StudentZone—January 2018
ADALM1000 SMU Training
Topic 1: Voltage and Current Division

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By **Doug Mercer**

After the introduction of the SMU ADALM1000 in our *Analog Dialogue* December 2017 article, we want to start with the first of some small, basic measurements. You can find the previous ADALM1000 article here.

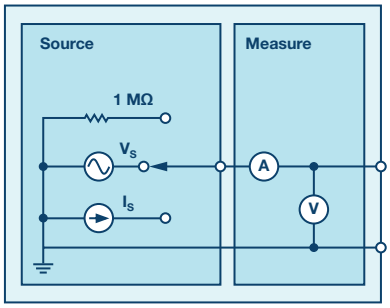


Figure 1. A schematic of the ADALM1000.

Now let's get started with the first experiment.

Objective

The objective of this lab activity is to verify the voltage and current division properties of resistor networks.

Background

Voltage and current division allow us to simplify the task of analyzing a circuit. Voltage division allows us to calculate what fraction of the total voltage across a series string of resistors is dropped across any one resistor. For the circuit of Figure 2, the voltage division formulas are:

$$V_1 = V_S\left(\frac{R_1}{R_1 + R_2}\right) \quad (1)$$

$$V_2 = V_S\left(\frac{R_2}{R_1 + R_2}\right) \quad (2)$$

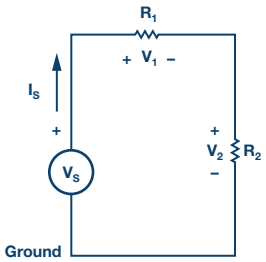


Figure 2. Voltage division.

Current division allows us to calculate what fraction of the total current into a parallel string of resistors flows through any one of the resistors.

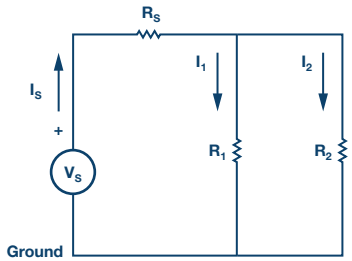


Figure 3. Current division.

For the circuit of Figure 3, the current division formulas are:

$$I_1 = I_S\left(\frac{R_2}{R_1 + R_2}\right) \quad (3)$$

$$I_2 = I_S\left(\frac{R_1}{R_1 + R_2}\right) \quad (4)$$

Materials

- ADALM1000 hardware module with installed ALICE software (see the Notes section at the end of this article).
- Various resistors: 470 Ω, 1 kΩ, 4.7 k Ω, and 1.5 k Ω.

Procedure

1. Verify the voltage division:

- a) Construct the circuit as shown in Figure 2. Set R_1 = 4.7 kΩ, R_2 = 1.5 kΩ, and use the fixed power supply 5 V as voltage source V_S.
- b) Use the ALICE desktop tool to measure voltages V_1 and V_2 with AWG Channels A and B in high-Z mode. The rest of the settings do not matter at this point. Under the **Curves** drop-down menu select **CA- V**, **CB-V**, **CA-I**, and **CB-I** traces for display. Or just click on **All** *to* select all four traces.

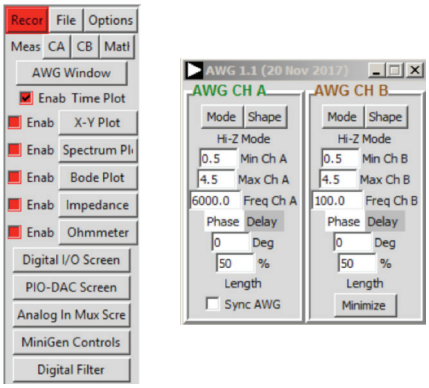


Figure 4. ALICE drop-down menus.

Under the **CA** and **CB Meas** drop-down menus, select **Avg** under the **-CA-V-** and **-CB-V-** sections to display the average voltages on each channel. Click on the green **Run** button to start taking measurements. The values will be displayed below the main grid.

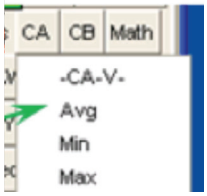


Figure 5. Main grid.

Repeat this step for $R_1 = R_2$ = 4.7 kΩ and write down the measurements.

- c) Calculate voltages V_1 and V_2 by using Equation 1 and Equation 2 in each case.
- d) Compare the results from Steps 1a and 1b.

2. Verifying the current division:

- a) Construct the circuit as shown in Figure 3. Set R_1 = 470 Ω, R_2 = 1 kΩ, and R_S = 470 Ω.
- b) Use the ALICE desktop tool to measure the currents I_S, I_1, and I_2. Connect the Channel A generator output as voltage source VS. Set CHA to source a dc voltage of 5 V. Use Channel B as an ammeter to alternately measure I_1 and I_2 by connecting the lower end of R_1 and R_2 to Channel B with Channel B set to 0 V.

