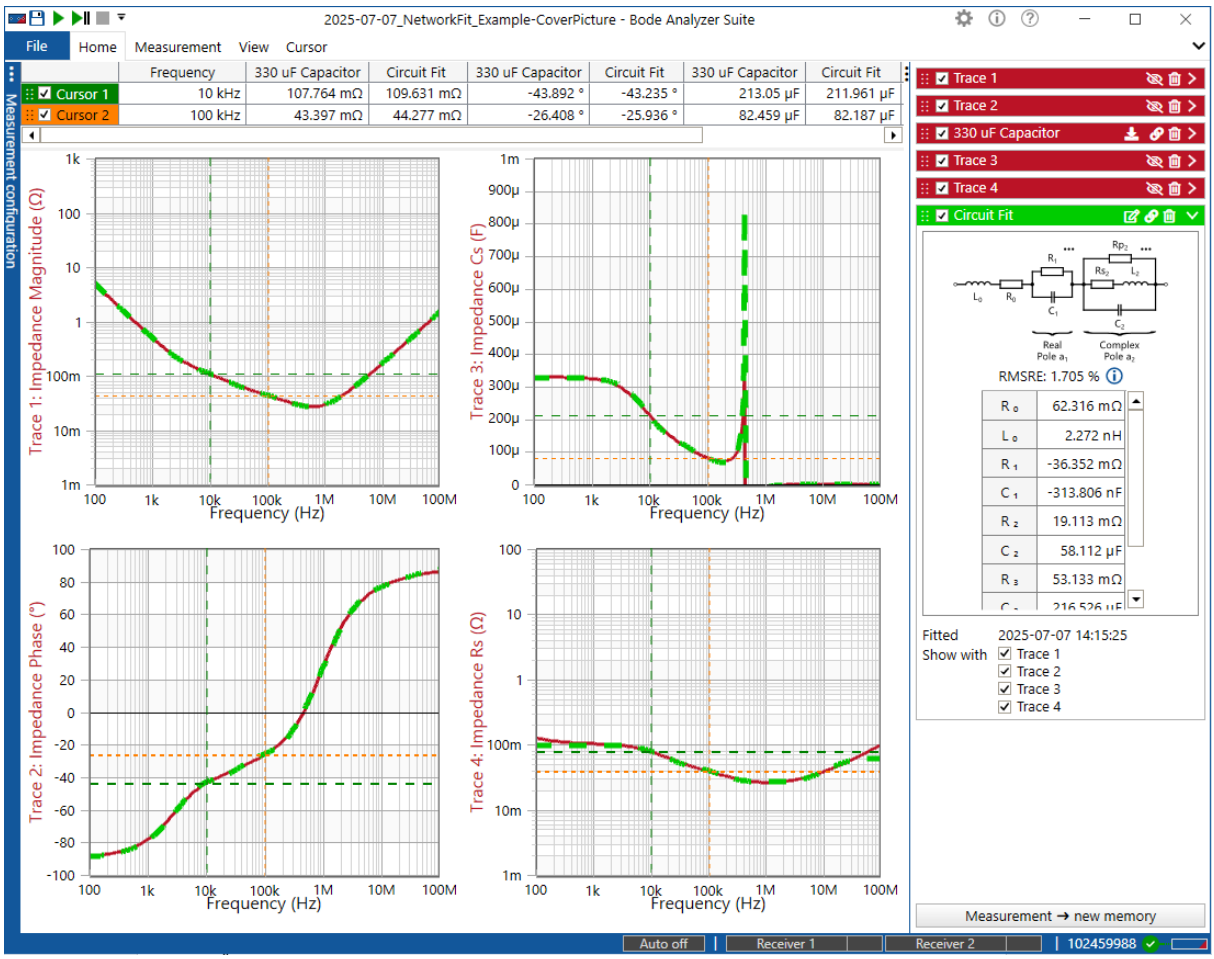
Bode Analyzer Suite – Information Note

Circuit Fit – Network Model Guide



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Contact support@omicron-lab.com for technical support.

