TEST YOUR MULTIMETER WITH THIS PRECISION VOLTAGE REFERENCE

By Bruce Pierson

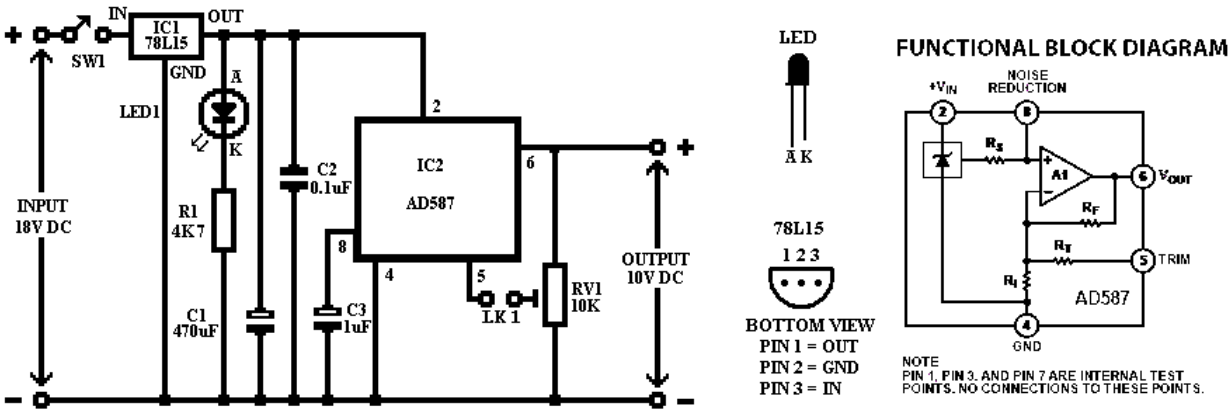
Above: This cheap multimeter proved to be surprisingly accurate

Multimeters have been been around for decades now and most people use a digital multimeter these days, as these are now commonplace, with the older style analogue instruments being few and far between now.

You might be impressed to get readings such as 5.02V on your digital display, whereas with an analogue meter, you'd be hard pressed to determine such an accurate reading. But, just how accurate is your multimeter? After all, it came from the factory with a set accuracy, depending on its price and after years of use, the accuracy may not be as good as when it was new. More expensive multimeters would be expected to have a much higher accuracy than a cheap, bargain shop version, but even the most expensive multimeter is not 100% accurate.

Multimeters can be sent for re-calibration, but the cost of this service would usually be more than the value of the instrument, particularly the cheaper ones. At least now it's possible to check the accuracy of a multimeter on the DC voltage ranges, with this cheap and easy to construct precision voltage reference.

What is a precision voltage reference, you ask? It is a source of voltage that is very accurate to a very fine tolerance. This circuit uses an AD587K high precision 10V reference, which is accurate to .005V, with an output current of up to 4mA, which is more than adequate for instrument testing.



Reference: ANALOG DEVICES AD587

The circuit is powered by two 9V alkaline batteries which provide power to the 78L15 voltage regulator, which provides 15V to the AD587 IC, which in turn provides 10VDC to the output terminals. The voltage provided by the AD587 will be between 9.995VDC and 10.005VDC, which is the accuracy of the device. Trimmer potentiometer RV1 can be connected to the circuit by Link LK1, to enable fine tuning of the output voltage to exactly 10.000VDC if access can be gained to a calibration voltmeter. Most people cannot gain access to such a device, so LK1 is left open. RV1 can actually be left out of the circuit completely if calibration is not planned, but it's handy to have the ability to do the fine adjustment if the opportunity ever arises.

