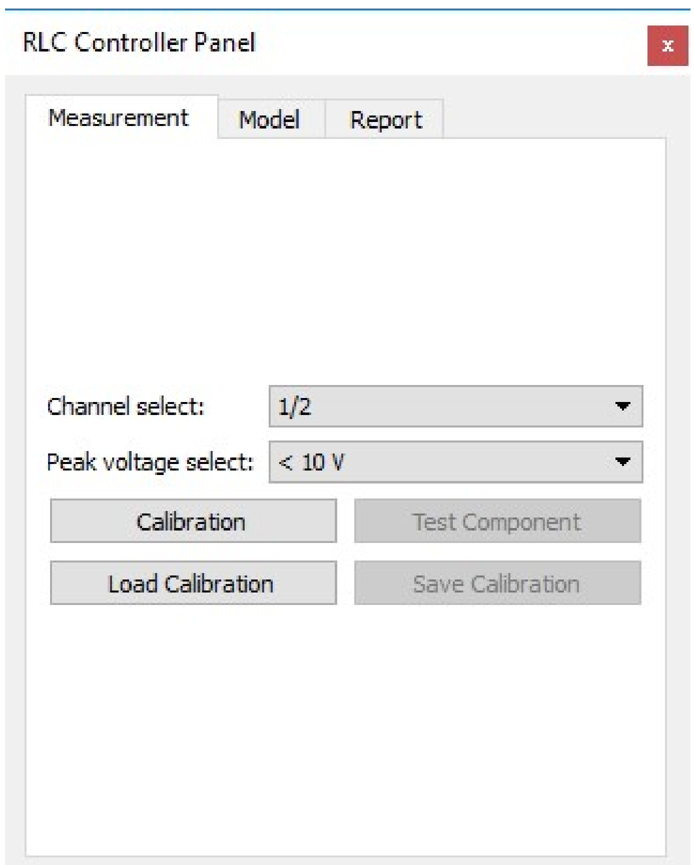
Measuring Impedance with the RLC Control Menu Option

Overview

The Venable RLC menu in combination with a supported Frequency Response Analyzer (FRA), allows you to measure the frequency response of passive components. You can calibrate your RLC fixture, run sweeps through a range of frequencies, build a theoretical model based on the empirical data and generate reports. This menu is enabled with the purchase of an additional RLC license for the Venable Stability Analysis software Ver. 6.1.

The RLC software is controlled mainly through the RLC Control Panel, which has three components: Measurement, Model, and Report.

Measurement Tab



The Measurement tab

Before measurements can be taken, the system must be calibrated. The purpose of the calibration process is to quantify the parasitic components that are present in the RLC fixture. With an estimation of the values of these parasitic elements, the actual measurements of RLC circuits can be corrected to improve measurement accuracy. The parasitic components are usually modeled as two elements: a low impedance in series (of inductive nature), and a high impedance in parallel (of capacitive nature).

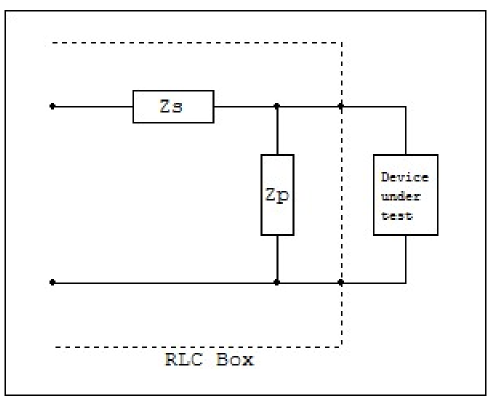
Channel Select: *(Models 74xx and 350c only)*

Channel Select allows the RLC box to be used on alternative channel combinations for analyzers with 3 or 4 channels.

Peak Voltage Select: *(Models 43xx, 51xx, 63xx, 74xx, 88xx and 350c only)*

This feature was added to correct for channel input attenuation changes during auto-ranging in data plots at voltage levels above 10V. Peak Voltage Select should be set to the peak combined AC and DC voltage level to be measured. Slight variances, due to channel input attenuation settings above 10V on the input, requires this setting to be set correctly for the calibration to be done based on the combined peak voltage level. Once the calibration has been completed, this value cannot be changed without closing and reopening the application. On an analyzer with 3 or more channels, the setting can be changed when the channel select is changed to a new setting

Calibration

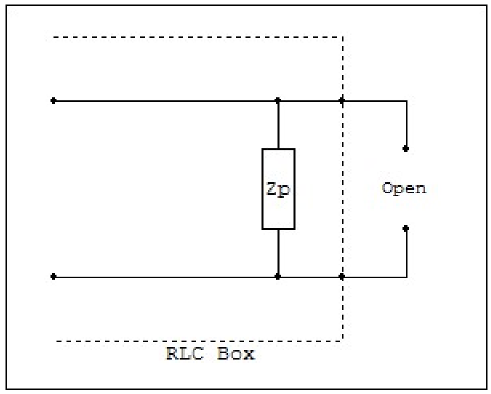


Parasitic model

The calibration process consists of two steps: an open-circuit sweep, and a closed-circuit sweep. Once the calibration process starts, the RLC software will prompt you to first open and then close the circuit in order to take the respective measurements.

