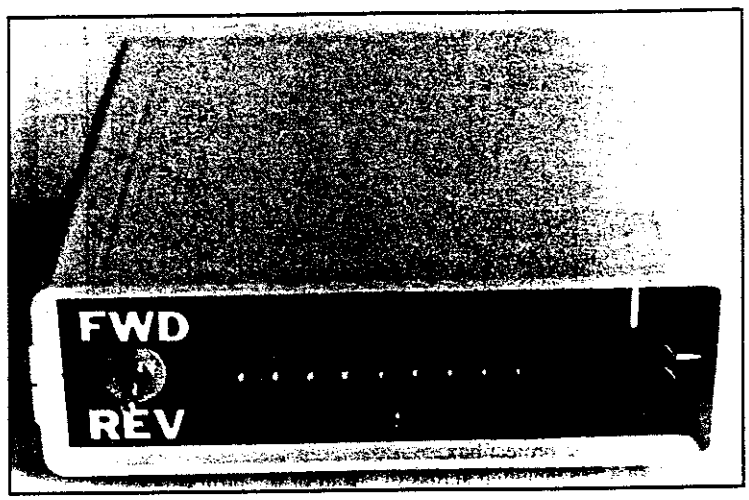
By Art Rideout, WA6IPD

A Simple LED SWR/Power Meter



Most analog SWR/power meters display *average* power readings. Their mechanical meter movements simply cannot react fast enough to show power fluctuations that take place in fractions of a second. When you speak into the microphone of an SSB transceiver, for example, the output power bounces up and down in sync with your voice. Maximum output occurs at split-second amplitude peaks. You'll never see these with an ordinary SWR/power meter. If you want to get a handle on the true output performance of your transceiver, you need a *peak-reading* meter.

"Oh, great—something else I have to buy!"

Not so! Why not add peak-reading capability to your existing SWR/power meter? The peak-reading LED display I'm about to describe works best when it is used to completely replace your analog indicators. (When the LED display is connected to the meter circuit, its accuracy may suffer if the analog indicators are used at the same time.) However, you can opt for a versatile combination if your analog meter features a **FWD/REF** switch. You can set the analog meter to read average reflected power while the LED meter displays peak forward power, or vice versa. They won't interfere with each other in this configuration.

I use my LED meter with a Drake L-4B linear amplifier, which has a meter that can be switched to indicate grid current, plate voltage or SWR/power. I usually monitor grid current with the analog meter and use the peak-reading LED display for SWR/power.

The meter works equally well with 100 W or 1500 W. The lowest power level for satisfactory operation is 15 W. The cost of parts can vary greatly, so I suggest you price shop. This project should cost under $20 to build.

Construction

As you can see in Figure 1, this is a very simple project with many parts readily available from Radio Shack. At its heart is U1, an LM3914 dot/bar display driver. I mounted U1, C1 and R3 on a Radio Shack prototyping board (Figure 2), but a printed-circuit board is

