The Home Microwave Station—*Part 1*

Historically, microwave operation has been a hobby for those willing to travel to hilltops. Early activity on the microwave spectrum required line of sight conditions to make QSOs possible, and the highest elevations almost always afford the best chances for a contact. We also know that operation at a remote hilltop, although it provides pleasant views and hiking experiences, adds significant challenges to radio operation. We endure the hardships of lugging heavy batteries, setting up a tripod, achieving alignment and frequency stability in the field, and managing to keep comfortable in a difficult environment while listening to weak signals for hours.

In the last decade, there has been a dramatic increase in home microwave stations; many on bands through 10 GHz, and some even on 24 and 47 GHz (see Figure 1). Although most of us do not live on the top of hills or even in especially good spots for microwaves, we put microwaves on the air from home. By being active in all weather, at night, able to fix problems as they arise, and able to run schedules on a regular basis, home stations have contributed to our understanding of propagation. By being there "at the right time," and by being able to operate with elevated power levels, home station operators have enjoyed significant DX, including a number of distance records.

The Basics

The basics of any microwave station, home, rover or hilltop are the same. All that we really need is an IF rig, a transverter and an antenna. Although the home station has many advantages, it also has its own problems, so its evolution reveals several successful approaches to efficient operation. The home station is not constrained by space or power, and so it can operate many more bands. The rover station falls in between a home and hilltop station—often covering many bands, but somewhat constrained in space and power.

IF Rig

Home stations have the advantage of using any size or weight of transceiver for the IF radio. This gives flexibility to use the same radio on VHF or HF, and usually affords uncompromised layout with large knobs, noise blanking, memories, and other amenities such as band scopes and passband shape control which are limited or non-existent on the smaller IF radios one

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Figure 1—Here is a stack of transverters in a home station. The top ones from Down East Microwave are for 903, 2304 and 3456 MHz, and the bottom one from SSB Electronic is for 1296 MHz. Other homebrew transverters for 5760 and 10,368 GHz are elsewhere in the shack.

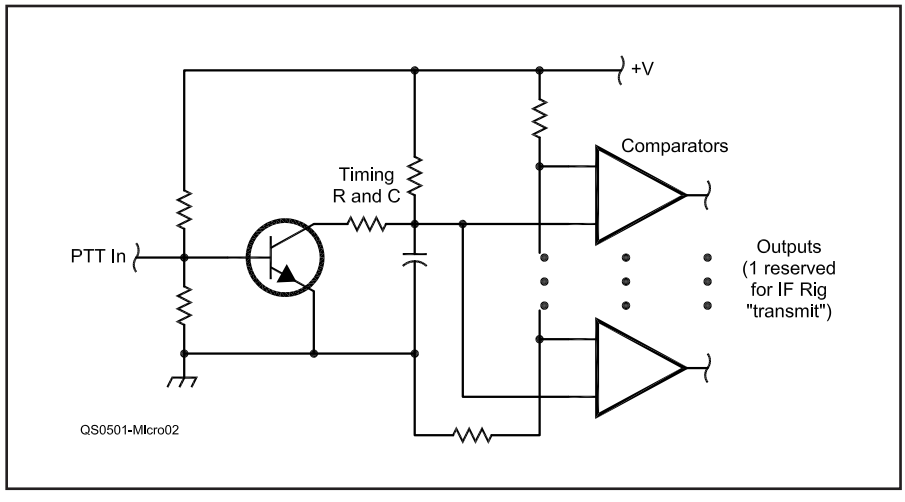

Figure 2—A simplified sequencer circuit.

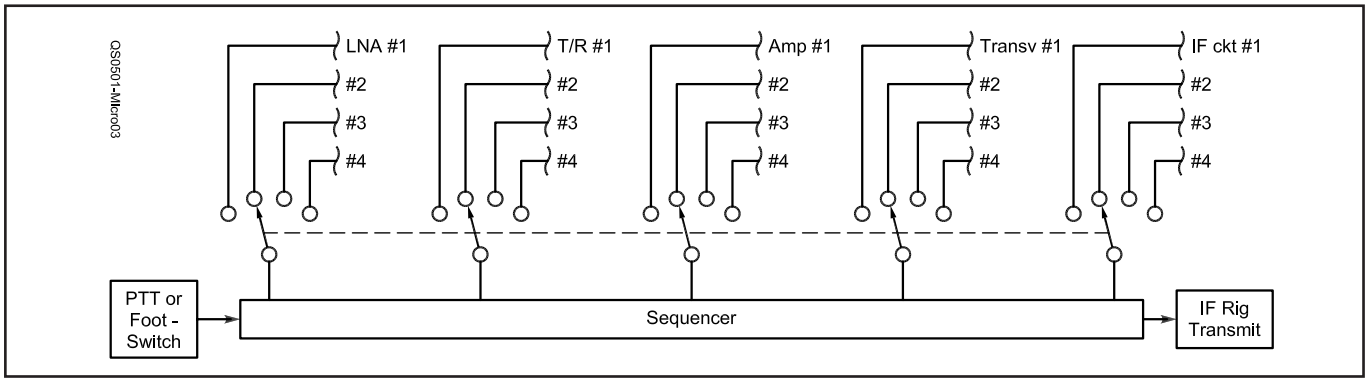

Figure 3—A simplified band-switch circuit with sequencer subsystem connected.