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Note: Basic procedures such as setting-up, adjusting and calibrating the Bode 100 are described in the Bode 100 user manual available at:
Bode 100, Bode 500 Vector Network Analyzer User Manual (omicron-lab.com)

Note: All measurements in this application note have been performed using the Bode Analyzer Suite V3.51 Use this version or a newer version to perform the measurements shown in this document. You can download the latest version at
Bode Analyzer Suite - Download Area - OMICRON Lab (omicron-lab.com)

1 Introduction

The Circuit Fit feature in the Bode Analyzer Suite (BAS) is a tool that produces data-driven models of impedance measurement to be used for circuit simulation and characterization of components. The **Network Fit** feature of the **Circuit Fit** tool models complex components that are beyond the scope of **Simple Fit** with only offers a limited amount of pre-defined models.

The network fit has an expanded control to achieve a good fit between measurement and model. The feature can be used to create models up to an order of 20 with more complexity to achieve a low error between model and measurement. This document will introduce some of the settings as it models the impedance response of a tantalum capacitor.

2 Measurement

The **Circuit Fit** feature requires an impedance measurement to generate a model. **Circuit Fit** is compatible with all impedance measurement setups in Bode 100 and Bode 500. The DUT used in this document is a tantalum capacitor measured with Bode 500 and the B-TCA accessory. The Shunt-Thru setup was used in this measurement.

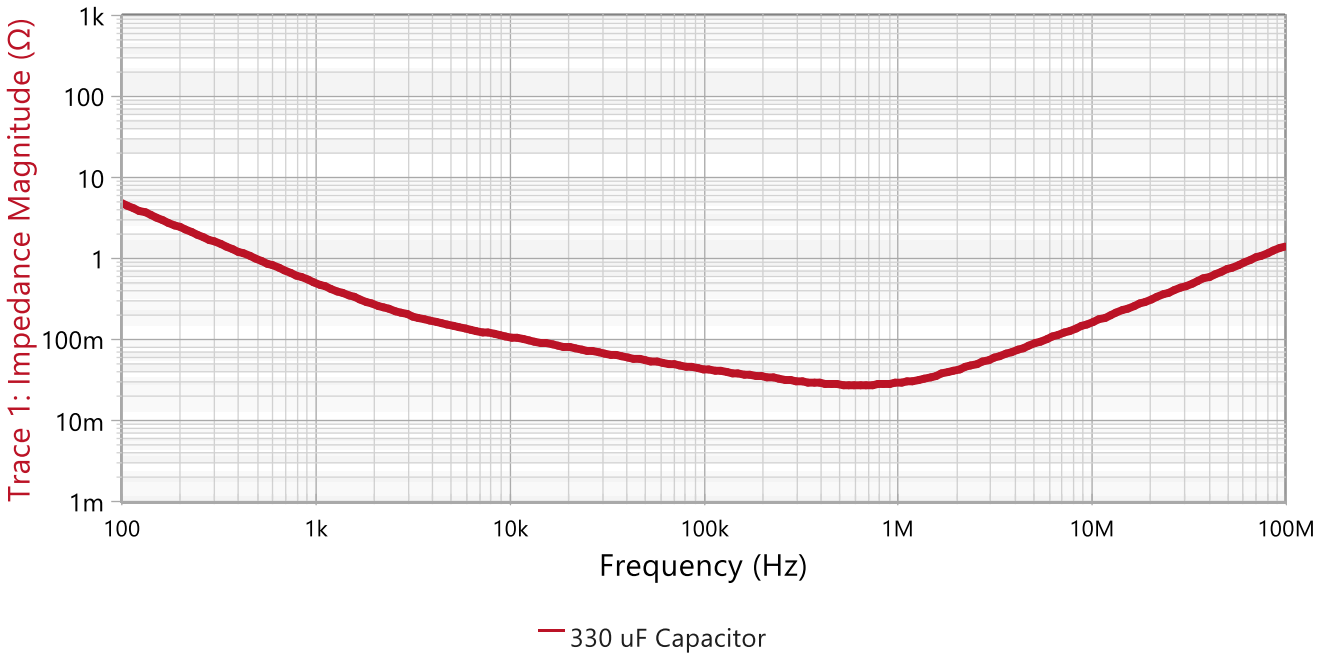


Figure 1: DUT capacitor measurement

3 Configure Circuit Fit

Select the **Measurement** tab on the top left corner of the BAS ribbon menu and click on **Add Circuit Fit.**