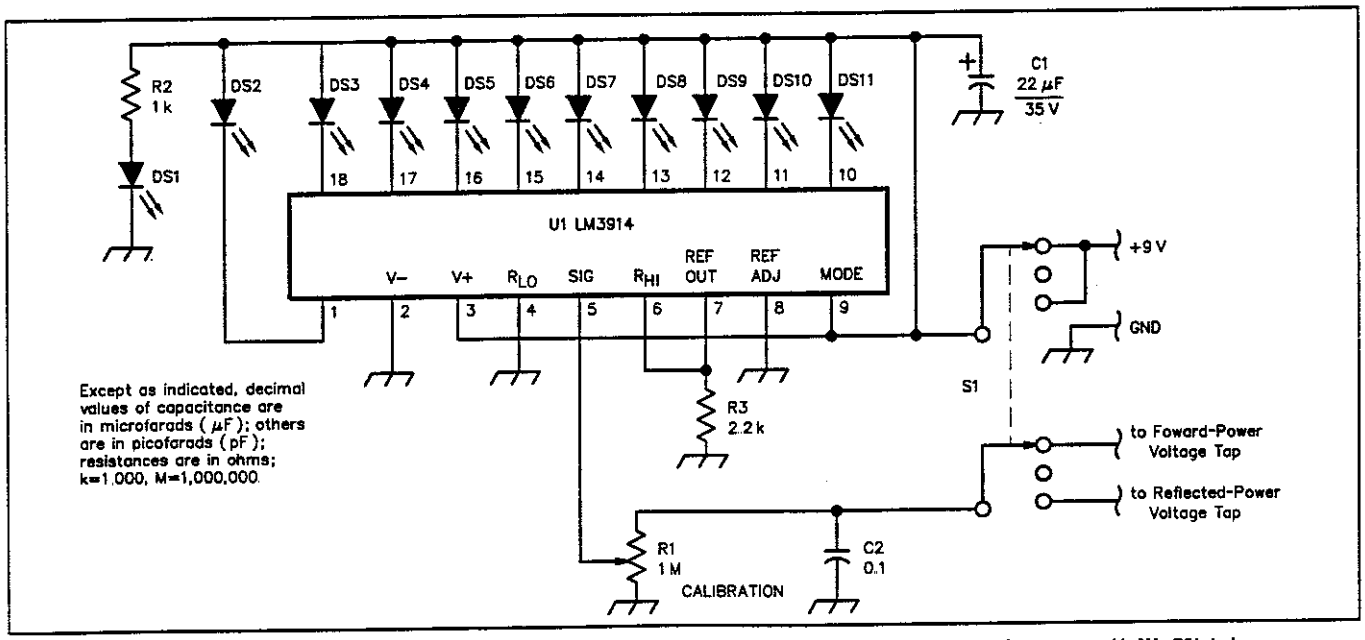


Figure 1—Schematic diagram of the peak-reading LED display. Unless otherwise specified, resistors are 1/4-W, 5% tolerance carbon composition or film.

C1—22 µF electrolytic capacitor, 35 V (Radio Shack 272-1026)
C2—0.1 µF ceramic disc capacitor (Radio Shack 272-135)
DS1, DS11—Red LEDs (Radio Shack 276-041)
DS2, DS3, DS4, DS5—Green LEDs (Radio Shack 276-022)
DS6, DS7, DS8, DS9, DS10—Yellow LEDs (Radio Shack 276-021)
R1—1 MΩ potentiometer (Radio Shack 271-211)
R2—1 kΩ resistor (Radio Shack 271-1118
R3—2.2 kΩ resistor (Radio Shack 271-1121)
S1—DPDT toggle switch (Radio Shack 275-1545)
U1—LM-3914 display driver (Hosfelt Electronics, 2700 Sunset Blvd, Steubenville, OH 43952; tel 800-524-6464)

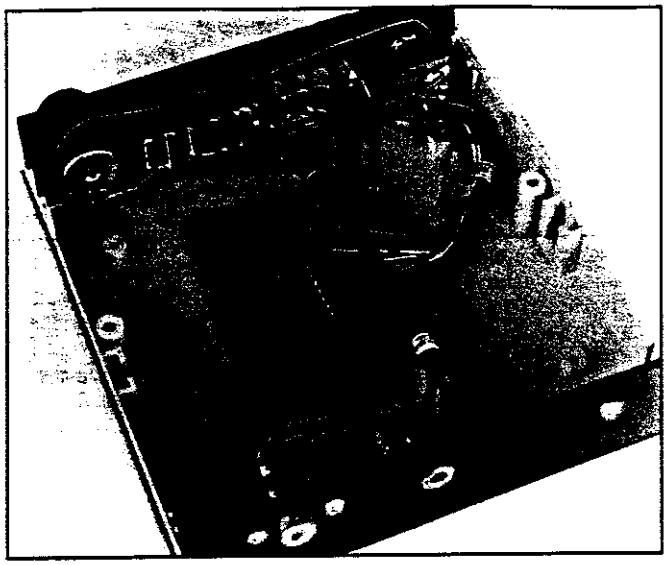


Figure 2—Internal view of the author's LED display.

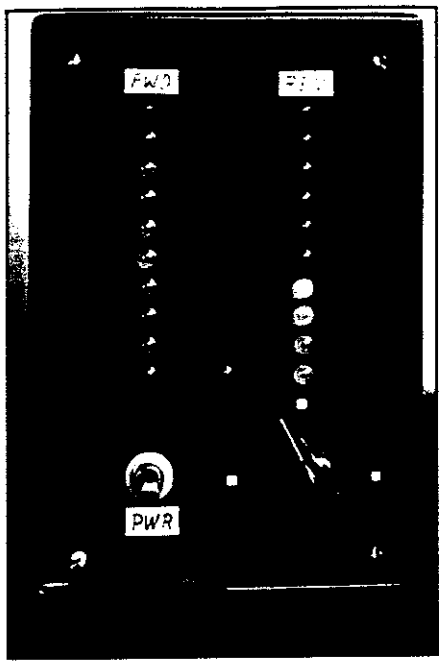


Figure 3—Why settle for one display when you can monitor forward and reflected power simultaneously? The next step for the curious experimenter is a *dual* LED display such as this one

also available.[1] All the other components are installed on or near the panels of a plastic project box.

