

***EMONA***  
***netCIRCUITlabs REL2.0***  
***Electric Circuit Theory***

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**Lab Manual**

*SAMPLE MANUAL*



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## Electric Circuit Theory Lab Manual - *SAMPLE MANUAL*

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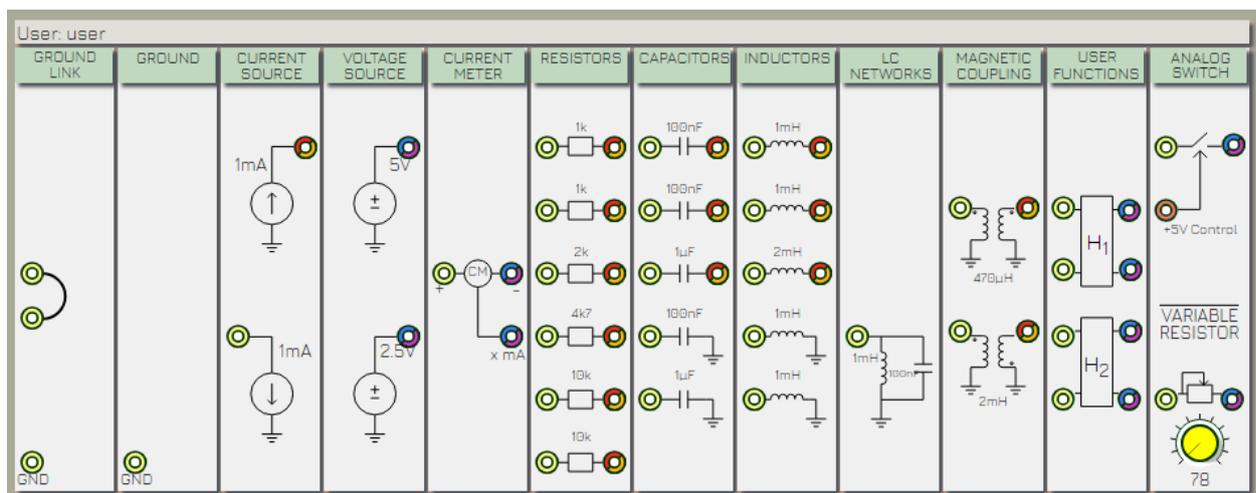
## REL 2.0 Electric Circuit Theory board overview:

In a typical Electric Circuit Theory laboratory session, students will patch together individual components on a breadboard to build up small circuits. They will study the performance of these small circuits and come to understand the behaviour of the components both independently and together.

The NCL ECT board also comprises of a collection of individual components which the student can patch together via electronic connections implemented by a matrix of analog switches. This activity can be performed remotely via a browser and signals can be both applied as well as monitored via this remote browser interface.

### Component overview

The real world components which are available to be connected are represented onscreen as shown below.



**Figure 1: Available components in module banks**

They are grouped more or less by type and presented in groups in a modular format.

The modules are labelled as listed below:

**GROUND LINK:** 0V input and connection between inputs

**GROUND:** single 0 V input

**CURRENT SOURCE:** 1mA current source output; 1 mA current sink input (accuracy +/- 5%)

**VOLTAGE SOURCE:** 5V voltage source output; 2.5V voltage source output (accuracy as measured)

**CURRENT METER:** inline current meter (10 ohm in series) with mA readout as a voltage output (accuracy +/- 5%)

**RESISTORS:** six resistors (typically 1% tolerance)

**CAPACITORS:** five capacitors (typically 5% tolerance) with 2 referred to ground.

**INDUCTORS:** five inductors (typical 20% tolerance) with 2 referred to ground

LC NETWORKS: single parallel LC network referred to ground

MAGNETIC COUPLING: two dual coupled magnetic coils; one having reversed polarity

USER FUNCTIONS: four input and outputs available to the user for implementing their own custom components or circuits on the ECT boards breadboard

ANALOG SWITCH: single digitally controlled analog switch; variable resistor (10K) with manual onscreen control and ohm readout

FUNCTION GENERATOR: a signal source module is also available with two outputs: a selectable analog output as well as a 5V TTL level digital output.

The analog signals are selected from a dropdown menu.

The digital signal is derived from the analogue signal via a zero crossing detector. This enables variable duty cycle TTL signals to be created.

