VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANA SANGAMA, BELAGAVI, KARNATAKAA-590018.

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Internship Report on

"OVERVIEW OF DIGITAL CONTROL SYSTEM AND PROPULSION AT BHEL-EDN"

Submitted in partial fulfillment for the award of the requirement of

INTERNSHIP [18ECI85]

In

ELECTRONICS & COMMUNICATION ENGINEERING

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Academic year: 2023-2024

MYSURU ROYAL INSTITUTE OF TECHNOLOGY

Lakshmipura Road, Palahally Post, SR Patna, Mandya-571606

DEPARTMENTOFELECTRICAL AND ELECTRONICS ENGINEERING

CERTIFICATE

Certified that the Internship report entitled **"OVERVIEW OF DIGITAL CONTROL SYSTEM AND PROPULSION AT BHEL-EDN"** is bonafide work of **POORVI G S [4MU20EC005]** students of VII semester B.E, at **Mysuru Royal Institute of Technology, MANDYA** in partial fulfillment for the requirement of Internship work of **VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI** during the academic year **2023-24**. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. This report has been approved as it satisfies the academic requirements as prescribed by the university

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EXTERNAL VIVA

Name of Examiners	Signature with date
1. ----------------------	--------------------------
2. ----------------------	--------------------------

INTERNSHIP COMPLETION CERTIFICATE

ಭಾರತ್ ಹೆವಿ ಎಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್, ವಿದ್ಯುನ್ಮಾನ ವಿಭಾಗ, ಬೆಂಗಳೂರು-26
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Certificate

This is to certify that

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were provided with facilities to do Internship at BHEL, ELECTRONICS DIVISION, BENGALURU as per following details :

"OVERVIEW OF DIGITAL CONTROL SYSTEM AND PROPULSION SYSTEM AT BHEL - EDN "

UNDER THE GUIDANCE OF

SHRI K. PRABHAKAR
SENIOR MANAGER / SA - PRODUCTION

During of Internship (Offline)	04 Weeks	From	14.08.2023	To	11.09.2023

This permission to do the Internship was accorded as per request from the institution where the students are studying, for partial fulfillment of the completion of the course.

The Student showed keen interest in the training and has completed the Internship. Her Character and Conduct during the training period was found as 'EXCELLENT'.

11/9.2023

Signature of Issuing Authority
with Seal

ನವೀನ್ ಚಂದ್ರ, ಹಿ. ಉ.ಪ್ರ.ವ್ಯ. (ಮಾ.ಸಂ.-ರಾ.ಭಾ. ಮತ್ತು ಮಾ.ಸಂ.ಅ.)
नवीन चन्द्र, वरि. उ.म.प्र.(मा.सं.-रा.भा. एवं मा.सं.वि.)
NAVIN CHANDRA, SR. DGM (HR-OL & HRD)
BHEL-EDN, MYSURU ROAD, BENGALURU-560026

Place : Bengaluru.
Date : 11.09.2023

Corporate & Regd. Office : BHEL House, Siri Fort, New Delhi - 110 049.
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ACKNOWLEDGEMENT

The joy and satisfaction that accompany the successful completion of any task would be incomplete without the mention of the people who made it possible. I am thankful to BHEL-EDN, for providing me an opportunity to be an intern. I express my sincere gratitude to my external guide **Mr. Prabhakaran Project Manager, BHEL-EDN**, for this constant support. We would like to express our gratitude to our Principal, **Dr. Abhinandhan K S** for providing as a congenial environment for engineering studies and also for having showed us the way to carry out the **INTERNSHIP**. We consider it, a privilege and honor to express our sincere thanks to **Dr. D J Ravi** Head, Department of **Electronic and Communication Engineering** for the support. We would like to thank our Guide, **MOHAMMED ALI** Department of Electronics and communication engineering for their support, guidance, motivation, encouragement for the successful completion of this Internship. We intend to thank all the teaching and non-teaching staff of our Department of Electronic and Communication Engineering for their immense help and co-operation Finally, I take this opportunity to extend my earnest gratitude and respect to our parents, teaching& technical staff of the department, the library staff and all my friends, who have directly or indirectlysupported me during the period of Internship work.

Regards,

POORVI GS

[4MU20EC005]

DECLARATION

I, the undersigned solemnly declare that the internship report entitled **"OVERVIEW OF DIGITAL CONTROL SYSTEM AND PROPULSION AT BHEL-EDN"** is based on my own Work carried out during the course of our study under the supervision of **MOHAMMED ALI, Associate Professor, and Dept. Of ECE, MRIT**

I assert the statements made and conclusions are drawn are an outcome of my internship work. I further certify that,

1 The work contained in the report is original and has been done by me under the general supervision of my supervisor.

2 The work has not been submitted to any other institution for any other degree/diploma/certificate in this university or any other university of India or abroad.

3 I have followed the guidelines provided by the university in writing the report.

4 Whenever I have used materials (data, theoretical analysis, and text) from other sources, I have given due credit to them in the text of the report and given their details in the references.

POORVI GS

[4MU20EC005]

ABSTRACT

One of the best professionally managed company like Bharat Heavy Electrical Limited. Was indeed a great help to my career. The initial phase of my training included familiarization with Performance Analysis Diagnostics and Optimization for Sub Assembly Production and Traction Propulsion System. I got experience & knowledge about the importance of Surface Mount Technology, PCB Testing and Traction Converters and Production. It is a great privilege to work in the BHEL, Electronics division, Mysore Road. Our project is study of Sub Assembly Production and Traction Unit also during my internship in BHEL I studied about the SMT technology, Through Hole Assembly, Wave Soldering, Lacquering and also, I learnt about the converters used in locomotives and different methods of controlling the locomotives.

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CHAPTER 1
ABOUT THE COMPANY

1.1 INTRODUCTION

Bharat Heavy Electrical Limited (BHEL) owned and founded by the Government of India, is an engineering and manufacturing company based in New Delhi, India. Established in 1964, BHEL is India's largest power generation equipment manufacturer.

BHEL was established in 1964 ushering in the indigenous Heavy electrical equipment industry in India. Heavy Electrical Limited (India) was merged with BHEL in 1974. In 1991, BHEL was converted into a public limited company. Over time, it developed the capability to produce a variety of electrical, electronic, and mechanical equipment's for all sectors, including transmission. Transportation, oil and gas and other allied industries. However, the bulk of the revenue of the company is derived from sale of equipment for power generation such as turbines, boilers, etc. As of 2017, BHEL supplied equipment contributed to about 55% of the total installed power generation capacity of India. The company has also supplied thousands of Electrical Locomotives to Indian Railways, as well as defense equipment such as the Super Rapid Gun Mount (SRGM) naval guns manufactured in partnership with the Indian Ordnance Factories and Defense Simulators to the Indian Armed Forces. BHEL is embracing the next phase of its growth on the strength of a sturdy foundation of 50 years of its journey of engineering excellence. BHEL is an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing companies of its kind in India. The company is engaged in the design, engineering. Manufacture, construction, testing, commissioning, and servicing of a wide range of products and services for the core sectors of the economy, viz. Power, Transmission, Industry, Transportation, Renewable Energy, Oil & Gas and defense with over 180 products offerings to meet the needs of these sectors. BHEL has been the solid bedrock of India's Heavy Electrical Equipment industry since its evolution in 1964.

BHEL is executing the world's largest 800kV, 6000 MW UHVDC Multi Terminal Northeast Agra transmission link on a turnkey basis together with ABB, including design, system engineering. Supply, installation, and commissioning for Power Grid Corporation of India Ltd. This dual Bi- Pole project consisting of Bi-pole 1 and Bi-pole 2 will enable the transmission of 600MW power over the distance of 1728 Km from Biswanath Charily in Assam and Alipurduar in West Bengal to Agra in Uttar Pradesh. The link has a 33% over loaded capability, making it

The world's largest multi-terminal 800Kv UHDC Project. In addition to it, the link is also capable of bi-directional power flow. Pole I of the first phase of the Bi-pole 1 is running successfully under commercial operation since 1st Nov 2015.

BHEL products include air preheaters, boilers, control relay panels, electrostatic precipitators, fabric filters, fans, gas turbines, and hydro power plant, piping systems, seamless steel tubes, soot blowers, steam generators, steam turbines, heat exchangers and many more.

1.2 MAJOR MILESTONES

Bharat Heavy Electricals Limited (BHEL) has achieved a major milestone with the successful manufacture and testing of the country's first large capacity new series Turbo Generator of 600 MW rating. The state-of-the-art generator shall be supplied and installed at the upcoming North Chennai Thermal Power Project of Tamil Nadu Electricity Board (TNEB).

Significantly, in addition to sub-critical thermal power plants of 600 MW rating, these new series Generators shall also cater to the requirements of thermal power stations with supercritical turbines of 660 and 700 MW ratings.

With the successful testing of the generator, a new benchmark has been set by BHEL with respect to indigenous manufacture of thermal sets with supercritical parameters. Several sets of 600 MW, 660 MW, 700 MW and 800 MW ratings are presently under various stages of manufacture at BHEL's Hardwar plant.

BHEL has fully established state-of-the-art technology for the manufacture of thermal sets up to 1,000 MW rating. The company has equipped itself to produce thermal sets with supercritical parameters of 660/700/800 MW unit ratings. Also, to meet customer demand, the company has introduced new rating thermal sets of 150 MW, 270 MW, 525 MW and 600 MW, in addition to 250 MW and 500 MW thermal sets.

BHEL has been committed to the nations power development programmed and has reaffirmed its commitment to the Indian Power Sector by equipping itself for the future, by way of technology, facilities and trained manpower to meet the country's power forecast for the 11th Plan and beyond. For this, it has already enhanced its manufacturing capacity to 15,000 MW per annum and is further augmenting it to 20,000 MW per annum by March, 2012.

