# Splitting a Signal

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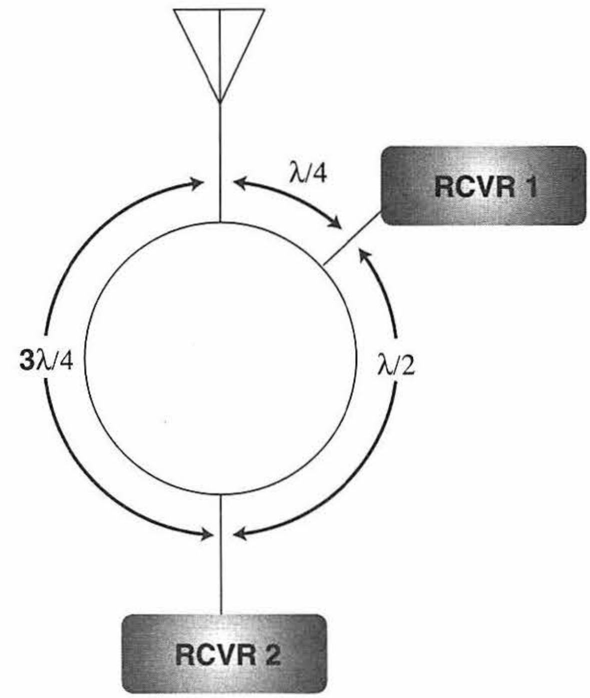



**FIGURE 1**

***A single antenna which uses coax feedline can be used with two receivers provided the receivers are isolated from each other to eliminate interaction. Using three lengths of coax and three T connectors, you can construct a simple and inexpensive hybrid splitter. The lengths of the coax can be calculated using information provided in the text.***

It may not be as complicated as splitting an atom, but to radio listeners splitting a signal can have real benefits. The splitters described here can be used from the longwave frequencies right up through to the UHF bands.

Anyone who has more than one TV set knows the basic reason for using a splitter: You have one antenna, but more than one receiver.

There is a variety of situations in which you benefit by using a signal splitter. It could be that you want to go DXing with a friend. It would be great to be able to put up one antenna for both of you to use instead of two separate antennas. That would save time and allow you to get to the DX part of the DXpedition sooner. It's also makes it easier to exchange DX tips. It's frustrating to find that someone else can hear a station, but your antenna won't pull the signal in. Using a single antenna, everyone can hear those great DX catches.

There may be times when you want to compare receivers. You could use a single antenna and a switch. But you can never hear both receivers at the same time with that system. If the signal is fading, you can misjudge the relative performance of the two receivers by using the switching method.

You can also check out devices such as preamplifiers and attenuators. With one signal going into both receivers you will hear the same signal level. Place a preamp or an attenuator in the line leading to one receiver and you can quickly determine the performance of the device.

You might think that in each of these situations you could simply connect both receivers in parallel across the antenna. At the very least, the two receivers will appear as a mismatched load on the antenna. Another problem with this simple solution is that the receivers can interact and interfere with reception.

What you need to do is to isolate the receivers so they don't "see" (or hear) one another while connected to a common antenna.

There are commercial devices that allow you to do that at shortwave frequencies. They are known as multicouplers and they are expensive. With a multicoupler you can connect many receivers to a single antenna.

For most listeners, there is rarely a need to connect six, twelve, or twenty-four receivers to a single antenna. The real solution for most listeners is to construct a simple hybrid splitter. A hybrid splitter that allows you to operate two receivers from one antenna is shown in Figure 1.

The key to the technique is the length of the coax cable. Notice that Rcvr 1 is connected to Rcvr 2 via two paths. The length of the shorter path is $\lambda/2$ (one-half wavelength long); the length of the longer path is $\lambda/4 + 31\lambda4$ or $\lambda$ (one wavelength long). Since the two paths differ in length by $\lambda/2$, Rcvr 1 is not affected by Rcvr 2. The same concept applies if you look from Rcvr 2 back toward Rcvr 1.

There are a few limitations to this circuit. First, you are limited to two receivers. Second, the length of the coax lines limits the frequency coverage. Third, at low frequencies, the coax lines can get fairly long.

