

Add-On Digital Voltmeter

Strictly for those who love to build it themselves.

While building a power supply for use in the shack lately, I thought that it would be nice to have a way to know what the voltage on the output was. Since the supply that I was constructing was going to have a variable output, this would add a nice feature to it. I could use a standard-type meter, commonly found at parts stores or mail order catalogs, but I thought that I would "dress" it up a little and opt for a digital-type display. This would be a more accurate way to measure, if I ever needed to do so.

I started to search for a way to accomplish this. I could purchase a digital display ready to go from a box, but being of the building type, I feel guilty when I do this sometimes. I decided that I could build this feature also, if I could find some information on the subject. While looking at an older IC data book, I ran across an analog-to-digital converter that would do the job nicely. And the best part was that it did not use any very expensive parts. A quick check in some parts catalogs and on the Internet told me that the parts I was looking for were still around.

The IC of choice is an analog-to-digital converter, the CA3162E, that does the nice job of providing an output to drive a display driver, the CA3161E, and displays the information on a 3-digit digital display. Just the thing to keep an eye on our output voltage, while it is being varied.

The range of the finished "Add-On Digital Voltmeter," as built, will display any voltage in the range of 0–99.9 volts. It will also show an over-range condition with EE.E on the display. But this feature would probably not be a concern, as our variable power supply could not reach this amount on its output.

Refer to the schematic diagram, **Fig. 1**. The power to supply the "Add-On Digital Voltmeter" can be supplied from a separate DC voltage source or, as in our case, directly from the source that it is measuring. About 10–15 volts is good to work with. This will keep our "on board" voltage regulator, U3, happy. The input voltage to the regulator is polarity-protected by the diodes D1 and D2. The 5 volt regulated output

is supplied to the A/D converter U2 and display driver U1, respectively. It is also used in the voltage divider circuit of R1, R2, VR3 for use as a 0.9 volt calibration source. (More on this later.) Resistors R3, R4, VR4 form a voltage divider circuit to "scale" our input voltage that we wish to measure down to a level that can be safely used at the input of our A/D converter.