1.3 PRODUCTS AND SERVICES

THERMAL POWER PLANTS : EPC and Turnkey contract for Thermal Power Plants u Steam Generators, Steam Turbines, Turbo Generators along with regenerative feed cycle upto 1000 MW capacities for steam-cycle and up to 350 MW for combined-cycle fossil fuel applications u Air andwater cooled Condensers, Condensate Extraction Pumps, Boiler Feed Pumps, Duplex Heaters, Valves and Heat Exchangers - meeting requirement of TG Sets up to 1000 MW u Residual Life Assessment (RLA) studies, Energy Efficient Renovation and Modernization (EE R&M) and Life Extension (LE) of old thermal power plants

NUCLEAR POWER PLANTS: Reactor side components like Steam Generators, Reactor Headers, End Shields, special purpose Heat Exchangers, Pressure Vessels, Motors etc. for Nuclear Power plants. u TG island equipment of PHWRs (Pressurized Heavy Water Reactors), FBRs (Fast Breeder Reactors) and AHWRs (Advanced Heavy Water Reactors) including 'EPC' solutions covering Steam Turbine, Turbo Generators, MSRs (Moisture Separator Repeaters), other heat exchangers and pumps.

GAS-BASED POWER PLANTS : Gas turbines and matching generators ranging from 25 MW to 299 MW (ISO) rating with following features: Gas turbine based co-generation and combined-cycle systems for industry and utility applications BHEL's Product and Service Profile includes design, manufacturing and installation in the following major segments: Capability to burn a variety of fuels (both gaseous and liquid) along with mixed firing in different combinations of fuels .Low exhaust emission levels up to 15ppm of NOx with Dry Low NOx (DLN) combustors &noise reduction.

HYDRO POWER PLANTS : EPC & Turnkey Contract with custom-built conventional hydro turbines of Kaplan type (up to 100 MW), Francis and Pelton types (up to 400 MW) with matching generators u Pump turbines with matching motor-generators up to 250 MW u Bulb turbine with matching generators up to 10 MW u High capacity pumps along with matching motors for Lift Irrigation Schemes (up to 200 MW) u Mini/ Micro and small hydro power plants up to 25 MW rating u Microprocessor based Digital Governing system for all types of Hydro Power plants u Renovation, Modernization and up rating of Hydro power plants u Spherical (rotary) valves, butterfly valves and auxiliaries for hydro stations you Balance of Plant & System Integration.

SOLAR POWER SYSTEM: EPC solutions of Solar PV Power Plants: • Grid Interactive systems with & without BESS (Battery Energy Storage System) • Standalone systems • Roof Top

Systems • Hybrid systems PRODUCT PROFILE 4 PRODUCT Profile • Canal Top Systems • Floating Solar power plants • Solar based water pumping systems.

STEAM GENERATORS: Steam generators for utilities, ranging from 30 to 800 MWcapacity, using coal, lignite, oil, natural gas or a combination of these fuels; capability to manufacture boilers with ultra supercritical parameters up to 1000 MW unit size u Steam generators for utilities, with Advanced Ultra Supercritical (AUSC) parameters of 310 ata and710℃ / 720℃. Circulating Fluidized Bed Combustion (CFBC) steam generators, with supercritical parameters up to 660 MW unit size for utilities u Fuel Flexible boilers capable of all combination of blending / co-firing diverse qualities of imported/ Indian coals, blending of lignite, pet coke, etc. u Capability for manufacturing and supply of Steam Generators and Reactor Headers for Nuclear Power Plant as per ASME Sec.-III NB claa 1 requirements.

GUILLOTINE GATES & DAMPERS: Guillotine gates with electric/ pneumatic actuator. 100% leak proof with seal air (Maximum Width/Height): Type-1: 7m/14.5m, Type-2: 14.6m/4.5 m, Type-3: 11.5m/6.5m • Bi-plane dampers with electric/ pneumatic actuator. 100% leak proof with seal air (Maximum Width/Height): Type-1: 7m/14.5m, Type-2: 12m/10.5 m • Louver dampers (open close/ regulating) with electric/ pneumatic actuator (Maximum Width/Height): Type-1: 6.5m/ 14.5 m, Type-2: 12m/10.5m • Control dampers (regulating) with electric/ pneumatic actuator (Maximum Width/ Height): Type- 1:6.5m/14.5m, Type-2: 12m/10.5m.

SOOT BLOWERS: Long Retractable Soot Blowers (LRSB) for travel upto 12.2m u Furnace Temperature Probe (FTP) for travel length up to 10m u Long Retractable Non-Rotating (LRNR) soot blowers with forward blowing for Air Pre heaters u Rotary Soot Blowers u Rack type Long Retractable Soot Blowers u Ash discharge valve for CFBC boiler application.

SEAMLESS STEEL TUBES : Hot-finished and cold-drawn seamless steel tubes with a range varying from outer diameter of 21 to 133 mm and wall thickness of 2 to 12.5 mm, in carbon steel and low-alloy steels to suit ASTM/ASME and other international specifications u Rifled tubes (ribbed) with a range varying from tube outer diameter of 38.1 to 63.5 mm and wall thickness of 5.6mm to 7.1mm, in carbon steel and low-alloy steels to suit ASME and other international specifications u Spiral finned Tubes with a range varying from tube outer diameter of 31.8 to 114.3 mm and wall thickness of 2.4mm to 9.5mm and with fin height of 12.5mm to 21mm and fin density ranges from 40 to 240 fins per meter, in carbon steel and alloy steels to suit ASME standards.

1.4 DEPARTMENTS AND THEIR FUNCTIONS

Research & Development

BHEL places strong emphasis on innovation and creative advancement, which leads to the development of technologically competitive products and services. The research and developmental efforts of the company are not only aimed at improving the performance of the products of current manufacture, but also developing new products and systems using state-of-the-art technologies, relevant to the needs of the various business sectors. With a spending of nearly 2.5% of its annual turnover on R&D projects, BHEL is the largest spender on R&D in the heavy industry segment, to which it belongs. BHEL also generates nearly 20% of its annual turnover from in-house developed products and services introduced in last five years

Spearheading this process is BHEL's highly qualified manpower engaged in R&D activities in the Corporate R&D Division, Hyderabad, and the Research and Product Development (RPD) centers at its manufacturing units

Innovation Capabilities

The lab has been working in the area of manufacturing technology and has been involved in developments like implementation of 3D printed of sand mould technology for Francis hydro turbine runner model, development of scoop milling technology for 5-axis manufacturing of 2D closed impellers, 3-Axis/5-Axis machining technology for the large size pump impeller blade casting on gantry machining centers, manufacturing 2D closed compressor impeller using 3D printing process, development of 5-axis scoop milling technology for turbo-generator fan shrouded 3D impeller , 5-Axis CNC manufacturing technology for proof-machining of hydro pump runner model etc.

Pollution control and research

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by: • Developing safety and sustainability culture through active leadership and by ensuring availability of required resources. • Ensuring compliance with applicable legislation, regulations and BHEL systems. • Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.

• Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/ substitution/reduction/control.

Laboratories at Corporate R&D

1. Insulation and Chemical Sciences:

1. Long term functional evaluation of insulation system.

2. Development of methodologies for residual life assessment of high voltage generatorsand insulating materials and components.

3. Activities related to water chemistry, corrosion, chemical auditing of the samplesrequired by various BHEL plants and sites.

2. Permanent Magnet Machines:

1. Development of special electrical machines, like permanent magnet motors andgenerators.

2. Electromagnetic analysis of electrical machines and equipment.

3. Intelligent Machine Control:

1. Development of special electrical controller, EMI/EMC complaint customized orapplication specific control systems for strategic applications.

2. Legacy program conversion for major BHEL products to meet the technology obsolescence. And product design up- gradation.

3. Electrical Machines:

1. Development of special electrical machines, like brushless exciters and high frequency motors & generators, HTSC motor.

2. Electromagnetic analysis of electrical machines and equipment.

4. BHEL's centers of excellence

1. Centre of Excellence for Simulators (COE-S) highlights the power plant simulation capabilities of BHEL. Having the core expertise in power plant domain, the following products and services were developed and offered by COE-S: Products: Operator Training Simulators (OTS), Compact Generator Simulator (CGS), Sequence of Events (SOE) Simulator and Performance Analysis, Diagnostics and Optimization (PADO) package.

2. Services: Dynamic Simulation Studies, Remote Monitoring and Diagnostic Service (RMDS)and training and development of New Control Logics.

Testing & Calibration facilities

Testing determines quality of product or material. With calibrated equipment and expert manpower, we provide services of testing for variety of materials like metals, transformer oil, paints, insulating tapes, cables etc. We also offer our expertise and testing services for products like transformers, motors, traction motors, hydro machines models, switchgear and controls to ensure compliance. Achieve and maintain compliance through consistent procedures and adhere to local and global regulations and standards.

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CHAPTER 2

2.1 OVERVIEW

OVERVIEW OF SUB ASSEMBLY PRODUCTION

The overview of sub-assembly product refers to a component or group of components that are assembled together to create a larger product. These sub-assemblies are typically part of a more complex manufacturing process where various smaller parts are combined to form the final product. Sub-assembly products help streamline manufacturing, improve quality control, and simplify maintenance or repairs. They play a crucial role in many industries, such as automotive, electronics,aerospace, and more.

