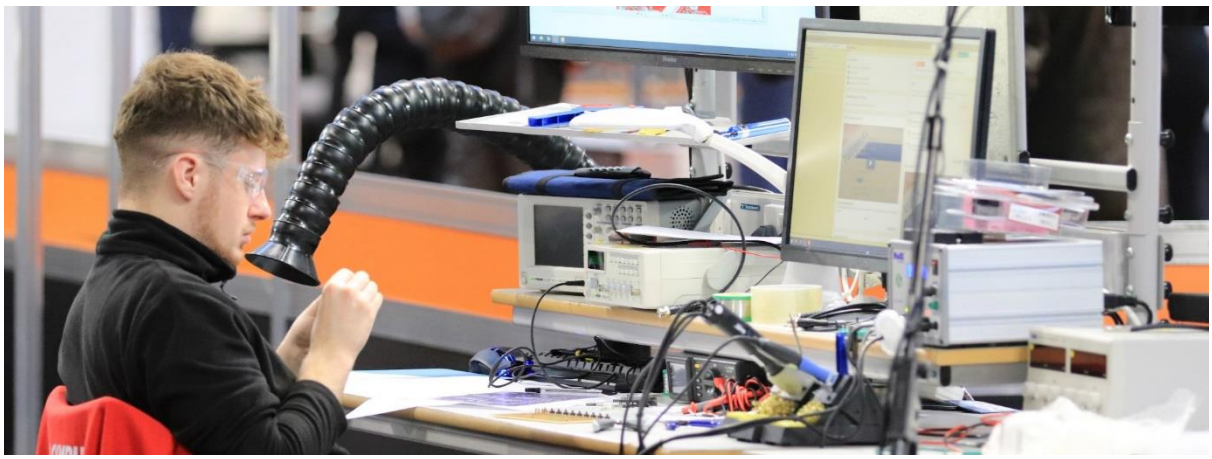

Industrial Electronics

Technical Handbook

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We thank all the amazing sponsors that make this competition possible:

Overview

Industrial Electronics encompasses a wide range of electronic applications. These include consumer electronics, medical electronics, industrial control electronics, and electronics in the aerospace and automotive industries, in fact, everything around us would not function without the world of electronics. Please see the following video which demonstrates the opportunities within the world of electronics. - https://www.youtube.com/watch?v=Xy4xf3SEwvM

Competition Journey

Stage 1 Pre-Competition Activity

This stage will provide some training to ensure the competitor is prepared for the passive stage. There are master class videos available for industrial electronics that will help develop core skills for the competition journey. This link will be available on the WorldSkills UK web site.

Stage 2 Passive stage

The competition journey will begin with what is called a passive stage. This will be an online task that will ask the competitor to complete a pre-set task and then return this to WorldSkills UK. This is a really important part of the competition journey as it gives the competitor an early taste of what skills are needed to be successful on the journey. The task will come with a pre training pack that the competitor will have to study. Once this is complete the competitor will complete the task and then return to WorldSkills UK for marking. This will inform WorldSkills UK of the current suitability for the competitor to continue on the competition journey. There will be feedback provided to aid with future development if the competitor.

Stage 3 National Qualifiers

For competitors who successfully completed the passive stage the next step is the national qualifiers. This is where the competitor will be allocated a physical local centre from where to compete.

This stage will involve the competitor completing the following tasks:

- project build (soldering and assembly of an electronics project)
- a theory paper set at level three to include analogue, digital and electronic principles.
- prototyping and measurement
- fault finding

This stage will be marked by WorldSkills UK expert judges. Each of the four disciplines attracts 25 marks giving a total of 100 marks. Competitors will be informed if they have been successful in progressing to the next stage.

Stage 4 National Finals (WorldSkills UK LIVE)

The top eight (8) competitors in the UK will be invited to compete in the UK National Final which is the pinnacle of the UK national competition cycle.

There is a host of pre competition training that will be offered to all finalists, this is normally a full week of electronics skill training. Further details of the competition are set out in the following information.

Resources

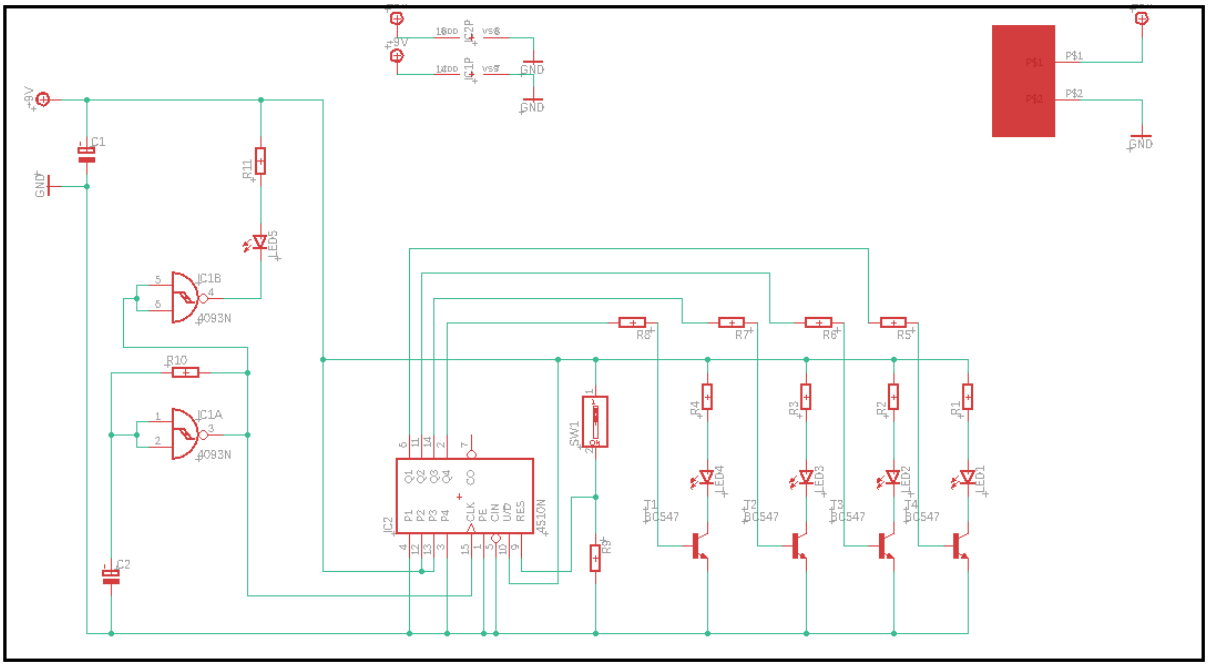
For information and resources, including how to register, competition rules, and the steps to competing, visit:
https://worldskillsuk.org/champions/national-skills-competitions/tools-and-resources