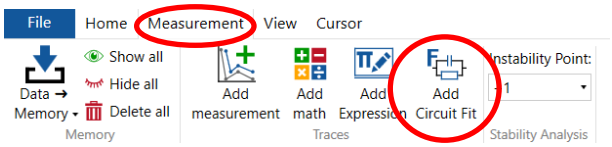


Figure 2: Measurement tab of Bode Analyzer Suite

Once the **Circuit Fit** window (Figure 3) opens, switch the **Fit Model** to **Network** to perform a **Network Fit**. In the **Data Source** line, select the trace from which you want to create a model. The feature can fit both Memory traces and active Measurement traces.

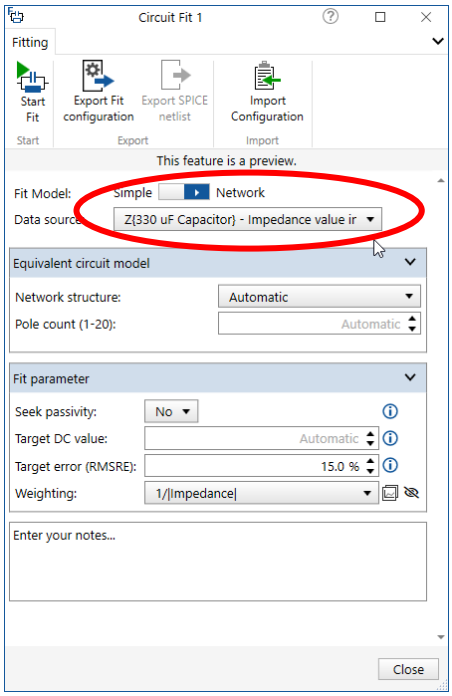


Figure 3: Circuit Fit window

The corresponding **Network** settings (shown in Figure 4) will appear on the screen. The **Data source** should be the trace data (memory or measurement) that will be used to fit the model to. The **Network Structure** option allows the user to pick a series or parallel network structure or perform an automatic best fit. For this example, it is set to automatic, allowing the Circuit Fit to decide on the best structure for the model. The **Pole count** is defined as the number of poles used for the **Network** fit. The higher the number, the more complex the structure and usually the better the fit. It is a trade-off between complexity and accuracy. When left blank, the **Circuit Fit** will increase the pole count until the target error is achieved. The **Pole count** can be defined manually to reduce complexity. The **Fit parameters** can be adjusted to target specific **DC values** or specific errors (**RMSRE**[1]) percentages. The values for

[1] Target RMSRE is the target Root Mean Square Relative Error.

these parameters can be set manually; however, each additional manual change will affect the fit and may not guarantee the achievement of all parameters.

For this **Circuit Network Fit**, the target error was reduced to 5% to achieve an accurate model and the target DC value was set to 1 MΩ since we try to model a capacitor and the resulting model should have a high resistance at DC.

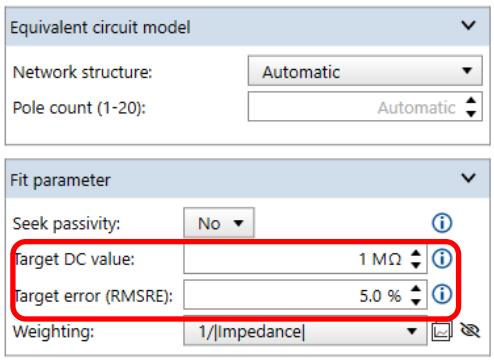


Figure 4: Network Fit window

Once the parameters are set, press Start Fit on the top left corner of the window. 

4 Fit Results

Once the fitting is completed (Figure 5), a green check mark will appear in the status bar at the bottom left corner of the window. If the **automatic Network** fit is performed, the Network Structure of the best-fit result will appear on the left side of the window. On the right side, the circuit fit transfer function, components, and fit result error and projection will be displayed.

