Check Your SWR Bridge!

Think you have a good bridge? Find out for sure.

by W. Paul Wing K1WVX

You should check your SWR (Standing Wave Ratio) bridge, rather than assume that you have a good one. Good-quality SWR bridges that have been left in the line have usually been overranged a number of times. Many inexpensive bridges have poor accuracy. Most SWR bridge construction articles only provide instructions for checking at an SWR of 1:1. This one-point check, which is made by using a standard 50-ohm dummy load, is inadequate.

I will describe how to use resistances in conjunction with your 50-ohm dummy load to check your bridge at several test points.

Resistances to Use

The easiest way to check your bridge at an additional point is to borrow a friend's 50-ohm dummy load and connect it in parallel with your own. You can make this connection with a coaxial tee and a short length of coaxial cable, as shown in Photo A. The resulting 25-ohm dummy load will produce an SWR of 2:1. The reason for this is that the SWR is equal to the ratio between the line impedance and the load resistance, which is 50/25 = 2.0. When necessary, this ratio is inverted in order always to produce a ratio greater than 1. This subject is more fully covered in *The ARRL Antenna Book*. If you cannot borrow a second dummy load, you can easily make one for use at reduced power. The construction of the unit will be covered in a subsequent paragraph.

Also, if you make a 25-ohm dummy load having two connectors, it can be used in series with your 50-ohm load to produce an SWR of 1.5:1, and it can be used in parallel to produce an SWR of 3.0:1. If both "add-on" dummy loads are provided, SWR values of 1.5, 2.0, and 3.0 can be checked, in addition to the usual 1.0 SWR check.

Reduced Power Dummy Load

The main difficulty with building dummy loads is that noninductive resistors are not generally available with power ratings above two watts. In order to avoid using 50 of these for each load, I chose to use a smaller number of 2-watt resistors in combination with my 50-ohm dummy load, and also to use reduced power. A transmitter output power of 35 watts was selected in order to substantially reduce the number of resistors required. Almost all solid state and tube-type transmitters can be reduced to the 35-watt output level by using the front panel controls. Remember that this is approximately equal to 70 watts of input power. Some SWR bridges are not sensitive enough to get readings on 75 and 80 meters with reduced power. In this case, the testing is limited to 10 through 40 meters.

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Accuracy

Two-watt resistors with tolerances of 2%, 5%, and 10% are usually available in radio parts stores. I used 2% resistors because they are not very expensive, and improve the overall accuracy. My conventional 50-ohm dummy load measures 47 ohms. This is an error of 6%. When this is used with an "add-on" load having an accuracy of 2%, the maximum errors range between 3.4% and 4.7%, depending on which test is being performed. This accuracy is considered adequate by most amateurs.

If you wish greater accuracy, you can build and substitute an additional 50-ohm load with 2% resistors. This will result in a complete 2% system. The power rating will remain at 35 watts.

