

Meet the SWAILER!

Make tuning up easier. You can "hear" your SWR with this Standing Wave Audible Indicator and Level of Effective Radiation monitor.

By George Murphy, VE3ERP
PO Box 759
Alliston, ON L0M 1A0, Canada



The SWAILER is a tune-up aid that not only provides an audible indication of RF output, but also indicates SWR, thus offering a simple method of tuning both the rig and the antenna.

Operation

As an RF-output indicator, the SWAILER functions much the same as many existing audible relative-power indicators in that the transmitter is tuned to obtain the highest possible tonal pitch from the built-in speaker without losing the tone altogether. After maximum output is achieved, the SWR push button is pressed—a change in tone indicates the presence of a reflected wave. While the push button is pressed, the antenna matching network is adjusted for a tonal pitch closer to the original tone. By alternately touching up the transmitter output (with the push button released) and the matching network (with the push button pressed), the two tones can be closely matched. Identical tones indicate an SWR of 1:1.

Circuit Description

The schematic diagram for the SWAILER is shown in Fig 1. A differential amplifier, U1, drives a voltage-to-audio-frequency (V-F) converter, U2. U1 amplifies the difference voltage between input 3 (forward voltage) and input 2 (reflected voltage when S2 is open and zero volts when S2 is normally closed). If all reflected power can be tuned out, the output of U1 will be the same with S2 open as with S2 closed, resulting in identical tones from U2.

Q1, Q2 and Q3 function as a current mirror, necessary for the unit to produce a usable range of audible tones. R4 is a "set-and-forget" control that establishes a usable tonal range.

Input Signals

The SWAILER requires samples of the forward and reflected dc voltages from the transmission line between your rig and the matching network. If your matching network has a meter, or meters, to indicate forward and reflected power, the wiring is probably similar to one shown in Fig 2. To obtain sample voltages for the SWAILER, install a 1/8-inch stereo jack on the rear panel of your matching network and wire it as shown in Fig 2. This must be an open-circuit jack. A closed-circuit jack will ground your meter when the SWAILER is not connected. Solder a 0.01- μ F capacitor between each jack lug and the ground lug if your matching network does not already have them at the point where you wire into the meter circuit. If your matching network does not have metering, an SWR indicator, such as the Radio Shack no 21-525 Field Strength/SWR Meter, with a stereo jack installed as described above will be required. If your SWR indicator has a nonmetallic case, make sure that the sleeve of the jack is directly connected to the internal ground of the meter circuitry. You will also require a cable, made up of two-conductor shielded wire, with a 1/8-in stereo plug at each end, and each end of the shield grounded.

Construction

The SWAILER can be installed in any small metal enclosure. I used a Radio Shack no 270-251 cabinet with S1 and S2 mounted

on the front panel, and J1 on the rear panel. Drill a hole pattern on the rear panel, and secure the speaker over the holes with epoxy glue. When choosing your enclosure, don't forget to allow room for the 9-V battery. Also remember to drill a small access hole in the cabinet top to allow adjustment of R4.

There is nothing critical about parts placement except that C1 and C2, which are soldered across J1, should have leads as short as possible. There are two possibilities for PC boards for this project. Fig 3 shows the layout for a hand-cut PC board that I used in my first unit. A conventional version of this layout, suitable for etching, is shown in Fig 4. Parts placement is the same using either circuit board and is shown in Fig 5. Fig 6 shows placement of the PC board and speaker, and battery space in the cabinet.

Initial Setup

When the SWAILER is turned on, it will emit a low-pitched growl. Turn on the transmitter, with carrier inserted (CW mode), and the tone should rise. Adjust R4 to establish the tone at a mid-range pitch, then tune the transmitter for the highest possible pitch. If the tone disappears altogether, adjust R4 to bring it back into the audible range. The setting of R4 depends on the forward voltage picked up by the SWR indicator and will vary with different power levels. Once set for a particular transmitter and SWR indicator combination, however, it will probably not require resetting.

The SWAILER seems to work best at levels of 100 W or less, so if you have an amplifier, turn it off while you tune up. I

