StudentZone—December 2016
A Complete Circuits Laboratory on Your Desk, in Your Backpack, and on the Go

By **Walt Kester**

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How would you like to have a flexible electronic circuit laboratory that's portable, fits on your desk, and costs less than one or two engineering textbooks? Welcome to the new exciting world of the ADALM1000 Active Learning Module, better known as the M1K.

The M1K is an evaluation platform that helps introduce the fundamentals of electrical engineering concepts in a hands-on environment and allows you to experience real-time engineering design scenarios earlier in your education process. The M1K acts as a function generator, oscilloscope, spectrum analyzer, and digital multimeter, and it requires no additional hardware other than a laptop or tablet.

Figure 1. ADALM1000 (M1K) Active Learning Module.

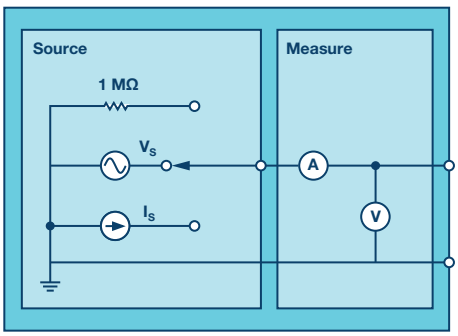


Figure 2. M1K simplified functional diagram showing one channel.

You can easily build your circuit using solderless breadboards and components in the ADALP2000 Analog Parts Kit, as described in last month's StudentZone column, and then test it with the M1K. You can even take the circuit and the M1K to class or lab in your backpack and demonstrate it to professors and students.

The ADALP2000 Analog Parts Kit contains a good selection of analog ICs, such as amplifiers and sensors as well as discrete components including transistors, diodes, resistors, capacitors, inductors, etc., in an easy to carry package. A complete parts list and ordering information can be found at the ADALP2000 product page.

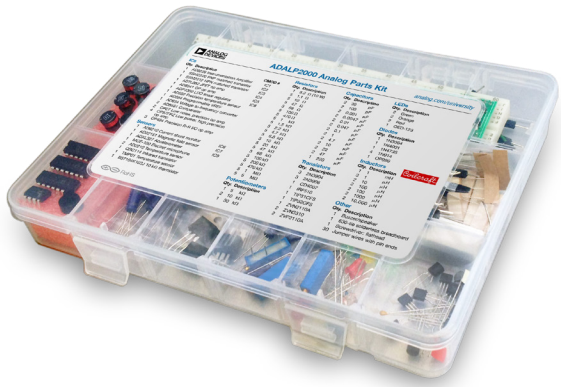


Figure 3. ADALP2000 Analog Parts Kit.

Doug Mercer, ADI Fellow, has some great suggestions for using the ADALP2000 Analog Parts Kit on his blog and how to supplement it with other useful inexpensive components:

https://ez.analog.com/community/university-program/blog/2016/07/14/beyond-the-adalp2000

What's Inside the M1K?

The M1K was designed by Analog Devices engineers and utilizes Analog Devices high performance, 16-bit data converters for signal generation and measurement, thereby eliminating the need for complex and expensive analog signal processing hardware. The M1K runs on the Pixelpulse2 software that features an innovative graphical user interface (GUI) to minimize the learning curve. The GUI enables you to learn faster, work smarter, and explore more.

Let's take a look at some of the key features of the M1K:

- USB interface for power and communications
- Two channels of signal generation—voltage or current output
- Two channels of signal measurement—voltage or current input
- DVM (voltage, current, ohmmeter)
- Voltage range: 0 V to 5 V
- Current range: –200 mA to +200 mA
- Function generator using 16-bit, 100 kSPS DAC
- Digital oscilloscope using 16-bit (0.05%), 100 kSPS ADC
- Digital spectrum analyzer: 16-bit (0.05%), 100 kSPS ADC
- Four digital signals
- Power supply outputs: 5 V at 200 mA, 2.5 V at 200 mA
- PixelPulse2 software (open source) supports Windows, Linux, OS X
- C, C++, and Python bindings

Getting up to speed and running with the M1K and PixelPulse2 software is easy and is described in the following link: http://www.analog.com/en/education/education-library/videos/4865877204001.html.

Analog Devices also has a number of online labs using the M1K and is continuously adding new ones.

The labs contain a video that walks you through various experiments using circuits of various degrees of complexity. The labs are available at the following link: https://wiki.analog.com/university/courses/engineering_discovery.

The following is an example of some of the M1K labs posted to the website:

- Introduction to Electronic Components and Equipment
- Introduction to RC Circuits
- LED Flasher
- Audio Amplifier with Microphone
- An Introduction to Electric Filters
- A Simple Magnetic Proximity Sensor
- A Simple Light Detector

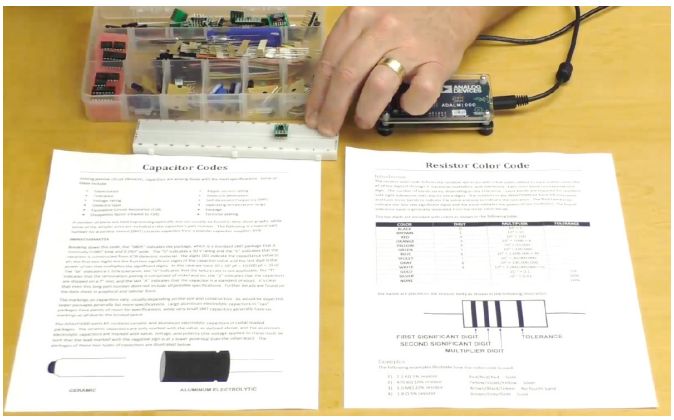


Figure 4. A set of online labs including videos are available for the M1K.