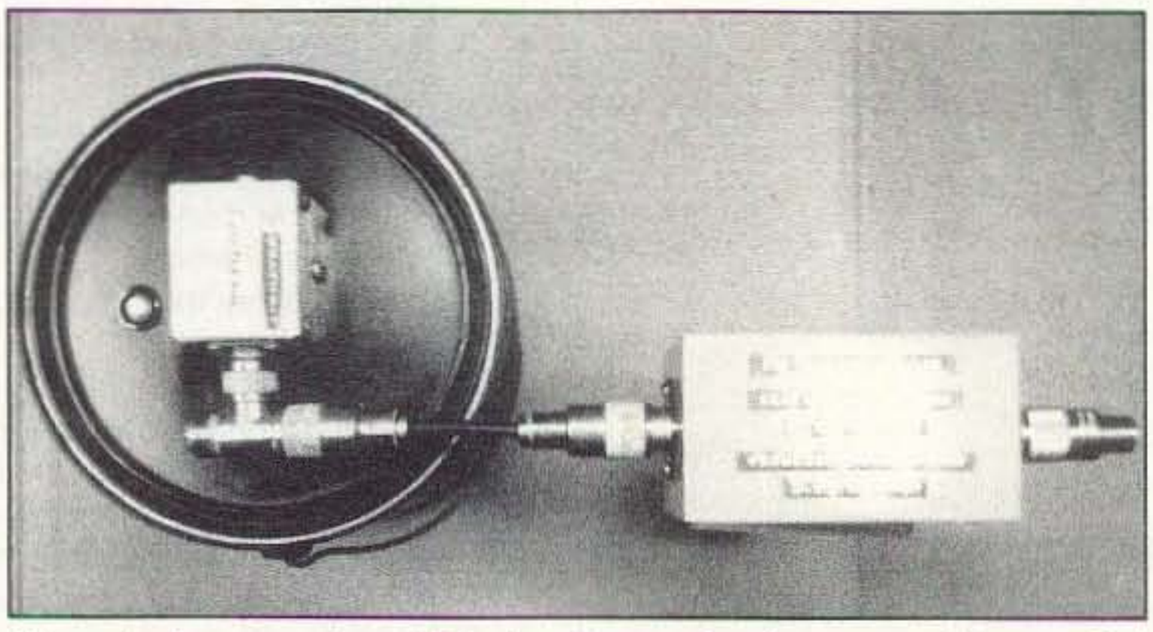

Photo A. A conventional 50-ohm dummy load, connected in parallel with an "add-on" load. The feedline is connected at the coaxial tee.

Construction

I will describe first the construction of the 25-ohm unit. It uses twelve 300-ohm resistors in parallel. The schematic is shown in Figure 1, and the completed unit is shown in Photo B. I used Radio Shack perfboard No. 276-1396A. It is 1/16" thick and has holes spaced 0.10" x

0.10" apart. Cut a piece of this perfboard 1-7/8" x 3-1/16" so that it has 18 holes along the short side and 30 holes along the long side. Drill two 1/8" diameter mounting holes at diagonally opposite corners, as shown in Photo B. These holes are located 7/32" from both edges of the board. Also cut five pieces of perfboard 1/2" x 2-5/16" long. These will be used as spacers during soldering. Bend both leads of the twelve resistors 90 degrees so that they will fit through holes in the perfboard that are 0.90" apart. Stack three spacers on the board and hold them in place with masking tape. Install six resistors on top of the spacers with their leads going through holes in the board. The resistors are spaced 0.40". from each other. Hold the resistors in place with masking tape.

Cut two pieces of No. 14 AWG copper wire 4" long. Solder one of these wires to the six resistor leads, as shown in Photo B. The wire is positioned 1/8" above the board by using the two remaining spacers. Turn the board around and repeat this process to solder the other #14 wire.

Stack the two spacers on top of the lower row of resistors and fasten with tape. Install the six top row resistors and solder their leads to both wires. Cut the lead lengths of the two end resistors to measure 9/16" below the board. Bend these four leads through holes 0.3" toward the centerline of the board so as to secure the resistor assembly to the board. Cut off the leads of the other 10 resistors flush with the bottom of the board. Remove all spacers and masking tape.

The enclosure is a Bud-Minibox No. CU-2103-B, which measures 2-1/4" x 2-1/4" x 4". Cut the center holes for the two SO-239 coaxial connectors at the center of each end of the box. Drill two screw holes for fastening each connector on the same horizontal centerline. Remove enough paint where the connectors mount to be sure of good electrical contact. Drill eight 3/16" diameter holes in the enclosure to provide ventilation. The two mounting brackets for the board are made from No. 5 solder lugs. Use a piece of #14 copper wire to solder each pair of lugs together as, shown in Photo B. Bend the brackets 90°, as shown. Attach the connectors and brackets with 4-40 x 1/4" long screws and nuts.

Bend the two #14 leads and trim their ends, as shown in Photo B. Bend the mounting brackets to keep them away from the resistor leads. Attach the board with 4-40 x 1/4" long screws and nuts. Solder the #14 wires to the coaxial connectors, and then install the enclosure cover. Check the resistance between the connector center conductors to be sure that the resistance is close to 25 ohms. Also check the resistance between the connector shells to be

SWR Bridge	Test Freq. (MHz)	Actual SWR 1.0	1.5	2.0	3.0
Bridge A	28.4	1.05	1.4	1.8	2.6
	7.25	1.05	1.05	2.2	3.2
Bridge B	28.4	1.3	1.3	2.4	3.1
	7.25	1.15	1.1	2.0	3.1
Bridge C	28.4	1.1	1.4	2.7	Approx. 4.0
	7.25	1.05	1.1	2.2	Approx. 4.0

Table 1. Test results for the three inexpensive SWR bridges.