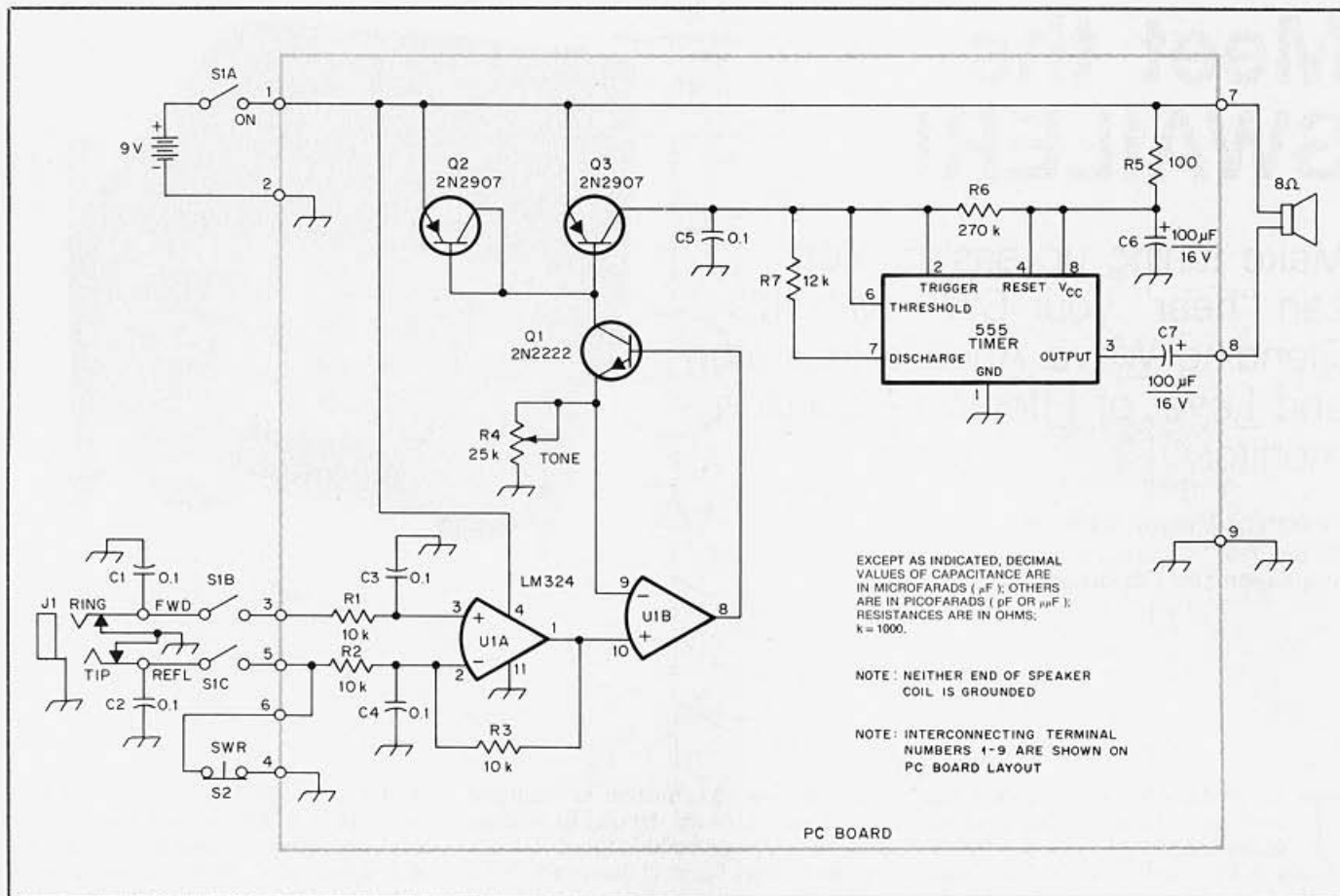


Fig 1—SWAILER schematic diagram. Radio Shack part numbers are shown in parentheses.

- C1, C2—0.1- μF disc ceramic (272-135).
 C3-C5—0.1- μF PC-mount capacitor (272-1069).
 C6, C7—100- μF , 16-V electrolytic (272-1028).
 J1—Closed-circuit stereo jack (274-250).
 J2—Open-circuit stereo jack (274-249).
 Q1—General-purpose NPN transistor (276-2009).
 Q2, Q3—General-purpose PNP transistor (276-2023).
 R1-R3—10-k Ω resistor (271-1335).
 R4—25-k Ω potentiometer (271-336).
 R5—100- Ω resistor (271-1311).
 R6—270-k Ω resistor.
 R7—12-k Ω resistor.
 S1—3PST or 3PDT switch (275-661).
 S2—Normally closed push-button switch (275-1548).
 U1—LM324 quad op amp (276-1711).
 U2—555 timer (276-1723).

Miscellaneous

Qty	PN	Description
1	(276-1999)	14-pin DIP socket.
1	(276-1995)	8-pin DIP socket.
1	(40-245)	2-in, 8- Ω speaker.
1	(270-251)	Cabinet.
1	(270-325)	Battery snap.
1	(278-1276)	Shielded cable, 2-wire.
2	(274-284)	Stereo plug.
1	(21-525)	SWR meter (if required).
9		Push-in terminals.

do not have an amplifier, so I have no idea what might happen if you fed one into the SWAILER.

