Brass Tacks

An in-depth look at a radio-related topic

How far can my little radio transmit?

Let's say you paid a visit to Dempsey (NMØAB) at his work place, Doug Smith Chrysler-Dodge-Jeep-Ram, pointed to a nice-looking vehicle, and asked, ***So, just how far will this vehicle take me?*** He might just give you a blank stare, while trying to decipher what you're really trying to ask. ***You mean on a tank of gas?*** he asks. ***No***, you say, ***how far, period.*** Our dealer friend, still unsure of your intention, might start by saying something like ***It depends*** and begin explaining concepts like fuel economy, engine size, terrain, and driving habits. Ok, in all fairness to Dempsey, that's not a perfect analogy, but to knowledgeable radio operators like him, explaining how far a little radio will reach can seem just as frustrating.

Believe it or not, I get asked that question quite a lot, yet as new hams, people honestly want to know how far apart two hams on HTs (handheld transceivers) can be, and still hear each other well enough to carry on a conversation.

They've seen the deceptive ads and labels at Costco and Walmart on the walkie-talkie packages that shout ***10 Miles!*** and ***25 Miles!*** and even ***35 MILES!*** and come to *you*, hoping to compare apples with apples. But before they go on a spending spree, they want to be sure they're getting their money's worth. And if *you* respond with something related to ***line-of-sight***, it might get them off your back for awhile, but that's not entirely accurate or satisfying, and they'll soon return with more questions.

How far can my rock transmit?

One of the first puzzles that a new ham runs into with a little HT is the fact that he and his ham friend can talk with each other on them in town up to a mile, maybe two if they're lucky, yet both can easily reach the repeater over 13 miles away. Why is that?

Radio waves act kind of like the waves on a still water surface. If you toss a rock into a calm pond, you can see the waves ripple outward from the point of impact. You'll also notice that the farther out the waves travel, the smaller the waves seem, even though their rate of travel (frequency) remains the same. Now, extend that pond to a hundred yards, and you'll see the waves become even smaller on the opposite side. A mile, and the ripples seem almost non-existent, yet they're still there.

The three big factors

Three primary factors are in control of just how far apart you and your contact can be for an intelligible conversation to take place. These include transmit ***power*** (how big the rock is), receiver ***sensitivity*** (how well your eyes can detect the pond ripples), and ***obstructions*** (island, boat, cattails, etc.) There are other factors (scattering, reflection, refraction, ducting, knife-edging, constructive / destructive interference, etc.) that might help or hinder your radio signal, but discussing them won't do much to help answer our question, which is regarding HTs.

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Power

Shine your flashlight through a pane of glass, and the light will seem to pass through as though the glass was absent. Multiply the glass by ten panes, twenty panes, thirty panes. It'll become quite apparent (no pun intended) that your once-see-through glass no longer seems so transparent. Now, if you used a higher-powered flashlight, you might be able to detect more of the light coming through all those panes.

So, will more power from your little radio help? Possibly, but to a point. Your HT can only put out so much wattage; furthermore, there are the other factors that might affect your signal. For example, if the light from your flashlight finds it difficult to punch through a thin cardboard box, you can increase your light intensity by double, triple, or even ten-fold, but still might find that most of the light has difficulty getting out of that opaque box.

Sensitivity

Assuming your transmitter is throwing out enough power to reach your friend's location with some amount of usable signal, and even if you and your friend can see each other clearly, his receiver still needs to be sensitive enough to detect and process (demodulate) your signal and turn it into intelligible audio. One of the biggest differences between a walkie-talkie that boasts a 25-mile limit over one that claims a 10-mile limit, for example, is its improved sensitivity. The manufacturer assertions are made based on ideal conditions using the same model of radio on both ends of the conversation.

Fortunately, modern transceivers are designed with very clever electrical circuitry and constructed using very high quality factory processes. Unfortunately, there's not a lot remaining for us, the user, to improve the sensitivity of our receivers. However, one important thing we can do to improve our reception is focus on our antennas, which is why the great majority of our DIY space concentrates on building antennas. To create the optimum receive experience, you need to have an optimal antenna, one that has low loss and high receive ability for the frequencies you expect to receive, and typically a half-wave antenna will work much better than a quarter-wave antenna.

Obstructions

When we refer to "line-of-sight" we're talking about radio line-of-sight, not necessarily human-eye line-of-sight. For example, a radio transmitting from behind a leafy bush will not be hampered much by the opaqueness of the leaves, even though it's obviously not within visible sight of any receiver. So, reaching the distant repeater is not a problem, because not much stands between you and it. Usually.

A cumulative effect occurs with seemingly radio-transparent objects, such as leaves and house walls. Because the repeater is (typically) up at an angle from your location, there are few obstructions between the repeater and your HT. But because there are many obstructions (trees, vehicles, buildings, small hills, greater air mass / moisture) between you and your ham friend, your signals will be reduced (attenuated) by quite a lot compared with that between you and the repeater. An interesting effect called the *Fresnel Zone* comes into play, but we'll address that in another issue.

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The farther away you want more of your signal to be detected, the fewer obstructions you can afford to leave in your way. That means you should ***locate your HT*** with the reasonably fewest obstructions between your radio and your friend's radio, so your locations become very important to the success of your communication.

An abbreviated table

This very brief and generalized table* can provide a rough summary of the range of your handheld radio under perhaps the most common conditions that affect VHF / UHF (FM) communication by HT. So, ***Distance*** in this table refers to the maximum distance between your HT and the HT of the other person you're trying to communicate with.

How	Location	Distance	Explanation / Dependencies
HT to HT	Vehicle to inside vehicle	Under ½ mile	Your vehicles are metal shields
HT to HT	Within your city	1 to 3 miles	Buildings, trees, other obstructions
HT to HT	Suburbs	3 to 6 miles	Buildings, trees, other obstructions
HT to HT	Flat desert or over water	6 to 12 miles	Line of sight
HT to HT	Mountaintop to valley floor	15 to 20 miles	Mountain height vs. terrain topology
HT to HT	Mountaintop to mountaintop	30 to 70 miles	Mountain heights
HT through a repeater	Standalone repeater	30 to 100 miles	Using the repeater's range
HT through a repeater	Repeater on the internet	Unlimited	The internet's the limit
HT through a satellite	Clear path to the satellite	Nearly halfway around the globe	Satellite angle above your horizon
HT to ISS	Clear path to the ISS	Hundreds of miles	ISS angle above your horizon

** some of this material unapologetically stolen from Miklor*

Why you need to know

It's a simple question, but the answer is anything but trivial. If you're new to ham radio, our purpose here is to give you some idea of how far your handheld radio can reach under a variety of circumstances. And if you're a long-time ham veteran, our purpose is to give you a little ammunition to help you answer that question by newer hams who just want to know.

So, how far can one of these little HTs reach? Depends.

— Noji Ratzlaff, KNØJI (kn0ji@arrl.net)