storage and accessibility of vital information. Cybersecurity measures are diligently implemented to safeguard against potential threats and breaches, while WLAN connections are maintained for seamless wireless communication. Moreover, the IT team handles software installation and development to optimize operational efficiency. Additionally, they are tasked with computer hardware and software repairs, swiftly addressing issues to minimize downtime and maintain smooth functionality across the organization's systems. This multifaceted approach ensures that both hardware and software components are well-maintained, enabling uninterrupted business operations and technological advancement.

Figure 20 : IT services

3.4 Maintenance Department

The maintenance department plays a vital role in ensuring the smooth functioning of various essential systems within the company. They oversee the electricity power supply, ensuring uninterrupted access to power for all operations. Additionally, they manage the air conditioning and dry air supply systems, maintaining optimal environmental conditions for employee comfort and equipment performance. The department is also responsible for developing and maintaining solar energy systems, contributing to the company's sustainability goals. Moreover, they handle fire safety works to prevent and mitigate fire hazards, as well as machine repairs and maintenance to uphold operational efficiency and minimize downtime.

Figure 21 : Maintenance department symbol

3.5 Finance Department

The finance department plays a critical role in an organization, overseeing several key functions. **Financial planning and analysis** involves budgeting, forecasting, and assessing financial performance to guide strategic decisions. **Financial reporting** ensures accurate and timely preparation of financial statements in compliance with regulatory standards. **Tax management** involves planning and compliance to optimize tax obligations and ensure adherence to tax laws. **Investor relations** focuses on maintaining effective communication with shareholders and investors, providing them with relevant financial information. **Treasury management** handles the organization's cash flow, investments, and financing activities to maintain liquidity and financial stability. Each function contributes to the overall financial health and strategic direction of the organization.

Figure 22 : Finance department symbol

3.6 Purchasing Department

The purchasing department of a company plays a crucial role in managing the procurement of electronic components. Key responsibilities include ordering components, obtaining and evaluating quotations, and ensuring timely payment of bills for purchases. This department ensures the continuous supply of necessary parts, negotiates favourable terms with suppliers, and maintains cost efficiency. Additionally, they are responsible for managing supplier relationships, ensuring quality standards, and keeping accurate records of transactions. Effective purchasing management is essential for maintaining production schedules, controlling costs, and supporting overall business operations. The department's role extends to inventory management, market research, and compliance with regulatory requirements.

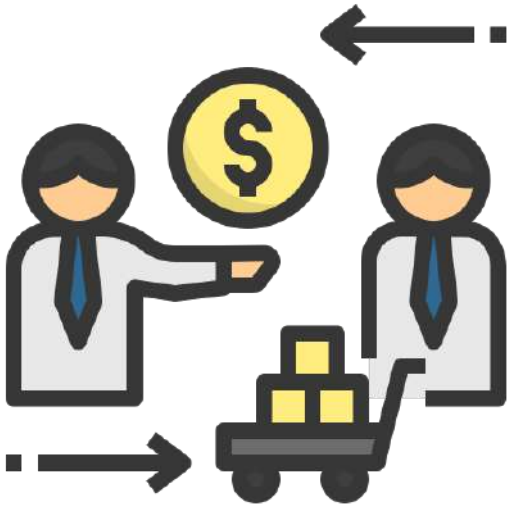

Figure 23 : Purchasing Department symbol

3.7 Medical Centre

The medical center provides essential services, such as physical therapies, specifically tailored to address issues commonly faced by employees at Variosystem. These treatments focus on alleviating repetitive strain injuries, musculoskeletal disorders, and ergonomic-related problems resulting from prolonged periods of precise, repetitive tasks and static postures. Services include personalized physical therapy sessions, ergonomic assessments, and preventative care programs to enhance employee well-being and productivity. Additionally, the center offers rehabilitative exercises, pain management strategies, and education on proper body mechanics to prevent future injuries, ensuring that employees maintain optimal health and performance in their demanding work environment.

Figure 24 : Medical Centre symbol

3.8 Test Engineering Department.

The Test Engineering Department at Variosystems has several key responsibilities aimed at ensuring the quality and functionality of electronic products. These responsibilities include:

Figure 25 : Test Engineering Department

1. **Defining Test Strategies**: This involves determining test coverage, methods, and equipment requirements to ensure comprehensive testing of products.
2. **Developing Automated Test Scripts**: Creating automated programs using languages such as VB, C#, and Python to streamline testing processes.
3. **Ensuring Quality Standards**: Making sure that test systems and procedures comply with quality standards and regulatory requirements like ISO and IPC.
4. **Troubleshooting and Analysis**: Investigating test failures, identifying root causes, and implementing corrective actions to improve test yields.
5. **Designing Test Circuits**: Developing analog and digital circuits specifically for test automation, ensuring seamless integration with automated test systems.
6. **Implementing Test Automation**: Using robotic systems and other technologies to enhance test workflows and efficiency.
7. **Collaborating with Engineering Teams**: Working closely with other engineering groups to define, document, analyse, and interpret tests for products, systems, and components.
8. **Maintaining Test Equipment**: Ensuring that customer-provided test equipment is properly documented and maintained, including incorporating engineering change orders (ECOs) and performing repairs as necessary.
9. **Supporting New Production Projects**: Assisting in the development and implementation of tests for new products and production projects.

3.8.1 Test Field

In the Variosystems, after completing the assembly of PCB, we do 3 tests for the PCBs. They are,

1. In-Circuit test
2. Function test
3. Programming test.

These tests are done by the test field work force.

3.8.1.1 ICT Test

ICT is done for measuring the performance of the components in the PCB. It checks the parameters such as resistance, capacitance, Inductance. And also, it checks some parameters in transistors,LEDs,diodes,Ics.

To check above components, test machines use test points in the PCB and the leads of the components which are soldered in PCB. In Variosystems, we use mainly 2 machines for in-circuit testing. They are,

- SPEA 4050
- SPEA 3030

3.8.1.1.1 SPEA 4050

Figure 26 : SPEA 4050 machine

This machine has 4 separate flying probes. These probes use CNC technology to move along the x, y, z axis. These movements are very quick and accurately. To move the probes, 4050 machine use linear motors. End of the z axis arm, there is a spring test probe. All measurements are done by using this test probes. This machine use Leonardo software to control the machine.

Figure 28 : Test probes

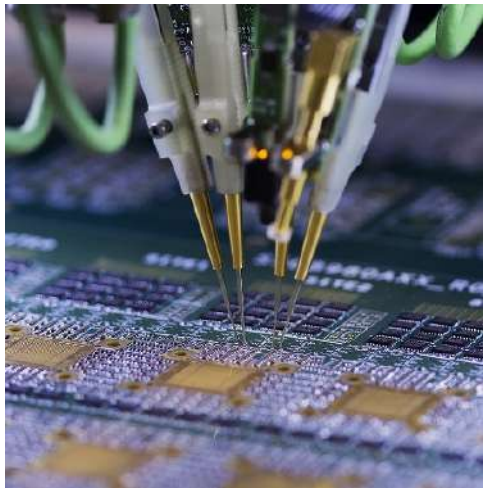

Figure 27 : During the test

Procedure of testing,

- Firstly, we have to put PCB on the conveyor. Then we have to direct it to the machine using the software.
- Then the machine initially does fiducial testing. It is done for checking the alignment of the PCB. To do this, machine use camera.
- After passing the fiducial test, machine starts to check the components.

3.8.1.1.2 SPEA 3030

Figure 29 : SPEA 3030 machine

To do this testing, this machine uses special fixture. We can use only one fixture for one PCB series. Fixture design vary production to production. This fixture is consisting of test probes. These test probes have located on the fixture board, to contact with the test points of the PCB, when the PCB place on the fixture. Another end of the test probe has connected to the machine.

