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What Rig Should I Buy?

The economy is picking up. The future is looking brighter. You've finally got some cash to spend on Amateur Radio equipment, but you want to make the right choice. Ask any veteran ham and he or she will tell you about that #%&$@ radio they purchased. No one wants to throw away money, but how do you know which rig is best? Ed Hare, KA1CV, ARRL Laboratory Supervisor, with help from Rus Healy, NJ2L, Senior Assistant Technical Editor (and conductor of our Product Review column), jumps feet-first into this sticky topic!

Every day the Technical Department staff answers a variety of questions arriving by mail and telephone. You don't have to be a staffer very long before you realize that the same questions keep popping up again and again. One of the most difficult is, "I am thinking of buying a new transceiver. Which one is best?"

Sounds like a simple, straightfoward inquiry, doesn't it? Well, that innocent question is filled with pitfalls. In a supreme act of bravery or stupidity (you choose), we're going to tackle that thorny question this month. We'll be referring to a multimode, MF/HF transceiver, but the same principles apply to VHF and FM equipment.

We should point out that the League has a clear policy about making rig recommendations—we don't do it! This policy was written for some pretty good reasons. *QST* features a Product Review column to help inform our readers about the characteristics, features and performance of most of the popular or otherwise significant Amateur Radio equipment sold today. A lot of careful consideration goes into the Product Review column to make it a valuable tool to help our members with their purchase decisions. It would not be fair to you, or to equipment manufacturers, to undo all of this work by having the ARRL staff impose their preferences on you.

Every radio has strengths, weaknesses and idiosyncrasies that must be considered. We could no more tell you which rig is best than we could tell you what car to buy or whom to marry! Either way, it is *your* preferences that are important to the choice . . . and it is *you* who must live with the result.

Q: When shopping for a radio, what features should I consider?

A: Here are the major features that most hams consider important when selecting an HF transceiver:

IF Filters: Receiver filtering is often performed in the intermediate-frequency (IF) chain, usually with crystal filters. Many transceivers offer several IF filters according to the mode selected (a wide filter for SSB, a narrow filter for CW). Check which IF filters are available, and whether or not accessory filters are offered as well. For example, many SSB operators prefer to install 1.8-kHz IF filters in their rigs. CW operators often choose 500- or 250-Hz filters.

Audio Filters: Filtering can also be done in the audio stages of the radio. Many radios use audio filtering as a supplement to IF filtering. The main disadvantage of audio filtering is that it is usually done outside the AGC circuitry of the receiver. Strong signals that are filtered out by the audio filter may affect the volume level of the desired signal by *pumping* the AGC.

Notch Filtering: Notch filtering is usually performed in the IF, but it can also take place at audio frequencies. This feature gives you the ability to reject or "tune out" an undesired CW signal or other heterodyne. It may be implemented by an adjustable, analog notch-frequency control, or *digital signal processing* (DSP) technology. DSP notch filtering can be particularly useful because it can "seek and destroy" multiple carriers.

Passband tuning (PBT) and variable-bandwidth tuning (VBT): PBT and VBT are two features that increase receiver flexibility in tuning signals on a crowded band. They work by shifting the receiver's passband to avoid an interfering signal, or by varying the width of the passband until the undesired signal is no longer heard. Both affect the fidelity of the desired signal, but it is usually better to endure muffled or "tinny" audio than to suffer interference from another station.

Two VFOs: Dual VFOs have become standard in modern radios. The primary advantage of a dual VFO is the ability to work split-frequency, transmitting on one VFO and receiving on the other. They also let you quickly bounce back and forth between two frequencies or bands.

Noise blanker: A good noise blanker can dramatically reduce impulse noise. Noise blankers generally work quite well on automotive ignition noise and will vary in effectiveness on other types of noise. FM has substantial inherent noise immunity, so noise blankers are not usually found in FM rigs.

Memories: Most modern radios also have memory channels into which you can program your favorite frequencies and modes. Memory features also "remember" the settings of filters and other controls, making it seem as if you had many separate radios at your fingertips!

Computer control: Most current transceivers include a computer control interface. This comes in handy for logging or contest software, satellite operating and other applications in which it is convenient or necessary to control the radio's features via computer.

General-coverage reception: This is a great feature for hams who want the ability to listen to international broadcasts and other signals *in addition* to Amateur Radio. The next time an international crisis flares up, you can listen to the action on your Amateur Radio rig!

