



The Amateur in You, Part 1

What have you been pondering?



Out-of-band reception

This question arrived originally for Dear Annette, but its answer was sufficiently deep to warrant a mini-article for itself.

Question: Recently I was tuning around and heard what sounded to me like an amateur radio QSO on 7.898 MHz, way outside the amateur bands. The two I heard both gave amateur call signs and sounded as though they were trying to follow the rules. Assuming they were, how was it that I heard them outside the ham bands?

Answer: There are a number of ways that these good hams could have their legal (assumed SSB, or single sideband) transmission heard outside the amateur bands. In the interest of brevity, however, let's consider three common ways: harmonics, IMD, and Image Response. (Others include splatter, reciprocal mixing, and corroded metal joints.)

To test whether 7.898 MHz is a *harmonic* of another frequency, simply divide the frequency by two, three, four, and five. Dividing any further results in harmonics that are typically attenuated (reduced) way below reasonably detected levels for SSB. (Digital can be detected at much greater attenuation.) $7.898 \text{ MHz} \div 2 = 3.949 \text{ MHz}$, which is a legal frequency in the amateur 80-meter band. Also, $7.898 \text{ MHz} \div 4 = 1.9745 \text{ MHz}$, a legal frequency in the amateur 160-meter band. Dividing by three and five do not result in values that fall within the amateur bands. Therefore, it's possible that you're hearing transmissions originating from either 80 meters or 160 meters, which is quite easy if the hams you heard were using multi-band antennas made of *traps*, for example, which are notoriously known for generating harmonics.

To confirm whether *IMD* (intermodulation distortion) is the cause, you can check *ballpark* figures, assuming the folks you're

hearing are on amateur frequencies near the receive frequency. Since you're hearing them on 7.898 MHz, the IMD products will be described by either

$$7.898 = 2f_1 - f_2 \text{ or } 7.898 = 2f_2 - f_1$$

As a test, if we assume the nearby amateur frequency (f_1) is 7.272 MHz, for example, solve for f_2 in both cases

$$7.898 = 2(7.272) - f_2$$

$$f_2 = 6.646 \text{ MHz}$$

$$7.898 = 2f_2 - 7.272$$

$$f_2 = 7.585 \text{ MHz}$$

Neither 6.646 MHz nor 7.585 MHz are legal amateur frequencies, and both are far enough away from amateur frequencies, that we can *safely* conclude that IMD is not the culprit, even if we put all 40-meter phone frequencies to this test.

Image response can be checked in a similar fashion, only it's typically due to the superheterodyning effect, in which one stage of the conversion is producing the image. That conversion process might produce a product that you're hearing, so that an IF (intermediate frequency) of 3.151 MHz, for example would result in

$$14.200 \text{ MHz} - 3.151 - 3.151 = 7.898 \text{ MHz}$$

if the QSO you heard was on 14.200 MHz, for example. (Admittedly, an IF of 3.151 MHz is quite unconventional, but was contrived in this example for demonstration purposes only, rendering this cause unlikely.)

So, the conclusion is that, assuming the two you heard were attempting to transmit legally on SSB, you likely heard them outside amateur bands due to either harmonics (likely) or image response (much less likely), but probably not IMD.