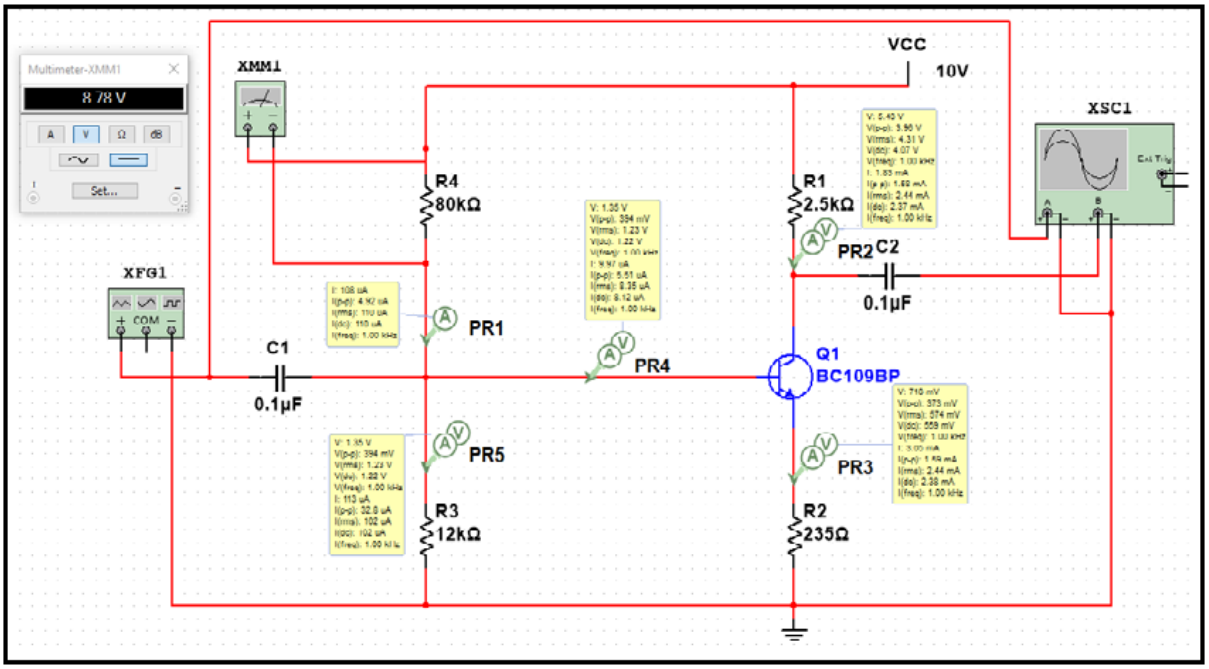
Project specifications

Projects will be designed to test competitor's technical ability, including:

- awareness of analogue and digital electronics
- soldering skills (through hole and surface mount)
- use of test equipment (oscilloscope, multimeters, power supply, function generator and logic probe)
- circuit design and simulation tools (AutoDesk Eagle and Multisim)
- awareness of coding
- fault finding
- hardware design and prototyping

Project example: National Qualifiers/Finals (Hardware Design)