OVERVIEW OF TRACTION PROPULSION SYSTEM

A traction propulsion system is a critical component in various modes of transportation, including trains, trams, and electric vehicles. It serves to convert electrical or mechanical energy into the motive force required to move the vehicle. Typically, in electric traction systems, electric power is supplied through overhead lines or a third rail and transmitted to electric motors, which drive the wheels. In diesel-electric systems, internal combustion engines generate electricity to power electrictraction motors. Traction systems are known for their efficiency and ability to provide high torque at low speeds, making them ideal for heavy-duty applications. They are also environmentally friendly, especially in electric variants, as they produce no direct emissions. Advances in technology continue to improve the performance and sustainability of traction propulsion systems, promoting their adoption in modern transportation solutions.

2.2 ACTIVITIES OF DEPARTMENT

A UNIT OF BHEL ELECTRONICS DIVISION

BHEL Electronics Division (EDN), located at Mysore Road, Bangalore along with Electronics Systems Division (ESD-part of EDN), located at Electronics City, Bangalore is a leading supplier of new Generation Power Plant Automation and Control Systems.

The Electronics Division has also emerged as a leading player in the field of power transmission and distribution, industry, transportation, and non- conventional energy sources. The state-of-the- art equipment and systems manufactured, meet the demanding requirements of both the national and international markets in terms of technical specification and quality.

The Division has established references both in India and overseas by successful Installation of Power Plant Automation and Photovoltaic Systems. Besides providing unified solutions for various control system applications, the Division proudly holds the largest market share for Power Plant Automation Systems in India

Figure 2.2: Electronics Division- Mysore, Bengaluru

BHEL is known for its high-quality products and services, and its Electronic Division in Bangalore and Mysore is no exception. The division has a strong focus on research and development and is constantly innovating to meet the changing needs of its customers.
Overall, BHEL's Electronic Division in Bangalore and Mysore plays an important role in the growth of India's electronics industry and is a leading supplier of electronic products to various sectors, including power, railways, and defense

Presence

1. Power Plant Industries: Advanced control & automation equipment and systems for power plants & process industries

2. Transmission and Distribution: Providing solutions for improving the efficiency, quality of power and system stability

3. IGBT based Traction Drive Systems for Locomotives.

4. Defense: Simulation systems and Controls for Naval Ships.

5. Non-Conventional Energy: Photo voltaic Cells, Modules, MW size Power Plants, Space grade Solar Panels, Space batteries and provide system level solutions.

2.3 Quality Objectives

1. Product Service Quality by improving key processes.
2. Value Addition by reducing Cost of Quality
3. Customer Satisfaction by improving delivery and response
4. Quality of Supplies by improving supplier performance.
5. Capability of human resources by upgrading skill and competence.

2.4 Main activities of Bangalore Division

1. Design, development, and manufacturing of electronic systems for defense applications such as radars, electronic warfare systems, communication systems, and missile systems.

2. Development and manufacturing of power electronics products like rectifiers, inverters, and converters used in industries like railways, steel plants, and refineries.

3. Production and servicing of solar photo voltaic (PV) modules, and solar water pumps.

4. Manufacturing of industrial drives and automation systems used in industries such as cement, paper, and sugar.

5. Repair and maintenance services for transformers, switch gears, and other electrical equipment.

6. Development of electric mobility solutions, including charging infrastructure, electric vehicle (EV) chargers, and battery management systems

7. Development of software and hardware for real-time control and monitoring systems used in industries like oil and gas, and water treatment

2.5 Services Offered

1. Harmonic Measurement and Analysis
2. System study for Reactive Power compensation Erection
3. Commissioning by highly experienced team of Engineers
4. A highly competent team to respond to Customers' emergency needs
5. Total Solutions to Renovation and Modernization requirements
6. Solar Power Plants

CHAPTER 3
TASK PERFORMED

3.1 Surface Mount Technology

Surface-mount technology (SMT), originally called planar mounting, is a method in which the electrical components are mounted directly onto the surface of a printed circuit board (PCB). The SMT Shown below.

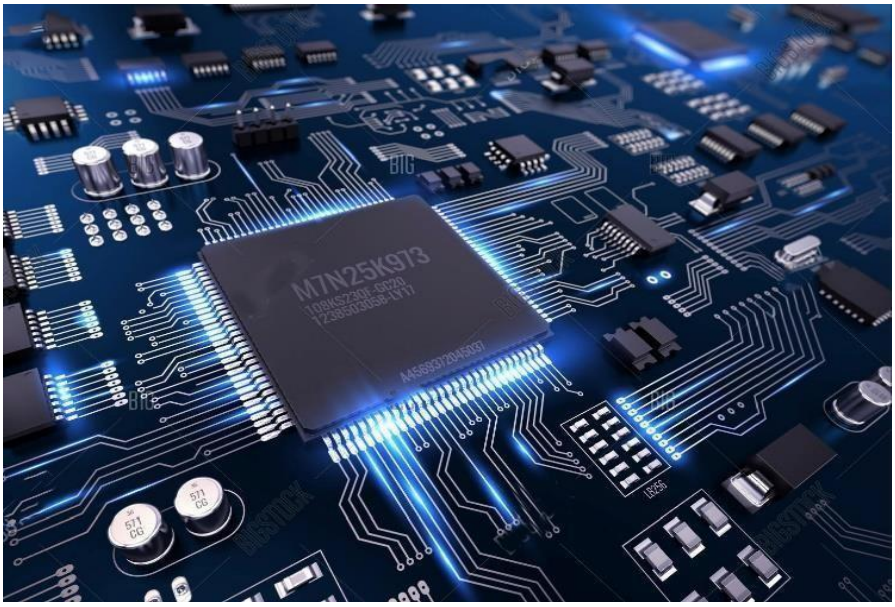

Fig 3.1.1 Surface Mount Technology

Surface Mount Technology (SMT) is a widely used electronic assembly process that involves placing and soldering electronic components onto the surface of a printed circuit board (PCB). It has largely replaced the older through-hole technology due to its efficiency and compactness.
SMT has enabled the development of smaller, faster, and more feature-rich electronic devices across various industries, including consumer electronics, telecommunications, automotive, and medical equipment.

In the SMT process:

1. Component Placement: Small components like resistors, capacitors, integrated circuits, and other electronic parts are picked and placed onto the surface of the PCB using automated equipment.

2. Soldering: Solder paste, a mixture of solder alloy and flux, is applied to the PCB before component placement. This paste melts during the soldering process, creating strong electrical connections between the components and the board.

3. Reflow Soldering: The PCB is heated in a reflow oven, causing the solder paste to melt and form solid connections when cooled. This process is carefully controlled to ensure the Components are attached securely without overheating.

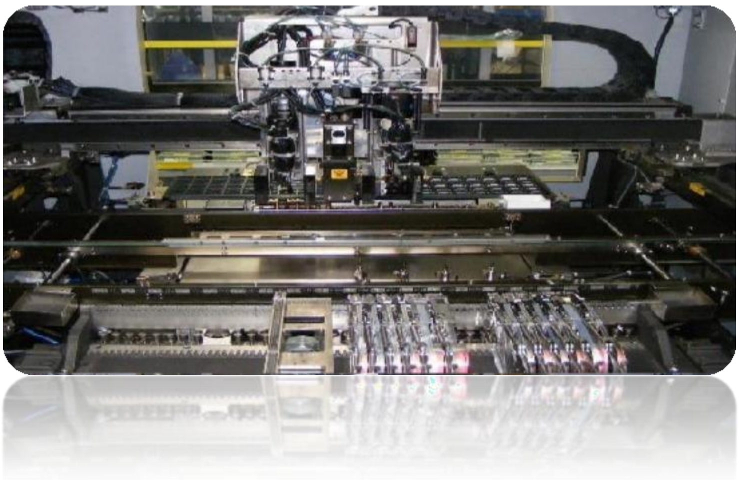

Fig 3.1.2 Pick and Place Machine

Fig 3.1.3 SMT Process

3.2 Through Hole Assembly

Through-hole is a method for mounting components on a printed circuit board (PCB) in which pins on the component are inserted into holes in the board and soldered in place. The typical through hole shown below

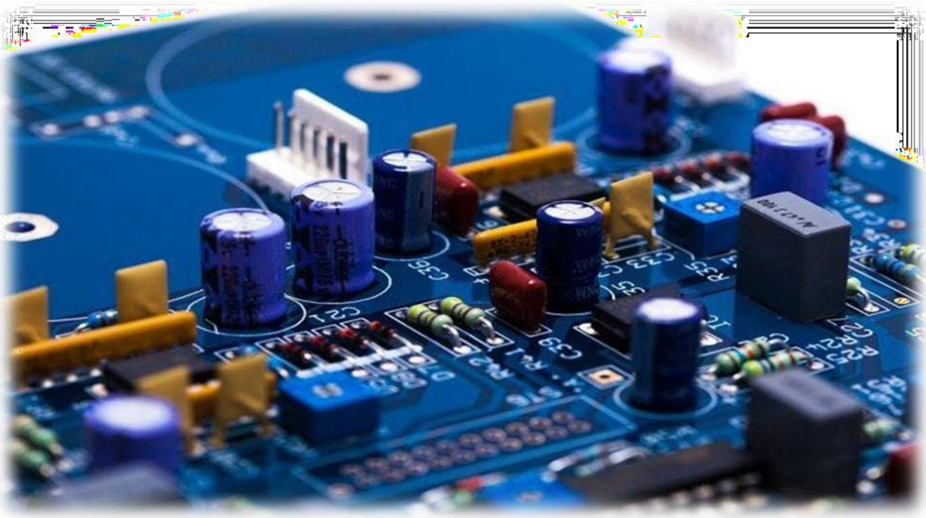

Fig 3.2.1 Through Hole Assembly

Through-Hole Assembly (THA) is an older electronic assembly process that involves inserting electronic components into holes drilled in a printed circuit board (PCB) and then soldering the components to the opposite side of the board.