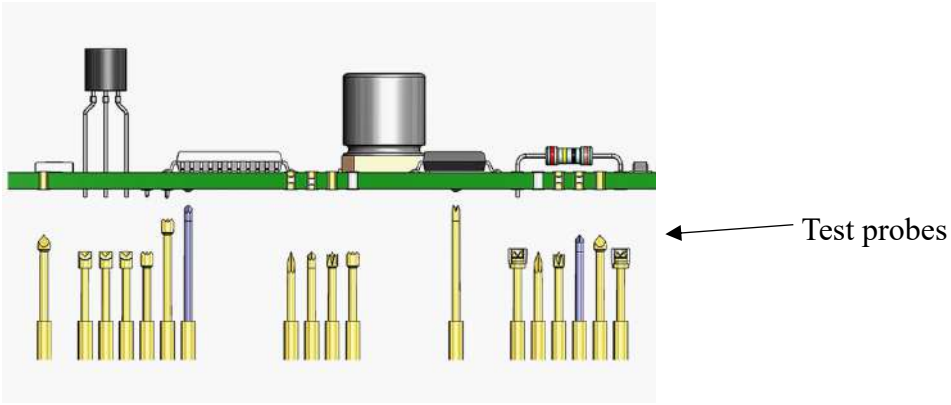

Figure 30 : During the test

Procedure for testing,

- Firstly, we have to place the PCB on the right place of the fixture probe plate.
- Then we can push the PCB downwards until contact the test points with the test probes, from the fingers in the pressure plate. This movement can do using the software.
- After that, machine initially checks the alignment of the PCB and then starts to check the components.

3.8.1.2 Function Test

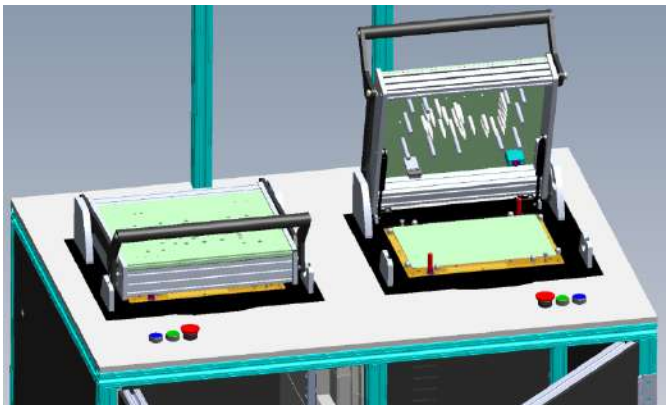

Figure 31 : Function tester

This test is done for checking the function of the PCB, whether it is working or not properly. To do this test, Variosystems have function test machines. Mainly, we can categorize them in to 2 categories according to the number of measuring devices. They are,

- Variosystems function test tower (VSFT Tower)
- Variosystems function test lite (VSFT Lite)

This VSFT tower consist of oscilloscope, DC power supply, Wave form generator, frequency counter, Multiplexer, Electronic DC load supply. But VSFT lite doesn't have all above devices.

The main part of this machine is the fixture. We can use only one fixture for one PCB series. Fixture design vary production to production. There are test probes have located on the fixture board, to connect with the test points of the PCB, when the PCB place on the fixture. The function of the PCB has built under the fixture board using real world components.

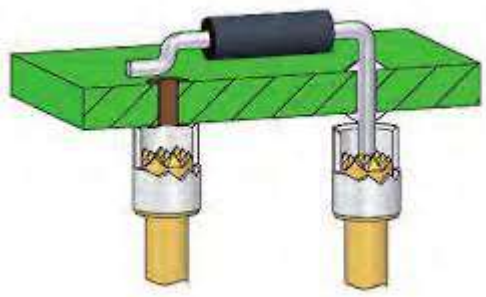

Figure 32 : During the test

3.8.1.3 Programming Test

Programming test is done to upload the program to the microcontroller or chip and check the function of the microcontroller. We upload the hex file of the program to the microcontroller. There are different kind of microcontroller series are used in the PCBs. Some of them are, Atmel, ESP32, STM32, PIC microcontrollers. There are different kind of methods used for uploading the program. They are, using proper cable (USB) and using test probes (On board programming). After uploading the program, we can start the function test.

IC programming also can be done from the SPEA 3030 machine. ICT testing and the IC programming both are done from the same test probes. When we upload the program, we have to disconnect the test point from the machine and connect it to the USB of the programmer. If we need to program, first we have to supply the 5V to the relay coil. Then relay gets energized and test probe connects to the USB. Mainly, Variosystems use 3 types of programmers. They are, u link, J link (Segger) and ST link.

4 Project Work - Power Supply Calibration Automation Project

4.1 Problem Statement

The current calibration process at VARIOSYSTEMS involves a Windows application that facilitates the calibration of power supplies. During this process, the power supply and the main multimeter need to be physically connected to the computer. The software controls the power supply to output specific voltages and currents, while the multimeter measures these values. The software then compares the power supply output with the multimeter readings.

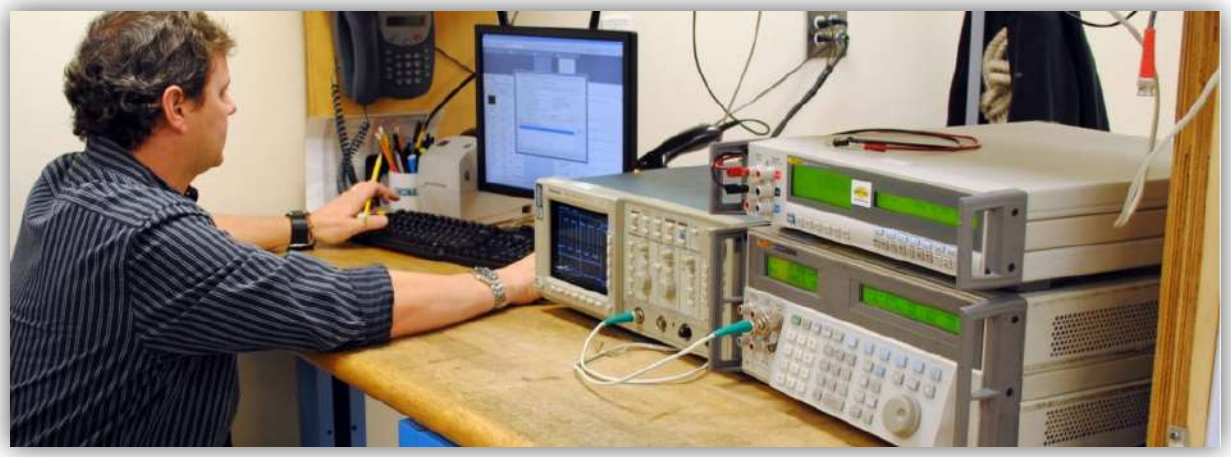

Figure 33 : Existing method for calibration

One key challenge is that the operator must manually connect the probes for voltage and current measurements. This manual intervention requires the operator to stay close to the computer throughout the entire calibration process. As a result, this process is time-consuming for the operator or engineer involved.

To address this issue, it would be beneficial to explore ways to automate or streamline the probe connection process. This could involve developing a system that automatically connects the probes based on the current or voltage measurement requirements, reducing the need for constant manual oversight. This improvement would not only save time for the operator but also enhance the overall efficiency of the calibration process.

4.2 Objectives of the Project

The primary objective of this project is to enhance the efficiency and intelligence of the calibration process for power supplies at Variosystems. Key goals include automating manual aspects of calibration, minimizing operator involvement, and streamlining probe connections through an intermediate switching unit that automatically manages probes based on calibration requirements. By focusing on efficiency, the project aims to reduce the overall time needed for calibration, allowing operators to concentrate on higher-level tasks and improve throughput.

Automating probe connections not only frees operators from continuous manual intervention but also enhances the accuracy and precision of calibration measurements, reducing human error. A new Windows application will be developed to intelligently control the calibration process, integrating seamlessly with the power supply, multimeter, and switching unit. This application will employ smart algorithms to manage sequences, adjust parameters, and analyse results in real-time.

Comprehensive reporting is integral, with detailed calibration reports covering all tested voltage and current levels, providing pass/fail statuses based on specified criteria. Additionally, the project will incorporate RFID technology to automate the autofill option for operator details in final reports, ensuring traceability and accountability.