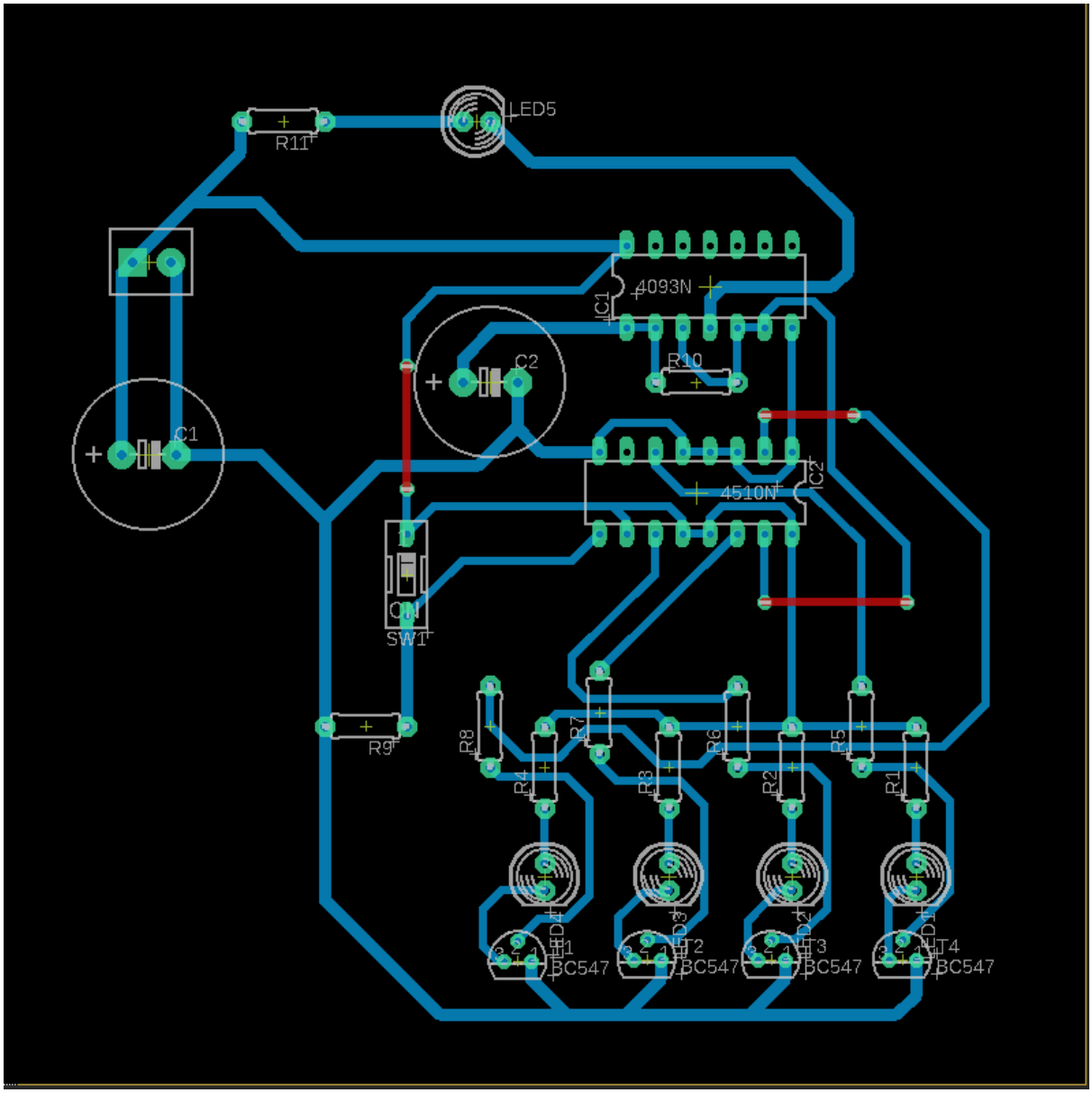




Design requirements

Competitors shall be able to:

- design small modifications to electronic basic electronics blocks
- draw a developed circuit using E-CAD program
- design a Printed Circuit Board using E-CAD program
- assemble circuits and a Printed Circuit Board and develop into a prototype
- display working simulation before production



The above images show the full production phase. The first image is the schematic/circuit design using AutoDesk Eagle. The second image shows a circuit fully simulating using Multisim, allowing the competitor to complete the final production stage. The final image then shows the circuit board neatly laid out following the design rules and ready to be milled.

Marking Scheme

The marking scheme is designed to fairly compare every competitor's work. Marking is split between measurement and judgement aspects. The marking scheme for the Hardware design considers elements such as design rules, functionality, PCB and soldering quality and the use of the E-CAD software packages. The tasks are broken down to four tasks with weighting applied. Each of the four tasks are worth 25 marks again giving a total of 100 marks. Marking is both measurement and judgment see detail below.

Measurement

There are a number of design rules which can be used to determine measurement marks. The value of a given dimension is decided by its tolerance, which is split into:

- board dimension (0% tolerance, exact size to be entered)
- net line size (minimum of 0.2mm, maximum of 0.5mm)
- power line size (minimum of 0.5mm, maximum of 1.0mm)
- clear difference in size between Net lines and Power lines.

All projects will be supplied with a mark summary form. The mark summary form will show only the number of marks assigned to each aspect, not the breakdown of marks (e.g., Hardware design will tally a total of 30 marks).

All marks for measurement criteria are "all or nothing", e.g., if the board dimensions are 160mm x 120mm and they fall outside of these parameters, then they are awarded zero marks for that aspect. If the board is to the correct size, then the competitor would be awarded full marks.

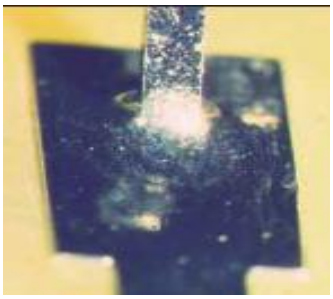
Judgement

Judgement marks are more subjective, for aspects such as:

- neat design with correctly aligned IC's and components
- quality of finished PCB
- assembled PCB
- functionality
- voltage/current measurements
- correctly labelled waveforms

Judges will work to a judgement handbook with examples of each criterion. Each judge will reveal a value from zero to three, and an average will be taken. For example, if all judges assess the soldering quality as a two overall, the competitor will receive 66% of the possible marks. Judgement marking accounts for only 10% of the overall score.

