NOTE: While the ideas in this article and the discussion of 'deviations' are still relevant, due to changes made by the FCC in September 2017—1) the power level values, 2) the specifics of hybrid radios, and 3) base station antenna limitations described below are **OBSOLETE as of September 2017.** For more accurate info see the more currrent article and chart available on this website.

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

By Larry Bush, W5NCD and John Chamberlain, AC5CV

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 let's 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 amateur television (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 radio 440 MHz repeater, but quickly rejected that idea because 1) most hams don't have 440 MHz handheld radios, 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 inexpensive FRS radios operate on similar frequencies, maybe these consumer-grade radios could become part of the solution.

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 van have demonstrated that, with handheld 5-watt GMRS units, this repeater setup has a useful range of 10 to 15 miles. I could now imagine a possible scenario:

1) The communications van (and portable repeater station) is parked in a disaster control 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 and/or Net Control by an operator in the communications van.
5) With the aid of a yagi antenna mounted at the van (as high as 60 feet), the EmComm station and/or Net Control could be located 30 miles or more from the van.

This sounded like a wonderful opportunity to make use of handheld GMRS radios—and maybe the new FRS radios. You've probably noticed that 1) FRS radios use almost the same frequencies, 2) are less costly than GMRS equipment, and 3) are often packaged as combination FRS/GMRS 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 services (as detailed in Part 95 of the Title 47 legislation). I'll first examine the GMRS, then the FRS, and finally, consider how they might work together.

General Mobile Radio Service (or GMRS)

NOTE: The power levels for each service described below, the specifics of the hybrid radios, and base station antenna limitations are obsolete as of September 2017. The discussion about deviations is still relevant. See more currrent article on this website.

The GMRS has eight frequency pairs designated for GMRS repeater use, with the input and output frequencies separated by exactly 5 MHz, as listed in Table 1. We can conveniently 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

* May also be used for simplex communications.

Thus, GMRS stations will monitor the above 462 MHz frequencies for repeater transmissions. Stations wishing to use those repeaters use an offset of +5 MHz to transmit on the 467 MHz input frequencies (i.e., just as ham radio operators use 5 MHz offsets for 440-band repeaters).

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 for simplex communications, or on the 467 MHz *input* frequencies for repeater communications. So, technically, GMRS users may transmit on any of the above sixteen frequencies. However, GPRS users normally listen on only the eight 462 MHz frequencies.

The FCC rules of course specify power restrictions. 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.** At these power levels, we can imagine high-power operations from base stations, repeaters, and mobile (i.e. vehicle-mounted) rigs, or low-power operations from hand-held transceivers. GMRS antennas using these frequencies must remain under 200 ft altitude.

Additionally, the GMRS authorizes the use of seven intermediate or interstitial frequencies, as shown in Table 2. These frequencies are located midway between each of the Table-1 simplex 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 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 limited somewhat in that its antenna is raised no more than 20 feet above ground or the existing structure on which it is mounted. Thus, for example, an antenna mounted on a 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 transmit power of a typical base station have to be reduced, but the gain of the antenna must also be taken into consideration. So, clearly these interstitial frequencies are intended primarily for 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. Keep this last fact in mind.

Table 5. Hybrid Radios

Family Radio Service (or FRS)

Let's now turn our attention to the FRS. We saw the use of interstitial frequencies in the 462 MHz band in the GMRS. Interstitial frequencies in the ***467 MHz*** band are given solely to FRS users, as shown in Table 3. They are designated channels 8 through 14 (for reasons that will become clear later).

Table 3. FRS Radios
Channels 8-14, FRS Frequencies

FRS 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

Compared to GMRS radios, FRS transmissions are very restricted in power. The FCC rules restrict FRS radios transmitting on FRS frequencies to:

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

Radio manufacturers convinced the FCC to include some overlap in the GMRS and FRS, so FRS users got the 7 interstitial GMRS frequencies, 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 power and deviation limitations imposed by the FRS.

Table 4. FRS Radios
Channels 1-7, FRS/GMRS Frequencies

FRS 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

But radio manufacturers pushed the FCC a bit more, and were allowed to produce so-called "hybrid" FRS radios, that include the eight GMRS simplex frequencies, too. These hybrids have channels designated 15 through 22, as shown in Table 5. Since these GMRS frequencies permit up to 50 watts of transmitted power, users of the hybrid radios can also transmit with more power, that is, more than ½ watt. So, it is on these that the so-called "22-channel FRS radios" emit their maximum advertised power (typically 2 watts), and achieve their maximum range. But, according to the Part 95 rules, and mentioned in the owner's manual of every hybrid radio, clearly one needs a GMRS license to transmit on channels 15 through 22. In allowing the manufacture and sale of these hybrid radios, the FCC has effectively created an unenforceable situation (ala CB radio). 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. But few, if any, will take the steps to apply for the requisite GMRS license to use those channels.

