

Unit 6: Circuit simulation and manufacture

LO3: Be able to manufacture and construct electronic circuits safely

Introduction to PCB manufacture

Instructions and answers for teachers

These instructions should accompany the OCR resource: 'Be able to manufacture and construct electronic circuits safely' activity which supports OCR Level 3 Cambridge Technicals in Engineering.



**CAMBRIDGE TECHNICALS IN
ENGINEERING
LESSON ELEMENT**

Unit 6: Science for Engineering

LO3: Be able to manufacture and construct electronic circuits safely

Introduction to PCB manufacture

Activity 1

Printed Circuit Boards (PCBs) used in prototype design can be manufactured by several methods. The three most common methods are:

- photo-resist
- etch-resist
- milling/graving

The internet links below show short videos of each of these methods taking place.

Photo-resist method
<http://www.youtube.com/watch?v=VtRtE6mXU>

Etch-resist method
<http://www.youtube.com/watch?v=UgUg1-d4tIs>

Milling/graving method
<https://www.youtube.com/watch?v=8u8u8L120>

Watch the videos and explain each of these processes in detail. You may use other means in addition to the videos above to research how it is done.

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The Activity:

The purpose of this activity is to give learners an opportunity to investigate different methods available for manufacturing printed circuit boards.(PCBs).



This activity offers an opportunity for English skills development.



This activity offers an opportunity for maths skills development.

Suggested timings:

2 hours

Activity 1

The purpose of this activity is to give learners an opportunity to investigate different methods available for manufacturing printed circuit boards (PCBs). It is expected that this will form an introduction to the processes involved, and that learners will then have the opportunity, with teacher guidance, to practice one or more of these with their own circuit board design layout.

Learners have been provided with internet video sources showing examples of each of the main methods of PCB manufacture taking place: photo-resist, etch resist and milling/engraving.

Photo-resist method:

<http://www.youtube.com/watch?v=tWnfnt2rNO0>

Etch resist method:

<http://www.youtube.com/watch?v=rvpUp7-dwh8>

Milling/engraving method:

https://www.youtube.com/watch?v=na9-USi_hZQ

The teacher might task learners to research these individually or in pairs, or could use these or similar as part of a group discussion.

Teachers and learners might use other available resources to investigate each of the methods, or concentrate on one particular method in more detail if that is the method they will use practically. The teacher might wish, however, for learners to have an appreciation of all of the different methods available.

As supplementary activities, teachers could task learners to compare the advantages and disadvantages of each method, and to consider the associated health and safety issues involved with each.

Photo-resist method	Etch resist method	Milling/engraving method
<ul style="list-style-type: none"> • Perhaps the most common method • Circuit board has a substrate, a copper layer and a photo-resist layer (sensitive to light) • PCB design (track design) is printed onto clear film • Film (with design) is placed in contact with photo-resist layer of PCB • PCB is exposed to UltraViolet (UV) light (or even normal fluorescent light) • PCB is then 'developed' in chemical leaving an image of the design on the PCB • PCB then etched (usually with Ferric Chloride) – which leaves copper where image of design is (resistant to etching) but removes other areas of copper • PCB then cleaned and drilled ready for soldering of components 	<ul style="list-style-type: none"> • PCB is not sensitive to light in this case • Design is transferred directly to the copper layer of the PCB • Methods of transferring design include printing directly onto PCB, using a printed transfer or even drawing on PCB with an etch-resist pen • Printed designs and transfers also use an etch resistant ink • PCB is etched (usually using Ferric Chloride) – which leaves copper where the design is (etch resistant) and removes copper from other areas • PCB then cleaned and drilled ready for soldering of components 	<ul style="list-style-type: none"> • This method does not involve the use of a printed design at all • Data from the PCB design package is sent to a computer-controlled milling or engraving machine • The PCB is firmly clamped in place • Copper is removed from the PCB by milling or engraving to leave the finished PCB design • For simple designs the milling or engraving could be done manually • There are no etching chemicals involved with this method • PCB then cleaned and drilled ready for soldering of components

Activity 2

For Activity 2 learners have been tasked to produce a risk assessment for the particular process they will use to manufacture a PCB.

The risk assessment should include hazards present, the risks they present and how the risks might be reduced. It should also include the use of appropriate Personal Protective Equipment (PPE).

Learners have been provided with a table template based on one produced by the Health and Safety Executive (HSE). Learners should complete the table. Teachers may adapt the table format if required. Some further hazards have been included overleaf:

What are the hazards?	Who might be harmed and how?	What are you already doing?	Do you need to do anything else to control this risk?	Action by who?	Action by when?	Done
Chemical fumes	Operators, colleagues and visitors	Ventilation by open window	Fume extraction fan Wear face mask (PPE)	Jon Smith	1/3/16	Pending
Chemical spills – slips						
Chemicals on body/clothing						
Chemicals in eyes						
Burns – from chemical/water baths						
Electrical hazards – from supply to equipment						
Injury from milling cutter (milling method)						
Injury from swarf (milling method)						

Learners might also append a risk matrix to their risk assessment (see <http://www.hse.gov.uk/risk/faq.htm> for details). The risk matrix is used to score the likelihood of harm occurring (due to a hazard) and the potential severity of the harm (post-reduction methods).

Teachers could further extend the activity by tasking learners to produce a method statement for the activity. The differences between risk assessment and a method statement are explained on the HSE website.



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