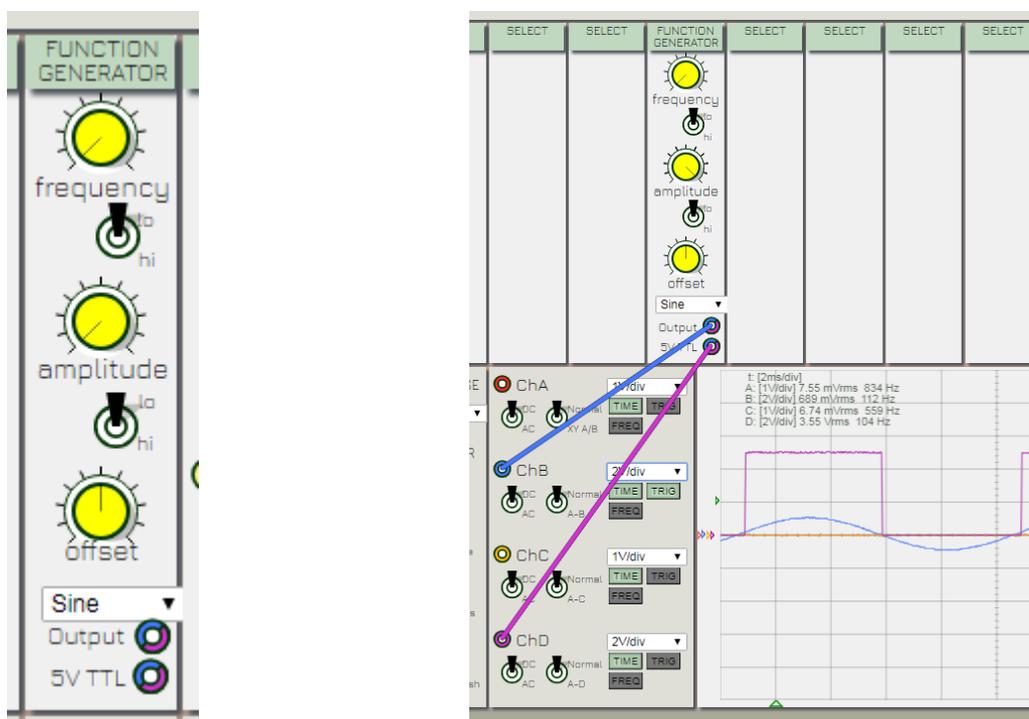


Figure 2: FUNCTION GENERATOR module; TTL signal output is derived from analog output and a "zero crossing detector" function

## Measurements with the oscilloscope

The 4 channel oscilloscope provided onscreen is used for all AC and DC measurements.

The RMS values displayed on the oscilloscope display are convenient for taking accurate DC measurements. Simply ignore the frequency component displayed alongside these values and keep in mind that the RMS value of a DC voltage is simply its DC value.

You will note that the component output terminals are color-coded. These colours relate to the scope channels which may be used to view those outputs. Each output is capable of being viewed by 2 of the 4 channels only.

Inputs cannot be viewed, however this is not needed as inputs are always connected to an output which can be viewed.

Inputs can only be connected to 1 output, however outputs may be connected to many inputs.

Clicking and dragging in the signal display panel enables cursors for taking measurements.

## **Connection description**

On a breadboard the connections are made manually via single strand wires with minimal resistance, usually fractions of an ohm.

Using electronics analog switches has the difference in that the connections have a resistance of between 100-130 ohms per connection. This resistance must be taken into account in the experimental calculations. Hence this connection resistance must be measured and this is one of the first exercises in this guide.

With real world components, we must take into consideration both the output impedance of the signal sources as well as the connection resistances between connected components.

## **Contrasting real world with simulation**

Once the differences between real world implementation and simulation can be accounted for, it is useful to use simulation to compare the measured results to the simulated, and hence, theoretical results.

The student should aim to be able to explain the differences between both modes of experimentation and develop an appreciation for real world issues such as : connection resistance, power supply issues, output and input impedances, component tolerances, etc.

The circuit elements on the board are not "ideal" as in the sense of theoretically ideal. The voltage sources do not have zero output impedance and the current sources only operate between certain voltage ranges, as to be expected with real world devices.

The student should always keep in mind the benefit of experimenting with real world components as ultimately the real world is the final implementation environment they will be operating in, not the simulation.

In this guide, the use of NI MULTISIM is documented. Any circuit simulator can also be used if available. The simulation diagrams shown are available for use online. Follow the links as listed alongside the diagram.

## Relating to textbook theory

Exercise in this experiment guide are all related to sections in commonly available ECT textbooks. An important part of this guide will be referring to and relating back to the theory in these textbooks.

The specific textbooks referred to in this guide are:

*Fundamentals of Electric Circuits*  
Charles K. Alexander / Matthew N.O.Sadiku  
McGraw Hill 6<sup>th</sup> Edition

*Electric Circuits*  
Nilsson / Riedel  
Pearson 11<sup>th</sup> Edition