Everything You Need to Know About GMRS/FRS, But Were Afraid to Ask

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After licensing and installing a General Mobile Radio Service (or GMRS) repeater, I have learned a lot about GMRS and Family Radio Service (or FRS) equipment, the laws concerning them, and some of their performance characteristics. But allow me to back up a bit…

In the early Spring of 2001—about the time the hams of east Texas were coping with the Columbia Space Shuttle disaster—David Bush, KC5UOZ was working on an ATV mobile van, that included a 60-foot crank up tower. It occurred to me that this van, equipped as it was, could someday have a valuable service role for a future disaster response team—just as we were witnessing in east Texas. In a role like this, I thought, "Couldn't the van be equipped with a portable repeater to facilitate emergency communications?" I considered an amateur 440 MHz repeater, but quickly rejected that idea because 1) most of our local hams don't have 440 MHz handie-talkies and 2) at such an incident, there would likely be many volunteers who were not licensed hams anyway. On the other hand, a GMRS repeater could serve non-hams and hams alike who could be equipped with more affordable handheld GMRS radios. And, since FRS radios operate on similar frequencies, maybe these inexpensive radios could also be used.

To that end, I applied to the FCC as control operator for a GMRS repeater, and was granted the license KAF7259. The repeater output frequency is 462.700 MHz; the input frequency is 467.700 MHz; with a PL tone of 97.4 Hz. Tests with my repeater mounted in the KC5UOZ ATV van have demonstrated that, with handheld 5-watt GMRS units, this repeater setup has a useful range of 10 to 15 miles. I can now imagine a possible scenario:

1) The van (and portable repeater station) might be parked in a disaster search area.
2) Workers would use GMRS radio communications as much as 10 to 15 miles away from the van.
3) Workers would operate under the privileges of my GMRS license.
4) Worker reports could be relayed to an Emergency Communication (EmComm) station by a control operator in the ATV van.
5) With the aid of a yagi antenna mounted at the van (as high as 60 feet), the EmComm station could be 30 miles or more from the van.

This sounded like a wonderful opportunity to make use of handheld GMRS radios. And lately, you've probably noticed that 1) FRS radios use almost the same frequencies, 2) are even less costly than GMRS equipment, and 3) are starting to appear packaged as combination GMRS/FRS radios.

To further explore these possibilities, I found it necessary to get a bit more technical. Let's first look at how the FCC has mapped out the frequencies and capabilities for these two services (as detailed in Part 95).

General Mobile Radio Service (or GMRS)

The GMRS has 8 frequency pairs designated for GMRS repeater use, with the input and output frequencies separated by exactly 5 MHz, as listed in Table 1. Notice that we can use the kilohertz values of each pair as "channel designators" (e.g., "channel 550," "channel 575," and so forth).

Table 1. GMRS Frequencies for Repeater Use

Designator	Repeater Output Freq.	Repeater Input Freq.
550	462.550 MHz	467.550 MHz
575	462.575 MHz	467.575 MHz
600	462.600 MHz	467.600 MHz
625	462.625 MHz	467.625 MHz
650	462.650 MHz	467.650 MHz
675	462.675 MHz	467.675 MHz
700	462.700 MHz	467.700 MHz
725	462.725 MHz	467.725 MHz

Thus, all GMRS stations will monitor the 462 MHz frequencies above for transmissions coming from repeater stations. Stations wishing to use those repeaters must use an offset of +5 MHz to achieve the 467 MHz input frequencies (i.e., just as 2-meter repeater users use a +600 kHz or –600 kHz offset for 2-meter repeater inputs).

However, the FCC rules also permit GMRS *simplex* operation on the above 462 MHz frequencies. Consequently, GMRS stations may transmit on the 462 MHz repeater *output* frequencies to achieve simplex communications, as well as the 467 MHz *input* frequencies for repeater communications.

Of course, the FCC rules specify power restrictions for these frequencies. Transmissions on the frequencies listed in Table 1 are permitted a maximum power output of 50 watts and a maximum FM deviation of ±5 kHz. So, at these power levels,

we can imagine high-power operations from base stations, repeaters, and mobile (i.e. automobile-mounted) rigs, or low-power operations from hand-held transceivers. Remember this information for a moment.

The GMRS also authorizes the use of 7 intermediate or interstitial frequencies, as shown in Table 2. These frequencies are located midway between each of the Table-1 frequencies.

Table 2. GMRS Interstitial Frequencies	
Interstitial Channel	**Frequency**
1	462.5625 MHz
2	462.5875 MHz
3	462.6125 MHz
4	462.6375 MHz
5	462.6625 MHz
6	462.6875 MHz
7	462.7125 MHz

The use of these interstitial frequencies by GMRS users are more restricted than the Table-1 frequencies. According to the FCC rules, the interstitial frequencies are

1) solely for simplex use by mobile units and "small base stations," and
2) limited to 5 watts effective radiated power (ERP) at a maximum deviation of 5 kHz.