Overview of the Through-Hole Assembly process:

1. **Component Insertion:** Electronic components with wire leads (such as resistors, capacitors, diodes, and connectors) are manually or semi-automatically inserted through holes in the PCB.

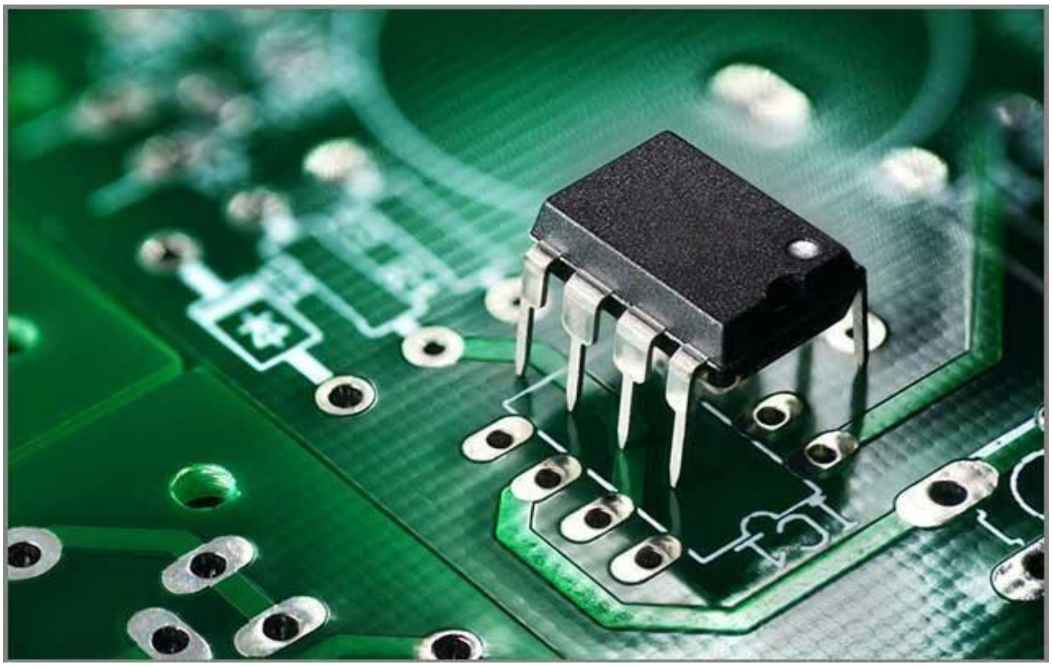

Fig 3.2.2 Component Insertion

2. **Component Leads:** The leads protrude through the holes and are bent or trimmed on the opposite side of the board to keep the components in place during soldering.

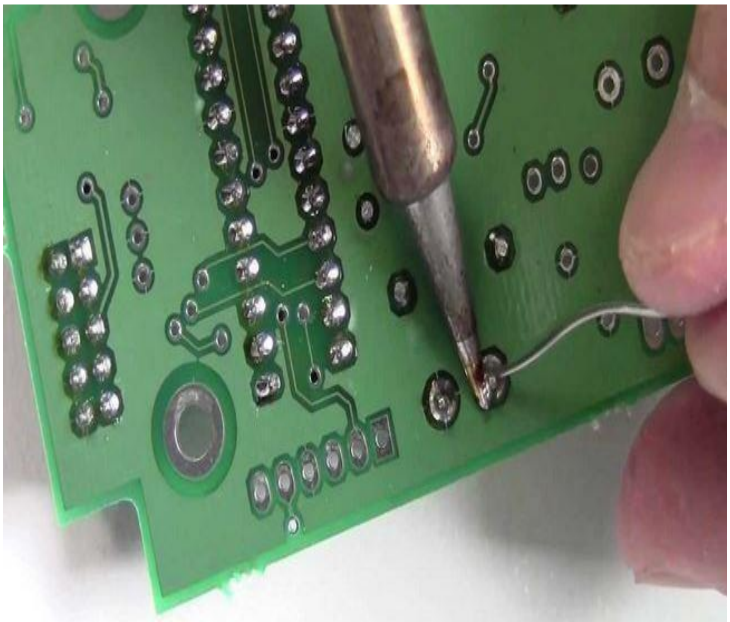

Fig 3.2.3 Component Leads

3. **Soldering:** The PCB is then soldered either by hand using a soldering iron or through a wave soldering process. In wave soldering, the entire PCB is passed over a molten solder bath, which forms solder connections on the bottom side of the board where the leads are located.

3.3 Wave Soldering

Wave soldering is a bulk soldering process that enables one to manufacture many circuit boards in a very short amount of time.

Wave soldering is a soldering process used to connect electronic components to printed circuit boards (PCBs). It involves passing the PCB over a molten wave of solder, which creates reliable connections between the components and the board. The components are first placed on the PCB, and then it's passed over the solder wave, where the solder attaches to the exposed metal surfaces, forming solder joints. This method is commonly used for through-hole components, as surface mount components require a different soldering technique. Wave soldering helps streamline the assembly process and ensure consistent connections.

Fig 3.3.1 Wave Soldering

Wave Soldering Process:

1. Preparation: The PCB is first prepared by applying a solder mask to areas where solder is not required. This prevents unintended solder bridges.

2. Component Placement: Through-hole electronic components are placed on the PCB. These components have metal leads that pass through holes in the board.

3. Flux Application: Flux, a chemical cleaning agent, is applied to the areas where solder joints willbe formed. Flux helps remove oxidation and contaminants from the metal surfaces, allowing the solder to adhere properly.

4. Preheating: The PCB is preheated to a specific temperature. This helps to minimize thermal shock when it comes into contact with the molten solder.

5. Wave Soldering: The PCB is then passed over a wave of molten solder. The solder wave is usually made of a lead-tin alloy. As the PCB passes over the wave, the solder adheres to the exposedmetal surfaces, creating solder joints.

6. Solder Solidification: After passing over the solder wave, the PCB moves to a cooling zone. The solder quickly solidifies and forms strong connections between the components and the PCB.

7. Cleaning: Once the solder has solidified, the PCB may go through a cleaning process to remove any remaining flux residue. Cleanliness is important to prevent long-term reliability issues.

8. Inspection: The soldered connections are inspected for quality. Any defects or issues are identified and rectified.

9. Testing: The assembled PCB may undergo functional testing to ensure that all components are properly connected and the circuit functions as intended.

10. Further Processing: The PCB can then proceed to additional manufacturing steps, such as adding surface mount components, final testing, and packaging.

Dry Soldering:

A dry solder joint is a soldering defect that occurs when the solder does not properly wet or adhereto the component leads and PCB pads.

Fig 3.3.2 Dry Soldering

3.4 Thermal Cycling

A thermal cycle is defined as any recursive thermal test in which the temperature is regularlyaltered,touching a high-temperature peak and a low-temperature peak.

Fig 3.4.1 Thermal Cycling

Thermal cycling in PCBs (Printed Circuit Boards) refers to the process of exposing the board to alternating cycles of temperature, usually between high and low extremes. This is done to simulate real-world conditions and test the reliability of the PCB. It helps identify potential issues like solder joint failures, material degradation, and component defects that might occur due to repeated temperature changes. Thermal cycling tests are vital to ensure the durability and performance of PCBs, especially in industries where temperature variations are common, like automotive or aerospace.

Thermal Cycling Process:

1. Preconditioning: The PCB is placed in a controlled environment to stabilize it at a specific temperature. This ensures that the initial conditions are consistent across all samples.

2. Temperature Cycling: The PCB is then subjected to a series of temperature cycles. These cycles involve moving the PCB between high and low temperatures at specified rates. The temperature range and cycling rates depend on the intended application and industry standards.

3. Dwell Time: The PCB is held at both the high and low temperatures for a certain period, allowing the materials to expand and contract fully. This step helps to identify potential weak points and failures that might occur during temperature transitions

4. Monitoring: During the thermal cycling, various measurements are taken, such as electrical performance, resistance, continuity, and more. These measurements help identify any deviations or failures that might occur due to the temperature changes.

5. Analysis: After completing the specified number of thermal cycles, the PCB is carefully examined for any visible damage, such as cracks; solder joint failures, delamination, or changes in electrical characteristics.

6. Data Interpretation: The collected data is then analyzed to determine the effects of thermal cycling on the PCB's reliability and performance. This analysis helps in making informed decisions about the design, materials, and manufacturing processes.

7. Iterative Testing: Based on the results, adjustments can be made to the PCB design, materials, or manufacturing methods and the thermal cycling process may be repeated tovalidate the improvements.

3.5 PCB Testing

Printed circuit board testing methods that check if a PCB meets standards. Some of these PCB standards revolve around ensuring the PCB functions properly according to a project's specifications and that it doesn't have any defects.