Expanded frequency coverage: Now we're talking about expanded transmit *and* receive capability. For example, both the Kenwood TS-690 and the ICOM IC-729 transceivers include 6 meters. Some HF transceivers feature the ability to add internal or external transverters or *modules* that permit operation on VHF/UHF bands.

Antenna Tuners: While antenna tuners are not required in every station, they sure make life easier! A well-designed antenna tuner will allow you to use antennas that aren't resonant at your desired frequency. You can put up a dipole for one band (40 meters, for instance) and operate on several other bands as long as you use a low-loss feed line.

A number of transceivers provide built-in antenna tuners that adjust themselves automatically. Many hams find it handy to have an antenna tuner right where they need it—in the radio.

Variety of modes: SSB and CW are standard in most rigs, but others add AM and FM, too. Yes, there is still AM activity on the amateur bands and FM flourishes on the high end of 10 meters. If you're a RTTY or AMTOR enthusiast, look for a rig with an *FSK* mode. You don't *need* FSK to operate RTTY or AMTOR, but rigs with FSK often provide narrower IF and/or audio filters when this mode is selected. Filtering makes a big difference when the RTTY/AMTOR subbands are crowded!

13.8-volt dc operation: If you plan to operate mobile or portable, will the transceiver accept a 13.8-volt power source? Some rigs feature an internal 13.8-volt dc option while others offer a dc accessory supply.

Size: How big is the radio? Will it fit in your car? Will it fit on your operating desk? Transceiver sizes vary from tiny boxes to behemoths!

Q: Let's talk performance. How can I decide which rig performs best?

A: Rather than get into every single performance issue in detail (that would take a book), we'll concentrate on the most important performance issues. The performance characteristics that are most important are subject to some disagreement, but most people will agree on the following:

Receiving: Sensitivity, dynamic range

and cleanliness.

Transmitting: Output power and spectral purity.

Q: Could you review receiver characteristics for me? How about sensitivity?

A: Sensitivity is a measure of the ability of a receiver to detect weak signals. Sensitivity can be expressed in several different ways, some more common than others. The two conventions most often seen are *microvolts* into 50 ohms (0.15 μV for a 10-dB signal-to-noise ratio), or *dBm* (decibels relative to 1 milliwatt into 50 ohms).

Q: This is starting to sound complex. What's the bottom line?

A: The bottom line, for the most part, is the lower the sensitivity number, the better. A sensitivity of 0.16 μV is better than a sensitivity of 0.2 μV. The larger the negative noise floor number, the better. A noise floor of −140 dBm is better than a noise floor of −130 dBm. Typical HF receivers have noise floors between −135 and −140 dBm.

Keep in mind, though, that more sensitivity is not always better! The band noise floor sets the practical limit. Once you've reached that point, greater receiver sensitivity simply amplifies band noise. Also, too much sensitivity may make a receiver more susceptible to overload.

Q: I've heard a lot about dynamic range. Can you explain it?

A: A radio's intermodulation or *IMD* dynamic range tells how strong two simultaneous, same strength incoming signals can be before they overload the radio and make it generate fake signals of its own. This number is expressed in decibels relative to the radio's noise floor. The larger the IMD dynamic range, the better. Look for a rig with an IMD dynamic range greater than 85 dB.

Blocking dynamic range (also expressed in decibels), is how strong a signal can be (compared to the radio's noise floor) before it overloads and *desenses* the radio. The larger the blocking dynamic range number, the better. Look for a radio with a blocking dynamic range greater than 120 dB.

Q: What do you mean by receiver "cleanliness"?

A: In modern, synthesized transceivers, a key receiver-performance issue is spurious-free, highly linear, low-noise signal reproduction. The introduction of frequency-synthesis techniques in Amateur Radio gear has created a new set of challenges for radio designers. This is because using these techniques creates the potential for receiver spurs ("birdies"), internally-generated noise that rises with signal levels, and related effects that can mask or distort desired signals. An unrelated but important issue is freedom from excessive hiss outside the desired-signal passband in audio and IF amplifiers. You'll see these issues and their impact discussed in *QST* Product Reviews.

