Aim

This unit will develop learners’ understanding of the principles and techniques used in the production of modern electronic products.

Unit abstract

This unit introduces learners to the principles and current practices used in the production of a wide variety of electronic products.

Techniques used in the fabrication of microelectronic devices are discussed, as are techniques used for the assembly of printed circuit boards (PCB), both single and double-sided, and multi-layer types. Conventional through-hole and surface mounted manufacturing techniques are considered, together with the use of robots for components placement including selection criteria and associated costs.

The design and fabrication of sheet metal and non-metal enclosures for electronic products is covered and associated assembly processes are also discussed.

Learning outcomes

On successful completion of this unit a learner will:

1. Understand the production and packaging of solid-state electronic devices
2. Understand electronic component design parameters
3. Understand the methods used for the design, simulation, manufacture and testing of printed circuit boards (PCB)
4. Understand the key elements of an automated PCB assembly facility.
1 **Understand the production and packaging of solid-state electronic devices**

*Production of solid-state electronic devices*: semiconductors; silicon; wafer preparation; crystal growing; design and production of components eg transistors, diodes, capacitors, resistors; integrated circuits; film deposition; oxidation; lithographic techniques; etching; diffusion; ion implantation; metallisation; bonding and packaging

*Device packaging*: comparison of leaded and surface mount devices, physical characteristics, production requirements, applications, motivators, economics of production and market requirements

2 **Understand electronic component design parameters**

*Design rules*: smallest obtainable transistor size – gains and losses; wet and dry etching – minimum photoresist width, selectivity of etchants; effects of altering polysilicon gate width on transistor speed

*Failure modes*: relationship with chip size; testing and prediction of failure modes – statistical methods, failure mechanisms; wafer manufacture – effects of changes in chip size, wafer size, process complexity

3 **Understand the methods used for the design, simulation, manufacture and testing of printed circuit boards (PCB)**

*PCB design and simulation*: electromagnetic compatibility (EMC); special requirements of radio frequency (RF) circuits; benefits of surface mount technology; circuit board layout – electronic computer-aided design (ECAD); simulation of circuit operation; design for test; link to computer numerical control (CNC) eg drilling and routing machines

*PCB manufacture*: print and etch; drilling; routing; deburring; wave and flow soldering; conductive adhesion; fluxes and cleaning; component solder-ability; thermal stresses; safety considerations; inspection methods and equipment; reworking of PCBs

*Electronic enclosures*: metal and non-metal enclosures, fabrication and assembly of enclosures, screening and electromagnetic compatibility (EMC)

*Testing of PCBs and finished products*: ‘burn-in’ and accelerated life tests; automatic test equipment (ATE); boundary scanning; mean time to failure (MTTF)

4 **Understand the key elements of an automated PCB assembly facility**

*Automated PCB assembly*: component supply, packaging and form of supply; component orientation and polarisation; suitability for automated assembly; static sensitivity; automated component placement

*Use of robots*: robotic assembly; selection criteria for assembly machines and systems eg sequential, simultaneous, test during placement, assembly performance and cost, accuracy and reliability, re-tooling time and cost of tooling; adhesive dispensing; safe use of adhesives; programming of machines
## Learning outcomes and assessment criteria

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<thead>
<tr>
<th>Learning outcomes</th>
<th>Assessment criteria for pass</th>
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<tr>
<td><strong>On successful completion of this unit a learner will:</strong></td>
<td><strong>The learner can:</strong></td>
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| LO1 Understand the production and packaging of solid-state electronic devices | 1.1 describe the production of solid-state devices common to the electronics industry  
1.2 evaluate the different types of device packaging available |
| LO2 Understand electronic component design parameters | 2.1 explain the effects of altering given design rules on microelectronic devices  
2.2 explain failure modes and mechanisms for a range of microelectronic devices |
| LO3 Understand the methods used for the design, simulation, manufacture and testing of printed circuit boards (PCB) | 3.1 explain the design and simulation of single- and multi-layer PCBs  
3.2 specify the types of equipment required for automated PCB manufacture and assembly  
3.3 explain the methods of testing completed PCBs and finished electronic products  
3.4 explain the methods of designing and producing casings and housings for electronic products |
| LO4 Understand the key elements of an automated PCB assembly facility | 4.1 describe the key elements of an automated PCB assembly facility  
4.2 evaluate the use of robots for components placement including selection criteria and associated costs. |
Guidance

Links

This unit can be linked to Unit 39: Electronic Principles.

Essential requirements

Learners will need to have access to appropriate PCB design and production equipment.

Employer engagement and vocational contexts

Delivery would benefit from visits to local electronic manufacturing companies and from visits from guest speakers with relevant industrial experience.