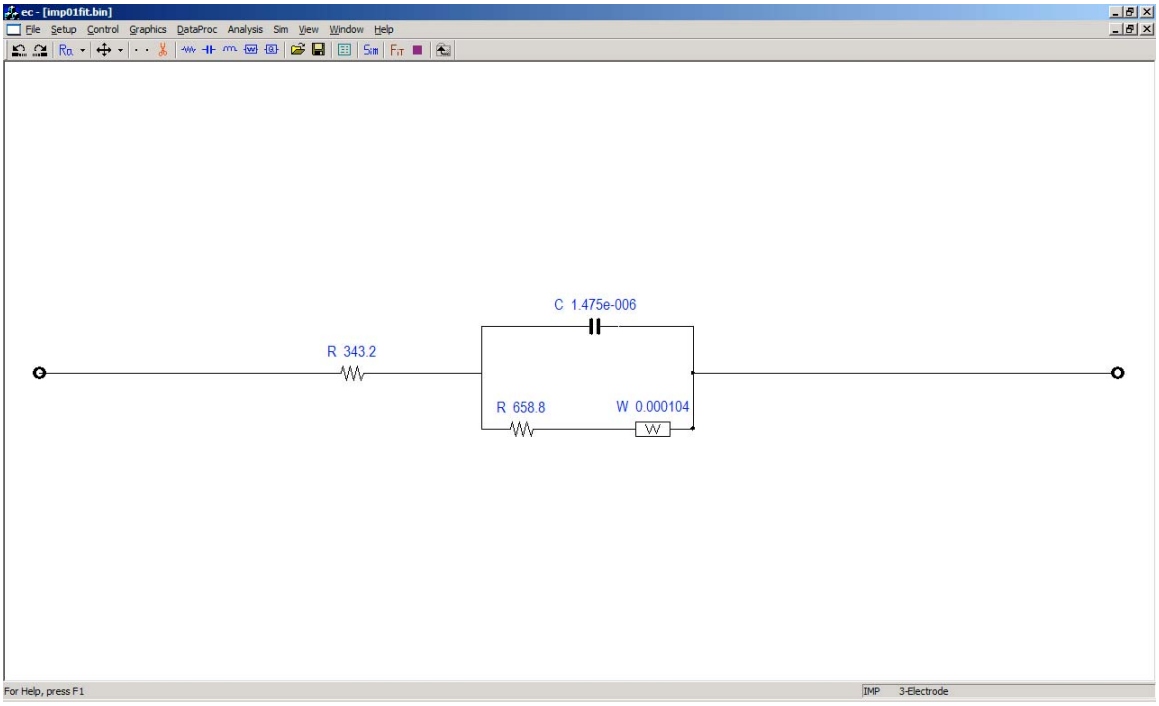
AC Impedance Simulator and Fitting Program

An impedance simulator is integrated into the software. To use the impedance simulator, you need to set the Technique to AC Impedance (IMP). You then use the Mechanism command to enter the equivalent circuitry. Once you invoke the Mechanism command, the original tool bar will be replaced with a new one. The new tool bar contains the symbols of components and commands. The following shows the tool bar and the mechanism edit field:



Here are the explanation of the tool bar buttons:

 Undo

 Redo

 Rearrange the components

 Move components left, right, up and down

 Clear all the components in edit field

 Cut a component or connection

 Add a resistor in Ohm

 Add a capacitor in Farads

 Add an inductor in Henry

 Add a Warburg impedance

 Add a constant phase element

 Change simulation parameters such as frequency range

 Open an equivalent circuit file for simulation or fitting

 Save the current equivalent circuit to a disk file

 Run impedance simulator
 Run impedance fitting program
 Stop fitting in progress
 Exit the simulation mechanism editor environment

The equivalent circuitry drawing is visual. To add a component, click the component symbol on the tool bar and then click the edit field, the component will appear in the edit field. If you double click the component you placed in the edit field, it will allow you to name the component and enter the value for the component.

You can make connection of the two components by moving the mouse to the left or right of a component. When the mouse cursor is close to the left or right side of the components, a black dot will appear. You press the left mouse button when the dot appears, you can then drag the mouse while holding the left mouse button down, a trace will appear as you drag the mouse. You drag the mouse to the left or right of the other component that you would like to make the connection. If a black dot appears on the left or right side of the other component, you can release the left mouse button. A connection should be made between the two components.

