

# Circuit and Robot Simulator

## Manual

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## 1. Introduction

The Circuit and Robot Simulation software was developed as a CAD tool to aid in the teaching of electronics. It is largely based on the free Falstad Circuit simulator developed by Paul Falstad (<http://www.falstad.com/circuit/>). In this document we will refer to the original circuit simulator as FCS (Falstad Circuit Simulator) and the current simulator as CRS. CRS provides the following additions to the simulator:

- The possibility of importing Fritzing circuit models into the simulator,
- A robot simulator that communicates with the circuit simulator. This allows the simulation of electronic circuits that control robot behavior,
- Some user interface functionalities were added or changed,
- A few models of components related to the robotics experiments were added.

In order to install the application simply run CRSAppInstaller.exe. CRS requires that Matlab Compiler Runtime (MCR) is installed in your computer. It is distributed with CRS so, if MCR does not already exist, the installation procedure will install it for you.

## 2. Circuit simulator

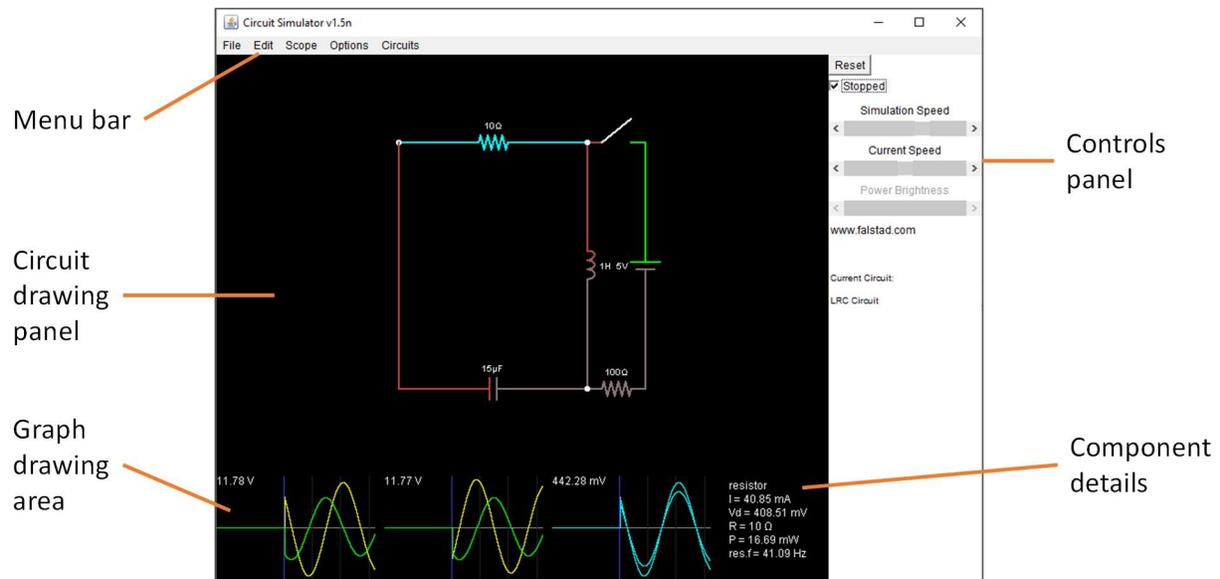


Fig. 2.1 – Circuit simulator GUI.

### 2.1 GUI

The CRS Graphical User Interface consists, as in FCS, of a menu bar, a circuit drawing panel and a control panel (Fig. 2.1). The circuit drawing panel, which functionalities are detailed in the following sections, is the area where circuit diagrams are created. The control panel provides controls starting/stopping the simulation, setting its speed, as well as the speed of the charged particles that illustrate current flow. The bottom area of the circuit drawing panel is reserved for graph drawing. The bottom right area is reserved for presenting component details. This is shown by simply hovering the cursor over the component that is to be inspected.

### 2.2 Navigation functionalities

Zoom in/ Zoom out is available through the mouse scroll movement. Pan movement is available by pressing Alt combined with mouse click and drag.

