Impedance Measurements Using TEF

Using the SLX module of SoundLab for TEF is an excellent way to measure the input impedance of a loudspeaker. There are two methods whereby one may make this measurement. The first is by driving the DUT (device under test) through a known resistance and measuring the voltage drop across the DUT. The second is by a direct measurement of the current drawn by the DUT.

Series Resistance Method

An impedance adapter box is available from Gold Line for the TEF to perform impedance measurements. This adapter places a precision 1 kΩ resistor at the output of the TEF in series with the DUT. The input of the TEF is placed across (in parallel with) the DUT.

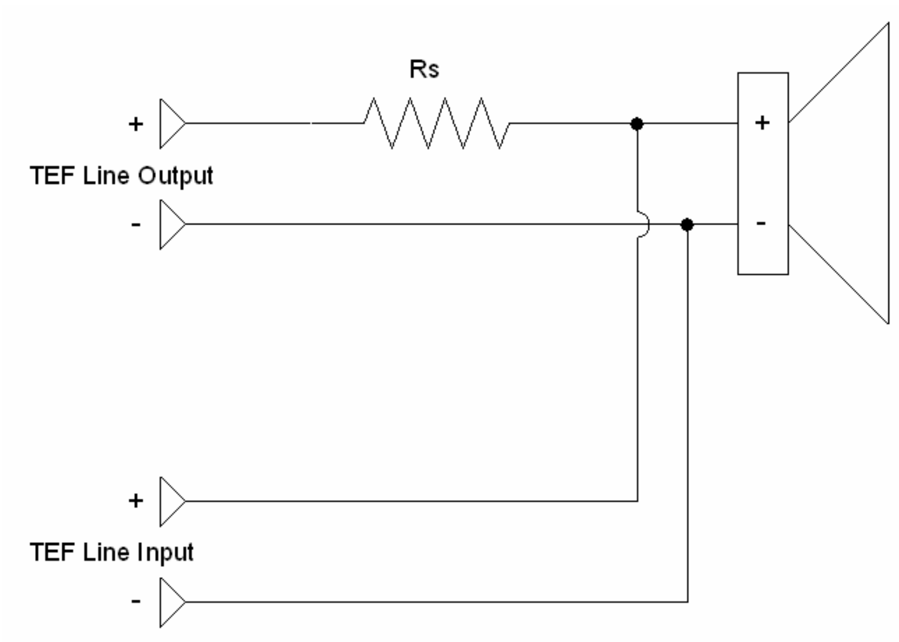

Figure 1 – TEF Impedance Adapter schematic

Figure 2 shows some typical parameters for a full range impedance measurement. Note that the value in the Series Resistance text box must be the same as the value of Rs + the output impedance of the TEF to obtain an accurate measurement.

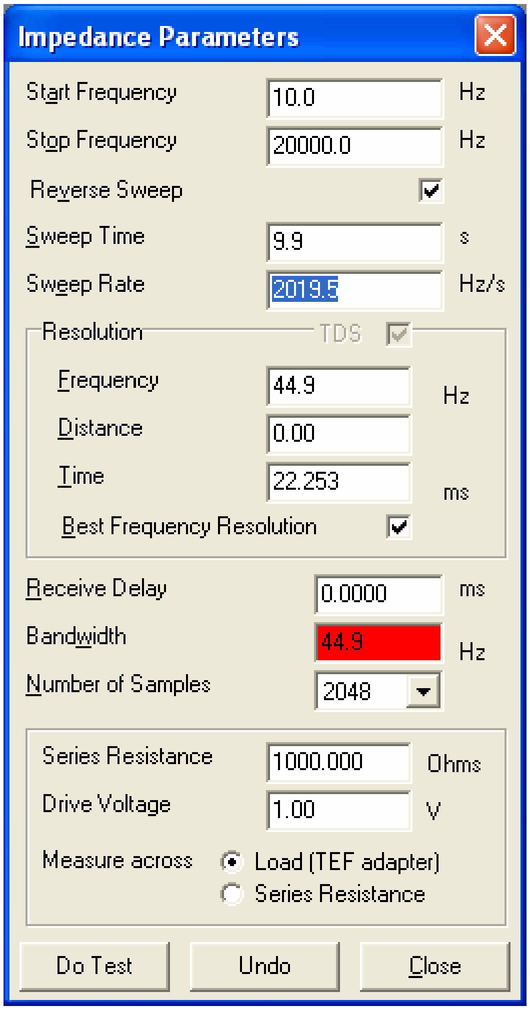

Figure 2 – Typical parameters for impedance measurement using a series resistor

Direct Connection Method

It is possible to connect the DUT directly to the amplifier driving it, unlike the Series Resistance Method described above. For an impedance measurement to be made using this method a current monitor must be employed. This will allow a direct measurement of the current drawn by the DUT from the amplifier. Pearson Electronics (http://pearsonelectronics.com/current-monitor-products/standard-current-monitor.htm) makes a line of precision current monitors suitable for this type of measurement. I have obtained very good results using the model 411.