By achieving these objectives, the project aims to transform the calibration process into a more efficient, intelligent, and streamlined operation, enhancing product quality and reducing operational overhead.

Figure 34 : Project objectives symbols

4.3 Implementation of Project

The solution introduces an innovative intermediate switching unit capable of connecting multimeter and power supply probes through a relay matrix, controlled by a Windows application. This application fully automates the power supply calibration process. Initially, the operator's RFID is scanned, allowing the application to recognize the user. The GUI then displays the probe connection configuration, instructing the user to connect the probes accordingly and press the start button. From this point, the process becomes fully automated, calibrating all channels' voltages and currents by switching the probes automatically. Upon completion, the system generates detailed reports in Excel and PDF formats, which include operator details and comprehensive calibration data. This streamlined approach not only ensures accuracy and efficiency but also significantly reduces manual intervention in the calibration process.

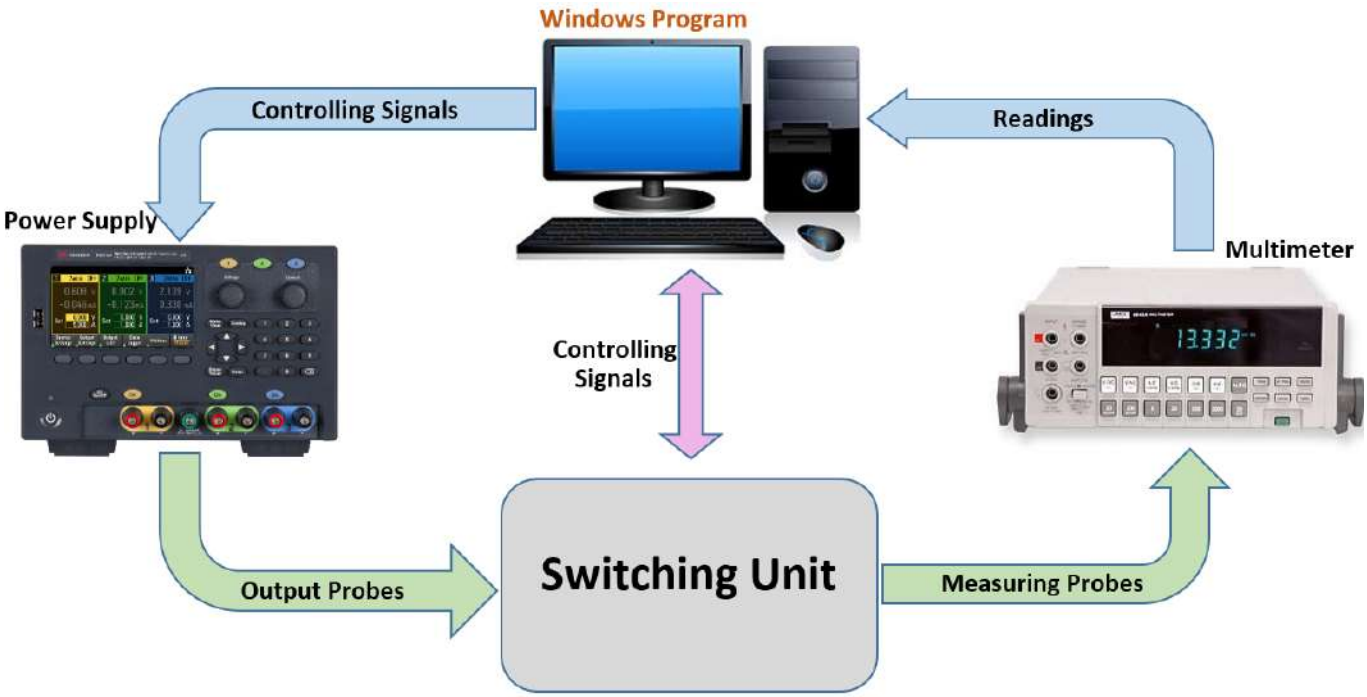

Figure 35 : Block Diagram of Project

This has three main parts,

1) Relay matrix & Controller Unit.
2) Windows Application.
3) Final Reports Generation.

4.3.1 Intermediate Switching Unit (Relay matrix & Controller Unit):

- The intermediate switching unit acts as a mediator between the power supply, multimeter, and the computer running the calibration software.
- It is equipped with automated switching capabilities, allowing it to connect the appropriate probes for voltage and current measurements based on the calibration requirements.
- This part is also responsible for RFID reading, probe connection detection, and RGB indication functions.

4.3.1.1 Prototype of Switching unit

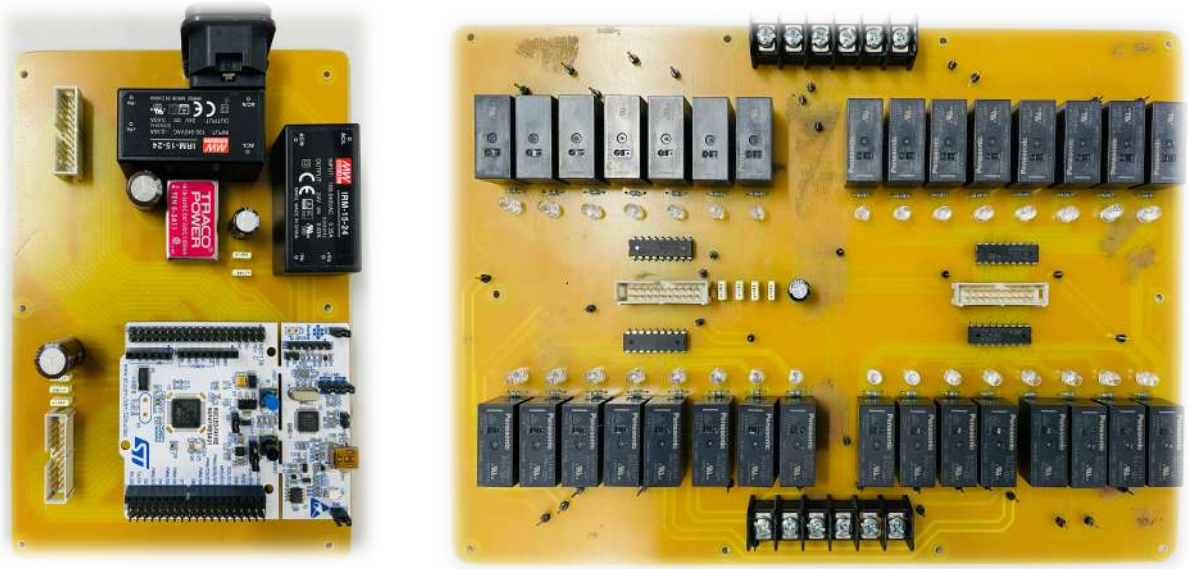

Figure 36 : Controller Unit & Relay Matrix (Prototype)