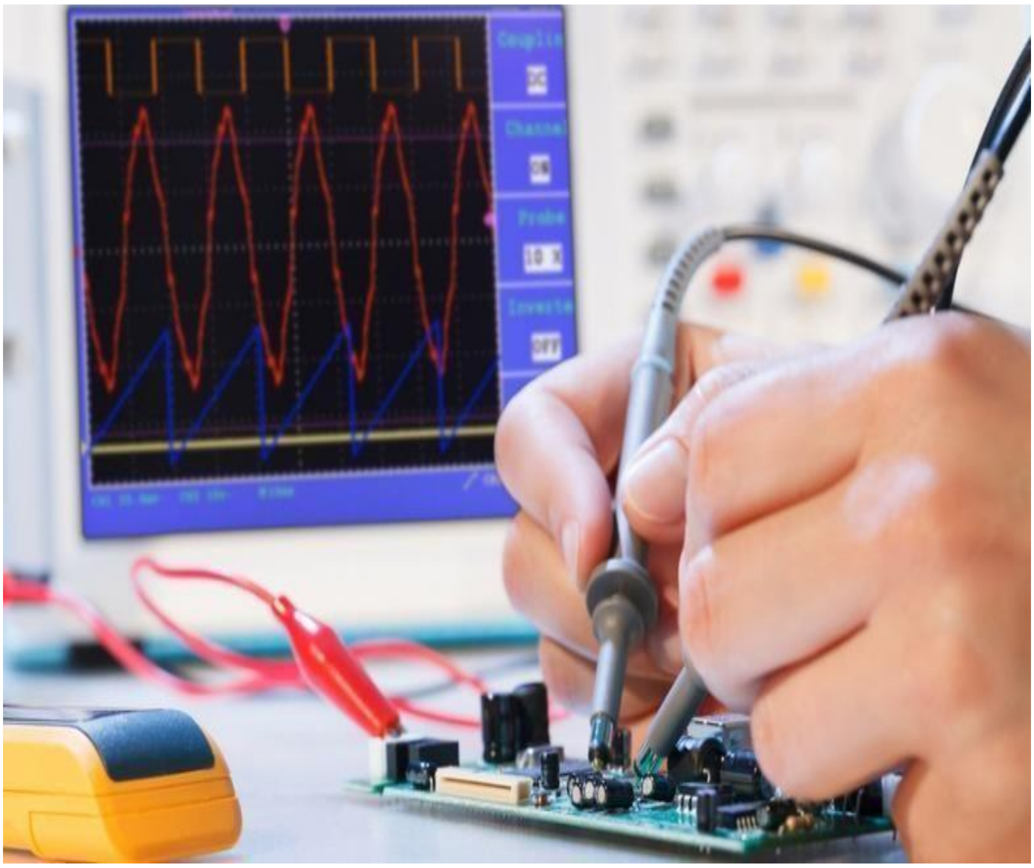

Fig 3.5.1 PCB Testing

The specific testing process can vary based on the complexity of the PCB and the intended application. Each of these steps contributes to ensuring that the PCB functions reliably and meets quality standards.

PCB Testing Steps:

1. **Visual Inspection:** A visual examination of the PCB to check for any physical defects like soldering issues, component placement errors, or damaged traces.
2. **Automated Optical Inspection (AOI):** Using automated systems to inspect the PCB for defects by analyzing high-resolution images. This helps catch issues that might be hard to identify with the naked eye.
3. **In-Circuit Testing (ICT):** This involves checking the functionality of individual components using specialized test equipment. It can help identify faulty components or manufacturing defects.
4. **Functional Testing:** This step involves checking if the PCB performs its intended function. It might involve powering the PCB and using various test signals to ensure all components work together as expected.
5. **Boundary Scan Testing:** Boundary scan tests the connections and functionality of digital components on the PCB. It's particularly useful for detecting issues in complex PCBs with a high component density.
6. **X-ray Inspection:** Used to inspect hidden solder joints, especially in surface-mounted components, and identify any potential defects or inconsistencies.
7. **Environmental Testing:** This includes exposing the PCB to various environmental conditions like temperature, humidity, vibration, and electromagnetic interference to ensure it can withstand real-world conditions.
8. **Burn-In Testing:** Running the PCB through an extended operational period under stress to identify early failures that might not show up during normal testing.
9. **Functional and Regression Testing:** For PCBs with programmable components, functional and regression testing ensures that firmware or software updates haven't introduced any issues.
10. **Reliability Testing:** This involves subjecting the PCB to accelerated aging conditions to predict its long-term reliability and identify potential weak points.
11. **EOL Testing:** End-of-line testing ensures that the PCB meets the required specifications before it's released for distribution.

3.6 Lacquering

PCB Lacquer or post flux was developed to prevent surface oxidation of copper pad and other contamination. High reliability resin used provides high oxidation prevention and fast drying.

Fig 3.6.1 Lacquering

Lacquering Process:

1. Preparation: Ensure the PCB is clean and free from contaminants, residues, and oils. Cleaning might involve using solvents or specialized cleaning solutions to make sure the coating adheres properly.

2. Selection of Coating: Choose the appropriate type of conformal coating based on the PCB's intended use and environmental conditions. Common types include acrylic, silicone, epoxy, andurethane coatings.

3. Masking: Mask off areas that should not be coated, such as connectors, switches, and sensitivecomponents. This prevents the coating from interfering with their functionality.

4. Application: Apply the selected coating evenly and uniformly over the PCB's surface using suitable methods such as spraying, brushing, or dipping. The application method depends on thecoating type and the PCB's design.

5. Curing: Allow the coating to cure according to manufacturer's guidelines. Curing can involve processes such as air drying, thermal curing, or UV curing, depending on the coating type.

6. Inspection: Inspect the coated PCB to ensure there are no defects, such as uneven coverage,bubbles, or drips. Any defects could compromise the coating's effectiveness.

7. Testing: Perform appropriate tests to ensure the coating meets the desired protective and electrical insulation requirements. Common tests include checking for electrical conductivity, adhesion, and resistance to environmental factors.

8. Quality Control: Conduct quality control checks to verify that the conformal coating has been applied correctly and consistently across all PCBs.

9. Rework and Repair: If any issues are identified during inspection or testing, take necessary steps to rework or repair the coating on the affected areas.

10. Final Inspection: Perform a final inspection to ensure the conformal coating is properly applied, and the PCB is ready for its intended use.

Serial Number on PCB:

The serial number of the assembly appears next to the circuit card assembly number. This may be handwritten or stamped with ink. Typically, the serial number is short, in hexadecimal or alphanumeric numbers. Some manufacturers etch the part number onto a large copper land or a broad wiring trace.

Fig 3.6.2 Serial Number on PCB

3.7 TRACTION PROPULSION SYSTEM

A traction propulsion system is a critical component in various modes of transportation, including trains, trams, and electric vehicles. It serves to convert electrical or mechanical energy into the motive force required to move the vehicle. Typically, in electric traction systems, electric power is supplied through overhead lines or a third rail and transmitted to electric motors, which drive the wheels. In diesel-electric systems, internal combustion engines generate electricity to power electric traction motors. Traction systems are known for their efficiency and ability to provide high torque at low speeds, making them ideal for heavy-duty applications. They are also environmentally friendly, especially in electric variants, as they produce no direct emissions. Advances in technology continue to improve the performance and sustainability of traction propulsion systems, promoting their adoption in modern transportation solutions.

3.8 Railways

Railway systems traditionally utilized series-wound brushed DC motors, commonly running at around 600 volts. The advancement of high-powered semiconductors, specifically thyristors and IGBTs, has enabled the practical use of more straightforward and reliable AC induction motors referred to as asynchronous traction motors. Synchronous AC motors are sporadically employed as well. Three-phase AC drive technology has gained prominence in modern rail vehicles, featuring GTO thyristors and microprocessor-based control systems. Microprocessors manage vehicle control, component health monitoring, operations supervision, and diagnostics. They allow electric braking to a complete stop and enable optimal PWM techniques for enhanced motor performance and power factor unity. This technology bears technical and economic advantages. The motor-end inverter could be a current source inverter or a voltage source inverter. Initially, with only conventional thyristors as an option, designers favored the current source inverter. Presently, approximately 70% of underground railways and light rail systems globally incorporate this technology, either partially or fully. The voltage source inverter, initially complex due to thyristors, became viable with the development of GTOs and microprocessor-based controls. Traction converters ensure continuous and automated control of speed and torque

for three-phase induction motors. Control electronics and converter power electronics translate inputs from the driver's cab—such as driving, braking, and speed—into necessary voltage, current, and frequency values on the motor side. Central vehicle control units (FLG), individual converter control units (SLG), and drive control units (ALG) manage traction converters, with no manual components except for the earthing switch Q21.

Traction Drives

• These panels control the traction motors.

• Traction drive systems are extensively used in 1600 HP Broad Gauge AC or AC/DC Electrical Multiple Units (EMUs) and 6000 HP three Phase AC Locomotives for Indian Railways.

• Gate Turn Off Thyristor (GTO)/Insulated Gate Bipolar Transistor (IGBT) are now-a- days used for Traction applications.

3.9 Traction Converters

These systems find application in transforming the alternating current (AC) from three-phase 50 Hz or 60 Hz sources into either a lower frequency and single-phase AC, suitable for older AC railway electrification setups, or into direct current (DC) required by certain systems, mainly in public transit applications. In traction substations, the local utility's three-phase voltage is stepped down and rectified to generate the necessary DC voltage for powering the railway.

A traction motor, utilized for propelling vehicles like locomotives, electric or hydrogen-powered vehicles, and electric multiple unit trains, operates with these converted power systems. Traction motors are integral to electrically driven railway vehicles such as electric multiple units, as well as other electric transport modes like electric milk floats, trolleybuses, elevators, roller coasters, and conveyors. They are also found in vehicles with electric transmission systems like diesel-electric locomotives, electric hybrids, and battery electric vehicles.

The earliest type of traction motors employ direct-current motors with series field windings. These motors offer a speed-torque profile conducive to propulsion needs, delivering high torque at lower speeds to accelerate the vehicle and decreasing torque as speed increases. By configuring the field winding with multiple taps, the speed characteristics can be adjusted, enabling relatively smooth control of acceleration. Further control is achieved by pairing motors on a vehicle in series-parallel configurations. For slower speeds or heavy loads, two motors can be operated in series from the direct-current supply. Conversely, for higher speeds, these motors can be run in parallel, providing a higher voltage to each motor and facilitating higher speeds.

Different sections of a rail system might necessitate varying voltages, with higher voltages used for longer stretches between stations and lower voltages near stations where slower operations arerequired. An alternative to the DC system is the AC series motor, also known as the universal motor,which functions similarly but operates on alternating current. This motor's behavior resembles that of a direct-current motor since both the armature and field current change direction simultaneously. In AC railways, the supplied current is often at a lower frequency compared to the standardcommercial supply used for general power and lighting.

