LED Bargraph Indicator

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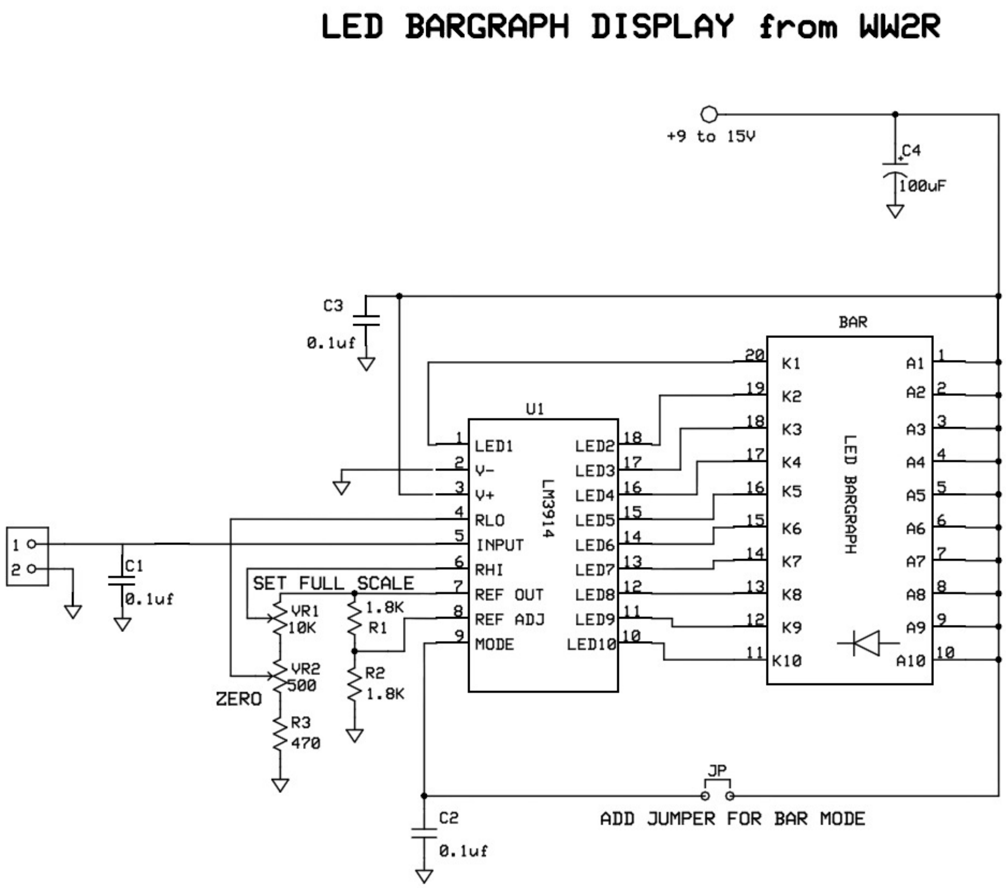
The LED bargraph indicator is a convenient display for quickly and unambiguously indicating something, for example, RF power, voltage, current, temperature, or VSWR. It is particularly useful with some of the newer RF detector ICs which have an output which is linear in dB, typically 25 millivolts per dB. The LED bargraph has 10 LED steps; the indicator circuit spaces them evenly with voltage, so each step can be the same number of dB, 1 dB per step, or 2, or 10 dB – whatever suits your fancy. Many of the detector chips, like the AD8307, good to 500 MHz, or the AD8318, good to 8 GHz, have an accurate range near 60 dB, so 6 dB per step (like an S-meter) would cover the whole range. Even better is the AD8317, good to 10 GHz, with a slightly smaller dynamic range of about 50 dB. Many of the higher frequency versions use a tiny surface-mount package which would be difficult to solder, but they may be found on ebay already assembled on PC boards at very reasonable cost.

The LED bargraph indicator uses a modification of a circuit by Dave Robinson[1], WW2R. The basic circuit is used in the model RFPM from Down East Microwave (www.downeastmicrowave.com). The modification is for compatibility with RF detector ICs like those from Linear Technologies (www.linear.com) and Analog Devices (www.analog.com) which have an output voltage greater than zero with no RF applied. Fortunately, the LM3914 bargraph chip can be configured to deal with this voltage offset. In my prototype Portable RF Sniffer and Power Meter[2], I hacked up an RFPM board to provide an LED readout with voltage offset. An improved version of the Power Meter is available from Down East Microwave[3] as the ABPM (All Band Power Meter). More recently, when I was assembling the Homebrew Antenna Ratiometer[4], the RFPM board did not fit in the available space, so I made a smaller PC board with only the components required for the power detector application.

The circuit is shown in the schematic diagram, Figure 1. There are two trimpots: one sets the zero offset, so that the first LED bar does not light until RF is detected, and the other sets the full scale reading. In some places, I prefer to set the zero so that the first LED bar is always lit, as a free pilot light, and the second bar lights at the first hint of RF. LED brightness is controlled by R1 and R2, which should be of equal resistance: make them a little smaller for more brightness, or a bit larger to dim the display and reduce current drain. A larger power savings is possible by using dot mode – with the jumper "BAR" removed, only one LED lights at a time, like a meter pointer; I prefer the continuous bar display.