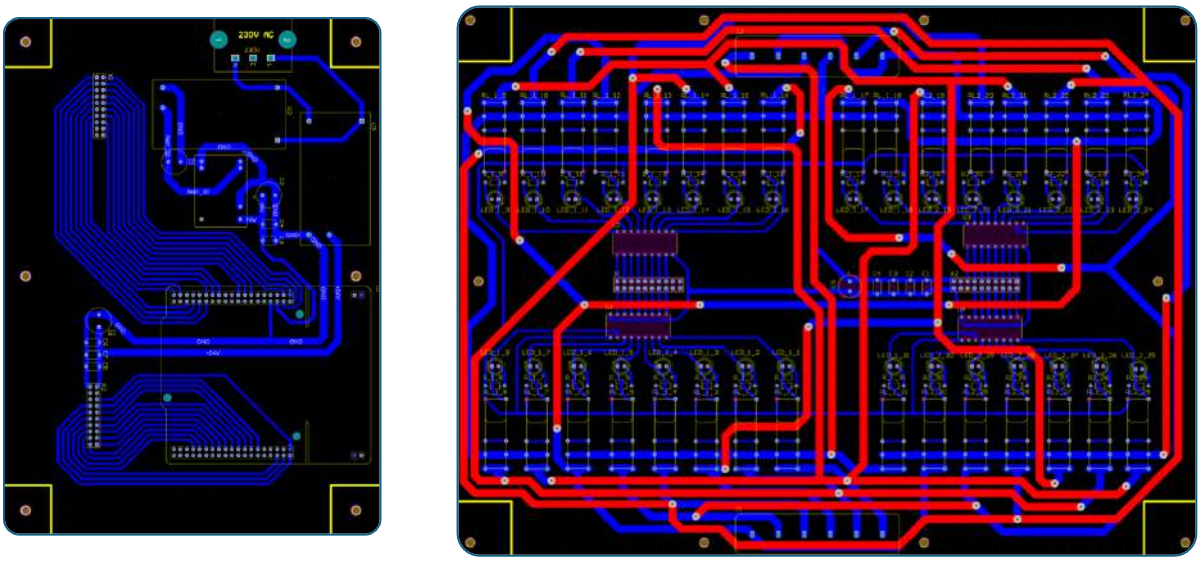

Figure 37 : Layouts of Controller Unit & Relay Matrix (Prototype)

