CHECK YOUR SWR... WHILE YOU TALK

Standing wave ratio can be measured without interrupting SSB transmission or recalibrating

BY PAUL DANZER

AS two-way radio users know, a standing wave ratio (SWR) meter indicates how well the antenna and cable are matched to the transmitter's output. A conventional SWR meter, however, has two distinct shortcomings. It must be calibrated before each SWR reading, and no calibration or reading can be made while the r-f carrier is modulated. (Unmodulated r-f is needed so the meter needle will not fluctuate.) Thus, sideband operators cannot check SWR unless they stop talking and insert an unmodulated carrier. By using the sensing elements of a conventional SWR meter together with a novel display head, as described here, these problems can be overcome.

How It Works. A conventional SWR meter typically contains two sensing elements used to sample voltage levels. These voltages are proportional to the forward (transmitted) and reverse (reflected) power level found in the antenna feed line (Fig. 1). A two-position switch is mounted on the front panel of the SWR meter. When it is in the CALIBRATE position, forward power is sampled and the SWR meter is set to read full scale.

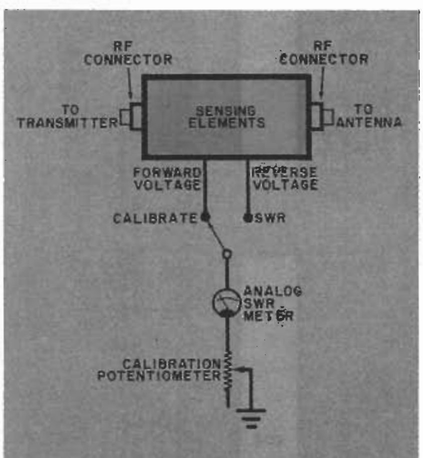

Fig. 1. The typical SWR meter measures ratio of forward to reverse voltages.

Next, the switch is thrown to the SWR position and the reflected power level is sampled. This second meter reading, always relative to the first meter reading, is taken as the measure of SWR. The meter scale is calibrated according to the formula:

$$SWR = (V_f + V_r)/(V_f - V_r)$$

where V_f and V_r are forward and reverse voltages, respectively.

So much for the traditional approach. Now see what happens when LEDs are used to monitor the forward and reverse voltages. The display consists of a simple grid, the horizontal and vertical axes studded with LEDs (Fig. 2). The top (horizontal) row is labeled 1 to 10 and used to measure the forward voltage. The side (vertical) row is also labeled 1 to 10 and used to measure the reverse voltage.

Multiple SWR scales are plotted across the grid. To measure SWR, simply find the highest-numbered LED illuminated in each row, trace horizontally and vertically to the intersection, and read the SWR from the appropriate scale. (Note that a modulated signal will cause identical fluctuations in each LED row, but it will still be easy to identify the highest-numbered LED illuminated in each row and find the intersection.)

Two integrated circuits are used to convert an ordinary SWR bridge to LED readout—allowing SWR measurement while single-sideband or modulated carrier signals are present

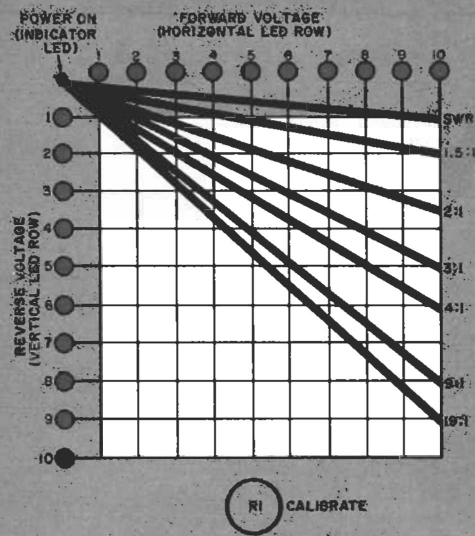

Fig. 2. The display consists of a simple grid whose horizontal (forward voltage) and vertical (reverse voltage) axes are studded with LEDs.