Photo 1 – Pearson current monitor

One conductor connecting the amplifier to the DUT must be run through the center of the current monitor. Care must be taken to observe the correct orientation of current flow as marked on the current monitor. Failure to do this may result in the measurement being made with reverse polarity. The Pearson units have a BNC connector that connects to the line input of the TEF.

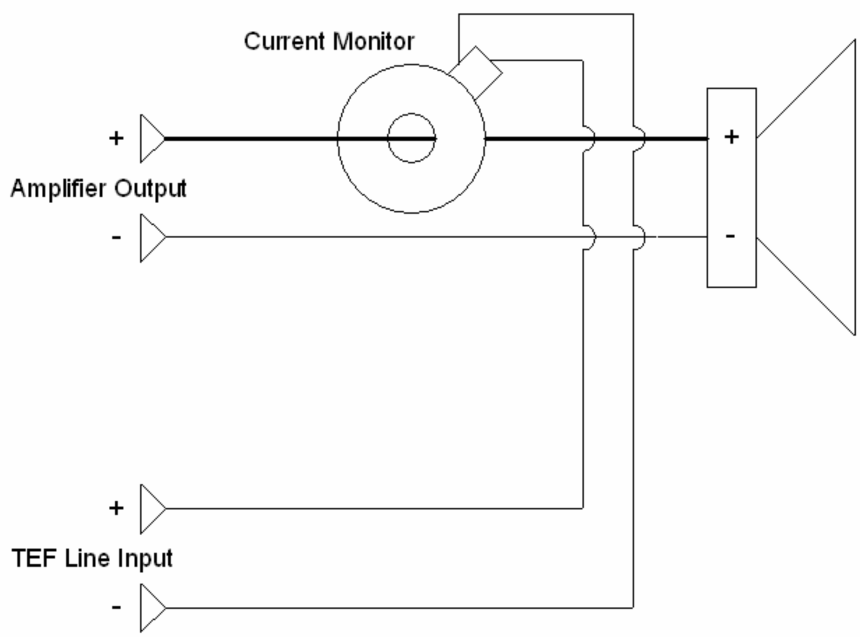

Figure 3 – Schematic for use of a current monitor

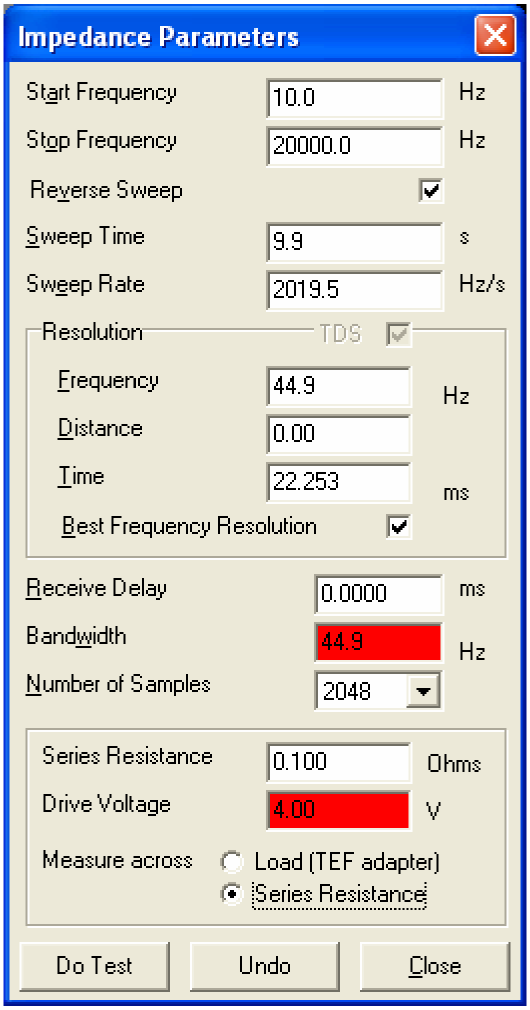

Figure 4 – Typical parameters for impedance measurement using a current monitor

Notice the change in the parameters for this configuration. The Drive Voltage is still the actual drive voltage out of the amplifier. This is now the same as the voltage across the terminals of the DUT. The Series Resistance, however, must now reflect the output sensitivity (volts/amp) of the current monitor. For the Pearson 411 the sensitivity is 0.100 volts/amp.

Low Frequency Analysis

The parameter settings in the figures above were for basic full range measurements. If one wishes to see greater detail in the lower frequency region a separate measurement should be made. This low frequency measurement should have parameters similar to those in Figure 5.