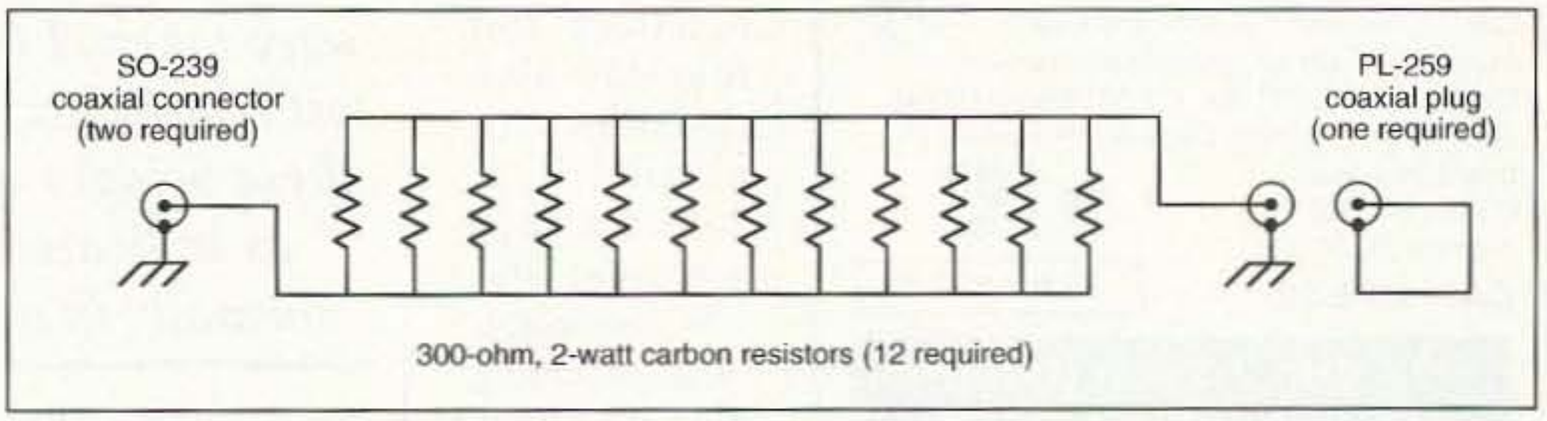

Figure 1. Schematic for the 25-ohm "add-on" load and grounding

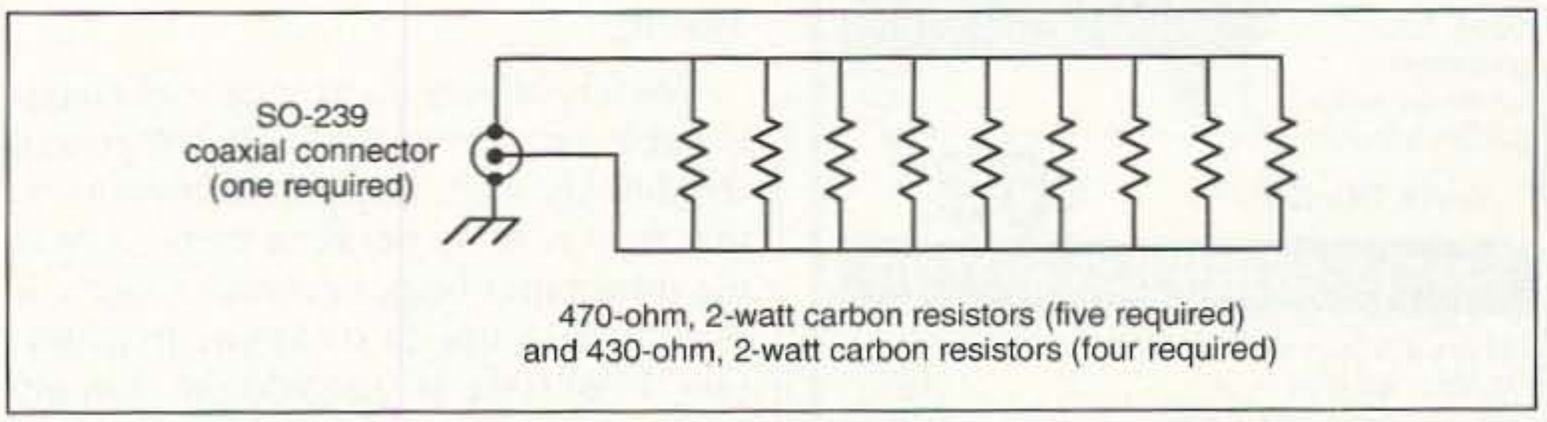

Figure 2. Schematic for the 50-ohm "add-on" load.