Soldering joints should look like the image below to align with the IPC standard.

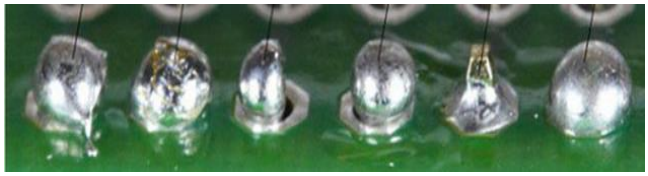


The soldering joints meet the IPC standards as they meet the following criteria:

- solder fillet appears generally smooth and exhibits good wetting of the solder to the parts being joined
- outline of the part is easily determined
- solder at the part being joined creates a feathered edge
- fillet is concave in shape

This competitor would be awarded full marks.

The following images show what you should avoid doing when soldering



This time the soldering does not meet the IPC standards. This is because of the following points:

- solder fillet does not appear smooth, good wetting of solder to the lead is **not** evident.
- less than 50% pad coverage
- solder splashes evident and shorting visible
- cold joints
- insufficient wetting
- too much solder

This competitor would likely receive zero marks.

What does excellence look like in Industrial Electronics?

1. A strong skill set in ALL CORE ELECTRONIC DISCIPLINES.
2. Excellent innovative skill set.
3. Excellent ability to realise electronic designs.
4. A strong mind set with attention to detail.
5. Ability to work accurately at a fast pace.

"Excellence in electronics is the ability to bring innovative ideas to life to improve the world around us".

Equipment

During training and delivery of the National Finals, lots of tooling and equipment will be provided by WorldSkills UK and various competition sponsors. All provided equipment to produce the test project is specified here:

Tools/Equipment
Oscilloscope
Function generator
Power supply
Bench Multimeter
Soldering iron and fume extraction (including different tips)
BNC cables
Red/black banana leads
Tweezers
Wire strippers, snips and long nosed pliers
Screwdrivers
Digital magnification scopes
PC's capable of running all necessary software
Bench lamps
Anti-static wrist bands
Solder Wick/De soldering stations
LPKF milling machine

Training

There is training available throughout each stage of the journey this is in the form of remote master classes culminating in mind set training with WorldSkills UK and a weeks dedicated technical training at the industrial electronics squad training centre.

Stage - 1 Pre Passive Stage:
Using the on line resources to check soldering skill level use the you tube link with your college training provider to run a soldering training event:
https://youtu.be/3-1x-tlg-mk

Stage 2 - Passive Stage Training:
Use the Autodesk Eagle Training package document linked in appendix

Stage 3 - National Qualifier Stage:
Use past examples linked in appendix

Stage - 4 WorldSkills UK National Live:
Use training plan outline in appendix

Self-directed training

All competitors will need to practice to make it to the National Finals. Dedication is key to confident performance in a competition. To help with this, WorldSkills UK has handy guides on best soldering practices, beginners guides on how to use AutoDesk Eagle, fault finding methods and sample codes that can be used to develop an understanding and how to interpret the code.

As part of the invitation to compete at the National Finals, competitors will be invited to a development training event, this will either be physical or online. This is an excellent opportunity for all competitors to boost their confidence using the equipment in a safe environment, while replicating the competition project and expectations. This training will cover:

- an introduction to AutoDesk Eagle (Both schematic and board design)
- correct soldering technique up to IPC 610 standard
- a number of fault-finding techniques
- increasing the student's ability to read and interpret schematics
- mind-set training
- competition craft

Companies may send representatives to visit the training at any point.

National Finals

What to expect

In previous years, the National finals were a huge largescale event, usually taking place at the NEC, Birmingham. There were many skills in diverse sectors, so you

had to be prepared to do a lot of walking in potentially crowded areas and your family, friends, and other visitors would try to get the best views of intense competitions going on.

Employers were able to enter the competition floor with the permission of the competition manager; and take sponsorship photos or gain a better understanding of the competition itself. Competitors were also expected to wear the appropriate H&S equipment (e.g., safety boots, glasses) while competing.

In 2022 you will get an opportunity to compete in the National Finals and more details will be released later.

The competition stand will be prepared with all the equipment necessary to compete. Each competitor will have a computer they can password protect, as well as a USB to back up files. Below is a typical timetable for national finals week:

Wednesday	08:00		09:00	10:00	11:00		12:00	13:00	14:00	15:00	16:00	17:00	18:00
			Judges arrive	Area Checks	Competitor arrival	Ground rules & brief	H&S House keeping	Competitors to get used to equipment/ practice boards to be issued		Lunch	Competitors to get used to equipment/practice boards to be issued	Competition readiness sign off	Run over time and workplace checks

Thursday	08:00		09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
		Judges/ competitors arrive	Morning brief	Hardware Design Part A - 3 hours		Lunch	Construction Task - 4 hours					Run over time and workplace checks

Friday	08:00		09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
		Judges/ competitors arrive	Morning brief	Embedded systems - 3 hours		Lunch	Hardware Design Part B - 2 hours			Fault finding - 2 hours		Run over time and workplace checks

Saturday	08:00		09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
		Judge arrival/ clean up	WSUK Live showcase			Staggered Lunch	WSUK Live showcase			Clean up

Beyond the National Finals

Looking beyond the National Finals, there are a host of opportunities for competitors. Age-eligible competitors who show the highest skills, passion, and drive to compete will be invited to train for the EuroSkills and WorldSkills international competitions.