Ten LEDs are mounted across the front of the project box in a particular left-to-right order: The first four LEDs are green, the next five are yellow and the last one is red. When installed correctly, the LEDs will light from left to right. If the meter is used to measure reflected power, any reading past the fourth green LED indicates an SWR greater than 3:1.

I suggest that you use a straight edge and carefully mark the LED holes prior to drilling. The alternative is to create a paper template and tape it onto the front of the case as a drilling guide. Your goal is to drill a series of 10 holes in a neat horizontal row. You'll need an additional hole below the row for the **POWER** LED (DS1). Its limiting resistor, R2, connects nearby. Push each LED through its appropriate hole from the inside. A little dab of Superglue or epoxy along the rear edge will hold it in place.

You should also install the **CALIBRATE** potentiometer (R1) on the front panel, along with the **FWD/REV** switch, S1. S1 is a center-off DPDT (double-pole, double-throw) switch that is used for dc power switching and for selecting the forward or reflected source voltages from the SWR meter. Note that capacitor C2 is wired across the terminals of R1.

I placed my circuit board in the center of the box, but this will vary, depending on the type of enclosure you use. You can secure the board with epoxy, or with screws and standoffs. Placement of the wiring between the PC board and the LEDs, switch, potentiometer and jacks isn't critical.

Speaking of jacks, I used a $^1/_8$-inch stereo phone jack for the connection to the SWR meter. A common phono plug is used for the 9-V power connector. Both jacks are installed on the rear panel.

Connecting Your SWR Meter

Remove the cover of your analog meter and look inside for two diodes. These diodes change the RF "sampled" from your coax into dc voltages for the meter(s). When you find the diodes, examine their connecting circuitry carefully. You'll discover that only one wire from each diode connects to small RF bypass capacitors. The points where these wires connect to the capacitors are where you must tap the forward and reflected source voltages.

I strongly recommend that you use a shielded cable to connect the LED display to your SWR meter. I used a two-conductor-plus-shield audio cable with an $^1/_8$-inch stereo plug on one end. Solder the conductors of the bare end of that cable to the tap points, and connect the shield braid to the meter case or circuit ground.

Calibration and Operation

Calibrating the LED meter is simple. With both the analog meter and the LED display connected in tandem, switch the LED display on (the center switch position). Place your transceiver in **CW, TUNE,** or whatever mode is necessary to achieve maximum *continuous* output. For our hypothetical example, we'll say that maximum output is 100 W. Then adjust the rig's RF power control until you measure 100 W on your analog power meter. Now, patch the LED meter into the circuit by switching S1 to the **FWD** mode. Adjust the **CALIBRATE** control (R1) until the red LED on the far right just lights. The peak reading on the LED meter now represents 100 W output. Switch S1 to the **REV** position and you'll display reflected power.

If your analog meter reads 100 W and your LED display barely flickers, try throwing S1 to the opposite position. You may have tapped the voltage sources "backward," mistaking the forward power voltage source for reflected, and vice versa. There is no need to rewire your switch unless you've already attached your **FWD/REV** labels to the box.

SWR readings are a snap. Adjust your transceiver output for full-scale reading in the FWD position and then switch to REV to read reflected power. Four green LEDs indicate an SWR of 3:1, three LEDs indicate 2:1, and so on.

This indicator does not automatically calibrate itself. So, *don't forget to recalibrate every time you change your transceiver output setting.*

Double Your Pleasure

The next obvious step is to build a unit that monitors both forward and reflected power *simultaneously*. We can eliminate S1 and bring both source voltages into a dual-potentiometer version of R1. Of course you need two sets of display drivers, LEDs and so forth. This time, however, another switch may have to be added to remove the analog meter completely from the circuit when the LED meter is in use.

My unit has LEDs running vertically (see Figure 3). Those on the left indicate forward power and are all green except for the top one, which is red. The LEDs on the right read reflected power. The first two are green, the second two are yellow and all the rest are red. The **POWER** LED is mounted in the center.

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Photos by the author

[1] A PC board for this project is available from FAR Circuits, 18N640 Field Ct, Dundee, IL 60118-9269; tel 847-836-9148 (voice and fax). Price: $3.75 plus $1.50 shipping for up to four boards. Visa and MasterCard accepted. This PC board includes mounting points for the LEDs to simplify assembly.