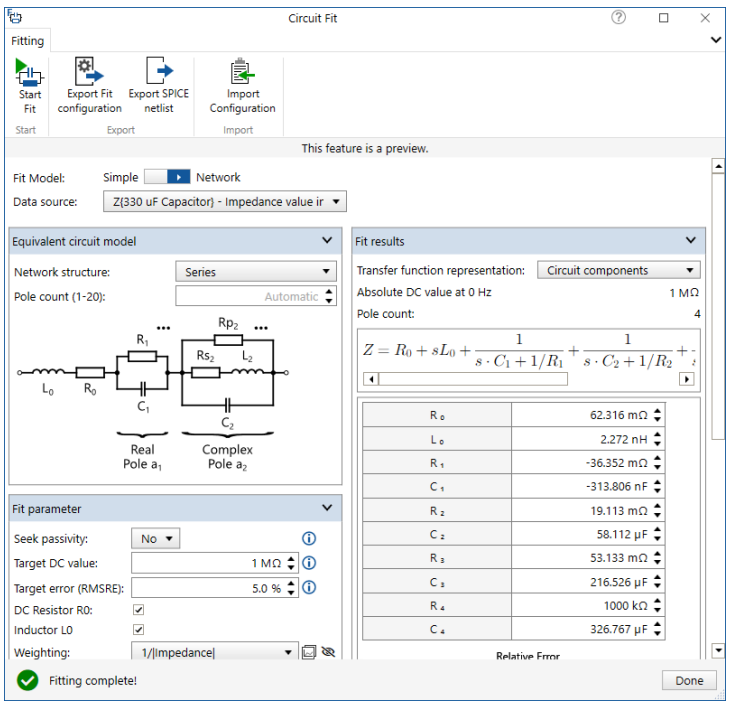


Figure 5: The Circuit Fit results

The **Transfer function representation** setting will provide options how to display the resulting transfer function. The possibilities are **Circuit Components**, **Polynomials**, **Partial Fractions**, or **Factorized**. The **Absolute DC value** and **Pole count** result will be displayed below the transfer function. The circuit components (transfer function) result list will be displayed but will change depending on how the transfer function is represented. These result values can be manually changed to modify the result. The result will be updated accordingly.

Note that some values may appear negative, which is acceptable if they are for simulation purposes, as this transfer function is a behavioral model of the system. If the requirement is to have all positive absolute component values, then switch the '**Seek Passivity'** option to **'Yes'** before executing the **Circuit Fit**.

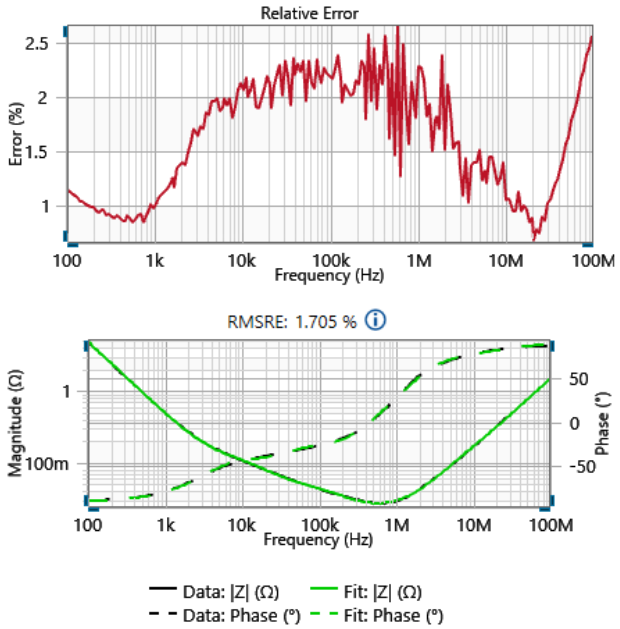
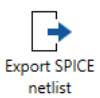


Figure 6: Relative Error and Model Fit Graphs.

The relative error of the measurement and model will also be displayed in the Fit Result section, as shown in Figure 6. The relative error graph is the error between the data source and the model result over frequency. While the The **Root Mean Square Relative Error (RMSRE)** result located above the fit result graph is a measure for the error between the model and the entire measurement. For more information on the RMSRE, please refer to the Bode 100, Bode 500 user manual.

The transfer function of the fitted model is shown in green color above the measurement data shown in black color (see Figure 6). If the fitted model satisfies your requirements, click the **Done** button at the bottom right corner of the window.

The fit result can easily be integrated into a SPICE model using the SPICE netlist export option located on the top ribbon of the circuit fit window (see Figure 5).