Those who are not eligible for international competitions may join the Champions programme, which allows continued involvement, including the opportunity to work with WorldSkills UK and visit schools, colleges, and events to inspire the next generations.

Alternatively, if training is of interest to you, you could consider supporting WorldSkills UK with organising and training, and even helping to run the National Finals.

Get inspired and you could become part of Team UK!

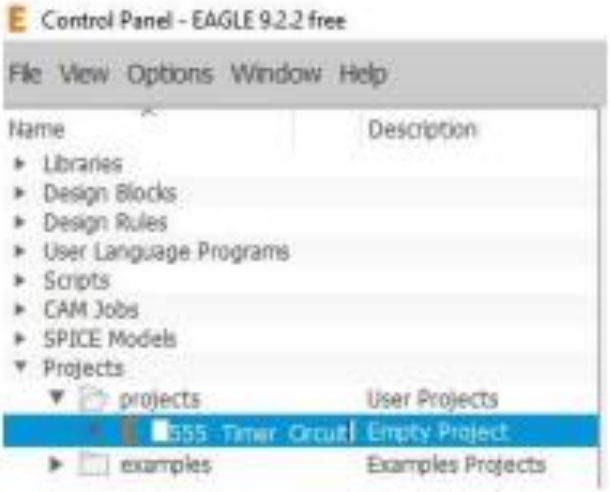
Coleg Gŵyr Abertawe
Gower College Swansea

worldskillsuk
excellence at work

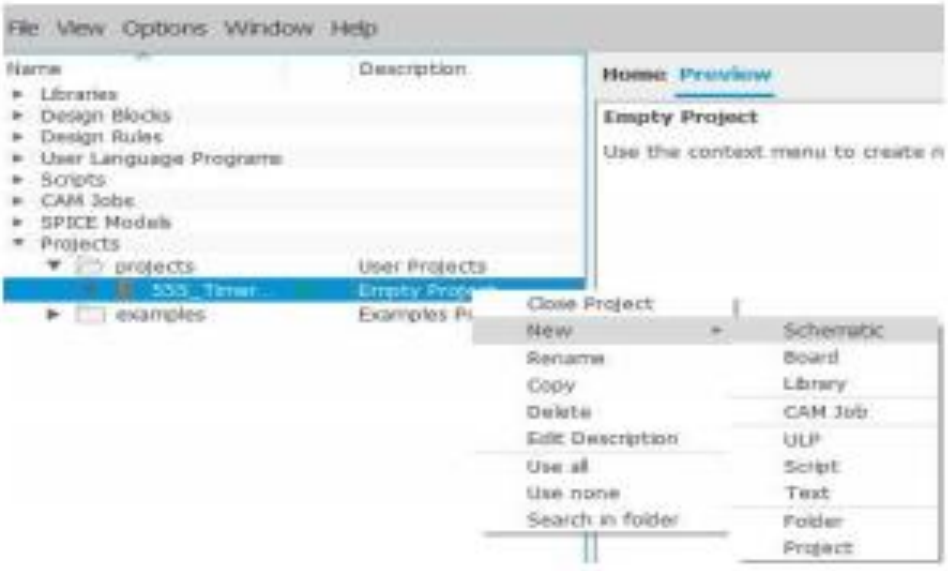
AUTODESK® EAGLE

Designing a 555 Timer Circuit in AutoDesk Eagle

The first thing you need to do when starting AutoDesk Eagle, is to create a project. This is done by clicking 'File > New > Project.' This will prompt you to name the project. For this example we are going to name it '555_Timer_Circuit.'

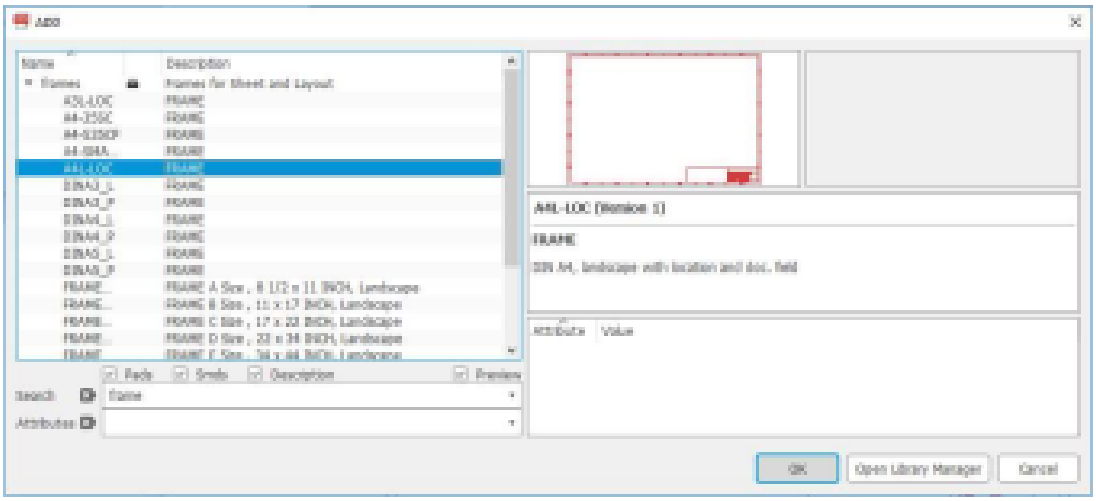


As we will be producing a schematic, we first need to add one to the project. This is done by right clicking the project name, and then 'New > Schematic.' This will add a schematic to the existing project and automatically open it.