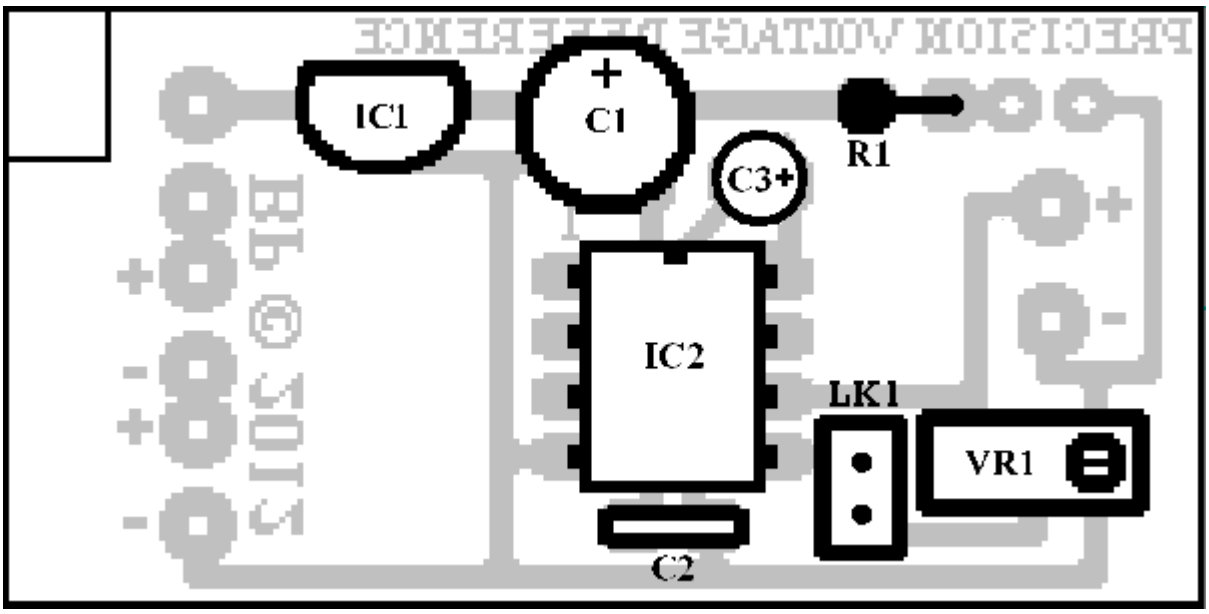
The AD587 uses a proprietary ion-implanted buried Zener diode and laser wafer trimming of high stability thin-film resistors, to provide a very accurate output. The buried Zener provides lower noise and drift than band gap voltage references and the AD587 has a noise-reduction pin (pin 8) that can be used to further reduce the noise level generated by the buried Zener by the use of a bypass capacitor to ground.

The laser trimming of both initial accuracy and temperature coefficients results in very low errors over a wide temperature range without the use of external components. The AD587K has an operating range of between −40°C and +85°C., which is well outside the operating range of this use of the device.