Open Circuit Sweep

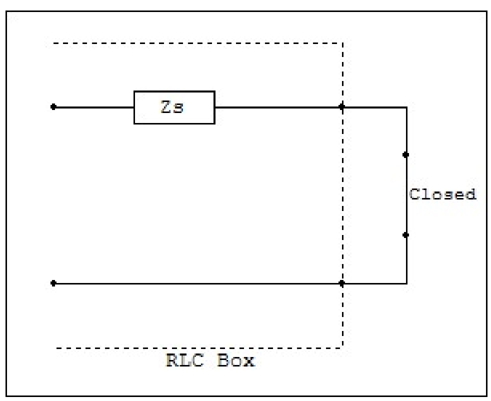
When the circuit is open, the impedance of the parallel parasitic element can be measured (the impedance of the series element is so much smaller that its effect is negligible in the measurement).



Open circuit model

Closed Circuit Sweep

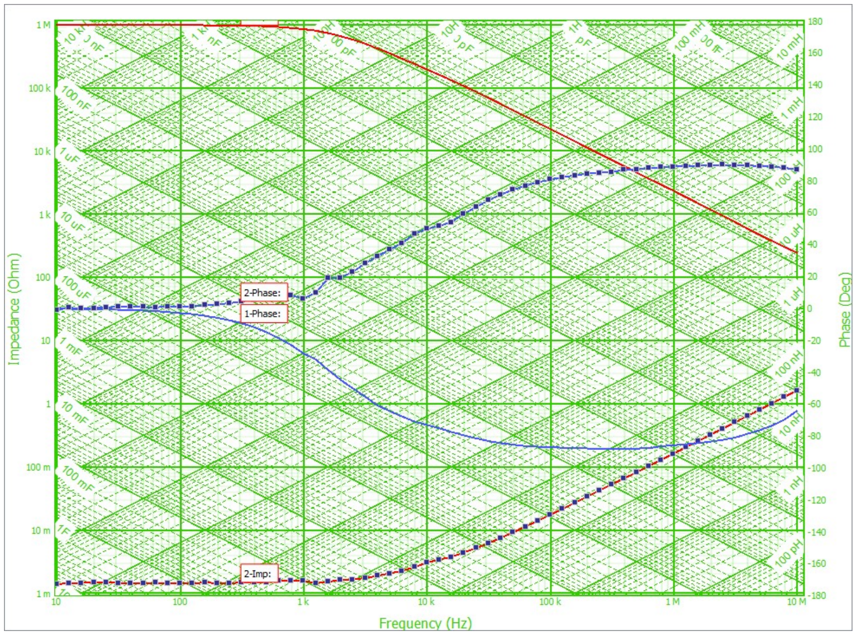
After the open-circuit sweep is complete, a closed-circuit sweep is run. In this case, the parallel element can be removed from the equation by shorting it, and the impedance of the series element can be calculated.



Closed circuit model

Load and Save Calibration

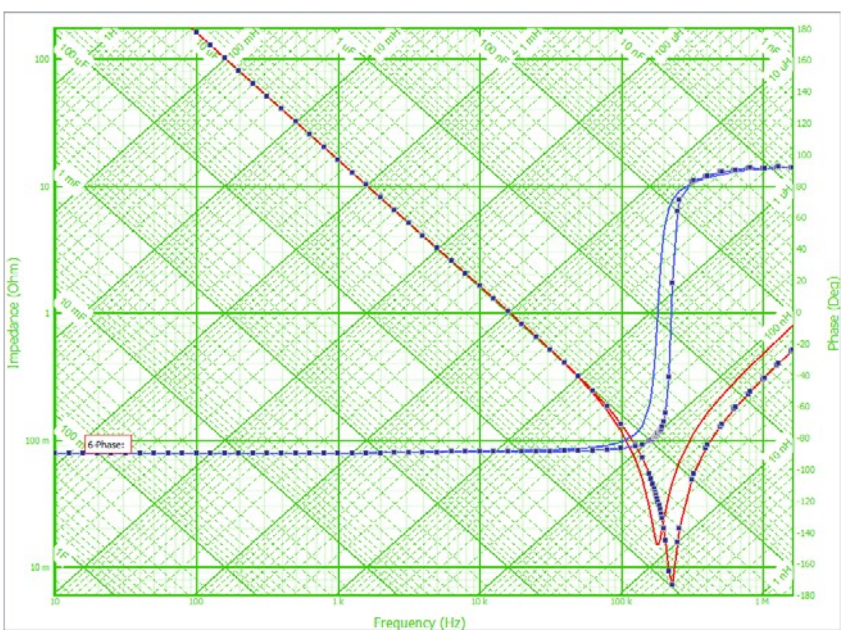
After the open-circuit and closed-circuit sweeps are complete, you can save and recall the calibration data for future use. That way, it is not necessary to re-calibrate when opening a new tab or a new file for a different set of measurements.