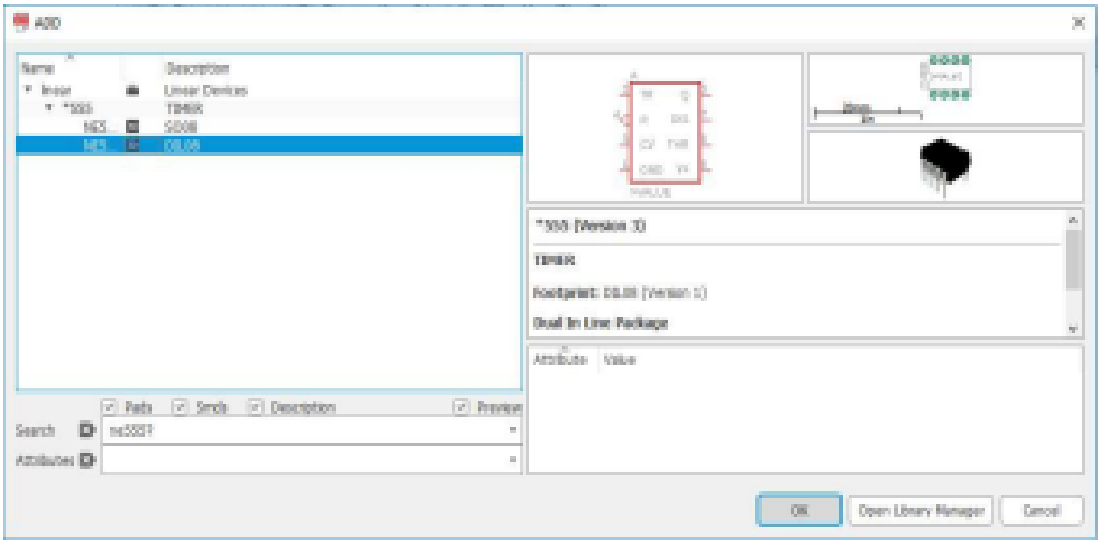
Before continuing, save the schematic and give it the same name as the project, '555_Timer_Circuit.' This is just done by the normal 'File > Save,' method.

To make the schematic look like a schematic, we need to add a frame. To do this we need to click the 'Add Part' button. This is found in the left hand toolbar.  This will open the default Eagle Library. From here you can search thousands of components. In the search bar we are going to type the word 'frame' and hit enter. The following list will appear.



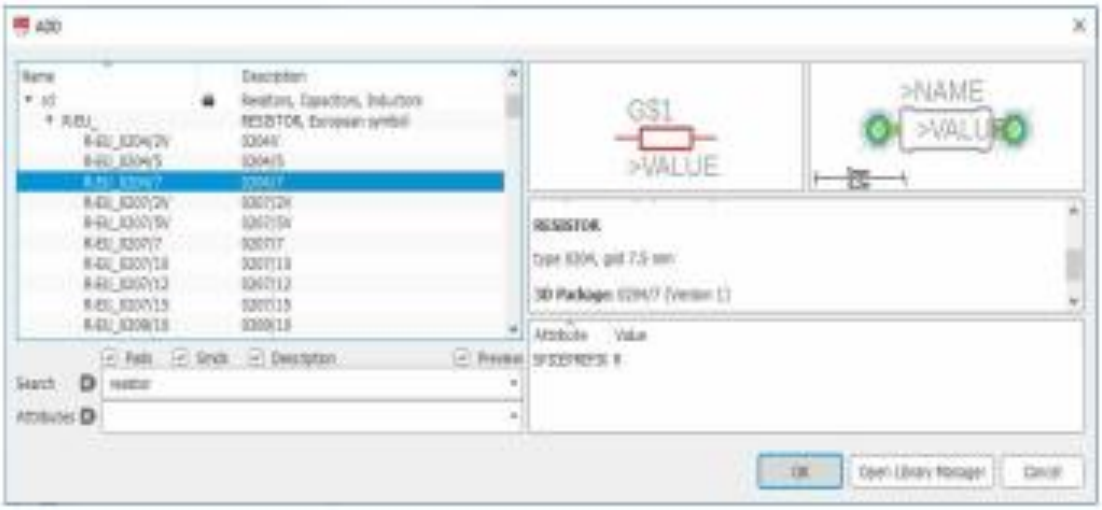
As the circuit is only small, we will only need a small schematic frame. So we will use the A4 landscape one named 'A4L-LOC.' Once you have selected it, press OK. You will notice that the bottom left hand corner of the schematic now replaces the mouse cursor. Simply left click to place the frame. Once you have done that Eagle automatically attaches another frame to the cursor in case you need to use multiples, just press 'Esc' to return to the 'Add Part' menu.

The first component we are going to add is the 555 IC. To do this we type NE555 in to the search bar, followed by a question mark. It is important that you remember to put the question mark, as Eagle's search bar will only look for direct matches otherwise.



Once you have typed 'ne555?' into the search bar and hit enter, the above screen will pop up. We are going to click the drop down where it says '*555,' and we are going to use the through hole 'DIL08' version. When you have selected it press 'OK.' We are going to left click to place the component in the centre of the schematic. Press 'Esc' to return to the 'Add Part' menu.