As I have used more of these displays in various applications, I found that changing VR2 to 1K and R3 to zero ohms (a wire) provides more flexibility in setting the desired range. VR2 is set for the minimum where the first LED lights, and VR1 for the full scale with all LEDs lit. There seems to be a bit of interaction, but it doesn't take long to get it right.



VR2 – see text

Figure 1 – Schematic of LED Bargraph Display

Figure 2 is a photo of a completed unit, top and bottom. Depending on how you wish the bars to display, the LED bargraph and the trimpots may be mounted on either side of the board – just make sure that the pin 1 side of the bargraph is at the edge of the PC board. If the bargraph LEDs are all red, then orientation doesn't matter, but the multi-color version will reverse colors depending on orientation (I haven't figured out which way is which). Component locations are marked in silkscreen on the PCB, so assembly should be straightforward. Note that R3 is a wire, zero ohms, as described above.

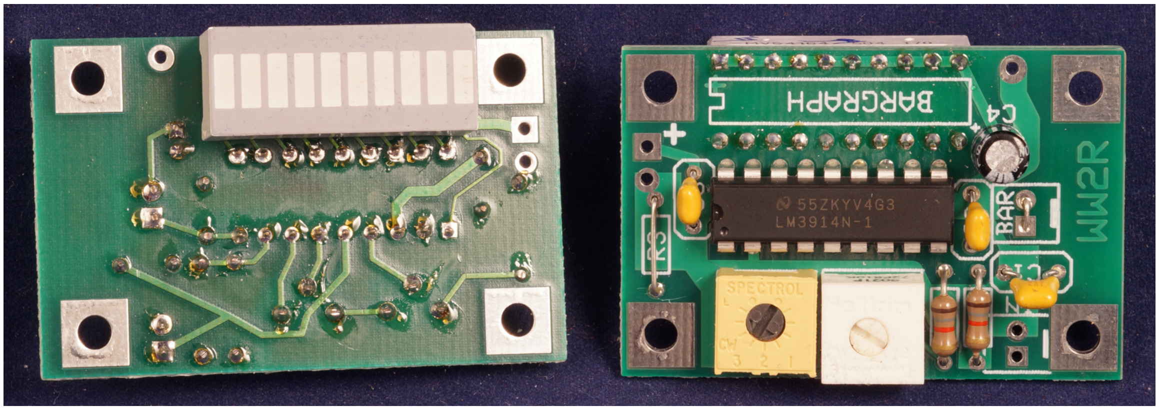


Figure 2 – LED Bargraph Display, top and bottom

Recently I was mounting a bargraph display in a tight space, to fit over an existing hole in a previously used cabinet. The only way to adjust the trimpots is vertical, parallel to the PC board, so I used right-angle trimpots and mounted them on the back of the board, as shown in Figure 3. They would be adjusted from the bottom of the photo.