Example of open and closed circuit impedance and phase plots

Test Component

Once the calibration is done, the system is ready to measure RLC circuits. Use the “Test Component” button on the RLC menu to run the RLC sweep. The software will automatically correct the raw data and create another plot with the tag “w/o parasitics”. This plot is the result of subtracting the series and parallel parasitic elements from the raw measurement and creating a corrected measurement plot with the parasitic elements of the RLC fixture removed.

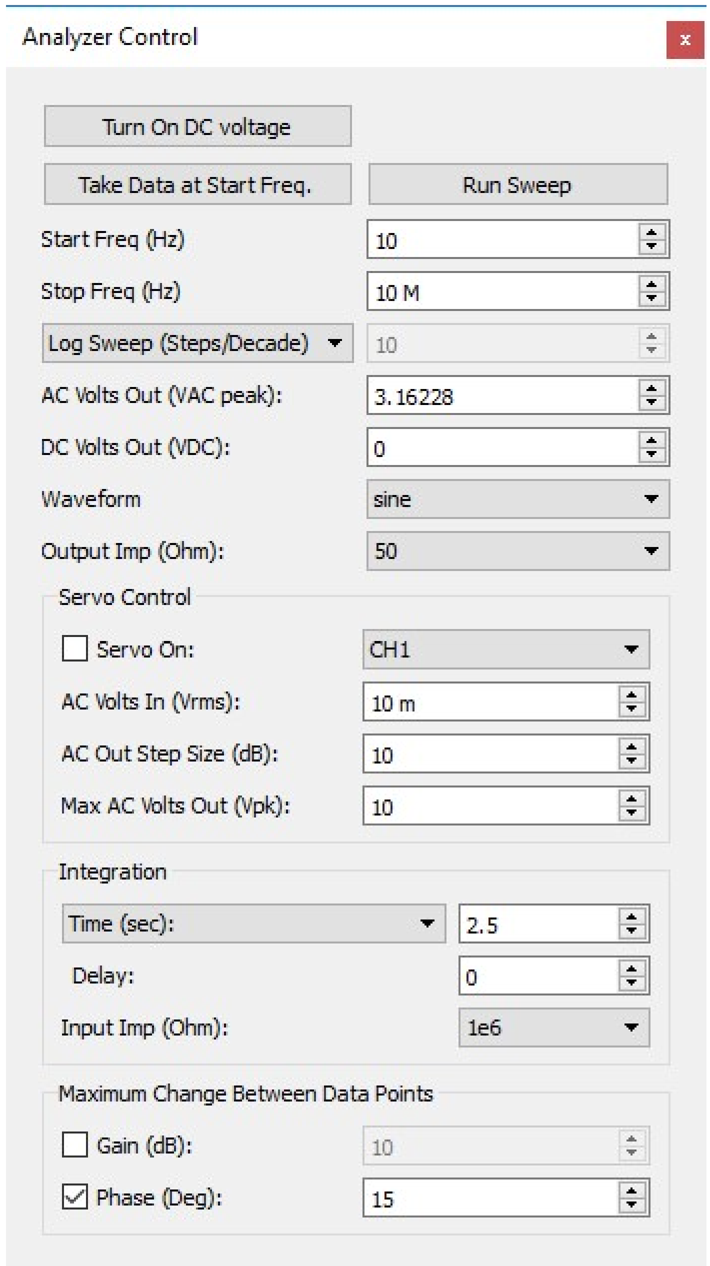


Uncorrected and corrected plots

The controls related to making measurements are set in the Analyzer Control Menu:

- Run Sweep: This control will run a standard sweep. No parasitic correction will be applied to the data. Use the “Test Component” button on the RLC menu to get a corrected plot of the measured component.