4.3.1.2 Final PCBs.

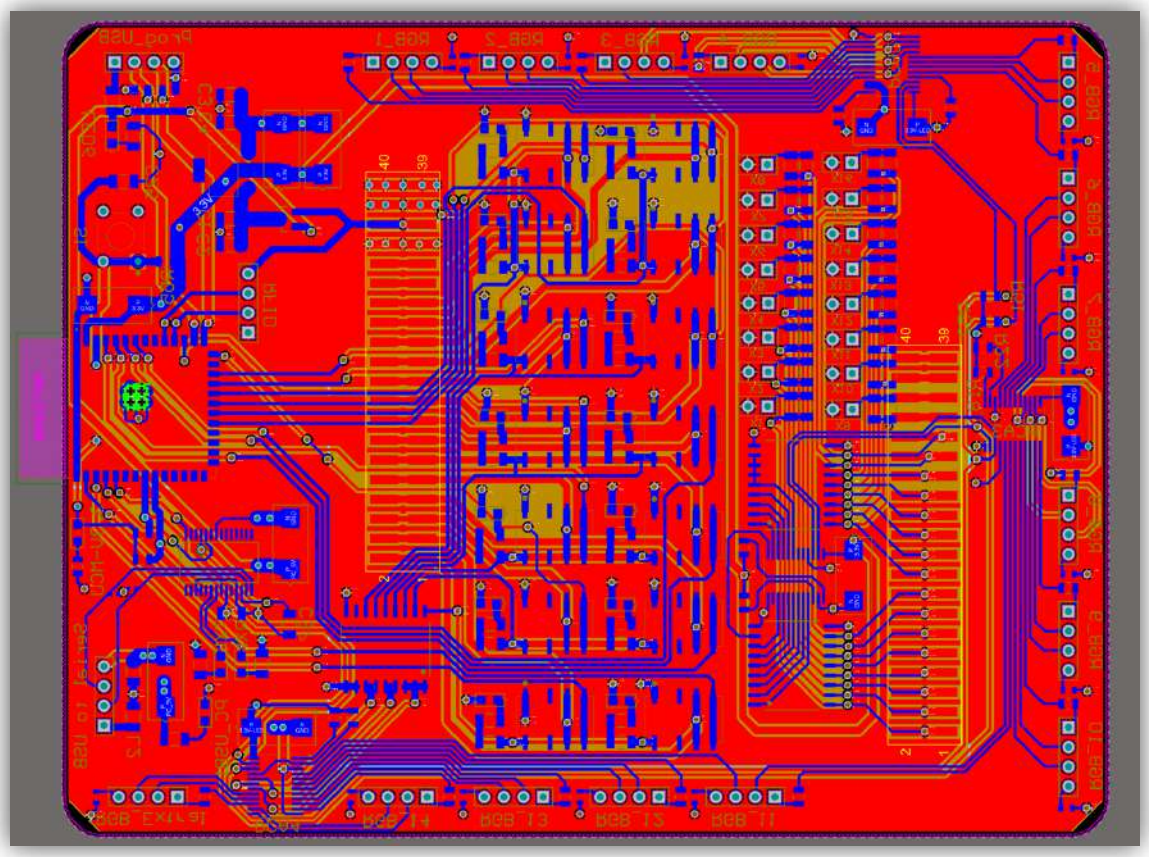

Figure 39 : Layout of Controller Unit

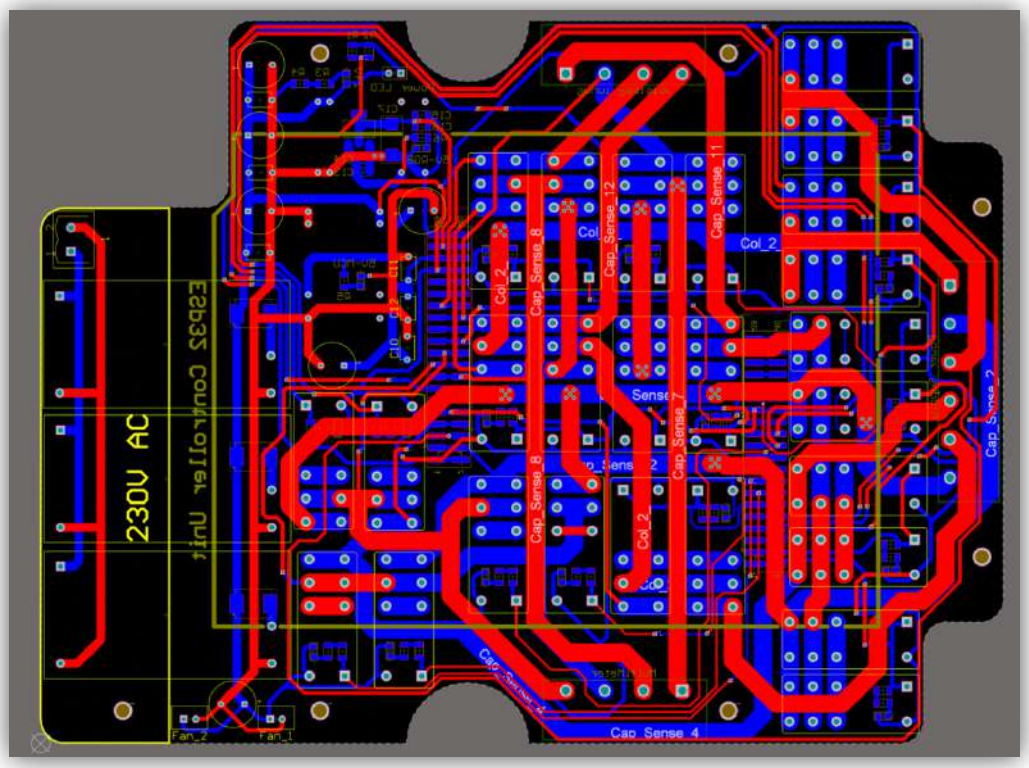

Figure 38 : Layout of the Relay Matrix

4.3.2 *3D View of Final* PCBs

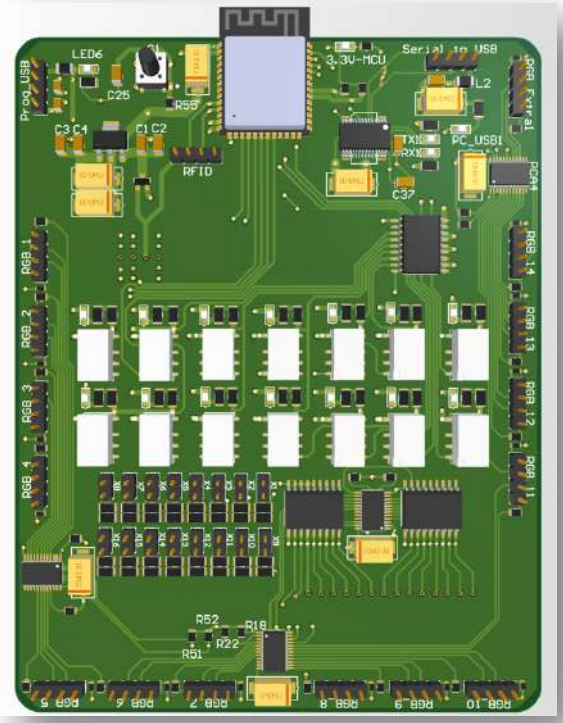

Figure 40 : 3D view of Controller Unit

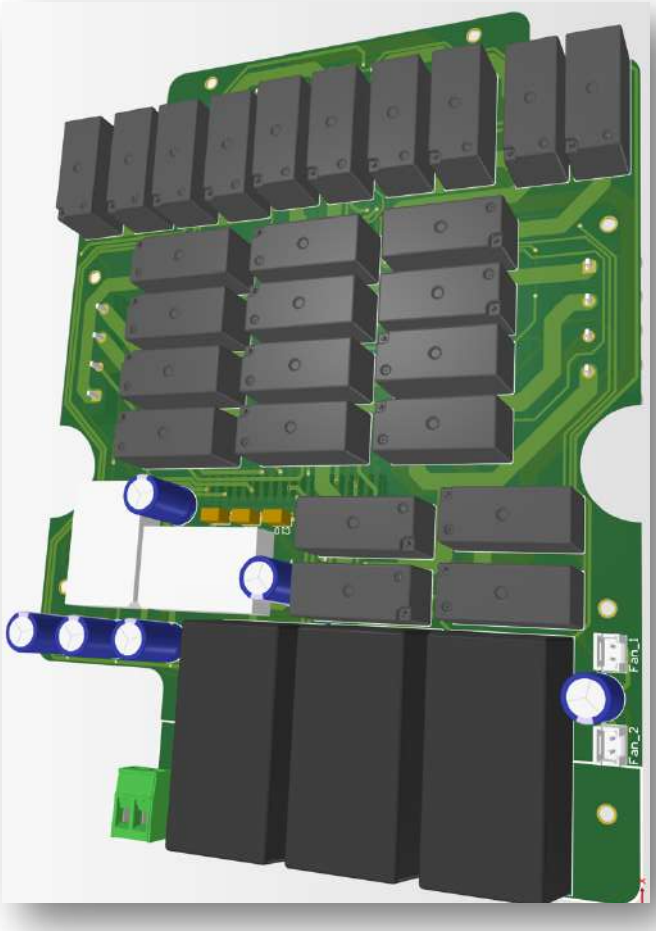

Figure 42 : 3D view of Relay Matrix

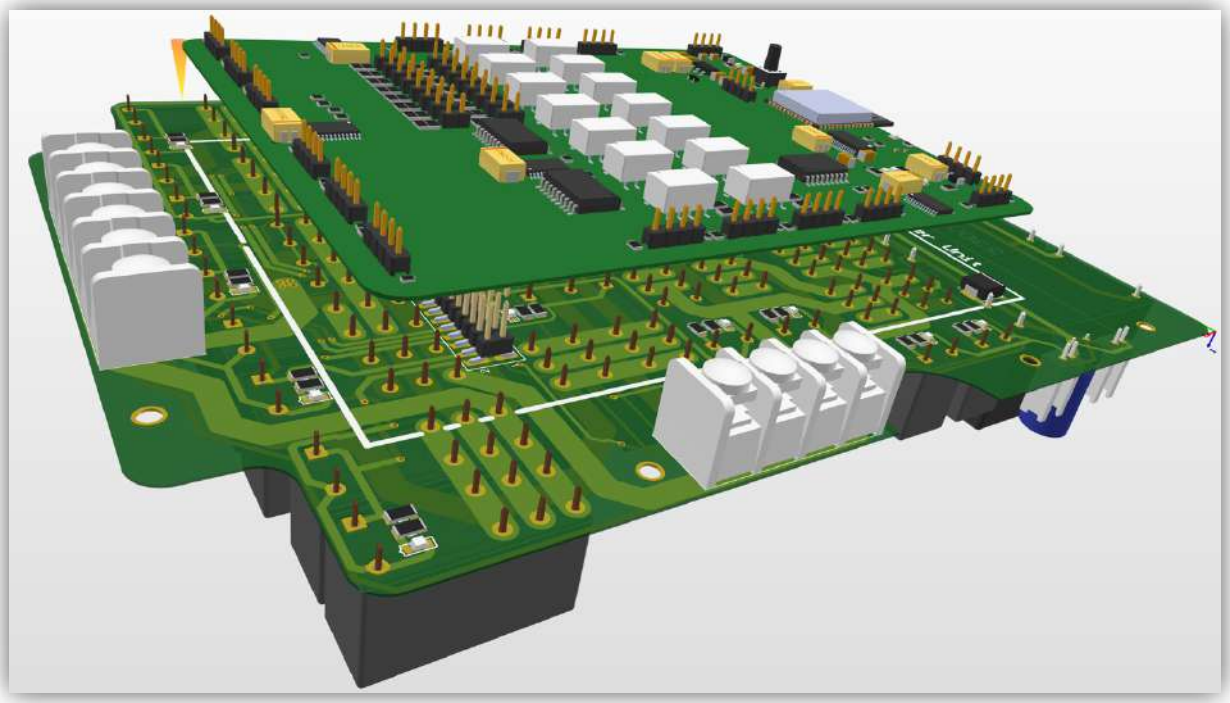

Figure 41 : 3D view of Controller Unit & Relay Matrix

4.3.3 Windows Application:

- A new Windows application is developed to control the entire calibration process.
- The software interfaces with the power supply, multimeter, and the intermediate switching unit.
- The operator initiates the calibration process by running the program and specifying calibration parameters.
- The application communicates with the intermediate switching unit to automate the probe connections, eliminating the need for manual intervention.
- It controls the power supply to output specific voltages and currents, while the multimeter measures these values.
- The software compares the power supply output with the multimeter readings and applies tolerance criteria to determine pass or fail for each voltage and current level. After calibration, it automatically generates a PDF and Excel report.

Figure 43 : Calibration Software Starting Splash Screen

- Developed using the .NET Framework and C# language, it contains over 6000 lines of code.