A "small base station" is a base station that has an antenna that extends no more than 20 feet above ground or an existing structure on which it is mounted. Thus, for example, an antenna mounted on the ATV mobile van at 60 feet could *not* be used to transmit on these frequencies. Furthermore, in light of the 5 watts ***ERP*** restriction, not only would the radio power of a typical base station have to be reduced, but the gain of the antenna must also be taken into consideration. So, it's clear that these interstitial frequencies are intended to be used primarily by handheld GMRS radios, or at most by other GMRS radios operating at a low power level with minimal antennas. However, note that even these transmissions are permitted a maximum deviation of 5 kHz. Again, make a note of this bit of information, as we will return to it later.

Family Radio Service (or FRS)

Let's now turn our attention to the Family Radio Service (or FRS). The interstitial frequencies in the 467 MHz band are given solely to FRS users, as shown in Table 3. They were designated channels 8 through 14 (for reasons that will be more clear in a moment).

Table 3. FRS Channel 8-14 Frequencies	
Channel	**Frequency**
8	467.5625 MHz
9	467.5875 MHz
10	467.6125 MHz
11	467.6375 MHz
12	467.6625 MHz
13	467.6875 MHz
14	467.7125 MHz

Radio manufacturers wanted to package radios that used both FRS and GMRS

frequencies. So the FCC was convinced to include the 7 interstitial GMRS frequencies in the FRS, too. These became FRS channels 1 through 7, as shown in Table 4. This meant that FRS users could both listen and talk to GMRS users on the interstitial frequencies, albeit under the ½ watt maximum power limitations imposed by the FRS. (GMRS users can use up to 5 watts on these channels.)

Table 4. FRS Channel 1-7 Frequencies	
Channel	**Frequency**
1	462.5625 MHz
2	462.5875 MHz
3	462.6125 MHz
4	462.6375 MHz
5	462.6625 MHz
6	462.6875 MHz
7	462.7125 MHz

By virtue of so-called "hybrid" FRS radios, FRS users would also seem to be able to communicate on the GMRS simplex frequencies. These hybrids use labeled channels 15 through 22, as shown in Table 5. Since licensed GMRS users are allowed to transmit with up to 50 watts of power on these frequencies, it is on these channels that the hybrids emit their maximum advertised power (typically 2 to 5 watts). According to the Part 95 rules, one needs a GMRS license to transmit on channels 15 though 22. However, in allowing the manufacture and sale of these hybrid radios, the FCC has effectively created an unenforceable situation certain to create new interference issues: When the average consumer buys a hybrid FRS/GMRS radio, the perception is that he gets a "22-channel walkie-talkie" that works best—because it transmits with higher power—on channels 15 through 22.

So, seven channels are exclusive to FRS, and fifteen channels are effectively shared with GMRS. For a summary of all the GMRS and FRS frequencies and their overlap see Table 6.

Table 5. Hybrid Radios Channel 15-22 Frequencies	
Channel	**Frequency**
15	462.550 MHz
16	462.575 MHz
17	462.600 MHz
18	462.625 MHz
19	462.650 MHz
20	462.675 MHz
21	462.700 MHz
22	462.725 MHz

However, compared to GMRS radios, FRS radios are very restricted in power. The FCC rules restrict FRS radios transmitting on FRS channels to:

1) a maximum power output of ½ watt,
2) a maximum FM deviation of ±2.5 kHz, and
3) an antenna that remains attached to the handheld unit (i.e., a non-detachable, "rubber duck" antenna).

On channels 15 through 22, although higher power is permitted, the radios will still be constrained by the maximum deviation and antenna restrictions.

Comparing GMRS and FRS

This leads to several contrasts between GMRS and FRS operations—some that may surprise you.

1) The most obvious difference is power. Most GMRS radios can operate at 50 watts. Even on the shared interstitial frequencies, GMRS radios are allowed 5 watts ERP. FRS radios operating on the FRS channels, on the other hand, are never permitted more than ½ watt power output. As hams, we all pretty much know how these differences will translate into everyday performance.
2) GMRS radios can use gain antennas to achieve rather impressive territorial coverage. Even on the shared interstitial frequencies, GMRS radios can use raised antennas that will increase the range of their 5-watt transmissions. FRS radios, on the other hand, may not improve their antenna performance beyond the "rubber-duck" antennas attached to the transmitter by the manufacturer. (One manufacturer has creatively packaged the transmitter and antenna as a mag-mount unit with a remote microphone attached by a cable.)
3) While the FRS channels share many frequencies with GMRS, they are ***not*** allowed to transmit on the GMRS repeater input frequencies. Thus, inexpensive FRS radios *cannot* serve as inputs to GMRS repeaters.
4) Lastly, the FCC has specified differences in maximum allowed deviation for the two services. For FM transmissions, loudness of audio is not dependent on the *strength* of the signal (as is the case with AM), but rather on the *deviation* of the signal. Recall that GMRS radios are allowed a ±5 kHz deviation, while FRS radios are allowed only ±2.5 kHz deviation. The bottom line is that, on the shared frequencies, GMRS radios are going to sound about twice as loud and clear as FRS radios and, consequently, have a much better signal to noise ratio.

