

## The Legality of Digital Voice Modes in Amateur Radio

The FCC has, over the course of the past several decades, reduced restrictions on amateur radio, thus allowing further experimentation within the hobby. This is, of course, in keeping in the spirit of amateur radio in general. If one looks back the 1960's, the FCC removed began to move towards an occupied bandwidth model for use of various modes within amateur circles. An early case was that of SSTV. In the 1970's regulations on unattended operation were modified to allow repeaters to grow to the extent they exist today. In the 1980's further modifications were granted that allowed ASCII text to be used, in addition to Baudot 5 level code (popular and legacy to RTTY); this ushered in the birth of packet radio and the emergence of common place digital techniques in amateur radio. As each of those rules were modified and / or added, the FCC also opened the door towards even further innovation in amateur radio by often times allowing liberal rules to replace specific limitation rules. While the Part 97 amateur rules are still quite specific, there is a fair amount of room to experiment and grow the hobby, especially in the area of digital communications.

The question is often raised of whether or not digital modes, including digital telephony transmissions, are allowed under the Amateur Rules of the FCC: Part 97.

Actually, the FCC has commented on this matter repeatedly; one case being a letter from Bill Cross recently declared a D-Star repeater to be specifically DATA, and subject only to the same rules as are used for other digital stations and digipeaters. (In this case, the voice is considered data and processed and forwarded much like Packet / AX25 and other modes.)

But the question requires a more cursory check of the rules and a discussion of those rules.

Given: The FCC has granted Type Approval for D-STAR equipment for use specifically under Part 97 of the FCC rules. The designator utilized is: 6K00F7W. This designator states a necessary bandwidth of 6.00kHz (6K00), Frequency (or Phase Modulation as spelled out in the rules) (F), 2 or more channels of quantized or digital information (7), and voice and / or data (W). Furthermore, the FCC has been asked on numerous occasions whether D-STAR is legal; it has pronounced "Yes" to that. (One can easily find an explanation of the designator on the web by performing a simple search).

In fact, in the case of D-STAR, arguments concerning legality do not stem from the emissions designator in use; they flow from the question whether the standard is open and public; a requirement of the Part 97 rules:

### ***§97.309 RTTY and data emission codes.***

*(4) An amateur station transmitting a RTTY or data emission using a digital code specified in this paragraph **may use any technique whose technical characteristics have been documented publicly**, such as CLOVER, G-TOR, or PacTOR, for the purpose of facilitating communications. (Emphasis added)*

While the D-STAR specification is obviously open and public, arguments have been made that the AMBE codec utilized to digitize the voice is not public. Again, the FCC has allowed D-STAR; we must take them at their word that it is legal to use in the amateur service. It also sets a precedent; if it is legal for D-STAR, it must, therefore, be legal for other digital audio systems as well within the Amateur Service as preference can not be given to one manufacturer over another.

Next, take the instance of P25 on the amateur bands.

Once again, we have a standard that is both public and openly available. P25, is utilized in the amateur service, usually operates with an emissions designator of either 8K00F1E or 16K0F1E. This implies either 8 or 16kHz necessary bandwidth (normal, analog FM uses either 16K0 or 20K0 bandwidth for 16 or 20kHz; important to note as we move forward in this discussion). The rest of the designator, F1E, indicates frequency modulation (F), a single channel of information (1), either digital or analog and voice or data, and telephony (E).

Again, the FCC has indicated that use of P25 is legal in the amateur service. I would add, that to be open (unencrypted), one should use NAC293 as that is published as the “open” code in the standard. Furthermore, on at least one instance, experimentation and adoption of bandwidth efficient systems, much like those mandated for commercial and private mobile radio services (narrowbanding), have been encouraged for use within the amateur community.

This brings us to MotoTRBO. Is it legal to use in the amateur services? MotoTRBO is Motorola’s marketed product built to the international Digital Mobile Radio (DMR) specification. Radios built to the DMR spec are available from a number of manufacturers; this is not a single-source product. Since MotoTRBO / DMR is an open standard, it meets the FCC requirement of 97.309 (4); above.

The published FCC emission designator for the Motorola DMR product for use under Part 90 is 7K60FXE. In this case, the necessary bandwidth is 7.6kHz, it is FM (or angularly modulated) (F), it is “Cases not otherwise covered” for the Nature of the Signal, and E for telephony. Decoding this, the bandwidth is certainly narrowband, and narrower than a standard voice communications requirement, the FM designator is the same as P25 and D-STAR, the X is a catch-all, but we’ll discuss that in a moment, and the E is a designator for voice, just as in P25 and D-STAR. The question is raised concerning the “X” designator for the nature of the signal.