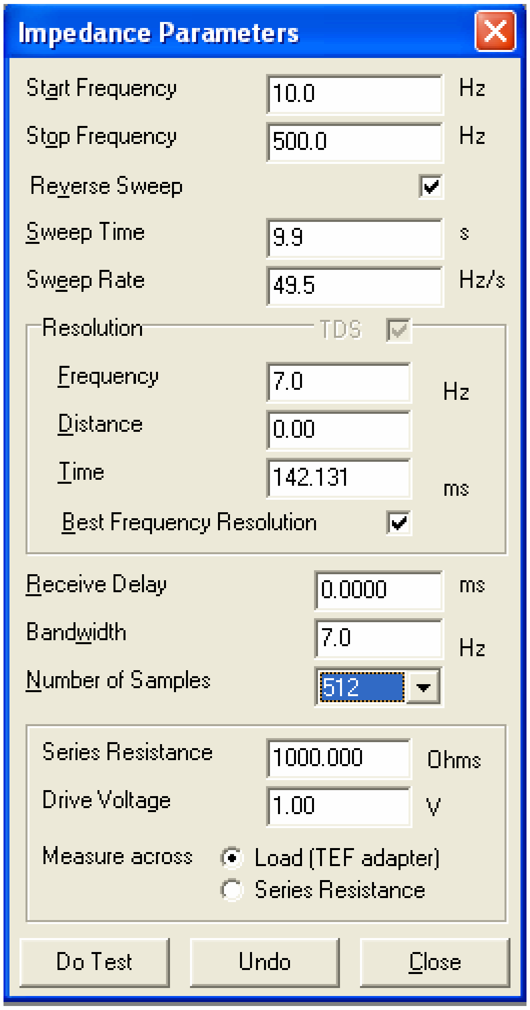

Figure 5 – Parameters for a low frequency impedance measurement

With these parameters the frequency resolution has increased from 44.9 Hz to 7.0 Hz. Quite a bit more detail can now be resolved. Moreover, the data point spacing is now approximately 1 Hz / point. The parameters in Figure 2 and Figure 4 yield a spacing of approximately 10 Hz / point. Again more detail can be resolved.

For even greater detail it may be necessary to increase the sweep time.

Other Applications

A rather out-of-the-ordinary use for impedance measurements is to make the measurement using the 3D Test parameters, not the Impedance parameters. This will allow one to investigate resonances in the impedance as a function of frequency and time. The receive delay is increased for each subsequent measurement so that a later time, after the test stimulus, is examined.

Since the Impedance section of SoundLab is not being used for this, the calculations to display impedance are not used. This needs to be kept in mind as the type of measurement configuration will affect what is actually displayed. If one configures the measurement using a current monitor, the current delivered to the load will be the measured quantity and this is what will be displayed. This is analogous to an admittance measurement. Accordingly, the display will look like an inverted impedance measurement. The Input Calibration settings should be similar to those shown in Figure 6. These parameters are for a current monitor with an output sensitivity of 0.10 volts/amp and a drive voltage of 2.83 volts. The Volts per Ref. Unit should be the reciprocal of the sensitivity. The Zero dB Ref. Value should be the drive voltage used.

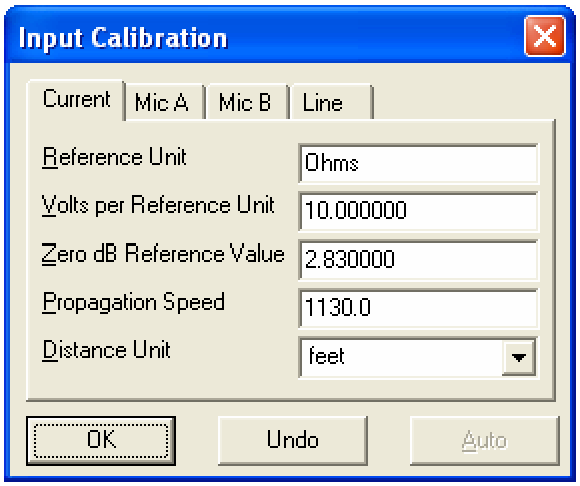

Figure 6 – Input calibration settings for using a current monitor

If, on the other hand, one wires the measurement using the series resistance method the voltage drop across the load will be the quantity measured. The display will be similar to an impedance curve. The Input Calibration settings should be similar to those shown in Figure 7. These parameters are for a 1.0 kΩ series resistor and a drive voltage of 1.00 volts. The Volts per Ref. Unit should be the reciprocal of the combined series resistance and output impedance of the driving amplifier. The Zero dB Ref. Value should be the drive voltage used.

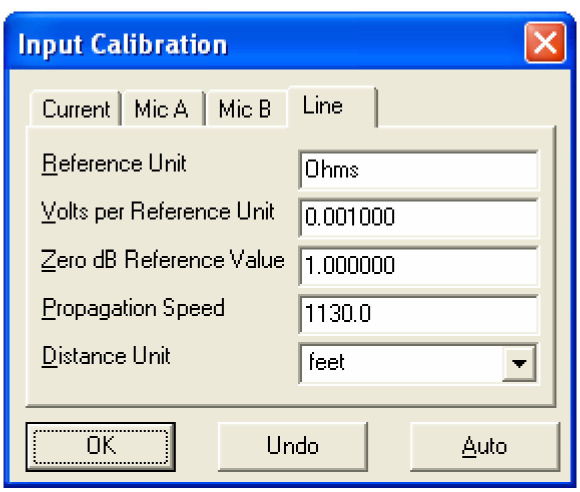

Figure 7 – Input calibration settings for using a series resistor