- Start and stop frequencies: they define the first and last points in the sweep. In the case of a single point setup, start and stop frequency are the same.



- Resolution: Sets the number of frequency points by steps per decade or steps per Hz.

- A/C and D/C voltages: controls that specify the AC injection voltage and bias.

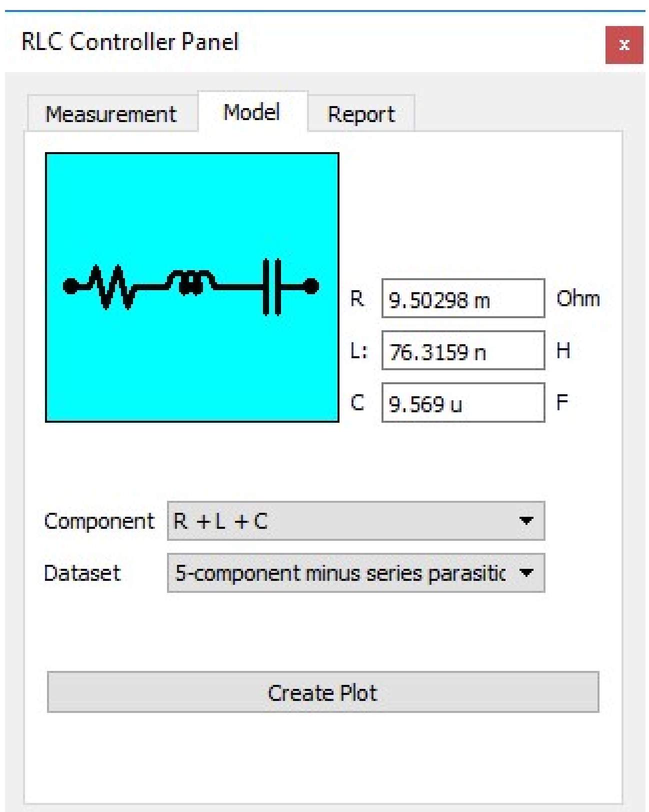
- Integration time: specifies the length of time over which each sample is taken. A longer time setting will take longer to run but will produce more precise results.

- Limit maximum phase change between data points: without this option, the software will always take 10 data points per frequency decade, regardless of the results. A problem arises when a sweep involves a resonant point, where the impedance and phase change abruptly from one frequency to the next. The resonant point can be missed. In this case, you can use this feature to mitigate the problem. If, for example, you set the maximum phase change at 15°, the software will adapt its frequency interval so that no two points will be more than 15° apart in phase.