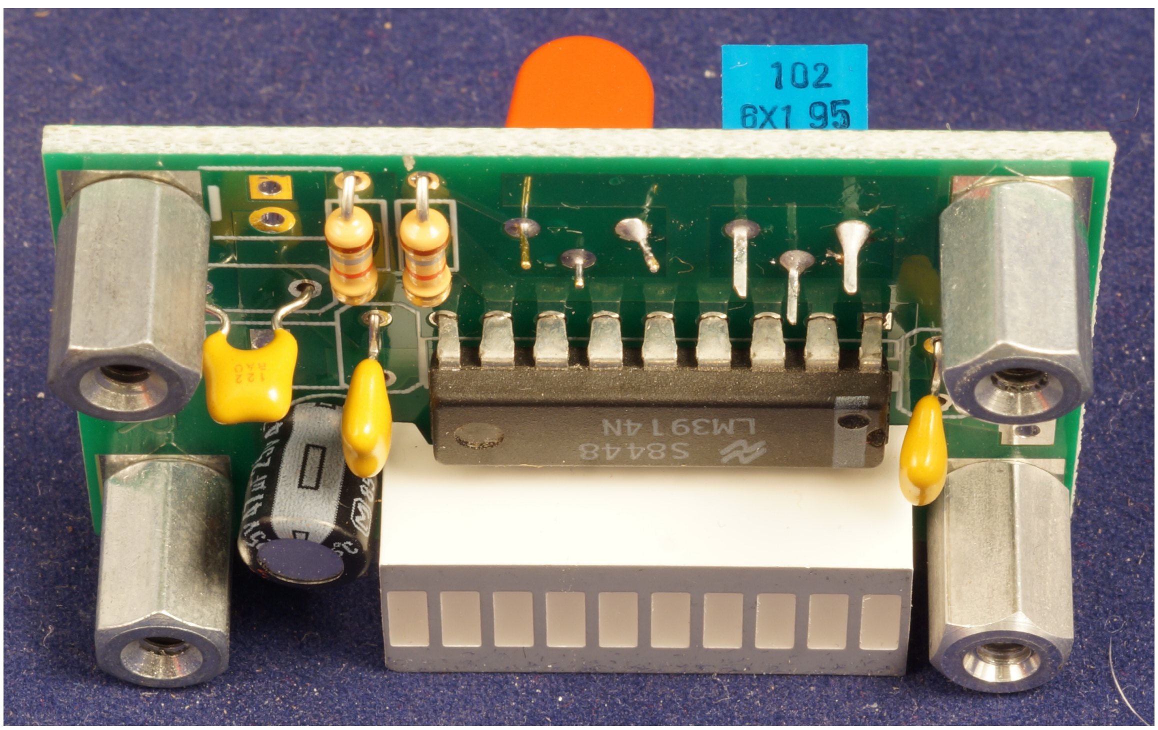


Figure 3 – LED bargraph indicator with right-angle trimpots for tight space

Printed-circuit boards are available, and all the other parts are common ones. The LM3914 bargraph driver IC is an old one, but still available. One good source is Jameco Electronics (www.jameco.com).

References:
1. Dave Robinson, WW2R, "A LED Power Meter for Roving Operations," *Proceedings of the 29th Eastern VHF/UHF Conference*, ARRL, 2003.
2. Paul Wade, W1GHZ, "Portable RF Sniffer and Power Meter," *Proceedings of the 30th Eastern VHF/UHF Conference*, ARRL, April 2004, pp. 60-69.
3. www.downeastmicrowave.com
4. Paul Wade, W1GHZ, "Antenna Ratiometry Measurements For the 21st Century Using a Homebrew Ratiometer," *Proceedings of the 30th Eastern VHF/UHF Conference*, ARRL, April 2004, pp. 60-69.

Appendix – Simple RF Power Monitor

For a recent transverter project, I wanted to monitor output power and display it on an LED bargraph, but I didn't want the size and complexity of a directional coupler. I remembered seeing something on the AD8307 data sheet (www.analog.com) – measuring power using a resistive divider, in Figure 41. The RF detector chip is connected by a 100K resistor, which forms a resistive divider with the 50 ohm input resistor at the detector, so that the RF voltage reaching the detector is roughly 60 dB down. The 100K resistor adds minimal loading to the 50 ohm circuit, and the stray capacitance is negligible at VHF. A quick test with a 47K resistor gave about 50 dB attenuation, so I used 10K, shown in the closeup photo, for this 30 watt module. Figure A shows the 10K resistor right at the output SMA connector with a short coax connection to an AD8307 detector board from China; they sell the whole board for less than the price of the IC alone.

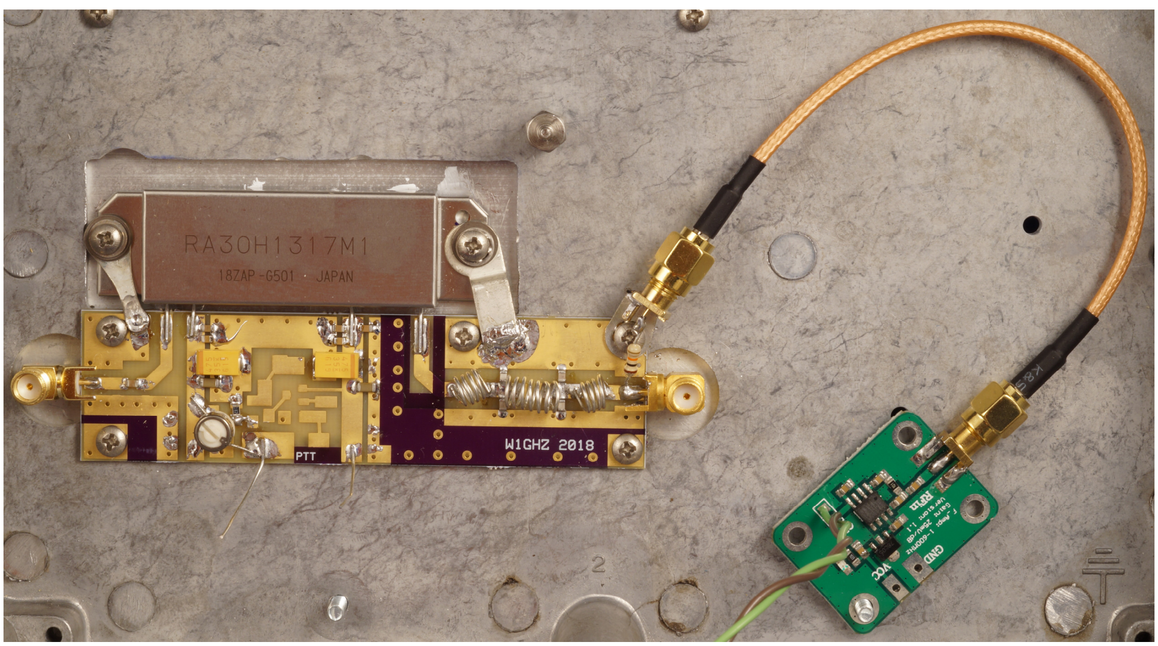


Figure A – Simple RF power detector with resistive divider