To remove a component, you first select the component by clicking the component to select it, the component will change to red in color. You can then press the Cut button on the tool bar. When a component is deleted, the corresponding connections are also deleted. You can also remove the component by moving the mouse to the component, press down the left button and drag it out of the edit field.

To remove a connection wire, select the wire by clicking trace (the trace will become red) and use Cut command on the tool bar.

You can move the component and wire around. Select the component or trace, drag it while the left mouse button is pressed down. After you move the component or trace to a desired location, release the left mouse button. You can make the circuit drawing more readable.

You can use the Move button on the toolbar to move all components left, right, up and down.

You can also use the Rearrange button on the toolbar to rearrange the components and connection wires. However, there are only four modes and they may not create ideal diagram. You may need to redraw the diagram manually.

To finish the equivalent circuit drawing, you need to connect the two big dots on the left and right side of the edit field. If you do not connect the two big dot, the program will not know what are the two terminals of your circuit and can not do simulation.

You might find the command buttons on the toolbar useful. You can undo or redo your previous actions. You can clear the edit field by removing all the components and connection wires. You can change the impedance simulation parameters such as frequency range and number of data points per decade of frequency.

Please notice that the equivalent circuit you draw can be used for both simulation and fitting. In case of simulation, you can click Sim button to do the simulation. After that, the program will exit the equivalent circuitry edit field and display the simulated data on the screen. Please be aware of that the unsaved data will be replaced by doing simulation. Please save your existing data before simulation.

In case of fitting, you need to have a set of impedance data first. The impedance data can be obtained by running impedance measurements or by simulation. You also need to draw the circuit that would match the equivalent circuit of your actual system.

If the equivalent circuit does not match with the mechanism of the actual data, the data may not fit very well. You may need to revise the circuit.

The fitting program may not be perfect. Sometimes you may find it does not fit very well even with a known (simulated) data set. You may also find that fitting results be affected by the initial value of the components. If you see problems, please e-mail us the data and we will try to study it and improve it, but we can not guarantee it. Fitting algorithm is difficult and complicated.

You can press the "Fit" button on the toolbar to start the fitting process. During fitting, you will see the time elapsed, fitting error and component parameter change. When time change stops, the fitting ends. You can then see the fitting results (parameter value of components) and fitting error. In order to over the fitted data, please press "Exit" button on the toolbar. The original data and the fitted data will be overlaid and displayed.

You can save your equivalent circuit drawing into a disk file and read it back later.

To exit the circuit editing field, click the exit button. You need to exit first in order to use other commands of the program.

Notes:

Before you run fitting program by pressing Fit button, please connect the instrument. The program will check instrument and see if the instrument model is proper. It needs only to check it once after the program is started. After the first fitting, you do not need to have the instrument connected.

When you do impedance simulation and fitting, please do not enter other technique or read data files other than impedance measurements. Otherwise the equivalent circuit editing field will go wrong.

Dimensions and Ranges of Components

Name	Dimension	Range
Resistor R	Ohms	0.001 - 1e12
Capacitor C	Farad	1e-12 - 1
Inductor L	Henry	1e-12 - 1
Warburg Impedance W	Siemens•sec$^{1/2}$	1e-6 - 1
Constant Phase Element Q	Siemens•sec^{n}	1e-12 - 1000

Property of Components

Component	Impedance	Conductance	Phase
Resistor R:	$Z_R = R$	$Y_R = 1/R$	independent with frequency
Capacitor C:	$Z_C = -j/\omega C$	$Y_C = j\omega C$	$\varphi = \pi / 2$
Inductor L:	$Z_L = j\omega L$	$Y_L = -j/\omega L$	$\varphi = - \pi / 2$
Warburg Impedance W:			
	$Z_W = (1/Yo)(j\omega)^{-1/2}$	$Y_W = Yo(j\omega)^{1/2}$	$\varphi = \pi / 4$
Constant Phase Element Q:			
	$Z_Q = (1/Yo)(j\omega)^{-n}$	$Y_Q = Yo(j\omega)^{n}$	$\varphi = n\pi / 2,\ 0 < n < 1$