Standalone digital voltmeter uses a multichannel ADC

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This Design Idea was realized for voltage/current measurement on a four-channel analog voltage source but has wide use in many other applications. The design is based on the Atmel ATmega8-16AC microcontroller and the Maxim MAX1230 12-bit ADC (references 1 and 2). Although the microcontroller has an internal 10-bit ADC, it’s more efficient to use an external multichannel ADC than to multiplex more analog channels to the ATmega8-16AC differential ADC inputs.

You accomplish the communication between IC₁ and IC₂ via the SPI according to the instructions in Reference 2. R₁₇ and R₁₈ are pull-ups for the end-of-conversion flag and chip-select modes. Signals for the SPI communication are tapped at header P₄ for a programmer connection. Pushbutton S₂ connects the IC₂ reset pin to ground; R₂₂ and C₄₂ debounce IC₂. Similarly, R₁₉ and C₃₉ debounce the auxiliary S₁ button connected to the INT0 pin of IC₂, which is used to switch between resolution patterns on the display.

IC₂ pins 23 to 28 are used through P₂ for communication with the 20×2-character BC2002CBNHEH LCD Bolymin display (Reference 3). Trimpot R₂₁ sets the display contrast. You can use IC₂ outputs RXD and TXD for USB communication via an optional USB-to-UART interface, such as the FTD232BM (not shown in Figure 1), for the purposes of data logging.
IC₁ analog inputs AIN0 to AIN15 are connected to eight voltage dividers R₁ to R₁₆. The divide ratios depend on the maximum input voltage to be measured. Also, you should take into account the reference voltage on pin REF+ to use the full bit resolution of the ADC. The IC₁ analog inputs work in track-and-hold mode, so input impedance can affect the conversion acquisition time. As a result, input capacitors C₁, C₂, and C₃, with values according to Reference 2, are used for differential inputs AIN0 and AIN1 on IC₁, and the same input capacitor arrangement is repeated for the other analog inputs. IC₁ has a sampling rate up to 300k samples/sec, so you can digitize low-speed transient events and measure periodic signals with bandwidths exceeding the ADC’s sampling rate by using undersampling techniques. Also, antialias prefiltering of the input signals is necessary.

Shunt regulator IC₅ generates the external 1.25V REF+ for IC₁ using R₂₄ and R₂₃ to set the appropriate current consumption according to Reference 4. Select power transformer TR1 for your local ac voltage (the schematic shows 230V ac with a 0.25A fuse) and fuse appropriately; that is, 0.5A when used at 120 V ac. The transformed voltages are rectified with diode bridges D₁ and D₂ and stabilized with 7805 series regulators. One 5V branch is used directly to supply the multichannel voltmeter; the other is auxiliary for global use.

Code listings for IC₂ are available here. This work was supported by the Slovak Research and Development Agency under contract No. APVV-0062-11.

References
1. “ATmega8-16AC: 8-bit with 8K Bytes In-System Programmable Flash,” Atmel Corp.