For the rest of the circuit we need 3 resistors, 2 capacitors, 1 LED and positive and negative connections. So with the 'Add Part' menu still open, we are going to type 'resistor.' For this example we are going to use the below resistor with a European symbol.



As the circuit needs 3, we will place 3 resistors. At the moment it doesn't matter where you place them, we will arrange them later on. Once you have placed them press 'Esc' to return to the 'Add Part' menu.

The next component we are going to add is the two capacitors. In the search bar we are going to type 'capacitor' and choose one with a European symbol as shown below. We are going to place 2, again doesn't matter where as we will arrange later, then press 'Esc' to return to the 'Add Part' menu.

You will notice that the components have names, but no values. To add values you need to select the 'Value' button  in the left hand tool bar, click the desired component and a text box will open. Enter the correct value then press OK.

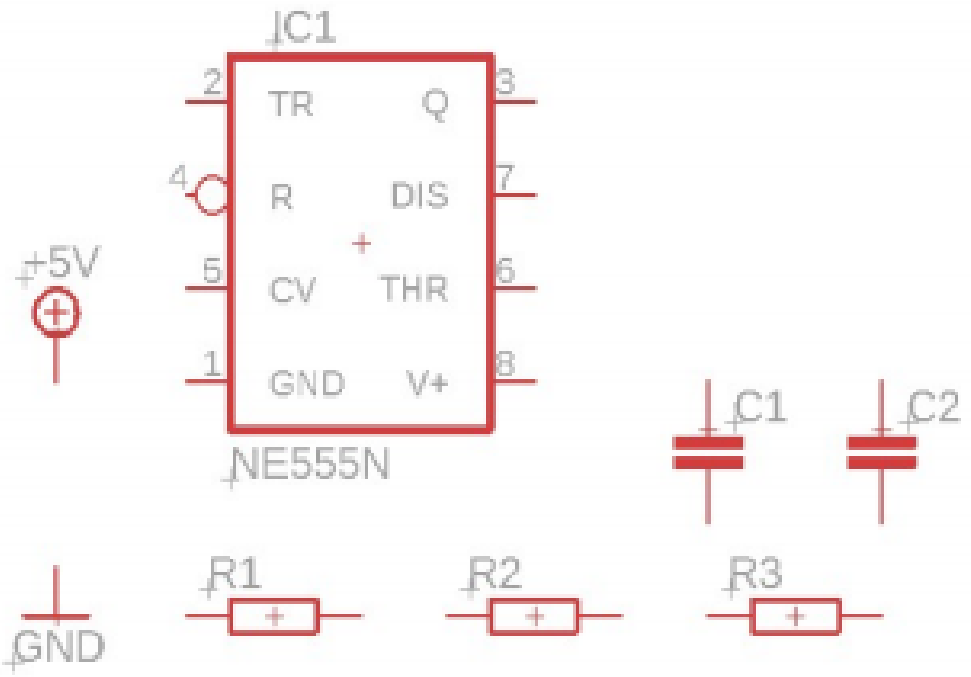
Add the following values to the following components.

R1 – 1K, R2 – 10K, R3 – 1K, C1 – 10uF, C2 – 10nF.

An LED will be the next component we will need to add. Again just type 'LED' into the search bar, and choose the below one. Place 1 LED and press 'Esc' to return to the 'Add Part' menu.

The positive and negative sources are going to be the final part to add to the schematic. For the positive line we are going to use +5V, so we will type '+5?' into the search bar, and for the 0V or GND line we will type 'gnd.' Choose a preferred symbol for each rail and place

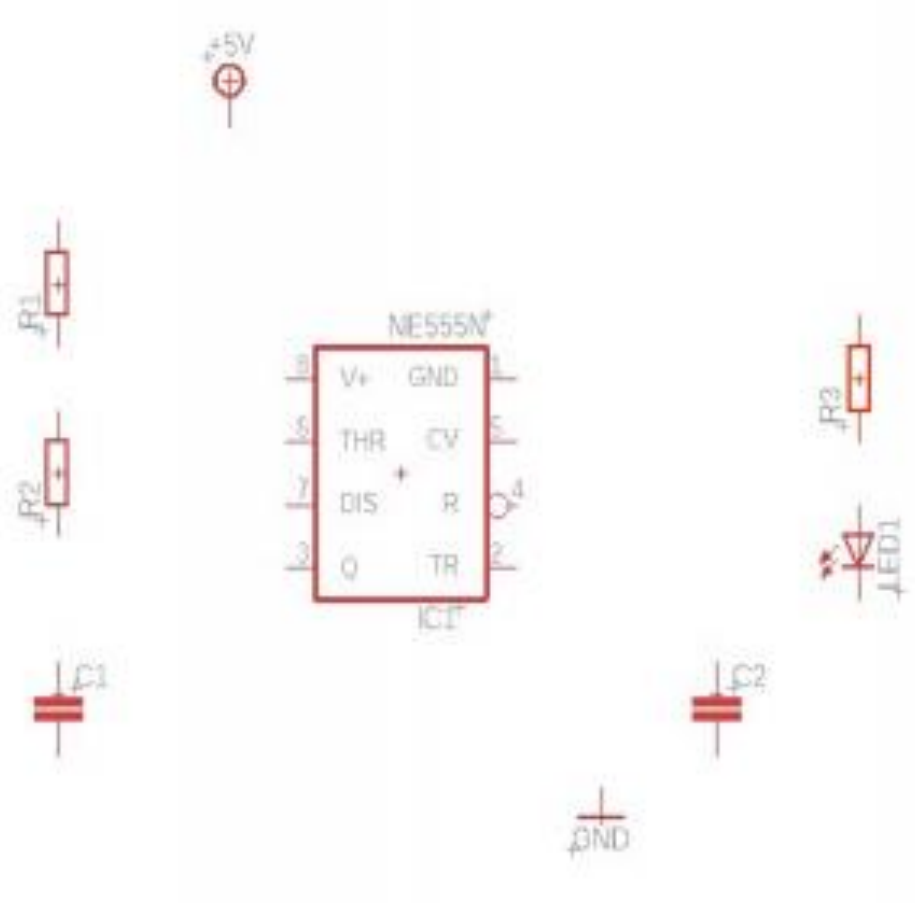
one each. You should now have something that looks like the schematic below.