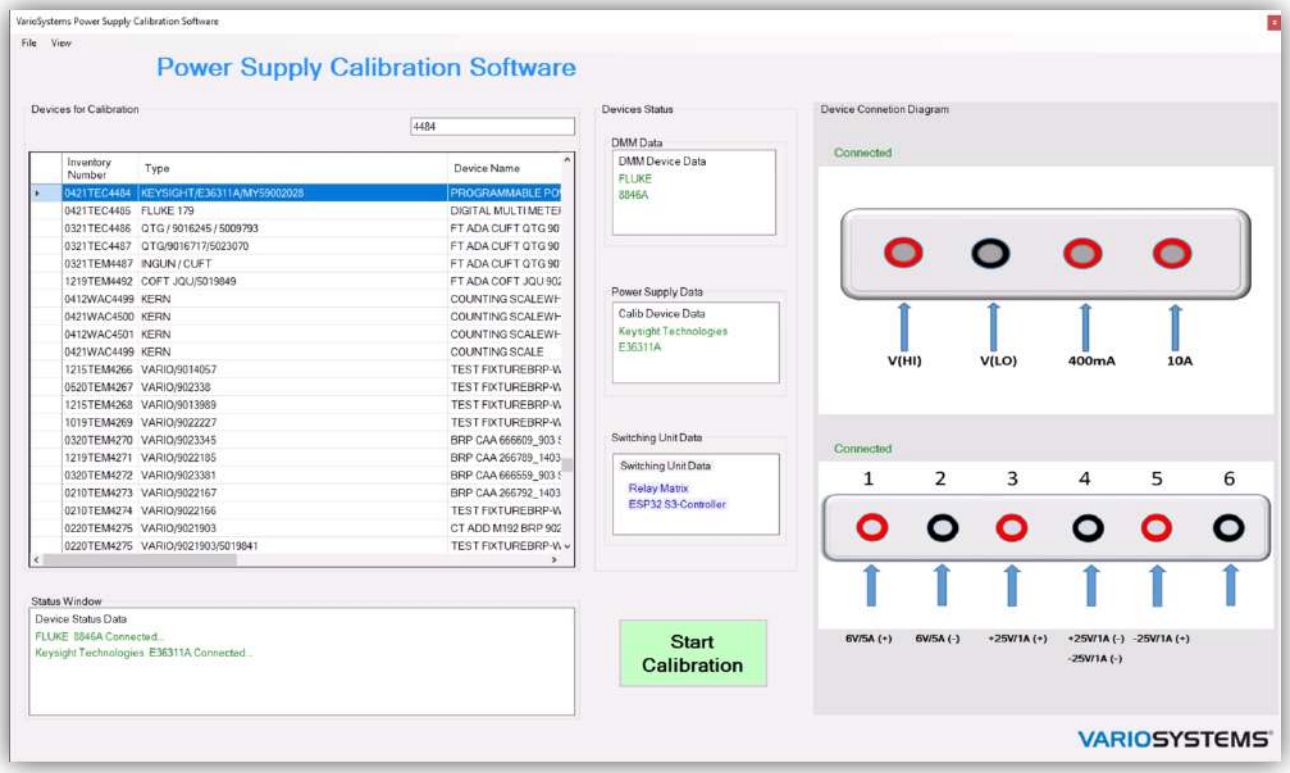

Figure 44 : Probe connecting & power supply connecting window

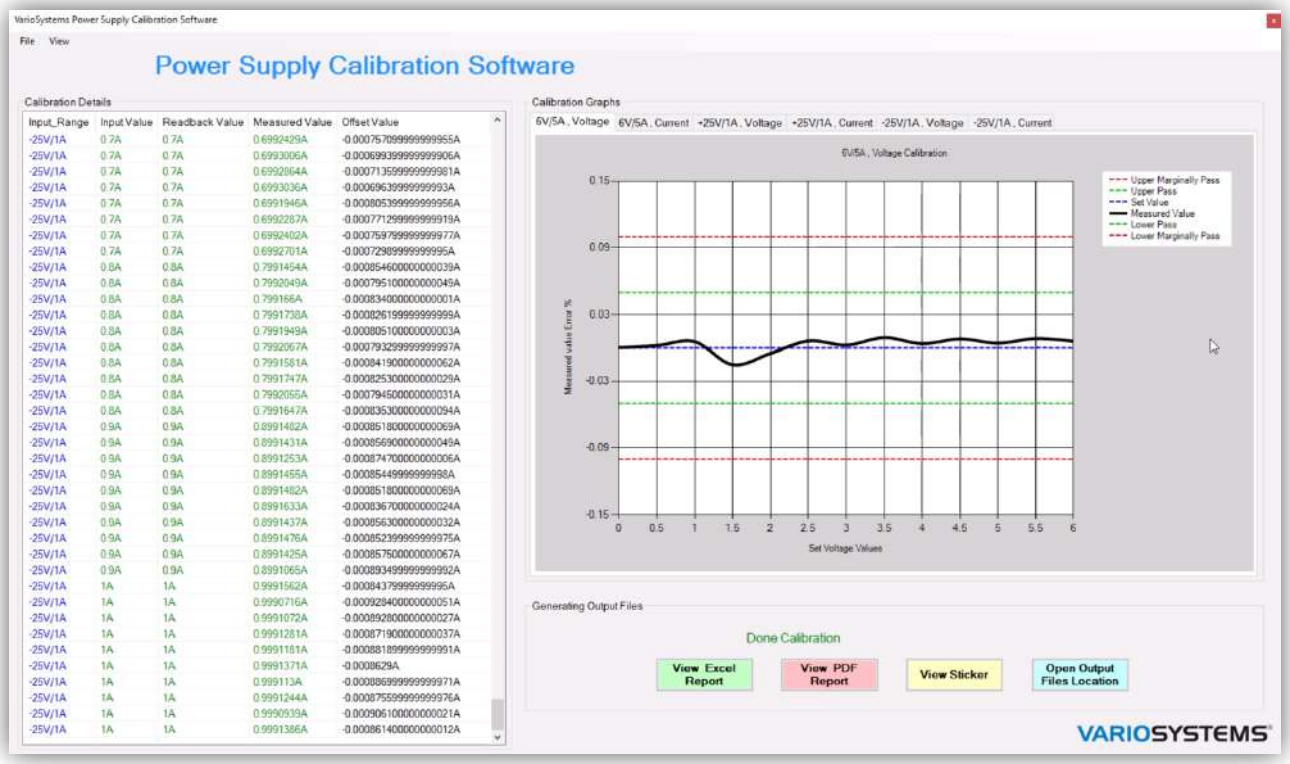

Figure 45 : Final documents and graphs view window

4.3.4 Report Generation:

- The Windows application generates a detailed calibration report after completing the calibration process. The report includes information on each tested voltage and current level, the actual measurements from the multimeter, the power supply outputs, and whether each test passed or failed based on tolerance criteria.
- This report provides a clear overview of the calibration results and can be saved or printed for documentation purposes.
- The operator's name and SAP number are automatically filled in.

Figure 46 : Final Report Formats

4.4 Conclusion of the Project

By introducing an intermediate switching unit and a dedicated software application, this solution revolutionizes the calibration process, automating tasks that previously demanded significant time and manual effort from operators. This innovative approach not only streamlines operations but also enhances efficiency and accuracy. Operators now simply connect probes according to provided visuals, initiating the process that the software seamlessly executes. The system generates comprehensive reports with detailed graphs, including measurements and pass/fail statuses for each test point. Additionally, the software automatically fills in operator details, ensuring streamlined documentation. This integrated solution not only reduces human error but also optimizes the overall calibration workflow, ultimately elevating quality control standards.

5 Hands on Experiences

5.1 Hand Soldering

I learned how to perform hand soldering properly and mastered the use of a soldering station.

Connecting the electronic components to the printed circuit board using solder and soldering iron called soldering. The leads of the component which we are going to solder, should place on the relevant hole or place in the PCB. Then heat the copper plate and pin or part which we are going to solder. When we touch the solder wire to the heated point, solder wire begins to melt and solder them properly. Steps of the soldering shown below.

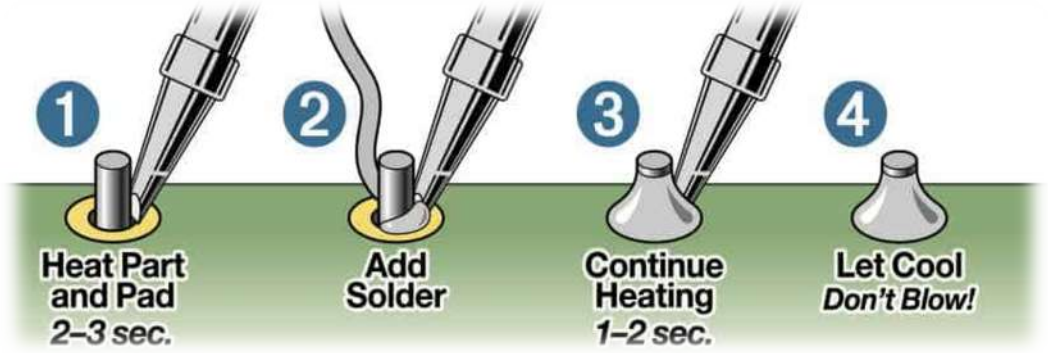

Figure 47 : Hand soldering steps

Figure 48 : Soldering station at variosystems test engineering department

5.2 Schematic Drawing & Layout Routing

I learned to draw schematics and route PCB layouts to an industrial level using Altium. Additionally, through numerous customer projects, I had the opportunity to review various documents, including schematics, layouts, and documentation, enabling me to observe industrial-level PCBs and schematics firsthand.