What Does It All Mean?

In summary, be careful that you're not confused by the growing popularity of "combination FRS/GMRS radios," or "hybrids." First, if you read the fine print accompanying these radios, you'll discover that the use of GMRS frequencies requires a license, requiring a rather substantial fee (compared to an amateur radio license fee, for example). If you were to operate under the auspices of a licensed GMRS entity (such as an existing GMRS-licensed repeater owner or small business), you might be able to avoid the cost of your own GMRS license.

Second, realize that while these combination radios may be advertised as 2-watt or even 5-watt radios, those power levels apply only to the GMRS frequencies. When set to the FRS channels 1 through 14, the power is automatically limited to ½ watt. When operating on the shared frequencies labeled as channels 15 through 22, although you get the higher output power levels, you are implicitly operating in the GMRS. (Are you licensed to do so? The FCC has seemed to open "Pandora's box" here…)

Third, due to the deviation limitations imposed by the Part 95 rules, the use of a mixture of FRS radios and GMRS radios on shared frequencies during a special or emergency event is going to be marked by noticeably decreased signal-to-noise ratios by transmissions from the FRS radios.

And last, while it's fun to imagine using the inexpensive FRS radios with the GMRS repeaters, most all of the combination FRS/GMRS radios do *not* include the GMRS repeater input frequencies. At this time, we've only seen one unit that does: the Motorola Talkabout (Model T-7200). (It also happens to receive 8 NOAA weather frequencies in the 162 MHz band.) However, it has a price tag around $110—a lot higher than the more common $25 hybrid radios (that will ***not*** work the repeaters).

FRS and GMRS radios can have a place in the amateur radio operator's arsenal of tools. For example, they're great for communicating at a family picnic or in a short mobile caravan down the highway. And they might even possibly serve a similar useful purpose for a civilian emergency response team. But as a knowledgeable amateur radio operator, you'd be well advised to know their limitations and restrictions before you buy.

Table 6. Summary of GMRS/FRS Frequencies and Limitations

GMRS up to 50W output, ±5 kHz dev		Interstitial Frequencies GMRS up to 5W (ERP, incl ant. gain), ±5 kHz dev		FRS/GMRS "hybrids" up to ½W, ±2½ kHz dev (rubber-duck ant.)
"550" Repeater Output / Simplex (1)	462.550	←	←	Handheld (ch 15)
		462.5625	Mobile, Small base stations*	Handheld (ch 1)**
"575" Repeater Output / Simplex (2)	462.575	←	←	Handheld (ch 16)
		462.5875	Mobile, Small base stations*	Handheld (ch 2)**
"600" Repeater Output / Simplex (3)	462.600	←	←	Handheld (ch 17)
		462.6125	Mobile, Small base stations*	Handheld (ch 3)**
"625" Repeater Output / Simplex (4)	462.625	←	←	Handheld (ch 18)
		462.6375	Mobile, Small base stations*	Handheld (ch 4)**
"650" Repeater Output / Simplex (5)	462.650	←	←	Handheld (ch 19)
		462.6625	Mobile, Small base stations*	Handheld (ch 5)**
"675" Repeater Output / Simplex (6)	462.675	←	←	Handheld (ch 20)
		462.6875	Mobile, Small base stations*	Handheld (ch 6)**
"700" Repeater Output / Simplex (7)	462.700	←	←	Handheld (ch 21)
		462.7125	Mobile, Small base stations*	Handheld (ch 7)**
"725" Repeater Output / Simplex (8)	462.725	←	←	Handheld (ch 22)
"550" Repeater Input	467.550			
		467.5625	(not allowed in GMRS)	Handheld (ch 8)
"575" Repeater Input	467.575			
		467.5875	(not allowed in GMRS)	Handheld (ch 9)
"600" Repeater Input	467.600			
		467.6125	(not allowed in GMRS)	Handheld (ch 10)
"625" Repeater Input	467.625			
		467.6375	(not allowed in GMRS)	Handheld (ch 11)
"650" Repeater Input	467.650			
		467.6625	(not allowed in GMRS)	Handheld (ch 12)
"675" Repeater Input	467.675			
		467.6875	(not allowed in GMRS)	Handheld (ch 13)
"700" Repeater Input	467.700			
		467.7125	(not allowed in GMRS)	Handheld (ch 14)
"725" Repeater Input	467.725			

*"small base stations" have antennas no higher than 20 feet above ground or existing structure

** FRS channels shared with GMRS

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