To move the components, you need to left click the red cross in the middle of each component. Alternatively, you can hold left click and drag the cursor around the group of required components. In both instances you will notice that the red outline of the component will get brighter. This means that the component is selected. You can now drag and move each component freely.

To rotate the components, you can either right click them and press rotate which will move it through 90 degrees. Or you can press the 'Rotate' button  in the left hand toolbar, and continually left click on each component until you are happy.

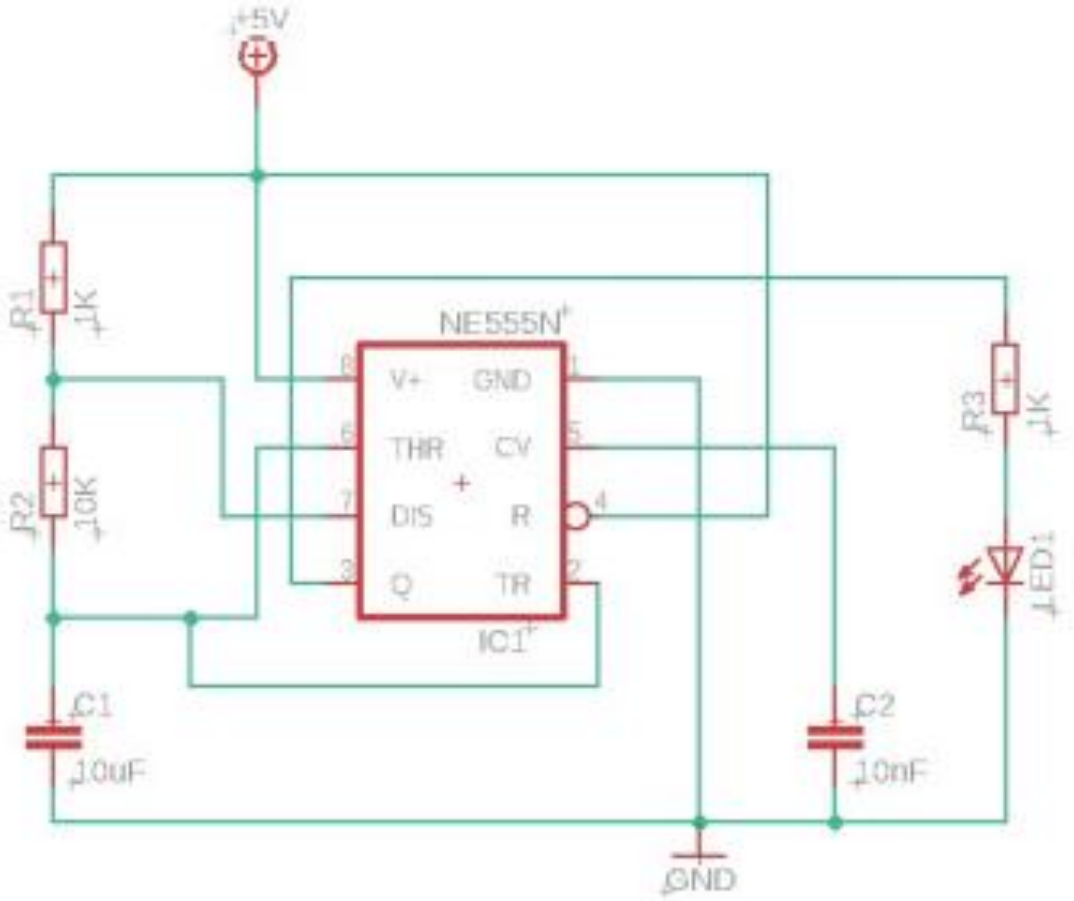
Arrange your components to mirror the following schematic.



When you have all the components placed correctly, the next thing to do it to wire the components in the correct order. To start placing the wires, or nets, you have to press the 'Net' button in the left hand toolbar. With the 'Net' button selected, you will notice when you move the cursor near the edges of components, small green circles will appear. These are the connection points for the nets. Simply left click once to start the net and when you move towards another component, another green circle will appear. Left click on the second circle and you will now have a net joining the two components. You can also add junctions where two nets join each other. This is done by following the same first step, and instead of

joining the net to another component, you just click the part of the net you wish to apply the junction.

Wire the following nets to match the schematic below.



You have now produced a schematic of a functioning 555 timing circuit.

Appendix:

- Autodesk Eagle Training booklet
- Sample past projects
- AutoDesk Eagle Schematic tutorial