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Figure 4—Two examples of multiport coaxial relays suitable for routing IF signals between one IF rig and multiple transverters. On the left is an 8-port SMA type. On the right is a 6-port BNC type.

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Figure 5—Here is a photo of a home built microwave band switch and sequencer. Many possibilities for control result in different designs, including indicating lights and override or bypass control.

would lug to a hilltop. Some of these larger radios also provide convenient interfacing options for TR control and transverter level outputs. I covered IF rigs in some detail in the July 2004 column.

Sequencer

Any home station operating on VHF and above where separate power amplifier and low noise amplifier are used, has to have a circuit that sequences the interconnecting relays along with the application or cessation of RF. This is accomplished with a sequencer circuit. Its purpose is to prevent RF from being present on relay contacts when they are switched, and to also prevent any significant RF from entering (either end of) an LNA.

Sequencer circuits are available from transverter suppliers and have been described in several publications over the years. Figure 2 shows a simplification of one type of design that provides reliable sequencing. In this case, an analog circuit charges a capacitor when the input transmit switch (PTT or footswitch) is closed. As it charges, a number of comparators sequentially move from "off" to "on" state because they are each set at a slightly higher voltage than the previous one by means of a voltage divider. When the input transmit line is opened, the process reverses. Although each band—transverter, amplifier, LNA, etc—may or may not have all components, one sequence will suffice for all situations and those components that don't need to be controlled can be ignored.

The normal sequence of events when going from receive to transmit is as follows: 1) Turn off LNA, 2) switch antenna TR relay to Transmit, 3) turn on Amplifier, 4) turn on transverter, 5) place transceiver (IF rig) into Transmit. Notice that for #1 the signal turns OFF the LNA. The rest of the signals turn things ON as we go from R to T. Another possible exception is the TR relay, where some setups apply relay power during the Transmit state, and other setups apply it during Receive. There will be more on this in Part 2.

Of course, timing is critical. Remember, we are trying to keep RF from being applied to any component until its output is properly connected. This means that the sequencer has to wait until the appropriate relay has changed state. Most mechanical relays require at least 20 milliseconds to switch, and it is a good idea to give a coaxial relay 50 ms just to be sure. Because almost every piece of equipment (or at least some piece of equipment in a multi-band setup) will have an internal or external relay for some control signal, it is a good idea to give each component a 50 ms delay from the last. If there are 5 components to switch, that means 250 ms, or 1/4 second to go from Receive to Transmit or back. If you are not used to it, you'll be surprised by all the clacking of relays around a microwaver's shack during every TR cycle.

Multiple Bands

A home station will often run several microwave bands, and especially during a contest, must be able to switch between them very quickly. Most home stations are equipped to change operating band with a single multi-position switch. This directs relays to switch the RF from the transceiver into the appropriate transverter, and switches control signals to the appropriate transceiver, LNA, power amplifier and relays. Figure 3 shows a simplified example circuit for multi-band switching system.

The single knob is connected to a multipole, multi-position switch. This will route each of the control functions from the sequencer (each sequencer output connected to a pole of the switch) to the appropriate equipment for the selected band. Additionally, the IF rig RF needs to be routed to the right transverter, so a multi-port coaxial relay is employed (see Figure 4), and it is also switched by this single knob control. Sounds complicated? Well, it can be a bit of a rat's nest of wire if you don't plan it out in advance. The use of color coding, multi-pin connectors, terminal strips and, especially, leaving extra connections (poles on the switch) for expansion will make your life a lot easier.

Figure 5 shows the band-switch and sequencer system at the author's home station. As you can imagine, with everything controlled by relays it is possible to add some extra circuits that will allow extra functions, such as bypassing LNAs in case of overload during a contest or segmenting bands so that you can keep one radio operational on a microwave band for talkback while trying to establish a contact on another band or return quickly if there is a problem. The possibilities are limitless.

In the next issue we will continue the development of the home microwave station with consideration of remote mounting, frequency stability and power sources. QST

STRAYS

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Due to popular demand, we have compiled the printed annual 2002, 2003 and 2004 indexes, and they are now available on-line in PDF format at **www.arrl.org/members-only/qst/Annual-Index/**. If you don't have Web access, send a 9×12 inch self-addressed envelope, along with a check for $2 (payable to ARRL) for each year's index you are requesting, to *QST* Index, c/o Maty Weinberg, ARRL HQ, 225 Main St, Newington, CT 06111. Please be sure to specify the year(s) you are requesting.