Special traction current power stations or rotary converters are employed to convert the 50 Hz or 60 Hz commercial power into the 25 Hz or 16+2/3 Hz frequency essential for AC traction motors. The AC system's advantage lies in its efficient distribution of power along the rail line using transformers, alongside speed control via onboard switchgear.

Fig 3.9.1 Traction Converters

Although AC induction motors and synchronous motors are uncomplicated and require minimal maintenance, applying them to traction motors was challenging prior to the advent of power semiconductors due to their fixed speed characteristics. AC induction motors produce usable power only within a narrow speed range dictated by their construction and the AC power supply frequency. The emergence of power semiconductors has enabled the incorporation of variable frequency drives in locomotives, allowing a broad range of speeds, AC power transmission, and the use of sturdy induction motors devoid of components like brushes and commutators.

3.10 Converter Protection

Various conditions during converter operation (wheel spin, pantograph bounces, and overload) as well as errors in the control electronics may endanger important components of the converter, especially the power GTOs

. **Automatic System Tests:**

The converter is regularly and automatically tested by the control electronics. This takes place when the vehicle is first powered-up and whenever the converter is powered-up again, e.g. after a protective shut-down during driving mode. The functional test consists of two parts, the OFF-LINE TEST and the ON-LINE TEST. The OFF-LINE test is performed before any turn-on (the

Converter being reenergizes). The ON-LINE test, however, is carried out during the charging of the DC link as well as during the operation.

Protection Stages

1. Protection stage 1: Monitoring of the minimum switching times of the GTO thyristors and mutual interlocking of the gate units of a GTO thyristor pair of arms

2. Protection stage 2: Power and current set value limitation: In order to prevent the converter from thermal overloading, it is important that certain current limits on both the line side and motor side are not exceeded. For this reason, the current and torque set values required by the converter control circuits are limited.

3. Protection stage 3: Instantaneous voltage limitation MUB: Normal operation is transiently affected but maintained. No fault is indicated.

4. Protection stage 4: Full reduction of load: (Controlled reduction of the motor torque to zero) To reduce the power flow in the converter as 32 quickly as possible, but without disturbing the power equilibrium between line and motor converter (otherwise there is a danger of overvoltage in the DC-link), the torque of the driving motors is quickly and continuously reduced to zero (ramp function). Subsequently, all the GTO-thyristors of both the line and motor converters are turned off. 5. Protection stage 5: Immediate converter shut-down: (Opening the vehicle main circuit breaker and firing the MUB) the converter is fully shut down without delay.

3.11 Control System

Control systems in trains play a crucial role in modern rail transportation. These systems use digital technology to monitor and control various aspects of train operations for safety, efficiency, and precision. There are some components and functions of digital control systems in trains:

1. **Signaling and Communication:** Digital control systems enable trains to communicate with control centers and other trains. This helps in managing traffic, preventing collisions, and ensuring safe and efficient movement on the tracks.

2. **Automatic Train Control (ATC):** ATC systems use digital technology to monitor a train's speed, position, and adherence to schedules. They can automatically adjust a train's speed and apply brakes if necessary to maintain safe distances between trains

3. **Positive Train Control (PTC):** PTC systems are designed to prevent train-to-train collisions, overspeed derailments, and other critical incidents. They rely on digital signals to continuously monitor a train's position and enforce safety measures.

4. **Train Management Systems:** These systems use digital control to optimize train operations, such as route planning, energy management, and maintenance scheduling. They help reduce energy consumption and improve efficiency.

5. **Passenger Information Systems:** Digital displays and announcements provide real-time information to passengers about upcoming stops, delays, and other relevant details for a more comfortable and informed travel experience.

6. **On-Board Control Systems:** Trains often have onboard computers and sensors that monitor various systems like brakes, engine performance, and door operations. Digital control systems ensure these components operate correctly.

7. **Remote Diagnostics and Maintenance**: Digital control systems can transmit data about the train's health to maintenance crews, allowing for proactive maintenance and minimizing downtime.

8. **Security and Surveillance:** Cameras and sensors are digitally integrated to enhance security by monitoring passengers, cargo, and critical infrastructure.

3.12 Vehicle Control Unit

A vehicle control unit (VCU) is a crucial component in modern automotive systems responsible for managing various aspects of vehicle performance and functionality. Typically, it consists of a microcontroller or microprocessor that processes data from sensors and communicates with different vehicle subsystems. The VCU controls engine management, transmission, brakes, steering, and other critical functions to optimize vehicle performance, safety, and efficiency. It plays a pivotal role in enhancing driving experience, ensuring compliance with emission standards, and supporting advanced driver assistance systems (ADAS) and autonomous driving features by processing real-time data and executing control algorithms. Overall, the VCU acts as the brain of the vehicle, orchestrating its various components to deliver a smooth and safe driving experience.

Fig 3.12 Vehicle Control Unit

3.13 Traction Control

BHEL Electronics Division has a long-standing presence in the transportation sector, specializing in the provision of Vehicle Control Electronics and GTO-based Converters for the Indian Railways. At present, BHEL's products play a pivotal role as they power over half of the 3 Phase AC Locomotives in operation. The system's functionality involves channeling incoming power from the overhead catenary through a transformer and subsequently distributing it to two converters responsible for propelling the locomotive via traction motors. An interesting feature of this system is its ability to harness energy generated during braking, redirecting it back into the traction supply network. This innovative design ensures a continuous supply of energy to both onboard equipment and the vehicle's battery, regardless of whether the locomotive is in motoring or braking mode.

The overall Traction Control System consists of:

1. Input Transformer
2. Drive Converter and motor inverter including
3. Control Electronics
4. Auxiliary Converter
5. Train Control and Monitoring System (TCMS) or
6. Vehicle Control Unit (VCU)
7. Cooling System

8. Powered Axle (Axle with Motor)

9. Battery Charger

10. Drivers screen (Cab Display)

11. Mechanical Design

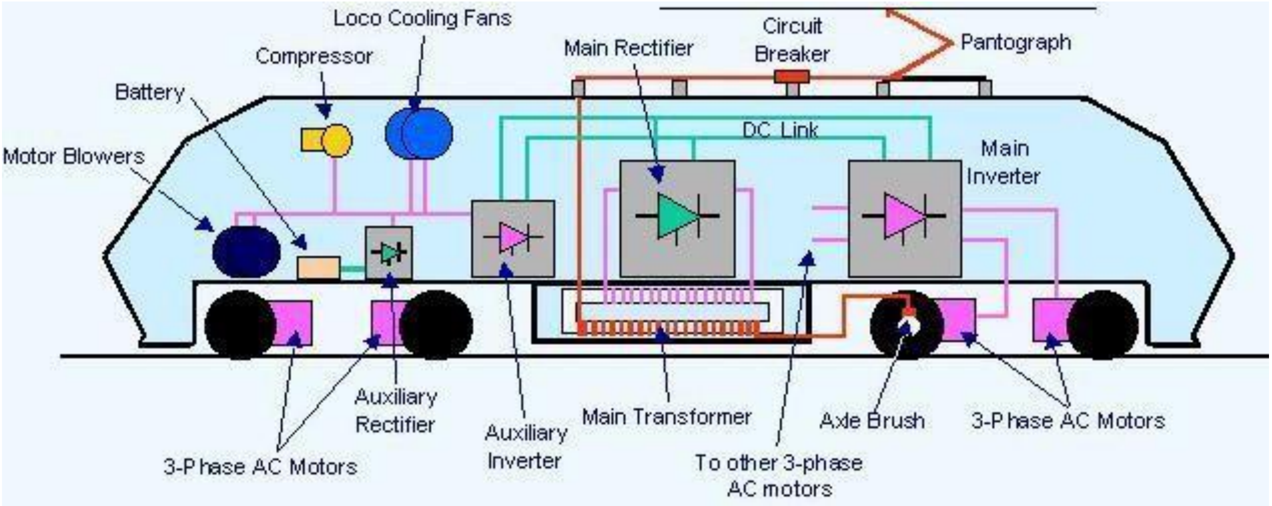

Fig 3.13.1 Block Diagram of Modern AC Electric Locomotive

Main Converters:

1. The Provide power to the traction motor for the movement of the trains.
2. The traction motors earlier were DC Motors, which now have been changed to 3 phase Induction Motors.
3. Each traction converter is made up of: 4 Single Phase Converters, 1 Intermediate DC Link, 1 Resonant Filter, 1 Soft Crowbar Resistor, 5 Single phase (2 leg) Inverting Modules, DC link and resonant capacitors, Ferrite Core Filters, 1 Vehicle Interface Unit, 3 Drive Control Unit, MVB to Fibre Interface, 1 Electronic Power Supply and an Earth Discharge Switch.
4. The 25kV, 50Hz input is taken through the pantograph; this is stepped down using the main transformer to the required voltage levels.
5. The main converter contains a total of 9 Power Modules each module containing 4 IGBT switches, each module can be configured to act as an inverter or a rectifier. Since the Modules are made of IGBT switches, they allow for Four Quadrant Control which allows for regenerative braking to be implemented.
6. The stepped down 1 phase AC input is provided to the 4 IGBT Modules that act as rectifiers which rectify the input to 2.8 kV DC, this power is provided to the inverter modules through a

DC Link busbar, all the 9 modules are connected in parallel to this DC Link busbar, capacitorsis also connected in parallel to each module to ensure constant DC voltage is available.