ALICE Software for M1K

For more advanced applications, the ALICE (active learning interface for circuits and electronics) software suite can be downloaded and installed: https://wiki.analog.com/university/tools/m1k/alice/desk-top-users-guide.

For an actual blogger's experience with ALICE, we recommend the following DESIGNSPARK link:

http://www.rs-online.com/designspark/electronics/eng/blog/fun-with-alice-and-op-amps

The ALICE software suite includes:

- 2-channel oscilloscope for time domain display and analysis of voltage and current waveforms
- 2-channel arbitrary waveform generator (AWG) controls
- X-Y display for plotting captured voltage and current vs. voltage and current data as well as voltage waveform histograms
- 2-channel spectrum analyzer for frequency domain display and analysis of voltage waveforms
- 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
- Board self-calibration using the AD584 precision 2.5 V reference from the ADALP2000 Analog Parts Kit

Coming Soon: The M2K (ADLM2000) with Expanded Analog and Digital Capability

With its sampling rate of 100 kSPS, the M1K is well suited for voice band and audio frequencies up to about 20 kHz. We realize that advanced signal processing requirements require higher sampling rates and are currently working on the next-generation learning module, the ADALM2000 (M2K) based on the AD9963 12-bit, low power, broadband MxFE (mixed-signal front end), which includes a 170 MSPS DAC, and a 100 MSPS ADC. These sampling rates allow generating and processing signals up to about 30 MHz.

The M2K has a dual-channel analog input and output, and it is configurable for multiple software-based instruments, including voltmeters, oscilloscopes, spectrum analyzers, function generators, arbitrary waveform generators, and network analyzers running on Windows, OS X, and Linux (via USB or Wi-Fi). The M2K will also have 16 digital I/O pins which can be configured for logic analyzers, digital pattern generators, or master/slave of common digital buses (I^2C, SPI, etc.). Being able to drive and measure analog, digital, SPI, I^2C, and other external peripherals via the digital I/O pins will allow students, makers, and enthusiasts to better understand the analog world around them. The M2K is expected to ship in December of 2016. Watch *analog.com* for further announcements.

Summary and Circuit Quiz Problem

We hope this column has been useful, and as always, please give us your suggestions at StudentZone. Let us know what thoughts you have regarding future topics or questions.

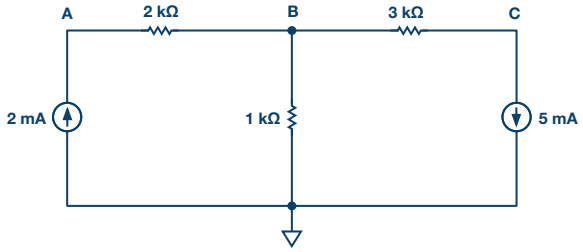


Figure 5. Calculate the voltages at A, B, and C with respect to ground.

Try and do this one in your head. Solution in the StudentZone forum on EngineerZone®.

References:

ADALM1000 (M1K) Active Learning Module. Analog Devices, Inc.

ADALP2000 Analog Parts Kit. Analog Devices, Inc.

Beyond the ADALP2000. Analog Devices, Inc.

Engineering Discovery Labs Using the M1K. Analog Devices, Inc.

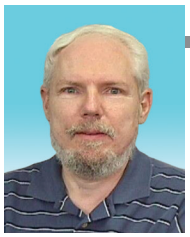
"Fun with ALICE and Op Amps." DESIGNSPARK Blog, January, 2016.

Introduction to the ADALM1000 SMU and PixelPulse Software. Analog Devices, Inc.

If you missed the first two StudentZone columns, you can find them here:

Kester, Walt. StudentZone: Introducing StudentZone. Analog Devices, Inc., October, 2016.

Kester, Walt. StudentZone: Breadboarding and Prototyping Circuits. Analog Devices, Inc., November, 2016.



Walt Kester

Walt Kester [walt.kester@analog.com] is a corporate staff applications engineer at Analog Devices. During his many years at ADI, he has designed, developed, and given applications support for high speed ADCs, DACs, SHAs, op amps, and analog multiplexers. An author of many papers and articles, he prepared and edited 11 major applications books for ADI's global technical seminar series; topics include op amps, data conversion, power management, sensor signal conditioning, mixed-signal circuits, and practical analog design techniques. His latest book, *Data Conversion Handbook* (Newnes), is a nearly 1000-page comprehensive guide to data conversion. Walt has a B.S.E.E. from NC State University and an M.S.E.E. from Duke University.