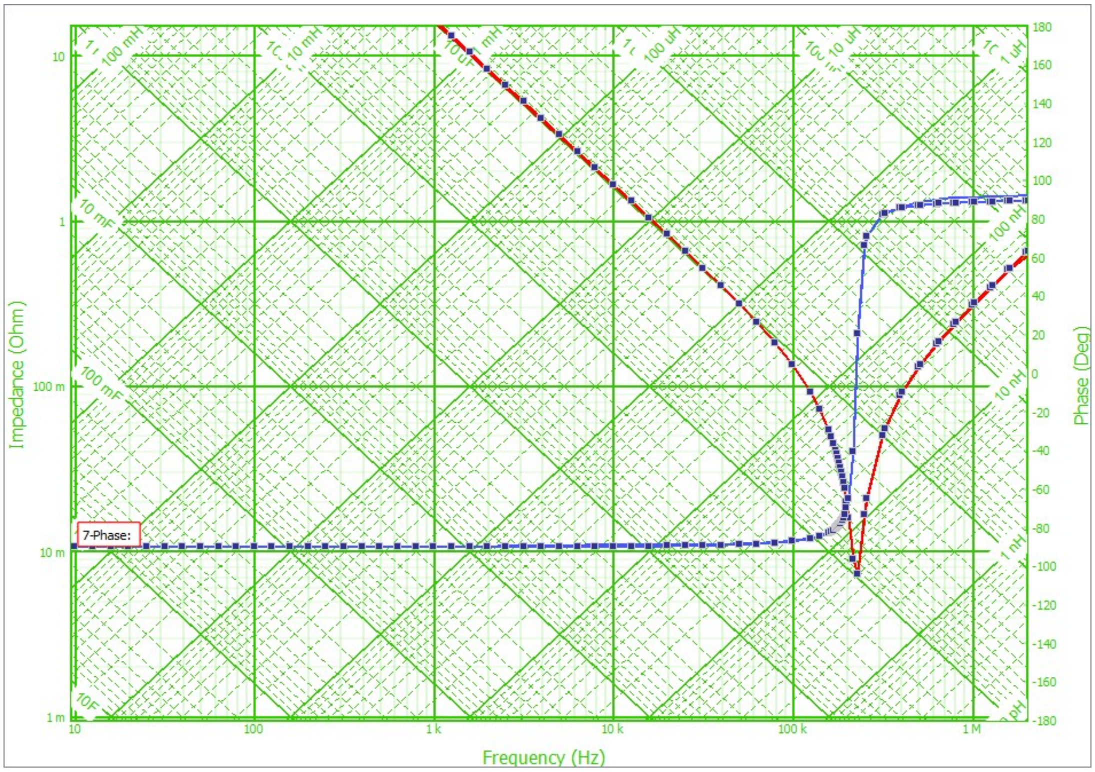
Modeling Tab

The modeling tab is used to create a theoretical model out of the circuit that was measured. You can choose the component type and the data set to model. The available component types are different combinations of a resistor, a capacitor, and an inductor, arranged in parallel or in series. After selecting the component type and data set, the calculated theoretical values for R, L, and C are displayed on the window. You can also override the values of R, L, and C by typing different values in the respective controls. You can create a plot that will represent the theoretical RLC circuit based on the values shown. If you wish to create a model with more than three components, you could create multiple models and combine them in series or in parallel using the math functions.

The theoretical values of the circuit components are calculated by attempting to fit the model to the measured data. In the case of components in series, the maximum or minimum values of susceptance (for capacitive or inductive circuits, respectively) are used to calculate the capacitance or inductance. In the case of components in parallel, the maximum or minimum values of reactance (for inductive or capacitive circuits, respectively) are used. In order to more accurately calculate the theoretical model, it is better to sweep through a wide frequency range.



The Modeling Tab



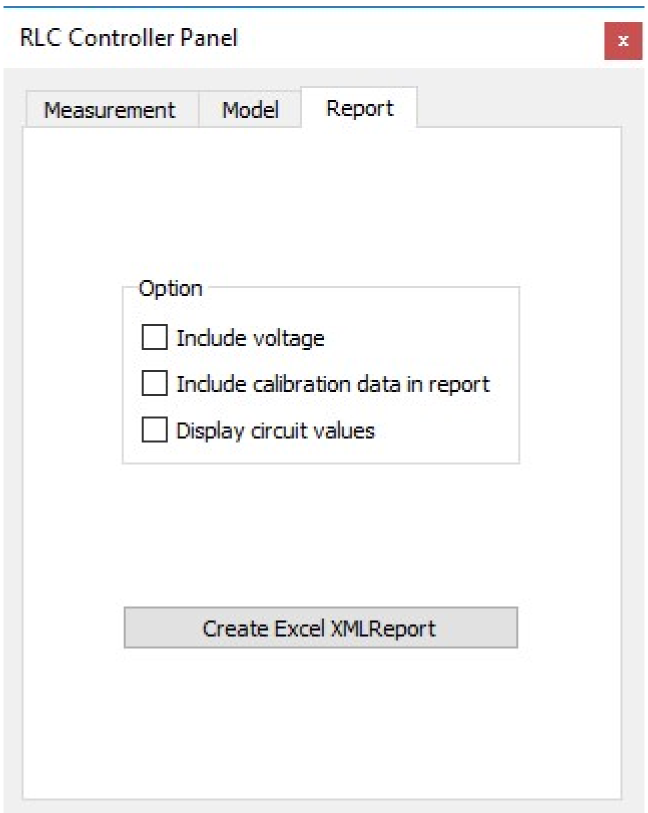
Example of a measured Capacitor and its derived model

Reporting Tab

The RLC application can generate reports in Microsoft Excel XML format, which is supported by Microsoft Excel version 2003 and later. The reports include the data in tabular format (optionally with voltage data), and information about the model. To enhance a report, you can copy a chart to the clipboard (with the “Copy Graph” menu item) and then paste it in an Excel spreadsheet. Also, the drawing of the circuit model can be copied by pressing CTRL-C while in the “Model” tab.

Alternatively to using the “XML report” feature, you can copy a dataset (first select it on the graph, then copy it with CTRL-C) from the Data Set Text Display tab and then paste the data in any text editor, word processor, or spreadsheet software.

NOTE: when you copy a dataset to the clipboard, you can control whether the data is copied as impedance/phase or as opposed to channel voltage/phase by using the radio button “Ratio” in the “Data Set Text Display tab.



Reporting tab