The length of a quarter-wavelength of coax can be calculated using Equation 1. The equation takes into account the velocity factor (0.66) of solid polyethylene-filled feedline. If other types of line are used, the velocity factor must be adjusted. (For example, RG-58 with foamed polyethylene dielectric has a velocity factor of 0.79.)

$$\ell = 75000 \times 0.66/f \qquad (1)$$

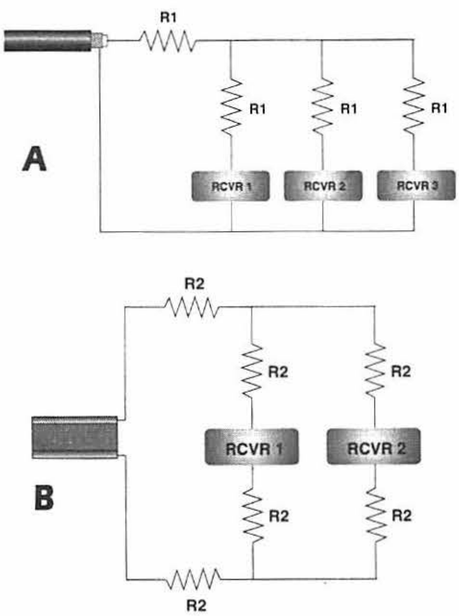
where $\ell$ is the length in meters of a quarter-wavelength of solid polyethylene-filled coax and f is the frequency in kHz.

For example, if you want to listen to signals in the 22-meter band (13570 to 13870 kHz), $\lambda/4$ would be 75000 x 0.66/13720 or 3.6 meters (11.8 ft.). To construct the hybrid splitter, you would need three lengths of coax—one piece $\lambda/4$ or 3.6 m long, a second piece $\lambda/2$ or 7.2 m long, and a third piece $3\lambda/4$ or 10.8 m long.

To use the splitter for DXing in the lower portion of the FM broadcast band (where the educational and non-commercial stations are), the lengths required are 0.55 m, 1.1 m and 1.65 m. To DX on the high band VHF TV channels (channel 13, for example) the lengths are even shorter: 0.23 m, 0.46 m and 0.70 m.

It's easy to see that this hybrid splitter is more practical and economical at higher frequencies.

To solve the problems of frequency dependence and to avoid long runs of coax in your listening post, you can use a resistive distribution network. A simple system is shown in Figure 2.




## FIGURE 2

***Resistive distribution networks are compact, broadband, and have the added advantage that you can connect more than two receivers to a single antenna. A star circuit for use with coax feedline is shown at (a). A similar circuit for use with balanced feedline, such as 300-ohm twinlead, is shown at (b).***

Not only is this system not frequency sensitive, you can also connect more than two receivers to a single antenna.

The value of the resistors ($R_1$) can be calculated using Equation 2.

$$R_1 = Z\,(n-1)/(n+1) \qquad (2)$$

where $R_1$ is the resistance in ohms, Z is the feedline impedance in ohms and n is the number of receivers. (This assumes that the feedline impedance and receiver impedance are equal.)

If, for example, you use 53.5-ohm coax (RG-58) and want to connect three receivers to an antenna, each resistor will have a value of 53.5 x (2/4) or about 27 ohms.

This seems like the ideal circuit. It's compact and you can connect any number of receivers to an antenna. There is a price, however. Since the receivers are connected in series with resistors, not all the signal from the antenna appears at the receiver input. The received signal will be 1/n of the signal at the input of the distribution network. For a network with two receivers, the signal level will be 1/2 the signal level at the network input; for three receivers, only 1/3 of the network input signal will appear across the input of each receiver.

Depending on the signal level from the antenna and how many receivers are connected, you may need to use a preamplifier to make up for the signal loss in the network.

If you use a balanced line (such as 300-ohm twinlead), use the circuit shown in Figure 2(b). Equation 3 provides the value of $R_2$.

$$R_2 = 1/2\,Z\,(n-1)/(n+1) \qquad (3)$$

where $R_2$ is the required resistance in ohms, Z is the feedline impedance in ohms and n is the number of receivers.