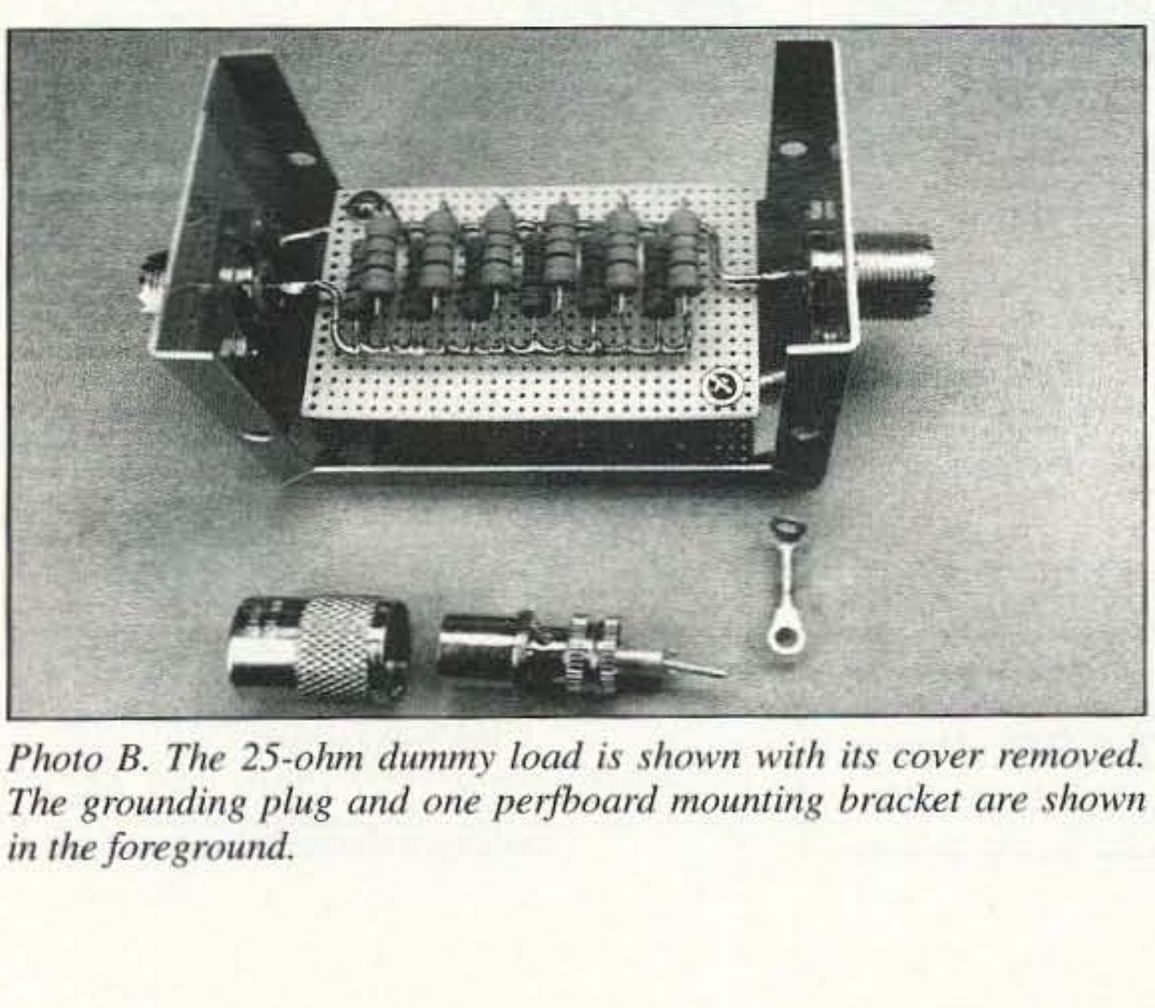

Photo B. The 25-ohm dummy load is shown with its cover removed. The grounding plug and one perfboard mounting bracket are shown in the foreground.