When the front-panel SWR button is pressed, the tone will change if reflected

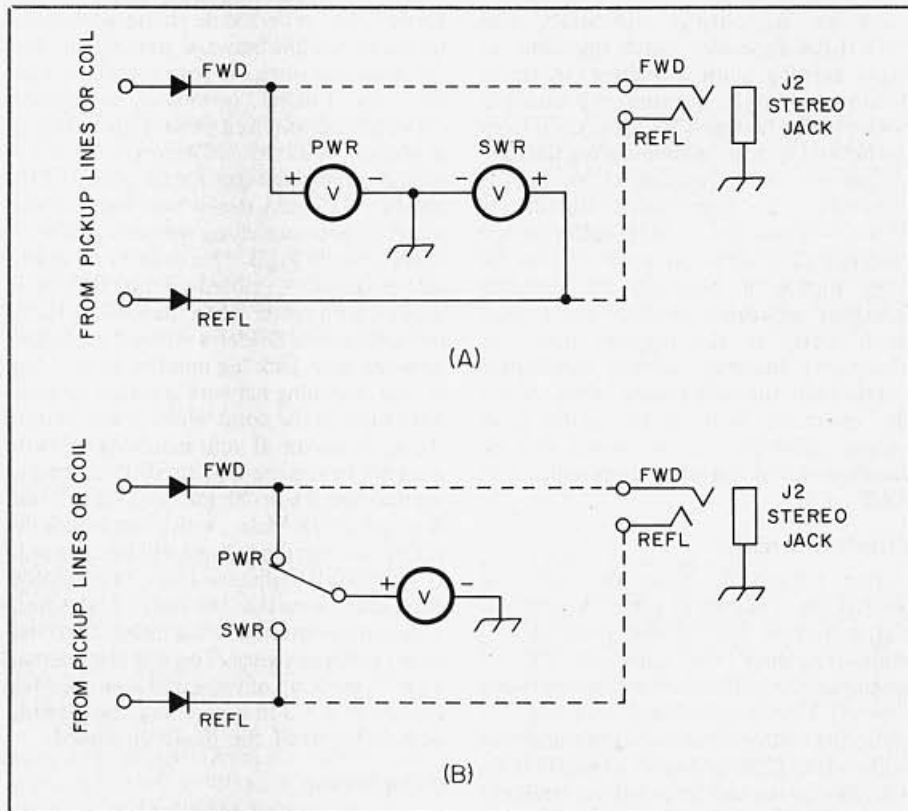


Fig 2—SWR indicator configurations. At A, 2 meters are used. At B, a single, switched meter is used.

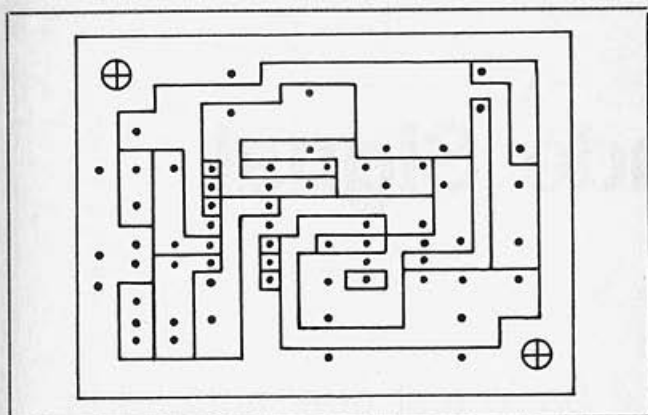


Fig 3—Hand-cut circuit board design.

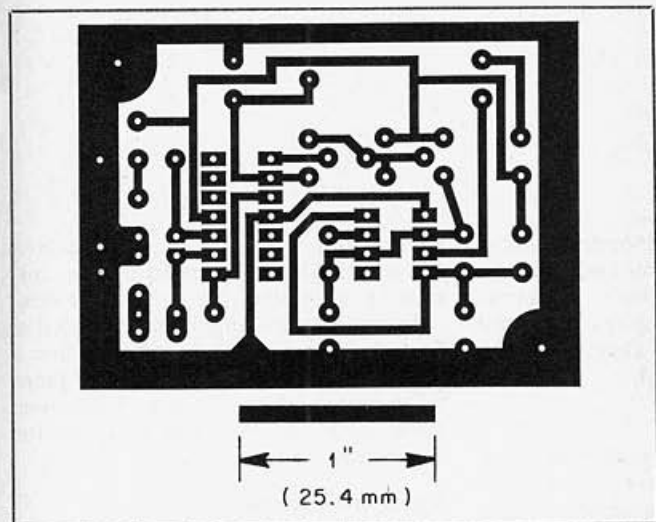


Fig 4—A conventional PC-board design.