One critical component is C3. A

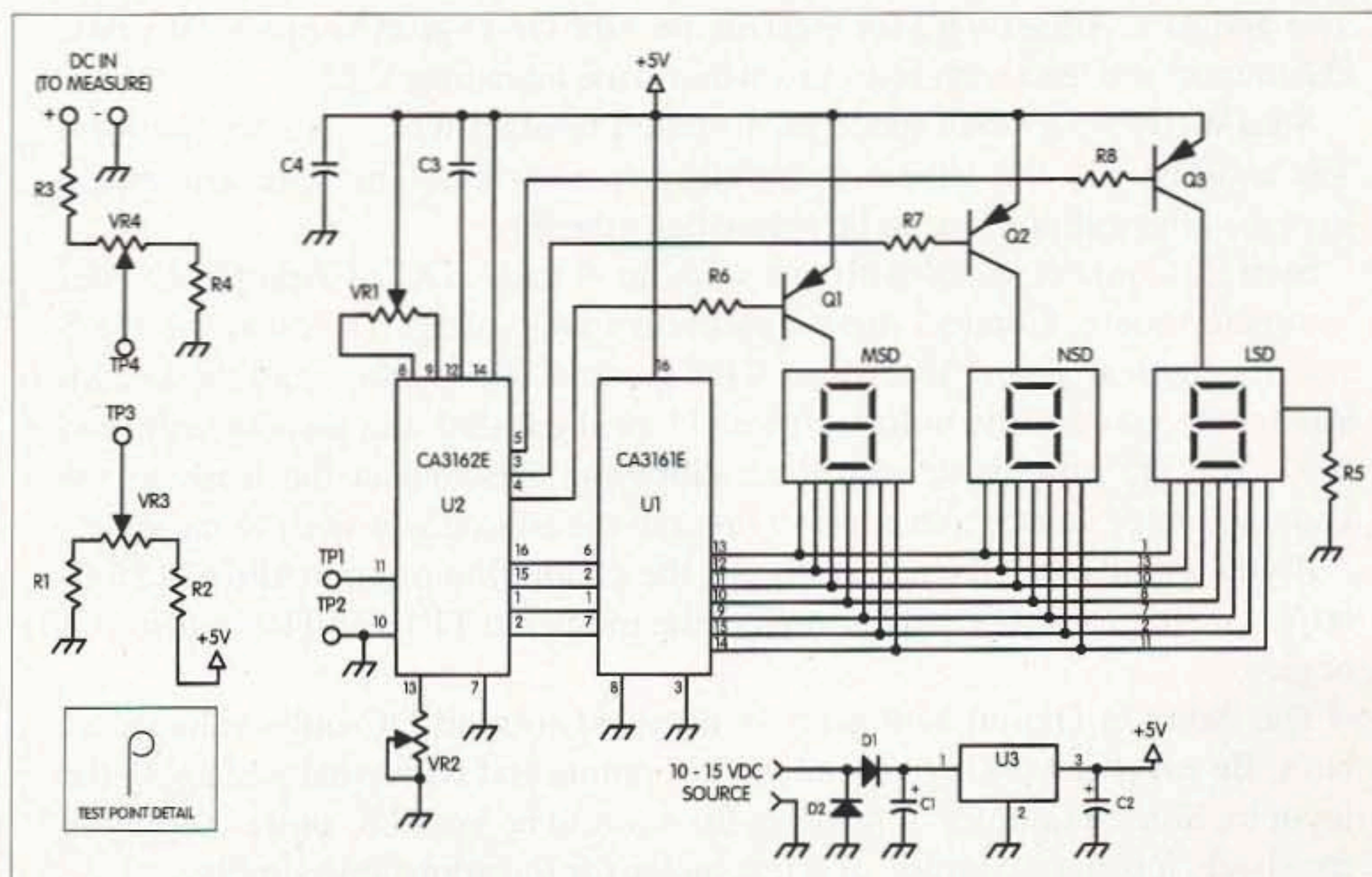


Fig. 1. Add-on digital voltmeter schematic.

