# 902 FM—UHF's Final Frontier

The 902 MHz band is the one of the last outposts for hams who enjoy converting surplus commercial radios for amateur use.

By Dave Page, KD3NC*

*Editor's Note: Just because it's FM doesn't mean that this is a beginner's article. It's not.*

If you want to find out what it's like to share a ham band with other services, come on up to 902. In the 902- to 928-MHz band, industrial, scientific, and medical users (ISM), government services and Automatic Vehicle Monitoring (AVM) have priority over amateur users. There are also unlicensed "Part 15" users (cordless phone operators, for instance) on the band. They're not protected against interference *from* licensed users and are prohibited from causing interference *to* licensed users.

The biggest differences between sharing here and on, say, 2 meters, are:

1) the band is 26 MHz wide, and

2) there are far fewer amateurs using the band (of course, if we want to keep it, we need to change that).

This article will introduce you to some of our "partners" on the band, propagation characteristics, and sources of equipment that can be converted to amateur use (there's virtually no commercially made ham gear for 902).

*You can modify cellular telephone equipment to operate on the 902- to 928-MHz ham band, but you'd better know what you're doing...and be prepared for a lot of work!*

## Getting Along with Other Users

ISM users don't receive, so we don't have to worry about interfering with them (but we must tolerate whatever interference they generate). Government use is very infrequent in most areas of the country; AVM, on the other hand, is quite another story.

The original idea behind AVM was to provide a commercial service to locate and monitor vehicles in an urban area; say, a home office keeping track of service or delivery trucks. This application hasn't become particularly popular, but the service has now been expanded to include other related vehicular applications, such as automated toll booth collection. Oh, well.

Practically speaking, I haven't had a significant problem with cordless phones and other Part 15 devices in the Albany, New York, area interfering with my ARRL-bandplan FM repeater. But, the incidence is likely to increase if we eventually adopt the Southern California bandplan nationwide (see below), as this more closely approximates the frequencies used by cordless phones.

## The FM Bandplan(s)

According to the current *ARRL Repeater Directory*, FM repeater inputs are 906.0 to 909.0 MHz and the outputs are 918.0 to 921.0 MHz (12-MHz split). However, the League says it's developing a new bandplan that "reflects our need not to cause interference to AVM...." The Southern California Repeater and Remote Base Association (SCRRBA) adopted a bandplan designed specifically to preclude interference to AVM. It has repeater inputs on 902.1 to 903.0 MHz and outputs on 927.1 to 928.0 MHz (25-MHz split). The SCRRBA bandplan also specifies narrow channel spacing (12.5

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kHz), which makes the use of modified cellular gear difficult. But that's only one source of equipment that can be modified—with considerable effort—for amateur use on the band.

## Equipment Sources

Bands adjacent to 902 to 928 include paging (just above 928), 900-MHz trunking (898- to 902-MHz input, 937- to 941-MHz output, 39-MHz split), and, of course, the 800-MHz cellular and trunking services. The paging systems at 928 and up are high power and make receiving at the high end of the ham band difficult at hilltop sites. The 900-MHz trunking services provide an excellent source of FM radios for ham use. The 800-MHz services are a good source of equipment, too, but amateur use requires fairly extensive modifications. To give you an idea of what's involved in putting up an FM repeater system on 902, let me tell you about mine:

I'm using analog cell site transceivers for the core of my repeater. I've modified a GE cellular RCU (the full-size 19" rack mount variety) for use on 902 to 928. In order to do this, I had to retune the VCOs (voltage controlled oscillators), replace some GigaFils (the ceramic RF bandpass filters they use), and write some firmware to program the PLLs (phase locked loops). I also had to re-tune the power amplifier. It's a substantial amount of work.

For talking through the repeater, I've modified GE CF-1000 cellphones. This also was a lot of work. I replaced the duplexer with a T/R (transmit/receive) relay, built a squelch circuit, hacked the VCO, and ported my "TMX" software to it. These modified cellphones will do about 1 to 1.5 watts on 902 to 928.

There's a problem with residual FM, though. I had to spend a fair amount of time with a spectrum analyzer to kill some of the biggest transmit spurs (spurious signals). GE relies on the duplexer to remove some ridiculously strong garbage. Its engineers cost-optimized a lot of bypassing out of the +10-volt bus, so the reference oscillator buffer, in particular, AMs the RF VCO buffering. It'll take some work to get a clean signal out of these on 902 to 928.

The easiest way to get onto 902 FM, in my opinion, is to use a GE TMX 10-watt 900-MHz radio. It can be modified for 902 by reprogramming with a custom ROM (socketed, so there's no messy unsoldering/soldering of big chips) and can be completely programmable from the headset. Simply replacing the EPROM with my firmware makes the radio usable. Replace the RX GigaFils, and it makes a pretty good 902 mobile radio. The "good" surplus price seems to be about $200.

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## Thoughts on 902 Propagation

The 902 to 928 band is quite a bit more optical than the typical amateur repeater bands. Signals are attenuated more heavily by green vegetation and are more readily reflected off of solid objects such as buildings, hills, trucks, etc. This is an advantage in that a 902-MHz repeater in an urban area may provide better penetration into and around structures than one on 440. The disadvantage is that 902 has deeper and more distinct phasing nulls than 440 for the same average signal strength. For example, while a 440-MHz signal with an average quieting of 10 dB may vary from 7 to 13 dBq (decibels of quieting) as a receiver moves, an equivalent 902 signal may vary from 3 to 17 dBq (and do so twice as fast as the 440 signal, due to the shorter wavelength). This multipath fading makes the 902-MHz received signal unusable sooner than the equivalent 440 signal.

The reflectivity of signals at 902 makes for some interesting effects, both positive and negative. For example, a low cloud layer tends to improve coverage. But nearby aircraft and some cloud formations can result in multipath fading, if the direct path is sufficiently attenuated. It's interesting to be parked, hear rapid mobile flutter, look up, and discover an aircraft or a lone cumulus cloud. In addition, cars and trucks moving around nearby can cause fading as well.

## RF Safety

As far as RF safety goes, the government-recommended exposure levels at 1 GHz are lower than at 450 MHz, but since most mobile radios only produce 10 watts or so, the hazard—if any—is minimal. A commercial handheld radio might put out 2 watts, so is doubtless the worst offender from an RF exposure standpoint. Typical output for a repeater is about 50 watts, so you may need to conduct a "routine evaluation" when the FCC's new RF exposure rules take effect next year.

## Is This Band for You?

If you love nothing more than digging into a piece of surplus commercial gear and magically making it work on a ham band, then 902 may be for you. Even if that's not your "thing," but you have a friend who enjoys it and is willing to modify a radio for you (he'll need someone to talk to), then by all means, join us on UHF-FM's "final frontier." ■

## Resources

For more information on Dave's modifications and repeater system, visit his World Wide Web page at <http://www .rpi.edu/~paged2/projects.html>. In addition, Dave can provide customized firmware and EPROMs for certain radios (as noted above). For information, contact Dave Page, KD3NC c/o Dynamic Systems Inc., P.O. Box 1234, Poestenkill, NY 12140; Phone: (518) 283-5350; Fax: (518) 283-3160; Web page: <http://www.gleeble.com/>.

*(Editor's note:* CQ VHF *thanks Dave Hockaday, WB4IUY, for sending some of this information our way. Dave is another excellent resource for 902 MHz information. You can visit his Web page at <http://www.ipass.net/~wb4iuy/>.)*