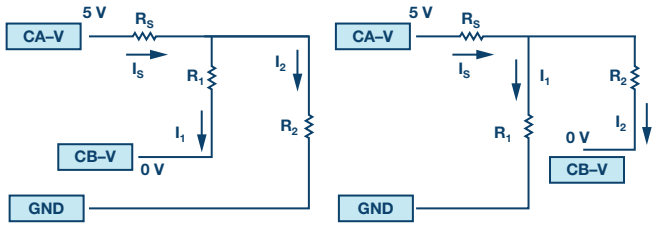


Figure 6. Measuring I_1 and I_2.

To display the average current in each channel, select **Avg** in the **-CA-I-** and **-CB-I-** sections of the **Meas** drop-down menus.

Figure 7. Meas drop-down menu.

Repeat this step by using $R_1 = R_2$ = 470 Ω and write down the measurements.

- c) Calculate the currents I_1 and I_2 by using Equation 3 and Equation 4.
- d) Compare the results from steps 2b and 2c.

Questions

- 1. How well did the measured outputs and calculated outputs compare? Explain any difference.
- 2. Can you apply current division to obtain I_1 and I_2 for the circuit shown in Figure 8? Explain briefly.

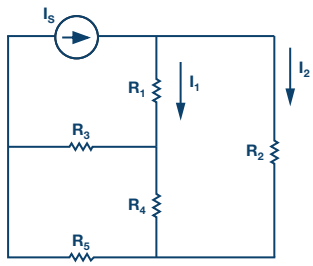


Figure 8. Example circuit.

Notes

As in all the ALM labs, we use the following terminology when referring to the connections to the ALM1000 connector and configuring the hardware. The green shaded rectangles indicate connections to the ADALM1000 analog I/O connector. The analog I/O channel pins are referred to as CA and CB. When configured to force voltage/measure current, –V is added as in CA-V or when configured to force current/measure voltage, –I is added as in CA-I. When a channel is configured in the high impedance mode to only measure voltage, –H is added as CA-H.

Scope traces are similarly referred to by channel and voltage/current, such as CA-V and CB-V for the voltage waveforms, and CA-I and CB-I for the current waveforms.

We are using the ALICE Rev 1.1 software for those examples here.

File: alice-desktop-1.1-setup.zip. Please download here.

The ALICE desktop software provides the following functions:

- A 2-channel oscilloscope for time domain display and analysis of voltage and current waveforms.
- The 2-channel arbitrary waveform generator (AWG) controls.
- The X and Y display for plotting captured voltage and current vs. voltage and current data, as well as voltage waveform histograms.
- The 2-channel spectrum analyzer for frequency domain display and analysis of voltage waveforms.
- The bode plotter and network analyzer with built-in sweep generator.
- An impedance analyzer for analyzing complex RLC networks and as an RLC meter and vector voltmeter.
- A dc ohmmeter measures unknown resistance with respect to known external resistor or known internal 50 Ω.
- Board self-calibration using the AD584 precision 2.5 V reference from the ADALP2000 analog parts kit.
- Alice M1K voltmeter.
- Alice M1K meter source.
- Alice M1K desktop tool.

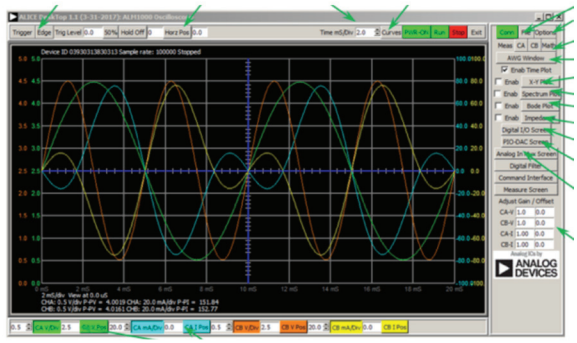
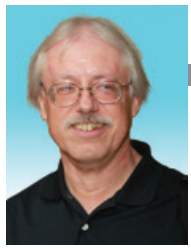


Figure 9. ALICE desktop 1.1 menu.

For more information, please look here.

Note: You need to have the ADALM1000 connected to your PC to use the software.

Doug Mercer [doug.mercer@analog.com] received his B.S.E.E. degree from Rensselaer Polytechnic Institute (RPI) in 1977. Since joining Analog Devices in 1977, he has contributed directly or indirectly to more than 30 data converter products and he holds 13 patents. He was appointed to the position of ADI Fellow in 1995. In 2009, he transitioned from full-time work and has continued consulting at ADI as a Fellow Emeritus contributing to the Active Learning Program. In 2016 he was named Engineer in Residence within the ECSE department at RPI.



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