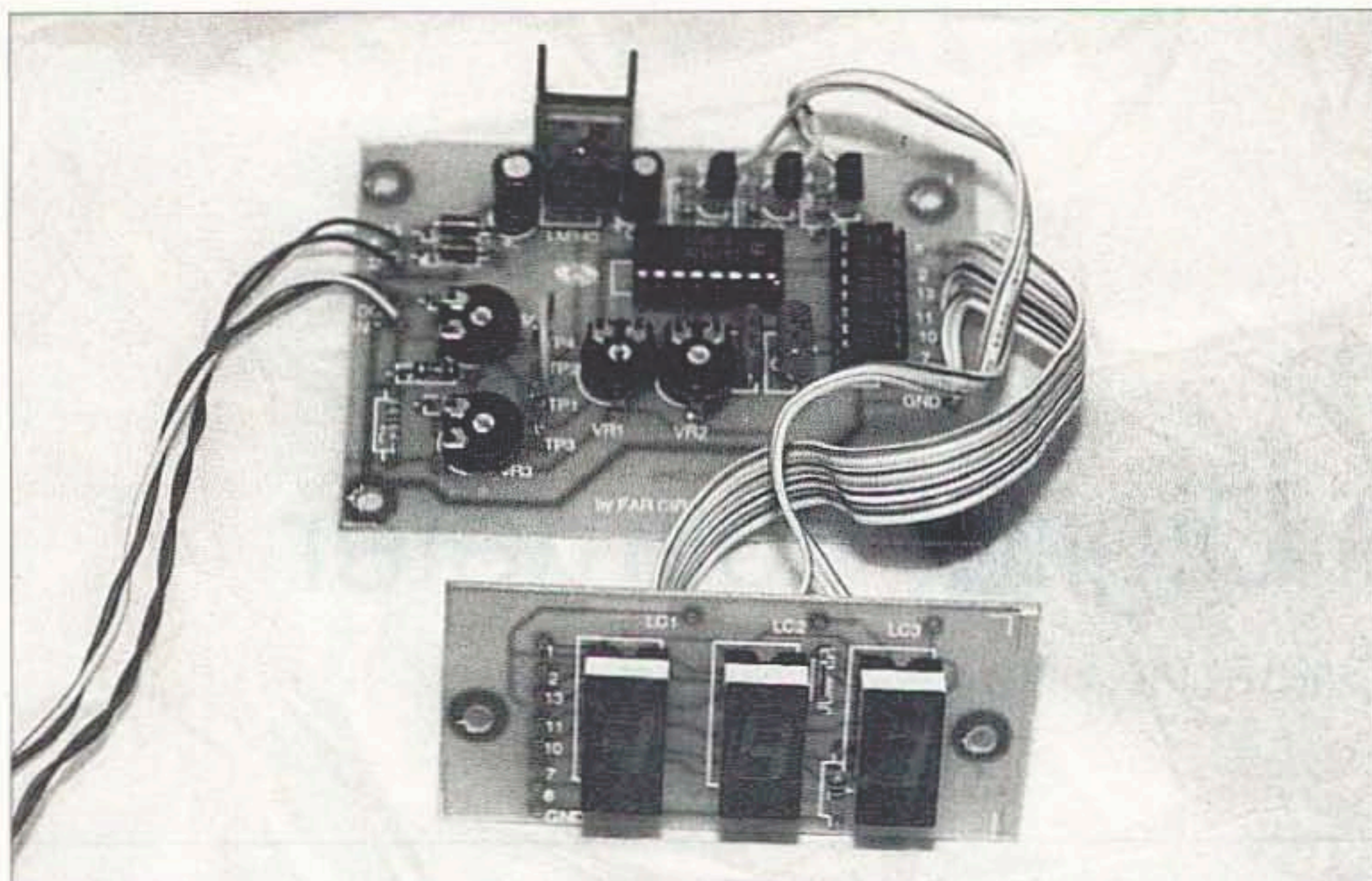


Photo A. Finished voltmeter showing digital display.

high-quality polyester type should be used here, as this component is used for timing by the A/D converter. Q1, Q2, Q3, are used as digit drivers, while

the outputs of the display driver, pins 9-15, are wired to the common anode displays in multiplex fashion. Test points, shown on the schematic, will be

Calibration Instructions

You will need to use a digital voltmeter to make some of the adjustments. Set the trimmer potentiometers VR1-VR4 to their center positions as a starting point.

Step 1. Provide 10-15 volts to the PC board at + and - VDC.

Step 2. Check output at U3, pin 3 for 5 volts.

Step 3. The display should read EE.E

Step 4. Attach a test lead with clips between TP1 and TP2. Adjust VR1 for a display of 00.0, then disconnect the test leads from TP1 and TP2.

Step 5. Attach a digital voltmeter (DVM) from TP3(+) and TP2(-). Adjust VR3 for 900 millivolts (.900 on the meter you attached). Disconnect the test leads to this meter when done adjusting. Attach test lead with clips between TP3 and TP1. Adjust VR2 for 90.0 on the Add-On Digital Voltmeter display. Disconnect the lead with test clips when done adjusting VR2.

Step 6. Using a small piece of insulated hookup wire, connect (jumper) TP1 and TP4 with this wire and carefully solder in place. This wire will remain in place after calibration, so be neat when attaching.

Step 7. Connect wires with test clips to + and - DC of Add-On Digital Voltmeter board. Connect these to a known DC voltage. You can use the 5 volt regulator if you wish. Adjust VR4 to make the display read the known voltage. If you use the voltage from U3 as suggested, the display will read 05.0. You are now done with the calibration. Disconnect the leads to the known voltage source and connect them to the source you wish to measure.