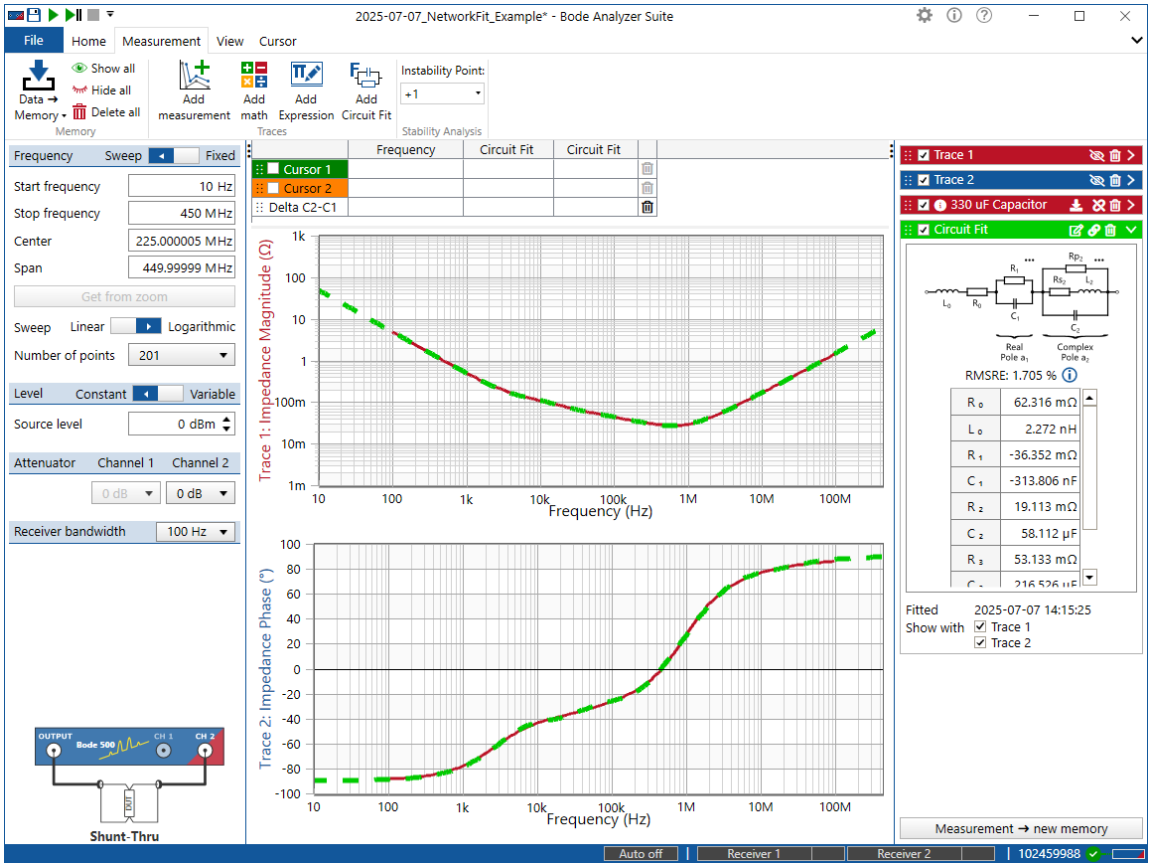


Figure 7: Circuit Fit with the measurement displayed as green dashed trace.

The circuit fit will be stored as a new trace and displayed in the trance configuration area on the right-hand side of the Bode Analyzer Suite. The fit can be edited, exported, or used to display the behavior of the components at frequencies not measured by changing the start and stop frequency settings. The **Circuit Fit** result can also be included in the BAS PDF report of the measurement.

5 Conclusion

The Network Fit option of the Circuit Fit feature offers a powerful and easy to use way to create a high-order model of measured impedance curves by a simple mouse-click. With a model order of up to 20, even complex transfer functions can be modelled easily. The SPICE netlist exports allows the user to use the fitted model in a larger system simulation for further analysis and system design.

Please refer to the Bode Analyzer Suite User Manual for further details. Additional measurement examples can be found in the Application Note section of the OMICRON Lab webpage www.omicron-lab.com.

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