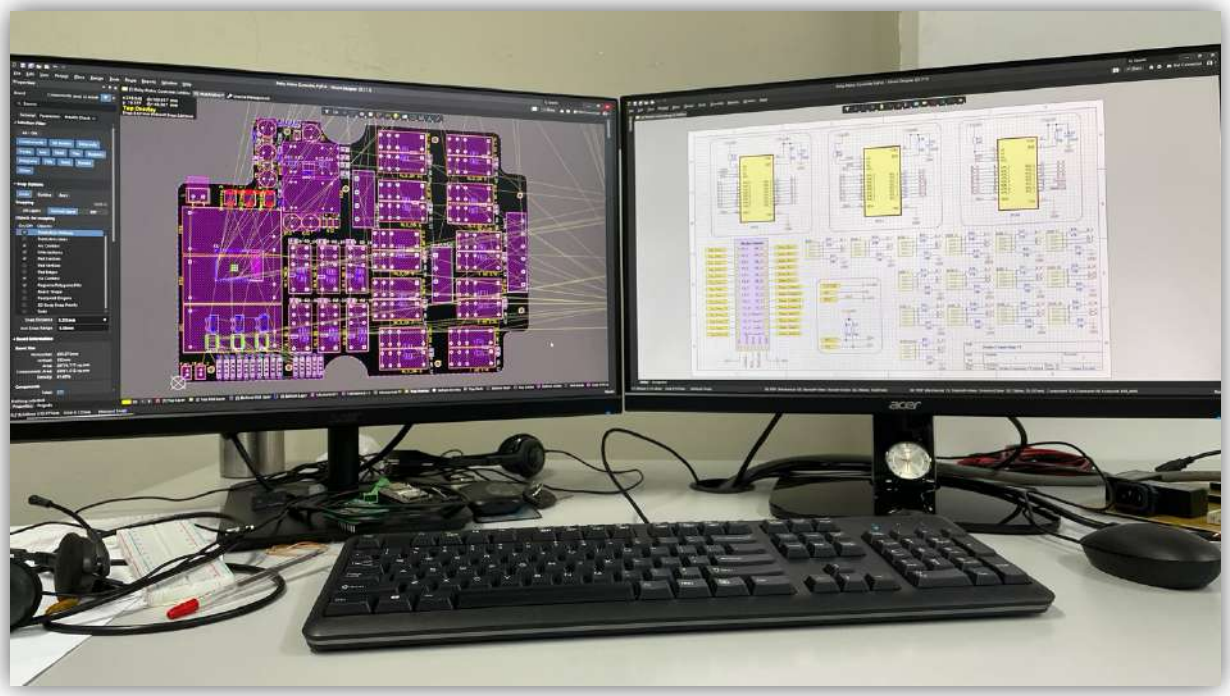

Figure 49 : Routing final PCB using Altium Designer

5.3 Windows Application Development

I gained proficiency in software development through my experience with Visual Studio, a versatile and powerful integrated development environment (IDE). Within Visual Studio, I learned to utilize both C# and Visual Basic programming languages, mastering their syntax and functionalities. With the support of the .NET Framework, I acquired the skills to develop robust and user-friendly Windows applications. This journey equipped me with the knowledge and tools needed to create efficient, reliable, and feature-rich software solutions tailored to various requirements and industries.

Programming language **Visual Studio**

5.4 Instruments Programming

I acquired proficiency in utilizing programmable power supplies and multimeters, encompassing both their operational use and programming capabilities. Through hands-on experience, I learned to effectively program these instruments to meet specific voltage and current requirements for diverse applications. Additionally, I gained insights into the communication protocols utilized by these devices to interface with PCs, enabling seamless data exchange and control. This knowledge empowered me to leverage these instruments efficiently within various projects, ensuring precise measurements and controlled power delivery for optimal performance and testing accuracy.

5.5 Workshop Experiences

During a test engineering workshop, I gained practical knowledge regarding the use of various tools essential for PCB soldering and wire stripping tasks. Through hands-on demonstrations and guidance, I learned how to effectively wield soldering irons, ensuring precise and reliable connections on printed circuit boards (PCBs). Additionally, I familiarized myself with the proper techniques for wire stripping, using specialized tools to remove insulation without damaging the underlying conductors. This workshop provided valuable insights into the intricate processes involved in electronic assembly and testing, equipping me with essential skills for executing soldering and wiring tasks with precision and efficiency in diverse engineering projects.

Figure 51 : Soldering place

Figure 50 : Making prototype PCB

6 Soft Skills Development

During my 24-week training period at Variosystems, I had the opportunity to develop and enhance a variety of essential soft skills through hands-on project experience. One of the first tasks I undertook was preparing and delivering numerous presentations for project proposals and demonstrations. This regular practice significantly improved my language proficiency, presentation techniques, and overall communication skills, enabling me to convey ideas more clearly and confidently.

When I was assigned the project, I faced the challenge of leveraging my existing knowledge and identifying new areas to learn. This process sharpened my problem-solving skills as I critically analysed how to approach the project effectively. I had to determine which skills I already possessed and what additional information or abilities were required, leading to a systematic approach in acquiring new knowledge.

Initially, I had no experience with Windows application development, which was crucial for my project. To bridge this gap, I utilized online resources and sought assistance fr[illegible] in our test engineering department. This experience not only taught me new techni[illegible] also enhanced my interpersonal skills, as I learned to communicate and coll[illegible] colleagues effectively. Moreover, adapting to this new domain underlined my ability to quickly adjust to changing requirements and environments, thereby improving my adaptability.

Throughout the project, adhering to company rules and ethics was paramount. This commitment to following organizational guidelines reinforced my understanding of professional conduct and work ethic.

At the outset of the project, I created a detailed time schedule to manage the project's progress. By strictly adhering to this schedule, I was able to complete the project on time, which greatly improved my time management skills. This disciplined approach to planning and execution ensured that all tasks were completed efficiently and within the designated timeframe.

In summary, my training period at Variosystems was instrumental in developing my soft skills, including communication, problem-solving, interpersonal interactions, adaptability, work ethic, and time management. These skills have prepared me to tackle future challenges and contribute effectively in a professional setting.

7 Variosystems SWOT Analysis

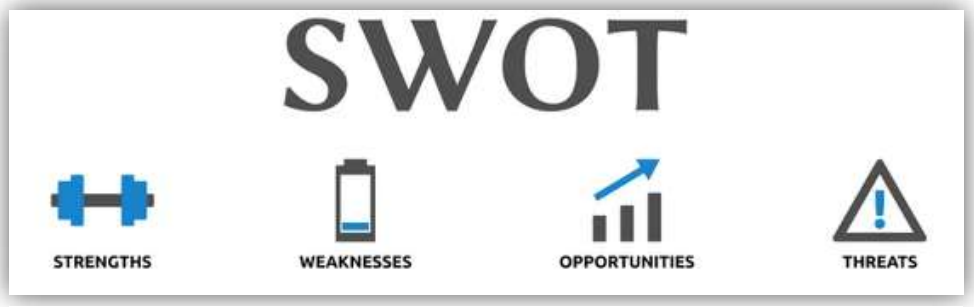

Figure 52 : SWOT Analysis

Strengths : Well-Trained Workforce and Technologically Advanced Infrastructure

Variosystems (Pvt) Ltd benefits from several internal strengths, including a workforce comprising well-trained and skilled employees. These individuals likely possess expertise across various domains, allowing the company to deliver high-quality solutions to its clients. Additionally, Variosystems boasts a robust infrastructure featuring machines equipped with the latest technology. This technological prowess not only enhances operational efficiency but also positions the company as a leader in innovation within its industry. Furthermore, the company may have established a strong reputation over time for reliability, quality, and innovation, further solidifying its position in the market. Strategic partnerships with key vendors or suppliers may also contribute to Variosystems' competitive advantage, providing access to resources and markets that competitors may find challenging to replicate.