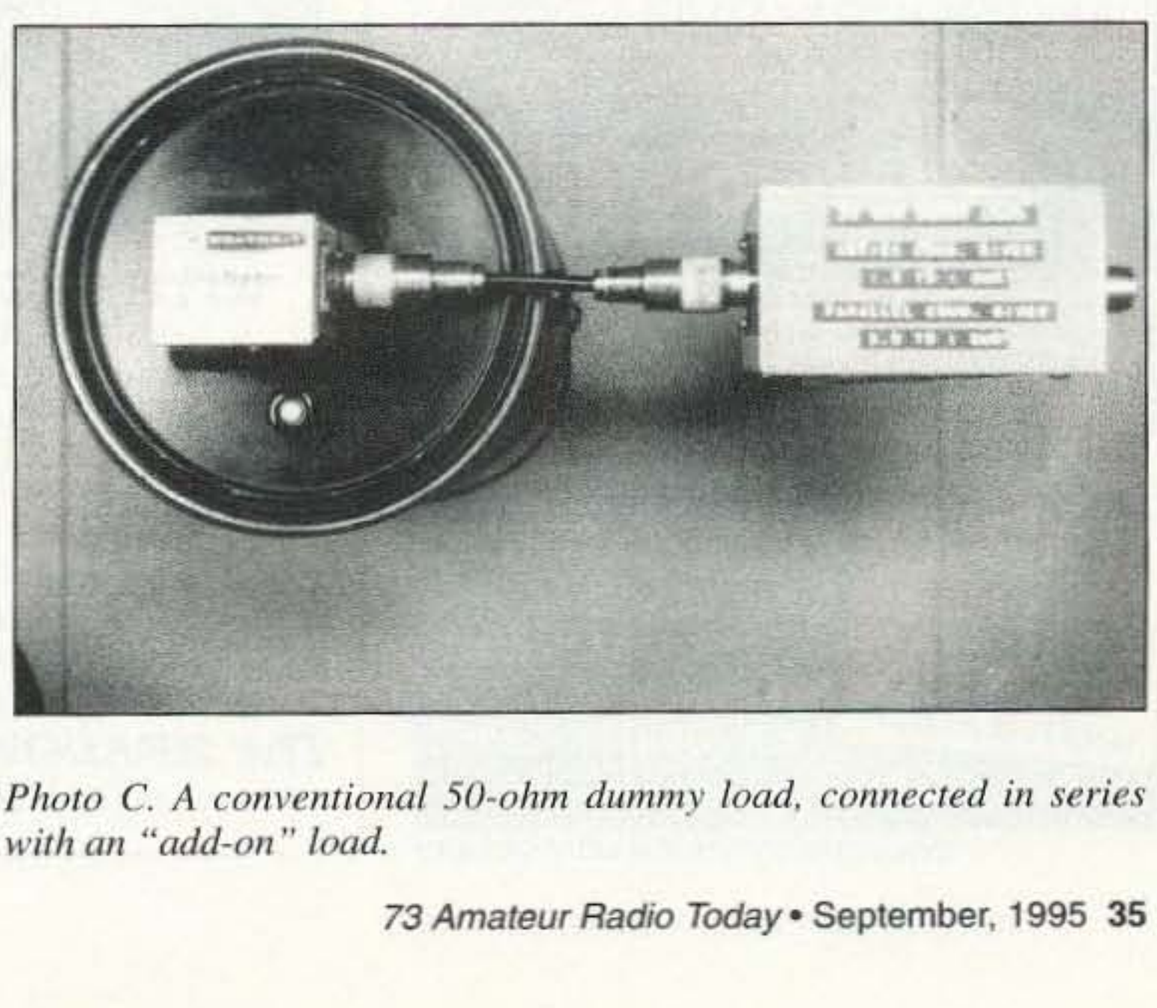

Photo C. A conventional 50-ohm dummy load, connected in series with an "add-on" load.

sure that it is close to zero.

The grounding plug is made by soldering a short piece of #14 wire between the center conductor and shell of a PL-259 coaxial plug. This is shown in Photo B before it was soldered and trimmed. Check the resistance between the center conductor and shell to be sure that it is close to zero. The schematic for the 50-ohm dummy load is shown in Figure 2. It has five 470-ohm resistors and four 430-ohm resistors in parallel. It does not have a second SO-239 connector, or a grounding plug. Otherwise, its construction is the same as the 25-ohm unit.

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Testing

Use a relatively short length of coaxial cable between your SWR bridge and the dummy load. Bypass all other items that may now be between them. Adjust the transmitter output power to approximately 35 watts. Discontinue transmitting. Install one of the "add-on" dummy loads and proceed with testing. Photo A shows the parallel connection, and Photo C shows the series connection. Don't forget to use the grounding plug with the parallel connection. It can be attached to either end of the 25-ohm dummy load.

Test Results

The test results for three inexpensive SWR bridges are shown in Table 1. The accuracy of these bridges was not as good as had been expected. Whenever poor accuracy was evident, the test setup was checked to be sure that the resistance was the correct value, and that a good ground connection existed. The SWR meters were also checked to be sure that they zeroed properly, and that they did not have broken jewels. Since many precautions were taken, I believe that the test results are valid, and that these bridges would perform as indicated when used normally in a ham station.

Conclusion

The test results show that many inexpensive SWR bridges have poor accuracy. You should check your bridge rather than assume that it is accurate.

You can check one additional point by simply borrowing another dummy load, build either one or two "add-on" loads or a complete 2% system. The choice is yours. 73

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