7. The DC Link provides input voltage to the 5 IGBT Modules that act as inverters, each module has 2 legs of output, a third leg from another module is used to generate 3 phase 415 V AC power. 9 phase legs out of the 10 available are used in investing the extra leg is connected across an earthing resistor which can divert power to earth in case of excess voltage.

8. Inductive (ferrite core) and capacitive filters are used wherever necessary.

9. The earth discharge switch is provided which can be used to safely discharge all the stored chargers in the DC Link capacitors, when the converter is separated from supply and needs to be worked on. The earthing switch is connected to earth through a resistor to prevent very high currents while discharging.

Auxiliary Converters:

1. Auxiliary Converters are responsible for supplying power to auxiliary equipment being used on the locomotive and the bogies.

2. Auxiliary equipment (Compressors, Blowers for cooling transformers, traction motors, machine room and scavenger including the battery charger) of the locomotive/EMU

3. Auxiliary equipment requires 415 V, 3 Phase supply for its operation. This power is supplied by a set of two/three forced air-cooled IGBT based auxiliary converters of suitable rating with provision for working either with fixed or a variable frequency. The single-phase supply requiredfor cabin/locomotive lighting is also supplied from the auxiliary converter.

4. Each auxiliary converter unit is made up of 2 Rectifier modules, 2 Inverter modules, 2 Buffer Modules (large capacitors), 1 charging module. The power rating of a two unit converter is 130 kVA, 1000 V, 127 A.

5. The rectifiers and inverters both have RLC filters to produce a uniform output.

Train Control and Monitoring System:

1 The Train Control and Monitoring System (TCMS) also known as Vehicle Control Unit (VCU) is composed of State-of-the-art Microprocessor/ Digital signal processors, remote I/O modules and driver display modules. All these are interconnected by buses and communicate with each other over a network complying to TCN (lEC 61375) protocol.

2 TCMS system administers the entire control of locomotive/EMU operation at different levels (Train, Vehicle and Equipment) over the network as defined in the Train Communication Network.

3 The important functions carried out by TCMS are:

- Tractive/braking effort generation.
- Regeneration of power to the catenary during braking.
- Four quadrant operation, control of all auxiliaries.
- Diagnostic tasks with a high level of reliability.
- Driver display with touch screen facility and automation for ease of operation.

Battery Charger:

1. It is a compact forced-air cooled, microprocessor controlled unit with a rated total power of 10KW suitable for operation in high ambient temperature.
2. Separate outputs for 110V DC loads and battery are available.
3. The battery charger is designed to perform the role of charging or DC-DC conversion or a combination of both, depending on the requirement of the system.

Control Philosophy:

1. Published Open Standard Platform.
2. Vendor independent.
3. Standard RTOS and third party Software tools.
4. State-of-the-art Digital Communication as per TCN - IEC 61375.
5. Reduction in the number of electronic cards.
6. Ease of configuration and modification using PC based tools.

3.14 CE Main Assembly

1. Empty Cubicles arrive at the Main Assembly and are fixed with doors and other structural components.
2. An individual cubicle has fixed dimension single or multiple cubicles are ayyached according to the need.

3. Each cubicle is two sided front and back and divided into horizontal racks, and terminal blocks which carry the various electrical control equipment and wiring required for the project.

4. Each horizontal rack can carry 13 processor modules, or other equipment like power supply modules, breakers, main processors etc. The cubicles also have slots for lighting and other necessary supplements.

5. Device list, General Assembly and other documents are received for the CE, these contain information about the control components, labelling and wiring that needs to be done for that particular CE.

6. Racks and Terminal blocks are fitted into empty cubicles, followed by device labelling, channeling and wiring according to the GA. Power supply modules, earthing connections are also made. Channels are plastic structures used to hold up the wiring within the CE.

7. Model parts are fitted into the racks to help with wiring in some cases, these parts are replaced by actual parts when the CE is sent for testing.

8. The CE is regularly cleaned using pressurized air and vacuuming.

9. After primary assembly the CE is sent to the testing division.

10. After successful testing the CE is sent back to assembly shop for final assembly

11. Quality Check is performed on the CE cubicles, after which the they are prepared for dispatch.

Tools Used in CE Main Assembly:

1. **Wire Clippers-** to remove insulation from wires of diameters 0.5mm2, 1 mm2, 1.5 mm2 etc.

2. **Lug Crimpers -** to fix lugs at the end of wires of varying diameters. Manual and Battery operated (for larger lugs)

3. **Copper tube crimpers -** to fix copper tubes to wires of varying diameters.

4. **Stripe-** mechanized wire strippers, used for faster stripping of wires.

5. **Channel Cutter -** to cut channels mentioned above.

6. **Riveting Tubes -** used to insert plastic rivets into the cubicle structure.

Control Equipment Testing

System testing of control equipment involves verifying the functionality and performance and reliability of the control system not only of individual components but also as a whole. It is a crucial step in the manufacturing process to ensure that the control equipment meets the desired specifications and performs as intended.

System testing in the control equipment manufacturing process ensures that the control equipment meets quality standards, performs reliably, and conforms to the specified requirements. It helps in identifying and rectifying any issues before the equipment is deployed or delivered to customers, thereby ensuring customer satisfaction and safety.

Process and Workflow of CE Main Assembly:

Control Equipment

Control equipment refers to a set of devices, systems, and instruments that are designed and employed to regulate, monitor, and manipulate various parameters and processes in industrial applications.

Control equipment is of utmost importance as it regulates and monitors various parameters in industrial processes, leading to optimized operations and enhanced safety. By maintaining optimal conditions, it improves process efficiency, productivity, and product quality while minimizing waste. It plays a crucial role in automating complex tasks, reducing manual intervention, and increasing operational efficiency. Additionally, control equipment enables timely detection of abnormal conditions, triggering safety mechanisms and alarms to prevent accidents and protect personnel and equipment. Overall, control equipment is essential for achieving optimal performance, energy efficiency, and ensuring a safe working environment in industrial settings.

BHEL-EDN's control equipment solutions are known for their quality, reliability, and adherence to international standards. They contribute to the efficient operation and automation of various industries, promoting sustainable development and energy management.

BHEL-EDN Control Equipment:

Programmable Logic Controllers (PLCs): BHEL-EDN designs and manufactures PLCs that are widely used for automation and control in industrial processes. PLCs provide a flexible and

Reliable control solution, enabling precise monitoring and execution of tasks in industries suchas power generation, oil and gas, and manufacturing.

Turbine Control Systems: BHEL-EDN has expertise in developing turbine control systems for steam and gas turbines. These systems monitor and control various parameters such as speed, temperature, and pressure, ensuring safe and efficient turbine operation in power plants and other applications.

Substation Automation Systems: BHEL-EDN offers substation automation systems that enable remote monitoring and control of electrical substations. These systems enhance the reliability, efficiency, and safety of power transmission and distribution networks by providing real-time data, fault detection, and automated control capabilities.

Instrumentation and Control Panels: BHEL-EDN designs and manufactures a wide range of instrumentation and control panels for different applications. These panels incorporate advanced control devices, sensors, and communication interfaces to enable efficient control and monitoring of industrial process

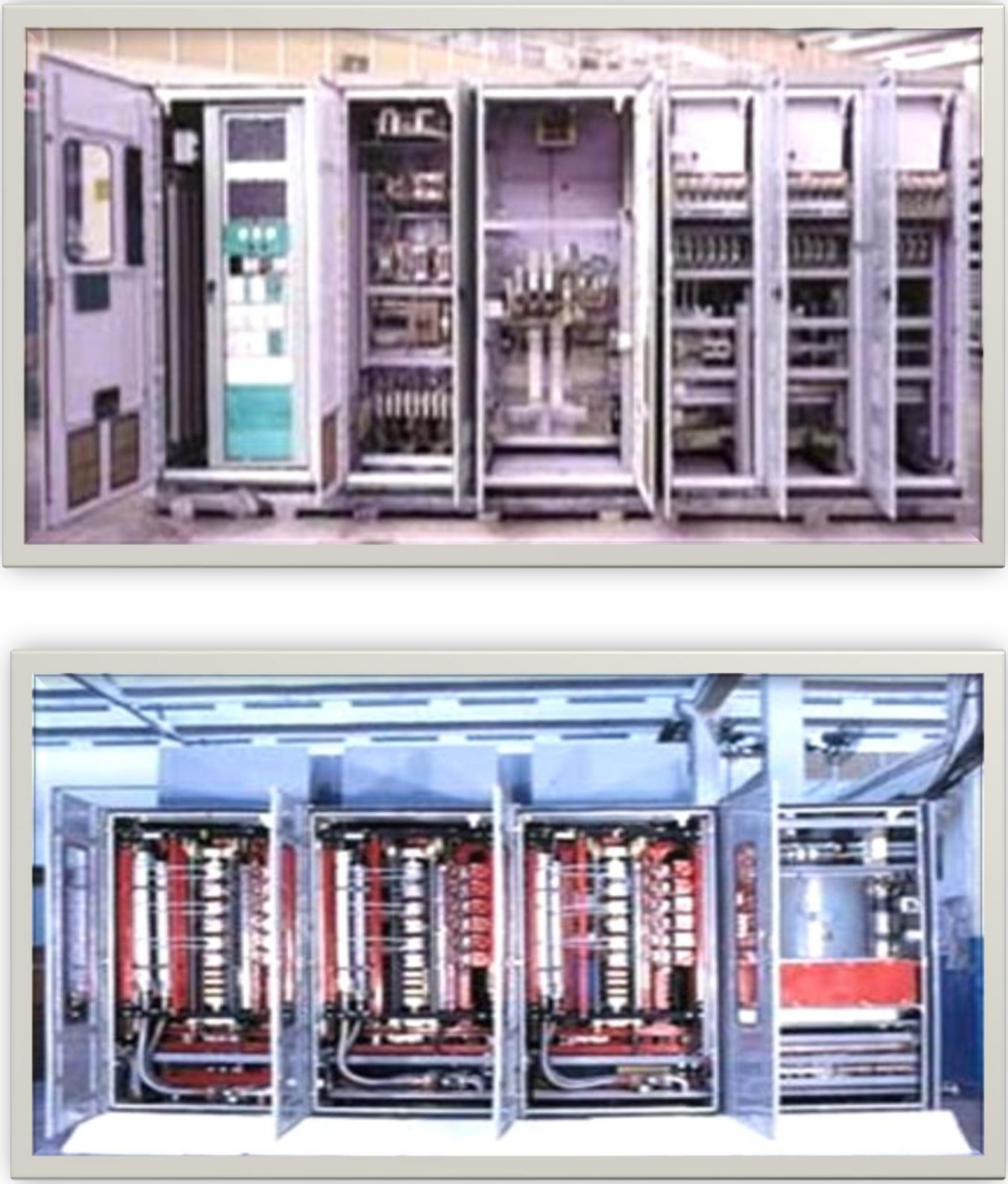

Fig 3.14.1 Control equipment's of Different Types

Workflow of CE Main Assembly:

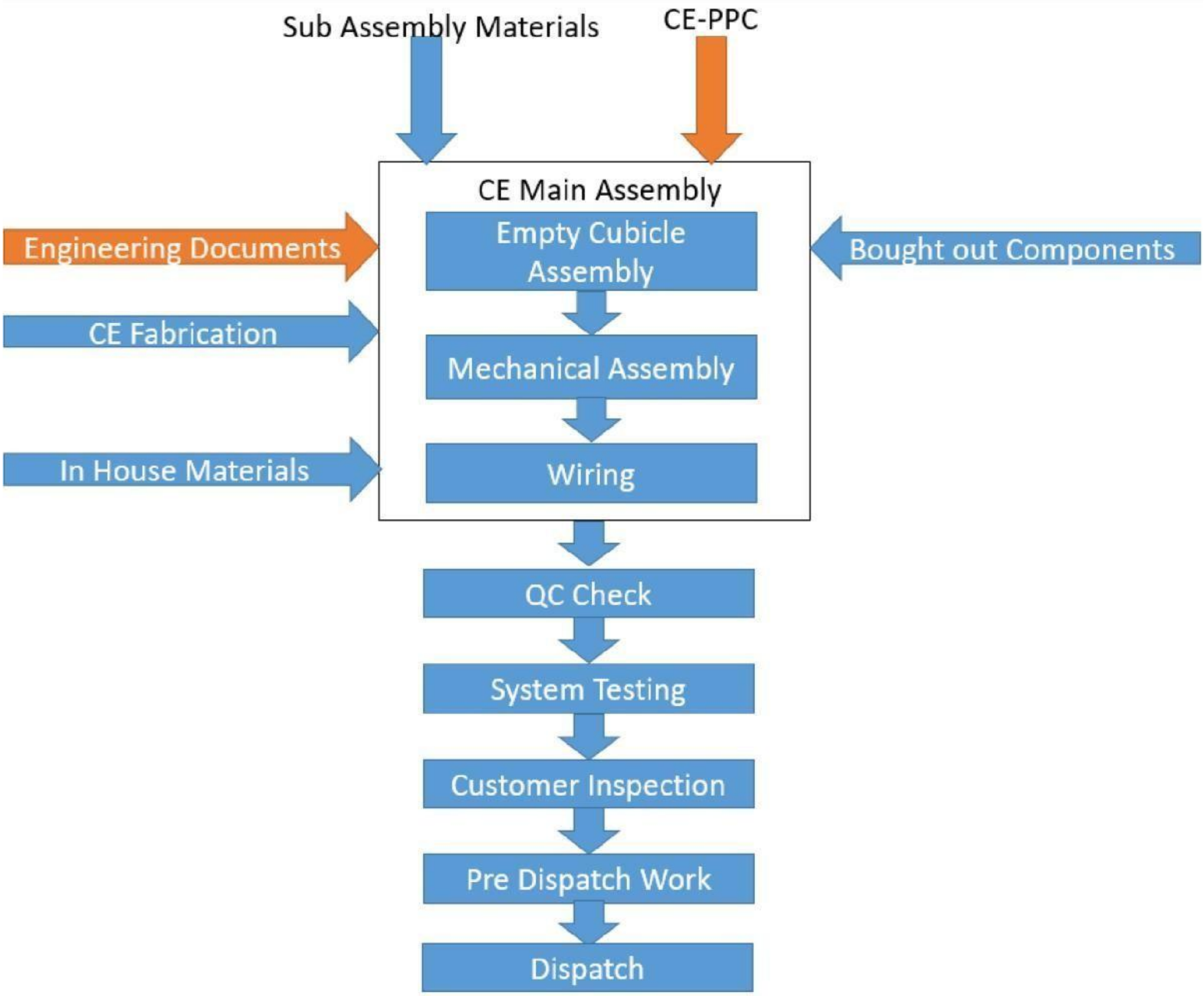

Fig.3.14.2 Flowchart Showing the Workflow of CE Main Assembly

CHAPTER 4

4.1 CONCLUSION

The internship was a useful experience. I have gained new knowledge, skills and many new people.I got insight into professional practice. I leant the different facets of working. Related to my study I learnt more about Surface Mount Technology (SMT) and Traction Unit, we were thought about lacquering, Through Hole Assembly. There is still a lot of scope to learn.

Furthermore, I experiencedthat it is of important that knowledge about the basics is objective to create more adverse PCB boards. Traction converters and batteries are vital for electrified transport, with the CE main assembly integrating them to create efficient, eco-friendly vehicles.

The internship was also good to find out what my strengths and weaknesses are. This helped me to define what skills and knowledge I have to improve in the coming time. It would be better that the thorough knowledge of the basics is sufficient to contribute for further studies. After my post- graduation I think I can present and express myself more confidentially. At last, this internship has given me new insight and motivation to pursue a career in the field of SMT and Traction systems.

CHAPTER 5

5.1 REFLECTION NOTES

BHEL-EDN Internship: My internship at BHEL-EDN was a valuable learning experience that gave me a great insight into the energy industry and manufacturing.

SMT Laboratory and Traction Unit: SMT Laboratory at BHEL-EDN has proven to be an excellent learning environment. Experienced instructors and instructors helped me understand the intricacies of lifting equipment, which is an important part of modern transportation.

Reality Lab: One of the best parts of my internship was the Traction Devices Realistic Nature Lab. The performance I achieved in these laboratories was priceless. It gives me an insight into the operation of various machines and devices in real use.

Battery and CE Main Assembly: As my internship progressed, I had the opportunity to check the battery and main assembly (CE assembly is large) in transportation. It's eye-opening to see howthese materials can be combined to create a great car and a great environment.

Wave Soldering Machine: My introduction to the wave soldering machine is another layer of learning. This experience gave me a unique insight into the design process of electronics and how important precision is to ensure they are reliable and functional.

In conclusion, my internship in the SMT laboratory at BHEL-EDN was a life-changing experience. It allowed me to learn from experts, experience a real test environment, and understand the critical role of cells, CE components, and manufacturing processes. This expansion not only expands my knowledge, but also demonstrates the interaction of various devices while creating new technologies for the future. It prepared me for a successful future in electrical engineering and electric transportation.

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MYSURU ROYAL INSTITUTE OF TECHNOLOGY

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Academic year: 2023-2024

Department of Electronics & Communication Engineering

COURSE OUTCOMES

Academic: 2023 –24

Semester	8	**Subject Name/Code**	**Internship/ 18ECI85**

	Course Outcomes	**PO & PSO**
CO1	Apply engineering and management principles	PO1, PO2, PO3, PO11, PSO1, PSO2
CO2	Analyse engineering problems and suggest alternate solutions	PO1, PO2, PO3, PO4, PSO1, PSO2
CO3	Communicate effectively and work in teams	PO8.PO9, PO10, PSO3
CO4	Imbibe the practice of professional ethics and need for lifelong learning	PO8, PO12, PSO3

Correlation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	3	2	1	2	1	-	-	-	-	-	-	2	2	-
CO3	-	-	-	-	-	-	-	3	3	3	-	-	-	-	2
CO4	-	-	-	-	-	-	-	3	-	-	-	2	-	-	3

MYSURU ROYAL INSTITUTE OF TECHNOLOGY

Lakshmipura Road, Palahally Post, SR Patna, Mandya-571606
Academic year: 2023-2024

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGG

Internship Outcome

Internship Title: OVERVIEW OF DIGITAL CONTROL SYSTEM AND PROPULSION AT BHEL-EDN

Year: 2023-24

Sl. No	Factors addressed through Internship	Applicable POs and PSOs	Justification
1.	Technology	PO1, PO3, P05	Offers higher component density, smaller footprint, and better electrical performance. Wave Soldering is a highly efficient method for soldering electronic components to PCBs.
2.	Skill	P02, PO4	Operating equipment requires specialized skills in programming, maintenance, and troubleshooting. Skilled technicians maintain quality standards and minimize defects.
3.	Economy	PO6, P07	Investing in these technologies allow BHEL to optimize production processes,

			reduce manufacturing costs, and stay competitive in the market by offering high-quality products at competitive prices.
4.	Safety	PO10, PO11	Ensuring the safety of workers is paramount in any manufacturing environment. BHEL must adhere to safety protocols to protect employees from hazards associated with operating machinery and handling chemicals used in soldering processes.
5.	Research	P012, P04	Constant research and development are necessary to stay updated with the latest advancements in electronic manufacturing technologies. BHEL's investment in these areas allows for ongoing innovation and improvement in production processes, leading to better products and services for customers.