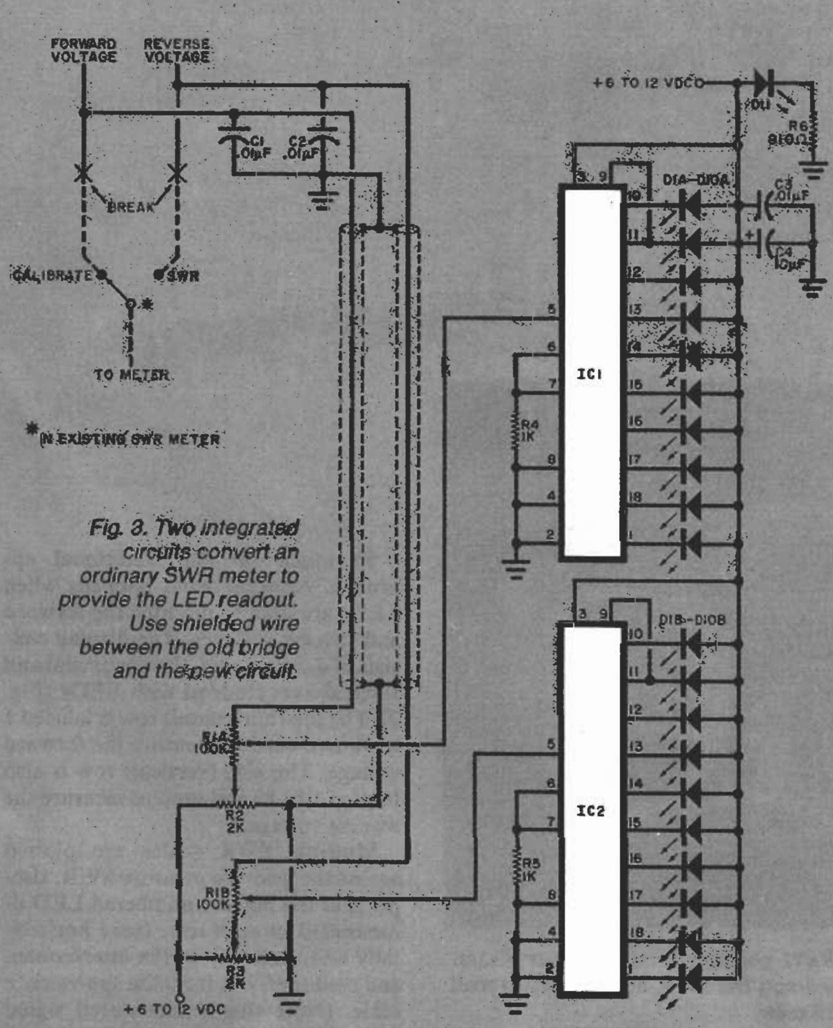

Fig. 3. Two integrated circuits convert an ordinary SWR meter to provide the LED readout. Use shielded wire between the old bridge and the new circuit.

PARTS LIST

C1 to C3—0.01-µF, 50-V dc capacitor
C4—10-µF, 50-V dc capacitor
D1A-D10A—2-V, 20-mA red LED (Radio Shack 276-041)
D1B-D10B—2-V, 20-mA red LED (Radio Shack 276-041)
D11—2-V, 20-mA red LED (Radio Shack 276-041)
IC1, IC2—LM3914 LED driver (Radio Shack 276-1707)
R1—100-kΩ dual potentiometer (Radio Shack 271-1732)
R2, R3—2-kΩ trimmer (Radio Shack 271-218)
R4, R5—1 kΩ, ½ W
R6—910Ω, ½ W
Misc.—Standard SWR meter, shielded wire, 6- to 12-V dc supply, plastic for faceplate, universal breadboard, etc.

(Fig. 3). The SWR meter is modified by breaking the two leads going to the CALIBRATE/SWR switch. These two wires plus a ground lead are brought out. Two bypass capacitors (*C1* and *C2*) are added, and two shielded leads are run to the LED display head, with the shields grounded.

Dual potentiometer *R1* consists of two 100-kilohm sections on one shaft. It is used as the calibrate control for the system. Trimmers *R2* and *R3* are used to provide identical dc offsets for the forward and reverse channels.

Construction Tips. In lieu of a custom printed circuit board, the LED driver can be mounted directly (or with sockets) on a universal breadboard such as the Radio Shack 276-170 (Fig. 4). Two busses are used, one above the ICs for the positive voltage (6 to 12 V) and one below the ICs for ground. LEDs *D1A* through *D10A*, and *D1B* through *D10B* are mounted as shown in Fig. 5. LED *D11* acts as a pilot light and is independent of incident or reflected r-f levels. Capacitors *C3* and *C4* are for power supply bypass. Any 6-to-12-V dc supply can be used for a power source.