If you would ever like to "touch up" the calibration of your Add-On Digital Voltmeter, remember to disconnect the jumper at TP1 and TP4 before you begin.

The Add-On Digital Voltmeter is intended to read DC-only voltages as built. **Be careful** working around the test points and with what you apply the input to. Some examples of possible uses would be your DC power supply in the shack, a battery charger, or a test meter for the adjustable supply.

| Quantity | Name | Description |
|----------|------------|--|
| 3 | | Common anode displays, 0.3", left-hand decimal points, HP #5082-7610 or MAN3620A or equivalent |
| 1 | U1 | CA3161E BCD-to-7-segment decoder |
| 1 | U2 | CA3162E A/D converter |
| 2 | | 16-pin IC sockets |
| 1 | U3 | LM340T5 +5 V regulator |
| 3 | Q1, Q2, Q3 | 2N3906 PNP transistors |
| 2 | D1, D2 | 1N4001 diodes |
| 1 | VR1 | 50k 10mm-style trimpot, Piher #PT10, horizontal (same for all trimmers) |
| 1 | VR2 | 10k 10mm-style trimpot |
| 2 | VR3, VR4 | 1k 10mm-style trimpot |
| 1 | R1 | 270 ohm 1/4 W resistor (all resistors carbon film 5%) |
| 1 | R2 | 2200 ohm 1/4 W resistor |
| 1 | R3 | 100k 1/4 W resistor |
| 1 | R4 | 680 ohm 1/4 W resistor |
| 1 | R5 | 100 ohm 1/4 W resistor |
| 3 | R6, R7, R8 | 4.7k 1/4 W resistor |
| 1 | C1 | 100 μ F 25 V electrolytic capacitor |
| 1 | C2 | 10 μ F 25 V electrolytic capacitor |
| 1 | C3 | 0.27 μ F 50 V polyester PC-mount capacitor |
| 1 | C4 | 0.1 μ F 50 V polyester PC-mount capacitor |
| 4 | | 1/2"-long wires, formed as shown in Fig. 2 (use clipped resistor leads) |
| 1 | | PCB or perfboard. PCB available from Far Circuits, 18N640 Field Court, Dundee IL 60118-9269, \$2 per set of 2. |
| 3 | | 14-pin IC sockets for displays |
| 1 | | Heatsink for regulator, Aavid #5971B used in model |

Optional parts: Connector for input voltages to PCB; enclosure; hookup wires; short length of ribbon-type cable. Parts can be obtained from a number of sources, including Jameco, Mouser, and Digi-Key.

Table 1. Parts list.

used during calibration — this makes finishing up your "Add-On Digital Voltmeter" easier. The test points are simply resistor leads with loops formed in one end, soldered into the PC board.

Constructing the "Add-On Digital Voltmeter" is very easy. The circuit

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can be laid out using perforated PC board, as was our first version, with copper on one side to solder our components. Or, a PC board set can be purchased — etched, ready to mount the components to, with a component silk-screen showing the layout of the parts. The purchased set includes two boards. One is for the separate display, which is nice because you will want to place this part in a window, to view it from. A clear plastic window or colored plastic display filter can be used to give the display a finished look. Either way is nice and, depending on your desires, you may decide to place everything on one board. Refer to the parts list for information on how to obtain the purchased set.

An interconnecting wire harness, or ribbon cable, can be used to connect the display portion of your project to the main PC board. Depending on your application, the desired length can be determined.

After assembly of the “Add-On Digital Voltmeter” is completed, you should double check your soldering, component layouts, and common construction faults. Be sure to use caution, when inserting the ICs in their sockets, to observe the correct locations of the number 1 pins. Refer to the Calibration Instructions to complete your project.

After calibration and installation of your “Add-On Digital Voltmeter,” you can easily check the voltage you are measuring. The places you will find to use the “Add-On Digital Voltmeter” are limitless around the shack or workbench. I’m sure that you will find a nice use for this project, and enjoy building it as I have.