Weaknesses : Limited Market Presence and Dependency on Key Personnel

However, despite these strengths, Variosystems faces certain internal weaknesses that could hinder its growth and sustainability. For instance, the company's limited market presence or niche focus may restrict its ability to compete with larger competitors or expand into new territories. Moreover, dependency on key personnel for critical tasks could pose a significant risk, as disruptions such as departures or incapacitation could adversely impact operations. Additionally, in an industry characterized by rapid technological advancements, Variosystems may face challenges in keeping its offerings up-to-date, potentially leading to technological obsolescence and loss of competitiveness. Furthermore, financial constraints could limit the company's ability to invest in research and development or expand its operations, posing a barrier to long-term growth.

Opportunities: Market Expansion and Technological Innovation

Despite these internal weaknesses, Variosystems can leverage several external opportunities to drive future success. Market expansion represents a significant opportunity for the company, whether through geographical diversification or by targeting new industries or customer segments. Collaborations and partnerships with other businesses could unlock access to new markets, technologies, or resources, fostering growth and innovation. Moreover, the emergence of new technologies presents opportunities for Variosystems to innovate and develop cutting-edge products or services that cater to evolving market demands. Diversification of its product or service offerings also presents an avenue for the company to mitigate risks associated with reliance on a single market or technology.

Threats: Intense Competition and Regulatory Changes

However, Variosystems must remain vigilant of external threats that could impede its progress and disrupt its operations. Intense competition within the industry poses a constant threat, potentially eroding market share, and squeezing margins. Regulatory changes or compliance requirements could also impact the company's operations, increasing costs or limiting market access. Economic uncertainty represents another significant threat, as downturns or instability could dampen demand for Variosystems' offerings and disrupt supply chains. Moreover, the increasing prevalence of cybersecurity risks, such as data breaches or malware attacks, poses a significant threat to the company's reputation and financial stability, necessitating robust security measures and vigilance.

8 Personal SWOT Analysis.

Figure 53 : Personal SWOT Analysis

My personal SWOT analysis reveals a robust foundation in electronics, enriched by my strong basic electronic knowledge, PCB design abilities, problem-solving skills, and critical thinking. Additionally, my programming skills, effective time management, and industrial-level experience from Variosystem are significant strengths that position me well in the field of electronic engineering. These attributes not only highlight my technical proficiency but also demonstrate my capability to manage complex projects efficiently and innovate solutions.

However, there are areas requiring improvement. My limited knowledge of artificial intelligence (AI) and object-oriented programming (OOP) concepts, coupled with an inability to work hard, present notable weaknesses. Addressing these gaps is crucial, as proficiency in AI and OOP is increasingly essential in modern electronics and technology fields. Furthermore, enhancing my work ethic will be necessary to meet the demands of rigorous projects and maintain competitiveness.

As an electronic engineering student, I have numerous opportunities at my disposal. The presence of globally renowned electronic companies offers potential for future employment and internships, providing valuable industry exposure. Additionally, the abundance of online courses presents an accessible means to upskill, particularly in AI and OOP, allowing me to stay current with technological advancements.

Conversely, the rapid pace of technological change necessitates continuous learning, posing a significant threat. Economic instability in Sri Lanka may impact job security, heightening the importance of building a resilient career path. Moreover, competition from peers with specialized skills and the growing impact of AI on the industry underscore the need for constant skill enhancement to remain relevant and competitive. By leveraging my strengths and opportunities while addressing my weaknesses and threats, I can strategically navigate my career in electronic engineering.

9 Conclusion

My experience at Variosystems (Pvt.) Ltd. has been nothing short of transformative, providing an immersive education in the multifaceted realm of electronic engineering and manufacturing. From the outset, the company proved to be an ideal environment for an engineering student eager to delve into PCB assembly technologies, wire harness manufacturing, and testing methods.

Upon my arrival, I was pleasantly surprised by the depth of exposure I received to the PCB assembly process. Witnessing the journey from stencil to Final PCB, including the intricate soldering of SMT and THT components, offered invaluable insights into industry practices. Moreover, gaining an understanding of PCB and wire harness testing methods was instrumental in grasping the importance of quality assurance in electronic manufacturing.

Beyond technical skills, my time at Variosystems illuminated the inner workings of business organization and the role of electronic engineers in industry. Collaborating with professionals across all levels, from top management to labour, provided a holistic view of company operations and fostered a culture of knowledge exchange and growth.

Throughout my training period, I had the opportunity to bridge the gap between theoretical knowledge and real-world application. Undertaking the power supply calibration automation project not only honed my technical skills but also exposed me to electronic product development processes, including schematic design using Altium Designer, STM32 chip programming, and windows application development in Visual Studio.

A highlight of my training was my immersion in the test engineering department, where I had the privilege of exploring top-tier PCB design documents, particularly in specialized fields such as medical, aerospace, and military applications. This exposure proved invaluable for an embedded system electronic engineering student like myself, providing a glimpse into the meticulous standards and rigorous requirements of these industries.

In conclusion, my time at Variosystems has been an enriching journey of learning and growth, equipping me with a diverse skill set and a profound understanding of electronic engineering at an industry level. The opportunity to witness the intricate processes behind electronic product development and manufacturing has solidified my passion for this dynamic field and prepared me for future challenges and opportunities in the industry.

10 Annexes

- KEYSIGHT power supply programming manuals.
- FLUKE multimeter programming manuals.
- STM32 datasheet
- ESP32 datasheet
- Altium playlist
  https://www.youtube.com/playlist?list=PL3aaAq2OJU5Gd4D2C7ny-pz18FQu2kdkL
  https://www.youtube.com/playlist?list=PLqo30NsEJyY2jWBDA6Y2magDIRzkw7c9m
- Visual basic playlist
  https://www.youtube.com/playlist?list=PLC601DEA22187BBF1
- Arduino IDE setup for STM32
  https://www.youtube.com/watch?v=yssEiMLGH90
- OOP concepts in C++
  https://www.youtube.com/watch?v=wN0x9eZLix4
- CSV file generation using C++
  https://www.youtube.com/watch?v=FwhfYlkm0yU&pp=ygUh4oCiCUNTViBmaWxlIGdlbmVyYXRpb24gdXNpbmcgQysr
- Arduino GUI playlist
  https://www.youtube.com/playlist?list=PLDxm-EGn62t7indrQcJGBchHJCJqTWdGP
- C# tutorials
  https://www.youtube.com/watch?v=GhQdlIFylQ8

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- Figure 2 : https://www.variosystems.com/en/links-en/
- Figure 5 : https://www.variosystems.com/en/customer-organizations-en/
- Figure 6 : https://www.variosystems.com/en/services/cable-assembly/
- Figure 7 : https://www.gwuesst.ch/variosystems-baut-ihre-praesenz-in-asien-aus/
- Figure 8 : https://www.autodesk.com/ca-en/solutions/pcb-design-software/
- Figure 12 : https://businessmap.io/lean-management/value-waste/7-wastes-of-lean
- Figure 13 : https://www.sixsigmadaily.com/what-are-the-eight-wastes-of-lean/
- Figure 14 : https://freeredar.shop/product_details/56793038.html
- Figure 15 : https://www.pngitem.com/middle/hTRhRxb_human-resources-department-logo-hd-png-download/
- Figure 17 : https://www.flaticon.com/free-icon/cyber-security_8522214
- Figure 18 : https://www.vectorstock.com/royalty-free-vector/training-center-icon-vector-29962176
- Figure 26 : https://www.spea.com/en/products/4060-s2-flying-probe-tester/
- Figure 27 : https://www.spea.com/en/product-category/flying-probe-test/
- Figure 29 : https://www.spea.com/en/products/3030-ce/
- Figure 30 : https://www.feinmetall.com/products/contact-probes/ict-/-fct/
- Figure 31 : https://www.dmcinfo.com/latest-thinking/case-studies/view/id/471/bed-of-nails-pcb-functional-test-system-automotive-gauge-cluster-controller
- Figure 32 : https://www.ret.hu/media/product/20891/529687/PTR-Catalogue_Test_Probes.pdf
- Figure 47 : https://www.raypcb.com/pcb-soldering/
- Figure 53 : https://blog.hubspot.com/marketing/soft-skills