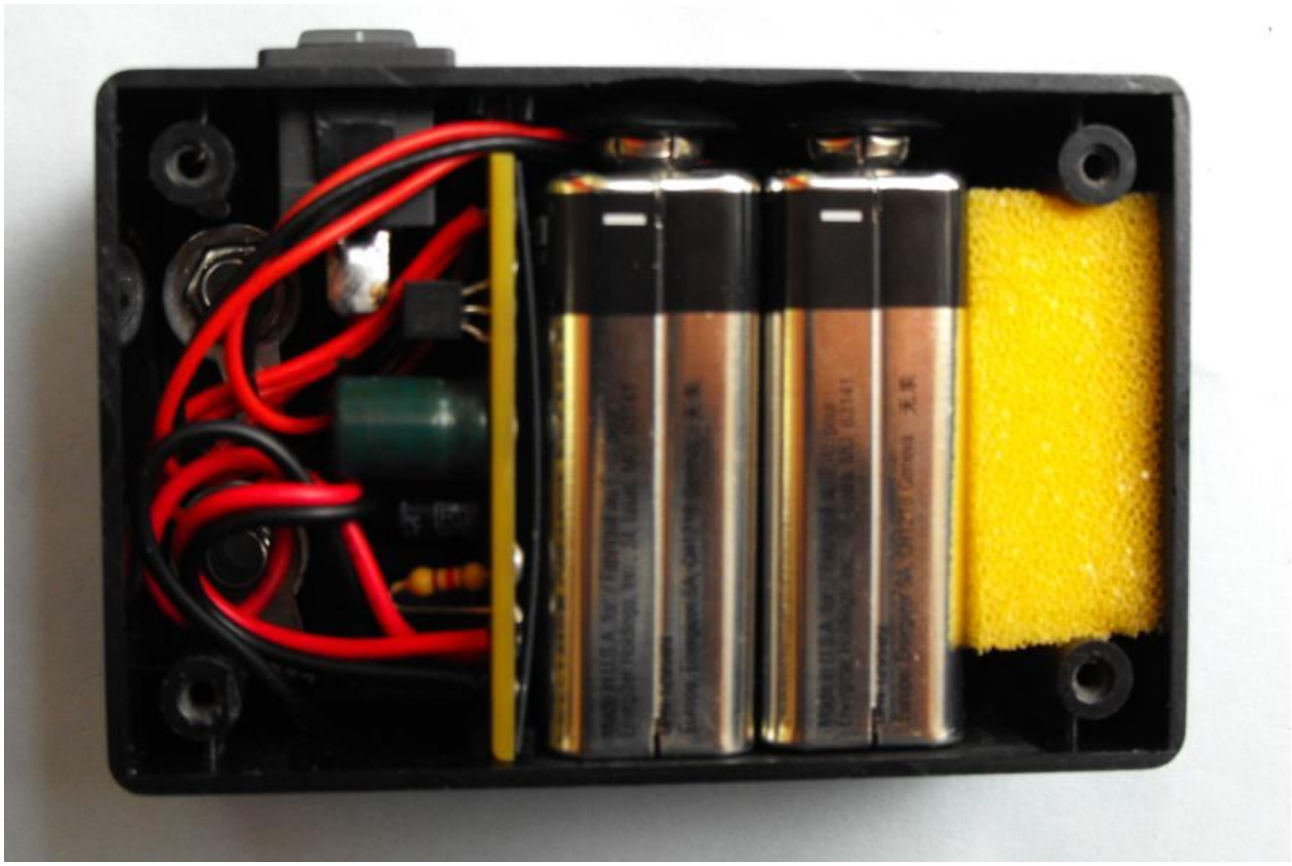
CONSTRUCTION

The components are mounted on a printed circuit board, measuring 50mm x 25mm, which is designed to fit neatly into a UB5 Jiffy Box. Construction is straightforward, but care must be taken with the orientation of IC1 and IC2 and the two electrolytic capacitors, C1 and C3. It is recommended to use an IC socket for IC2, considering that we are dealing with a very precisely accurate component here and overheating it during soldering could adversely affect its correct operation. The AD587 is static sensitive, so appropriate care needs to be taken to prevent electrostatic damage to the device.

Note that the top left-hand corner of the PCB is removed to make provision for the battery cables.



PREPARING THE JIFFY BOX



The componentry inside the jiffy box is quite a compact fit and must be assembled in the correct order. First, prepare the jiffy box by drilling the required holes. Start with the two banana sockets. Select a drill bit that will neatly fit the inside of the banana socket without damaging it. Push each banana socket in turn into the corner of the box and drill through it onto a block of wood. These holes are then reamed to size with a tapered reamer or filed to size with a round file and the banana sockets fitted.

Next, determine the position for the Power LED and drill and ream the hole to the correct size to accommodate the LED holder. The hole for the Power Switch can then be drilled and filed, taking care to position the hole in such a way that the power switch will not foul any of the internal components.

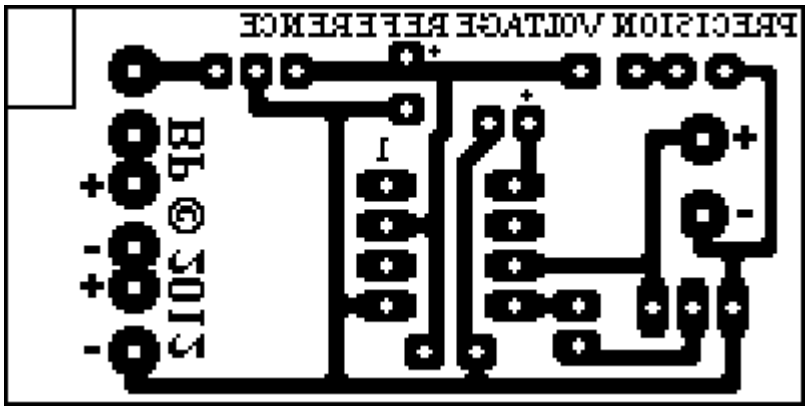
The battery snaps need to be the type that have the wires through the centre of the snap, not at the end. Some modification is required to the Jiffy Box in order to accommodate the batteries without spreading the sides of the box. A sharp knife can be used to form a slight hollow for the battery snaps and to remove a thin layer at the other end of the battery section.