For example, frequency-synthesizing circuitry is notorious for generating *phase noise*. Phase noise often manifests itself as broadband hiss caused by a phase-noisy oscillator chain in your transceiver. You'll hear it when you're tuned to a frequency adjacent to a strong signal. Phase noise can also be *transmitted* by your radio, causing interference to others. (Imagine having a phase-noisy receiver tuned to a frequency adjacent to a strong signal generated by a phase-noisy transmitter!) Phase noise has improved tremendously over the past five years, but can be an annoying problem in some older rigs. A clue to a phase-noise problem is *noise limited* dynamic range test results in *QST* Product Reviews.

Q: Let's move on to the transmitter. Are more watts always better?

A: Most amateur transceivers are in the 100-watt class. Some of them struggle to get there, or fall slightly short; others exceed 100 watts comfortably. Is the difference significant? For most people, no. The guy on the other end will never notice the difference between 95 and 110 watts.

If you're going to operate RTTY, look for a rig that's rated for *100% duty-cycle* operation. During a RTTY transmission, your transceiver is operating at maximum output *continuously*. This is hard on the final amplifier stage and the power supply! Many rigs perk along fine during low duty-cycle operating (CW or SSB), but overheat quickly on RTTY. For RTTY, a transceiver should be capable of tolerating continuous, 100% duty-cycle operation for at least 10 minutes.

And don't forget QRP capability! What if you want to crank down the power and see what you can do with a watt or so? Will the transceiver allow you to adjust the minimum output to whatever level you desire? Some rigs have a *minimum* output level as high as 5 or 10 watts.

Q: What is "spectral purity"?

A: Part 97 (the FCC regulations that govern the Amateur Radio service) requires that all transmitters meet standards for the purity of their signals. All transmitters emit some signals outside their intended frequency range. These signals are called *spurious emissions*—a term that includes all types of signals that are not the fundamental and its desired modulation. Amateurs must be concerned with the level of these spurious emissions, both to ensure that the transmitted signal is in compliance with Part 97, and to ensure that the transmitter doesn't interfere with other services.

Spectral purity is measured using a *spectrum analyzer*. Refer to the test-result table in each *QST* Product Review for spectral-purity test results. Any transceiver advertised in *QST* must meet the minimum FCC requirements.

Q: Earlier you said that convenience was one of the major factors to consider. What do you mean?

A: It's simple, really. Take a good, close look at the radio. Are the critical controls located on the front panel? Are the knobs the right size for your fingers? You should also consider the owner's manual. Is it well written? Does it answer your questions?

Q: All this information is very helpful and I think I have my list of candidates narrowed down. Still, I can't seem to make a decision. How do I decide which rig is really best for me?

A: We assume you've also been looking at advertisements and dealer displays. You can learn a lot about a piece of equipment from the way it is advertised and the marketing information supplied by the manufacturer or dealer. You can probably dismiss a few radios right away based on price, performance or features. That should leave you with only a handful of choices.

Now it's time to get serious. *QST* probably has done Product Reviews on most of the rigs you are considering. Read the Product Reviews. Read the advertisements, and read the manufacturers promotional material. Order the instruction manuals from the manufacturers. If you're considering older equipment, pick up a copy of *The ARRL Radio Buyer's Sourcebook* (see the publications order form elsewhere in this issue). The *Sourcebook* offers detailed *QST* Product Reviews dating back to the '60s.

Now, talk to people who own (or have owned) the rig you're considering. You may find a wealth of advice through your local radio club, repeater group or through on-the-air contacts. Look around the bands for people using the rig you are considering.

Service can be important, too. Ask about the service offered by local dealers and equipment manufacturers. Most hams will have a tale to tell (of happiness or woe) about their service experiences.

Q: Well, thanks! I think I know which radio I want. Is it time to bite the bullet and plunk down the dough?

A: We recommend one more step. There is no substitute for hands-on experience with the radio of your dreams. Find a local ham or dealer who has one. With luck, you'll be able to secure an invitation to visit and operate it for a while. This will let you have an opportunity to really put the radio through its paces. Considering the amount of money you'll spend, it's a worthwhile step!

If you have a local ham-radio dealer, you may be able to use the demo model in the store. This isn't as useful as spending an evening with the radio, but you'll get a decent feel for the equipment—and a chance to compare *all* of your choices in one place.

Good luck and enjoy your new radio!

We welcome your suggestions for topics to be discussed in *Lab Notes*, but we are unable to answer individual questions. Please send your comments or suggestions to: Lab Notes, ARRL, 225 Main St, Newington, CT 06111.