# Construction of circuits

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## **Introduction**

Throughout this project, we have designed several circuits to detect and analyse various signals emitted from mineral samples. These circuit schematics are shown throughout the report but how would they be constructed; the components shown have been chosen based on availability in the lab as well as those ordered online, yet where do we construct these circuits?

## **Breadboard Complications**

For this academic year, breadboards were used for constructing circuits due to components being installed and removed easily without additional equipment such as soldering irons, the ability to conduct rapid prototyping on circuit designs and test circuits before implementing them as PCBs. Breadboards are most familiar to us, but the project brief's requirements have caused us to reconsider its use in turn for other alternatives. The complete design of the EEE Rover must be reliable, robust, and weight-effective.

For our rover to be reliable and robust, we require our circuits to remain functional after several impacts and collisions – this means our circuits must be built securely and not break upon impact. This can be an issue with breadboards that have encountered numerous uses – components are held into place in the breadboard with metal clips**1** that squeeze the pins/leads of components and provide connections to other components. This means they can be installed and removed without solder but after many uses, the clips can become loose and make the connection of components less secure. We have experienced this with our breadboards and were concerned about the robustness and reliability of the rover as several wire disconnections could occur, damaging the circuit and breaking functionality.

Making sensor measurements reliable means removing as much interference to the circuits and signals as possible. Noise can interfere with our signals collected from the sensors; it is an unwanted signal**2** that is random and hard to predict, which affects the sensitivity of our signal and may cause incorrect readings collected by the sensors. There are several ways noise can enter a signal**3,4**: magnetic/inductive coupling, radio frequency inference, capacitive coupling, and common impedance coupling (the technical details of each can be viewed by following the corresponding links in the reference sections). Every electrical component will have an associated capacitance thus noise cannot be removed entirely, but it can be reduced through methods we have seen before such as incorporating bypass capacitors that act as short circuits to the ground for high-frequency noise signals. Like capacitance, inductance is also associated with all electrical components and can introduce noise into signals. One of the biggest sources of parasitic/unwanted inductance is wires used to provide connections between components. Using longer wires than necessary will introduce more unwanted noise in our signals and may interrupt readings and analysis of these signals so ideally, we’d like to use the minimal amount of wiring as possible.

Making our rover weight-effective involves using the minimal amount of components to assemble our signal-sensing circuits and make the circuit density as high as possible on our rover since we intend to use as few breadboards as possible in our final design. Breadboards are relatively heavy components and accumulate a lot of space thus we need to minimise the number of breadboards used as possible. Furthermore, for each breadboard that is introduced, we need to adjust the chassis of the rover to accommodate the breadboard – we could extend the length of the rover chassis or the height by having breadboards stacked on top of each other.

## **Stripboards**

Like breadboards, stripboards also have been used as a platform for prototyping electronic circuits. Stripboards**5** consist of one side with copper strips along the length of the stripboard and an isolated layer on the other side, with holes throughout the entire board. Component leads can be inserted through these holes and connections can be made by soldering the components together on the side with the copper strips. Using stripboards comes with several advantages such as more secure connections between the components, making them more robust and less likely to break the circuit upon impact. Also, the length of leads of components and wires can be reduced since contact between components is made using soldering joints, which can reduce the effects of parasitic capacitance and inductance that may accumulate in the wires/leads of the components.

With a stripboard, we can use as little space as we need to implement the circuit for our sensors – this effectively saves space and weight on the rover since we are utilising all the space available on a cut down to-size stripboard compared to a full-sized breadboard with empty pins. Stripboards are also thinner than breadboards, which also cuts down on weight, which is something we would like.

The use of strip boards has not been taught this year, so we need to know how to use these boards to construct our circuits. Stripboards are commercially available in a variety of sizes and can be cut down**6** to an appropriate size using hacksaws (or snapping them on a table edge, although this is not recommended due to the board breaking into smaller parts and the edges of the board being rough and will require sanding down to make the edges smooth). The copper strips on the stripboard can get dirty from oxidation to the air or corrode due to moisture in the air or sweat, therefore it is advised to clean the strips before use as this will make the solder adhere to the copper strips much better. A PCB rubber or isopropyl alcohol could be used to clean these strips. Place the component leads on different strips (or nodes) otherwise the component will be shorted out; try to solder the component to the strip as cleanly as possible since contact with strips above and below the soldered component pin may cause issues for the functionality of the circuit. Once a node has been soldered, use a track cutter to remove the copper strip at the end of the node since we don’t want that node to be connected to another node on the same stripboard. More detailed steps for using the stripboard can be viewed at Electronics Club’s website, referenced below.

Despite creating circuit schematics for each sensor circuit, we need to consider the arrangement of components on the stripboard before soldering as this helps to establish the minimum amount of stripboard that will be needed and the optimal arrangement of components. Wires will still need to be soldered to these boards, to provide them with connections to ground and voltage rails so they can operate as intended.

We intend to have each sensor circuit on its own stripboard, which will have connections to 3.3 and 5 V supply rails, ground rails and data wires (the connection between the circuits and the Adafruit board for signal processing). This minimises the number of breadboards we require, the space and weight accumulated for these circuits as well as noise that is introduced into the signal.

## **References:**

1. RS Components Ltd. The Complete Guide to Breadboards [Internet]. RS Components Ltd; n.d. [cited 2022 June 4]. Available from: <https://uk.rs-online.com/web/generalDisplay.html?id=ideas-and-advice/breadboard-guide>

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3. Edvard Csanyi. 4 ways in which noise can enter a signal cable and its control [Internet]. Electrical Engineering Portal; 2014 [updated 2014 September 8; cited 2022 June 4]. Available from: <https://electrical-engineering-portal.com/4-ways-in-which-noise-can-enter-a-signal-cable-and-its-control-part-1>

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5. RS Components Ltd. Stripboards [Internet]. RS Components Ltd; n.d. [cited 2022 June 5]. Available from: <https://uk.rs-online.com/web/c/esd-control-cleanroom-pcb-prototyping/prototyping-boards/stripboards/>

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