So, of the twenty-two channels on a hybrid radio, seven are exclusive to FRS, seven are shared with GMRS, and eight are actually GMRS channels which, legally, require a GMRS license to use. How all these channels fit together can get rather confusing. For a helpful summary of all the GMRS and FRS frequencies and their overlap, see Table 6.

Channels 15-22, GMRS Frequencies	
FRS/GMRS 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

But again, let's reiterate: transmissions on the fourteen FRS channels are restricted to:

1) a maximum power output of ½ watt,
2) a maximum FM deviation of ±2.5 kHz, and
3) use of a "rubber duck" antenna attached to the transmitting package.

On the GMRS channels 15 through 22, although higher power is permitted, the wattage will be limited by the small handheld package and batteries, and the transmissions are constrained by the maximum deviation and antenna restrictions imposed by the shared FRS radio package.

Comparing GMRS and FRS

This leads to several interesting contrasts between GMRS and FRS operations.

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. FRS radios operating on the GMRS channels can use more power, but are realistically limited by the small handheld package and its antenna to about 2 watts max.
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.)
3) While the FRS channels share several 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 different maximum allowed deviation values for the two services. For FM transmissions, loudness of audio is not dependent on the *strength* (modulation) of the signal (as with AM transmissions), but rather on the *deviation* of the signal. The FCC allows GMRS radios to use a ±5 kHz deviation, while FRS radios are permitted only half that amount: ±2.5 kHz deviation. The consequence 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, considering the "combination FRS/GMRS radios," or "hybrids", be careful that you're not distracted by their growing popularity and marketing. First, the fine print accompanying these radios reveals that the use of the GMRS frequencies (channels 15 to 22), where the radios can transmit at their maximum power, requires a GMRS license from the FCC. 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 individual GMRS licenses. Realistically, however, few hybrid radio users will apply for and obtain the GMRS license.

Second, realize that the capabilities of these hybrid handheld radios are seriously over-hyped. They may be advertised as able to communicate "up to 25 miles" or even more! However, a) ranges in excess of a few miles will seldom happen in real life with trees, buildings, and vehicles blocking most of the signal, and b) the advertised power levels apply only to the GMRS channels 15 to 22. The FRS channels 1 to 14, where the power is automatically limited to ½ watt from a small antenna, can be useful around a local campsite, flea market, or even a short caravan of vehicles, for example, but unless you're communicating between adjacent mountain peaks or two cruise ships at sea, ranges of several miles will be hard to achieve. And, to reach their maximum potential, the hybrid radio user must use channels 15 through 22. (They have obtained the requisite GMRS license, right?)

Third, although the GMRS and FRS have some frequencies in common that could be conceivably shared during an emergency or special event, due to the deviation limitations imposed on the FRS radios, a mixture of FRS radios and GMRS radios on those frequencies is going to be marked by noticeably decreased signal-to-noise ratios (effectively, lower volume) from the FRS users. The Net Control operator will struggle to hear the FRS transmissions.

And lastly—addressing my initial motivation for pursuing this study—while we can imagine how nice it could be to be able to use the inexpensive FRS radios with the GMRS repeaters, as a general rule, the hybrid FRS/GMRS radios do *not* include any of the GMRS repeater input frequencies. (The Motorola Talkabout, Model T-7200 did; however, it was rather expensive and is hard to find now.)

So, 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 covering a small area. But as a knowledgeable amateur radio operator, you'd be well advised to be sure everyone involved knows the limitations and restrictions before buying and including them in the emergency response plan.

Table 6. Summary of GMRS/FRS Frequencies and Limitations (NOTE: This table is out of date as of 2017.)

GMRS Frequencies		Interstitial Frequencies			GMRS Frequencies
GMRS radios up to 50W output, ±5 kHz dev		GMRS radios up to 5W (ERP, incl ant. gain), ±5 kHz dev		FRS radios up to ½W, ±2½ kHz dev (rubber-duck ant.)	FRS/GMRS "hybrids" (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 less than 20 ft above ground or existing structure* • ** *FRS channels shared with GMRS* • *** *GMRS license required, typically ~2W*

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