A faceplate can be made from a section of rigid plastic, approximately 7″ by 7″. Drill two rows of holes to mount the LEDs on half-inch centers. Then glue graph paper to the faceplate with rubber cement and draw the calibration scale on the graph paper. Now give the faceplate a light spraying with "artist fixitive" to keep it from smudging.

Each SWR calibration line begins at the "zero" point common to both the forward voltage and reverse voltage axes. The Table gives a number of points for constructing the SWR scales shown in Fig. 2, or you can calculate your own SWR scales from the basic relationship involving forward and reverse voltages given earlier.

Checkout and Operation. After construction, ac power is applied to the SWR meter and (with no r-f present) *R2* is rotated so that each of the diodes *D1A* through *D10A* goes on in turn. This test checks out the wiring of the diodes as well as *IC1*. Now rotate *R2* so that *D1A* goes on, then back off until *D1A* is just barely extinguished. Repeat this process for the other string of diodes, using *R3* to set up *D1B*. Checkout and adjustment is now complete.

To use the instrument as an ordinary SWR meter (and assuming it is connected in the antenna feed line), key the transmitter and adjust *R1* so that any one of the horizontal row of diodes is lit. If you chose to have *D10A* lit, make sure it is just barely lit (i.e., close to hav-

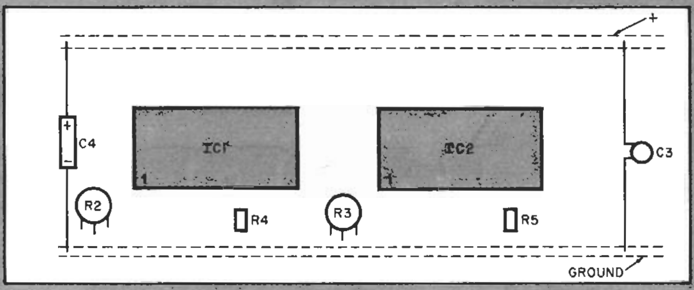

Fig. 4. In lieu of a custom printed circuit board, the LED driver can be mounted on a universal breadboard as shown here.

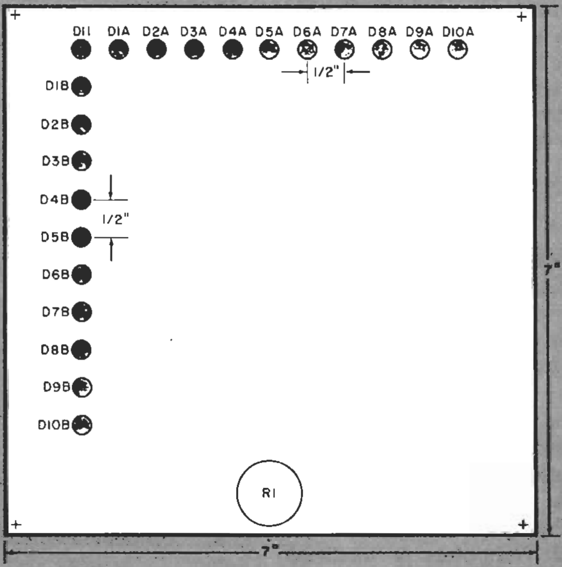

Fig. 5. Mount the LEDs in horizontal and vertical rows on the front panel as shown here.

TABLE—SCALE MEASUREMENTS

Note: Each SWR line starts at origin (*D11*) and extends as shown below.

Diode Intercept	SWR Label
D10A, D1B	1.2:1
D10A, D2B	1.5:1
D10A, Midway between D3B and D4B	2:1
D10A, D5B	3:1
D10A, D6B	4:1
D10A, D7B	5.6:1
D10A, Midway between D7B and D8B	7:1
D10A, D8B	9:1
D10A, D9B	19:1

ing *D9A* lit instead of *D10A*). This keeps the circuit from saturating. Now note which diode in the vertical column is lit, and read the SWR from the calibration line closest to the intersection extrapolated from the lit diodes. For example, if *D10A* is lit in the horizontal row and *D5B* is lit in the vertical row, the intersection lies on the 3:1 SWR calibration line.

To use the instrument with single-sideband, modulate your SSB transmitter and adjust *R1* so that horizontal diode *D10A* never lights (or flickers only occasionally). Again find the highest-number horizontal- and vertical-row diodes which do fully light and extrapolate to find the point of intersection. Read the SWR from the calibration curve closest to the intersection. ◇