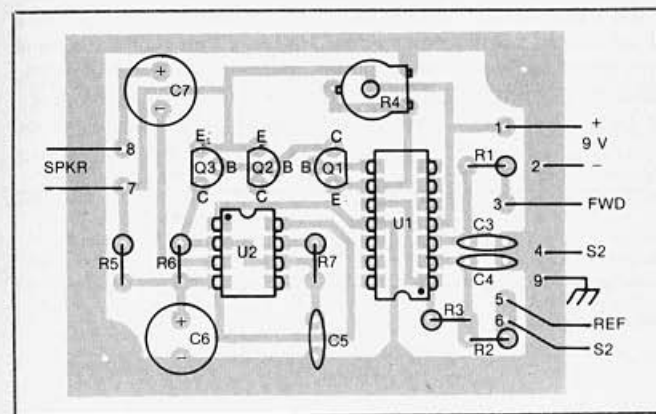


Fig 5—Parts-placement diagram for either PC-board configuration.

power is present. Adjust your matching network until the tone is as close as possible to the original tone. Release the push button from time to time to hear the forward tone, which will probably have changed somewhat. (As you reach a match, the forward power increases.) When the two tones are as close together as you can get them, you have achieved minimum SWR.

Don't expect to be able to match the two tones exactly. Unless you have the "ultimate antenna," there will probably always be a small amount of reflected power present. It may be so small that your meters won't show it, but the SWAILER will sniff it out if it is there.

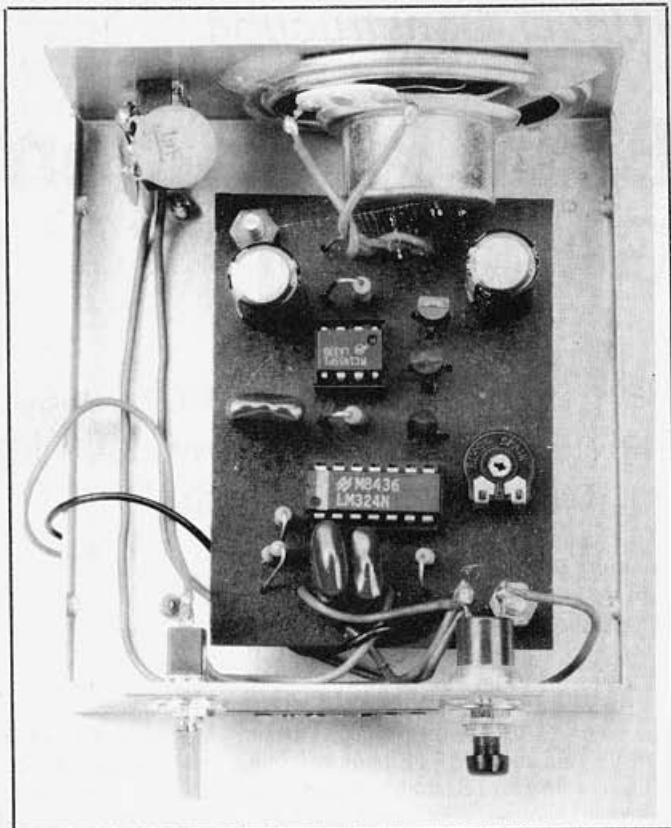


Fig 6—Internal view of the completed SWAILER. Note the position of the speaker on the rear panel.

If you lose the tone altogether during the initial adjustment procedure, adjust R4 until the tone is reestablished. Remember that where the tones are on the musical scale is unimportant—it is the *difference* between them that matters.

For your initial setup, you may want to install an additional SWR meter ahead of your matching network to check things out. The SWR push button on the SWAILER, being normally to ground, may ground the meter in your pickup unit when it is switched to read reflected power. When everything has been checked out, remove the temporary meter, and leave the meter in your pickup unit switched to the forward position to avoid grounding the meter when you are using the SWAILER. If your indicator has a separate meter for reflected power, it will be grounded by S2 when the SWAILER is in operation.

Afterthoughts

The SWAILER has lots of RF bypassing, but is still somewhat sensitive to strong RF fields. My station is upstairs, with no ground, and my antenna is a random wire running right from the matching network, so there is lots of RF in my shack. The SWAILER works fine there, however. Make sure that the SWAILER is completely enclosed in a metal cabinet. Running a ground strap from the cabinet to the station ground system wouldn't hurt. It is important that the cable between your SWR indicator and the SWAILER be shielded.

Conclusion

Try using the SWAILER. Listening to its gentle voice is a lot easier than trying to watch the antics of several meters at the same time.

Most of the credit for developing the SWAILER belongs to Jim Swail, VE3KF, and Lloyd McSheffney at the National Research Council in Ottawa, who took my original design (which didn't work very well), refined it, redesigned it and made it come to life.