To avoid mismatching when using these circuits (and possible ghosting with TV receivers), all network outputs must be connected to a receiver. A solution to this restriction is to connect a resistor equal to the receiver antenna impedance across any unused output.

Figure 3 shows a variation. Although three receivers are shown in this diagram, you can use this polygonal method of connection with two or more receivers. As with the circuit in Figure 2(a), the signal strength at the receiver input will be inversely proportional to the number of receivers connected.

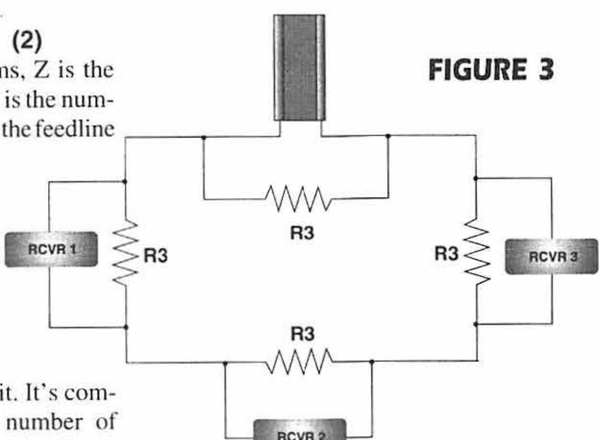
The value of each resistor ($R_3$) for the circuit in Figure 3 can be determined from Equation 4.

$$R_3 = Z\,(n+1)/(n-1) \qquad (4)$$

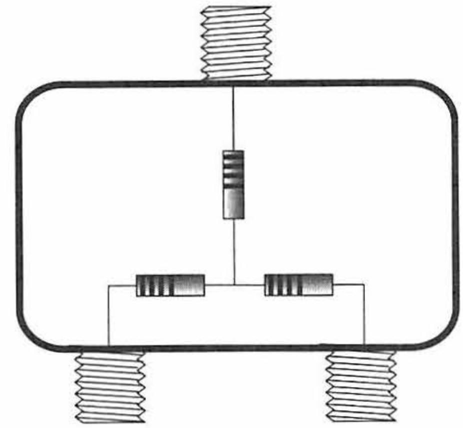
where $R_3$ is the required resistance in ohms, Z is the feedline impedance in ohms and n is the number of receivers.

Anyone with several TV sets and a single antenna knows that hybrid 2-way splitters for use on the VHF/UHF TV bands and the FM broadcast band are commonly available in consumer electronics stores. These splitters do not use resistors to maintain broadband characteristics, but use ferrite bead construction for coils.

## FIGURE 3




***A polygonal circuit configuration can also be used to feed several receivers from a single antenna. The more receivers you have connected to the antenna, the more likely it is you will need a preamplifier to boost the incoming signal.***



## FIGURE 4

***The signal splitter circuit is simple enough that it can be housed in a small, aluminum box. A custom-made unit can incorporate the type of socket that fits the plugs on your feedline. The case from a commercially-manufactured splitter can be used if you use F connectors, or if you use adapters to convert the F connector to the type of plug your receivers use.***

The metal case of a commercially-manufactured hybrid splitter makes a suitable (and inexpensive) case for the coax hybrid splitter or the resistive distribution network. Check the bottom of the splitter. If it is made of thin metal, simply pry it off. You can then remove the wires, ferrite beads, and capacitors and connect either sections of coax or resistors to the coax sockets. The ground lug inside the case can be used for grounding the shield of the coax. Since not many of us use F connectors (the type used on commercial splitters and on TV sets), you will need to buy adapters to convert the F connectors to the type your receiver uses.

If you want to avoid adapters, you can house the splitter in a small metal box available at Radio Shack and attach RF sockets that match the plugs on your feedline.

Whether you use a splitter at home or at a DX camp, you're bound to find all sorts of uses to increase your enjoyment and knowledge of radio listening. (Plus, you might earn the gratitude of a fellow DXer who doesn't need to put up his own antenna at the next DX camp.)