Next, take the lugs off the banana sockets and solder wires to them. This prevents melting the sockets, which would happen if the lugs were soldered while still on the sockets. Reassemble the lugs onto the banana sockets after soldering. Connect all the wiring to the PCB and file the soldering on the back of the PCB flat, to around 1mm thick. Install the LED holder and push the LED into it. Install the PCB and place the sheet of insulating plastic behind it to prevent the PCB shorting on the battery. Then solder the wires to the switch and install it. The batteries are then installed. Note that the wires from the second battery pass between the snap and the battery of the first battery. A piece of sponge is inserted behind the second battery to prevent movement of the batteries in the box.

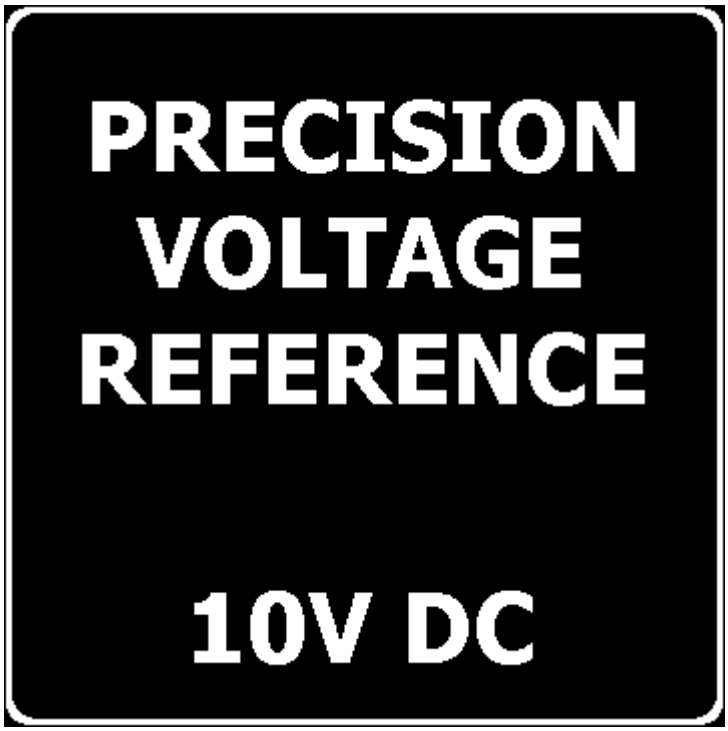
PARTS LIST

1 PCB measuring 50 x 25mm
1 piece of insulating plastic 50mm x 25mm
1 UB5 Jiffy Box
2 banana sockets – 1 RED, 1 BLACK
1 set test leads – banana plugs to alligator clips
1 5mm red LED with LED holder
1 AD587K IC with 8 pin IC socket
178L15 Voltage Regulator
1 4k7 5% carbon resistor
1 10k multi-turn trimmer potentiometer (optional)
1 Link Header with 1 Link (optional)
1 470µF Electrolytic Capacitor
1 1µF Electrolytic Capacitor
1 0.1µF greencap (miniature type) or MKT
1 slimline Power Switch SPST rocker type
2 9V Alkaline Batteries
2 Battery Snaps (Type with wires in the middle of the snap, not at the end)
1 piece of sponge to hold the batteries in place

The PCB artwork is supplied in mirror format at twice actual size. When printing the artwork, print at 50% to ensure that the artwork will be the correct size when printed.



The front Panel Artwork is supplied at twice actual size and needs to be printed at 50% to ensure the correct size for the label.



References

Reference is made to the ANALOG DEVICES AD587 data sheet. Some text in this article is copied from this data sheet and the schematic of the FUNCTIONAL BLOCK DIAGRAM is also from the data sheet.