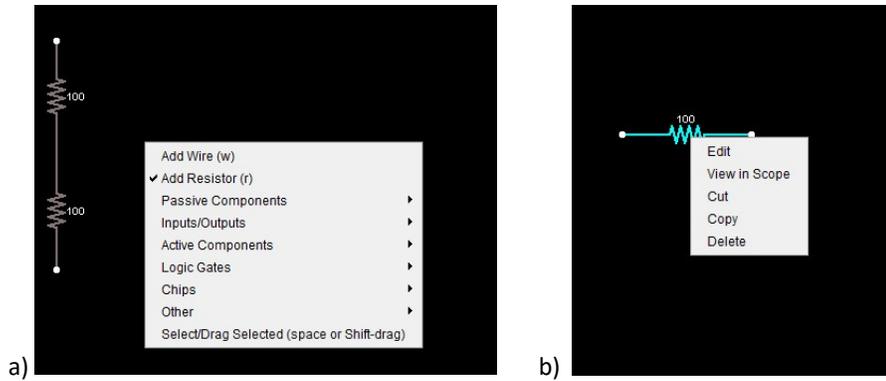


Fig. 2.2 – Context menus for circuit building functionalities.

## 2.3 Circuit building functionalities

- **Inserting a Component**

Component insertion is available through a context menu which is shown by right clicking on the background of the circuit panel. In that menu, components are organized by category (Fig. 2.2.a). Once you have selected a component, you enter the 'insert component mode', which is visible by a crosshair cursor. In this mode, whenever you click and drag on the circuit panel a new component will be added. You exit the 'insert component mode' and enter the 'drag mode' by double clicking anywhere on the background.

- **Adjusting component position**

To adjust component position you must be in the 'drag mode', which is the default mode. This is visible by the arrow cursor. Component position can be changed in two ways: by dragging any of its terminals (click near the terminal) or by dragging the whole component (click near the center of the component).

- **Component parameter editing**

When in the drag mode you can edit component parameters by right clicking on the component symbol. A context menu will be shown with the available options (Fig. 2.2.b).

- **Break connections on a component**

Since in the drag mode the act of dragging a component will displace it but keep the connections to other components, a different mechanism is needed to break connections. This is achieved by double clicking on the component, followed by dragging. In this case the component will be displaced and connections will be broken.

## 2.3 Menu bar

The menu bar provides the following menus:

File	Provides commands for saving, opening and printing circuit models (to SVG format) and for opening the robot simulator and importing Fritzing circuit models.
Edit	Provides undo/redo, cut/copy/paste and select all commands.
Scope	Enables stacking and unstacking graphs
Options	Here you can configure a number of specifications of the simulator regarding the way the diagram is shown and the electrical variables (voltage and current) are depicted. In the 'other options' item you can change the sample time of the simulation. It is useful to change the default value when you want to run the simulation faster, but its accuracy will be reduced.
Circuits	Through this menu you can select a circuit from a large number of standard textbook circuits, which are organized by topics. Also you can select 'blank circuit' in order to start a new circuit from scratch.

## 2.4 Graphs

FCS provides graphing functionalities for plotting electrical variables measured across a component or at a terminal. To do so, right-click on the component to make the component context menu visible and select 'View in scope' (Fig. 2.2.b). By right clicking on a graph a context menu is shown that enables many options to configure the graph.

## 2.5 Importing *Fritzing* circuit models

In order to import Fritzing circuit models select *File->import Fritzing* to open a file browser window. Next select the .xml file with the circuit netlist to be imported (see next section for how to create this file). The conversion from Fritzing to the FCS circuit representation may take some time (about a minute). After conversion, the resulting diagram is atypical. However, you may adjust component and node positions in order to improve its layout. If the circuit being imported contains a large number of components it is advised to maximize the circuit simulator window, in order to create a larger area for the components to be distributed.

### 3. Robot simulator

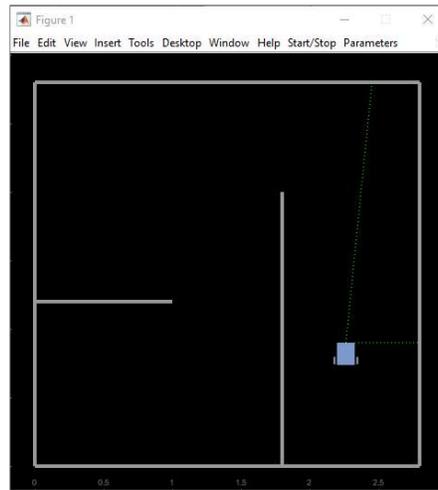


Fig. 3.1 Robot simulator window.

To open the robot simulator window select *File->Robot Simulation*. As a result, the window shown in Fig. 3.1 will be created. Here, a wall environment and a mobile robot are shown. The robot may be manually moved by left-clicking and dragging, and rotated, by right-clicking and dragging. Some parameters of the robot model can be changed through the menu parameters.

In order for the robot simulator to communicate variables with the circuit simulator, the relevant components must be conveniently named. The labels that should be used are listed in the table below. Changing a component label is done through the edit component parameters option (Fig. 2.2.b).

Description	Label
Left wheel motor	MotorLeft
Right wheel motor	MotorRight
Front Sensor	DistSensor1
Lateral Sensor	DistSensor2

## 4. Fritzing

*Fritzing* allows creating circuits in any of the following forms: breadboard prototype, circuit diagram and PCB. Here we are interested in circuits designed on the breadboard view and it is recommended that the diagram view is not manipulated. If you do so, the conversion to CRS is not guaranteed.

### 3.1 Building Fritzing circuits for exporting

Circuits built in Fritzing can be imported to Falstad given that only a subset of the Fritzing component library is used. This is because not every component has been covered by the conversion software. In the future more components may be addressed by this software. The following table lists the components that are currently accepted by the Fritzing to CRS interface. Notice that some component parameters are not included in the output file produced by Fritzing. Those parameters, which are identified in the *Notes* column of the table, should be manually set in CRS.

Components	Fritzing name	Notes
Resistors	<i>Resistor</i>	
Capacitor	<i>Ceramic Capacitor</i>	Capacitance value is not exported.
3V and 9V batteries	<i>Battery</i>	
DC Motor	<i>DC Motor</i>	
Power transistors NPN, PNP	<i>nnp-Powertransistor, pnp-Powertransistor</i>	Transistor gain is not exported.
Rectifier diode	<i>Diode-1n4148</i>	
Zener Diode	<i>Zener Diode</i> <i>Part 1N4732A</i>	Vz is not exported.
Photodiode	<i>S1133 Si Photodiode</i>	
Opamp	<i>LM 124-324</i>	Power supply connections to the opamp are not exported. This is not an inconvenience since these connections are not depicted in CRS.
Voltage regulator	<i>Voltage regulator package 78xxl,</i> <i>Chip 78005</i>	
Distance Sensor	<i>Infrared proximity sensor</i>	

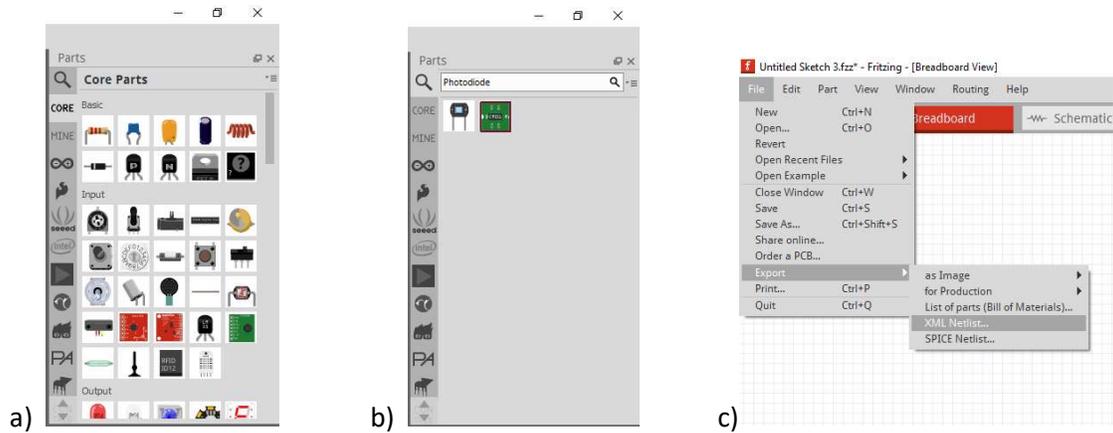


Fig. 3.1. Snapshots of the Fritzing GUI: a) core library, b) component search, c) model export to xml netlist.

Components that are not shown in the Fritzing *core catalog* (Fig. 3.1.a) can be found by searching by the names provided in the table (Fig. 3.1.b).

### 3.2 Exporting Fritzing models

In order to export a Fritzing model in a format that can be read by CRS, a .xml file must be produced. To do so, select *File-> Export -> XML Netlist* (Fig. 3.1.c).