To dive deeper into this, let’s look at the authorized emission types for the VHF, UHF and 1.2GHz bands:

***§ 97.305 Authorized emission types.***

*(c) A station may transmit the following emission types on the frequencies indicated, as authorized to the control operator, subject to the standards specified in § 97.307(f) of this part.*

**§ 97.307 Emission standards. (From the published table):**

**VHF:**

6 m 50.1–51.0 MHz	MCW, phone, image, RTTY, data (2), (5).
Do 51.0–54.0 MHz	MCW, phone, image, RTTY, data, test (2), (5), (8).
<b><u>2 m 144.1–148.0 MHz</u></b>	<b><u>MCW, phone, image, RTTY, data, test (2), (5), (8).</u></b>
1.25 m 219–220 MHz	Data (13)
Do 222–225 MHz	RTTY, data, test MCW, phone, SS, image (2),(6),(8)

**UHF:**

<b><u>70 cm Entire band</u></b>	<b><u>MCW, phone, image, RTTY, data, SS, test (6), (8).</u></b>
33 cm Entire band	MCW, phone, image, RTTY, data, SS, test, pulse (7), (8), and (12).
<b><u>23 cm Entire band</u></b>	<b><u>MCW, phone, image, RTTY, data, SS, test (7), (8), and (12).</u></b>

First of all, it is clear that in the 2M, 70cm, and 23cm bands, that phone and data are allowed. In the case of 2 meters, the limitation of footnote 2:

*(2) **No non-phone emission shall exceed the bandwidth of a communications quality phone emission of the same modulation type.** The total bandwidth of an independent sideband emission (having B as the first symbol), or a multiplexed image and phone emission, shall not exceed that of a communications quality A3E emission.*

specifies that non-phone emissions, may not exceed the bandwidth of a double sideband, amplitude modulation system (A3E), in the case of the current practice and acceptance, this is 9.0kHz. Clearly, all 3 systems (P25, D-STAR, and DMR) meet this requirement.

Secondly, in the VHF band (70cm) and above, this is relaxed by provision of (5):

*(5) A RTTY, data or multiplexed emission using a specified digital code listed in § 97.309(a) of this part may be transmitted. The symbol rate must not exceed 19.6 kilbauds. A RTTY, **data or multiplexed emission using an unspecified digital code under the limitations listed in § 97.309(b) of this part also may be transmitted. The authorized bandwidth is 20 kHz.***

Therefore, any data system using an unspecified code that occupies less than 20kHz bandwidth is acceptable.

When one considers the UHF / 70cm and 23cm bands, these restrictions are reduced further:

*(6) A RTTY, data or multiplexed emission using a specified digital code listed in § 97.309(a) of this part may be transmitted. The symbol rate must not exceed 56 kilbauds. **A RTTY, data or multiplexed emission using an unspecified***

**digital code under the limitations listed in § 97.309(b) of this part also may be transmitted. The authorized bandwidth is 100 kHz.**

Finally, the question of specific designators comes to light. While DMR is generically specified as 7K60FXE, this is due to the adaptive nature of the system. Without going into more details, the DMR specification allows the use of dynamic mixed mode where analog and digital voice can be supported, it can also be configured to handle multiple voice and data channels along with trunked configurations. Because of this, Motorola utilized a catch-all designator of FXE as the suffix. If one dives deeper into the emission designator, and looks into other DMR product, the list of available emission designators becomes apparent:

**11K0F3E, 16K0F3E, 6K60F2D, 9K60F2D 8K10F1E, 10K10F1E, 8K10F7E, 10K0F7E, 8K10F1D, 10K10F1D, 8K10F7D, 10K0F7D**

Per the current FCC rules, as well as precedent set by D-STAR and P25, the above-bolded designators are acceptable for use in the amateur service:

*(8) A RTTY or **data emission having designators** with A, B, C, D, E, **F**, G, H, J or R as the first symbol; **1**, **2**, **7** or 9 as the second symbol; and **D** or **W** as the third symbol is also authorized.*

Diving into these designators, this list being taken from Tait, a manufacturer of DMR radios, the first 2 designators are legacy analog modes (11K0F3E, 16K0F3E), the rest are acceptable mixes of data and/or voice in combination (D / W) that are allowed under the current rules.

Finally, with regard to the question of encrypted transmissions, as some imply digital modes are, the FCC is also clear in the following rule:

***§ 97.309 RTTY and data emission codes.***

***(b) Where authorized by §§ 97.305(c) and 97.307(f) of this part, a station may transmit a RTTY or data emission using an unspecified digital code, except to a station in a country with which the United States does not have an agreement permitting the code to be used. RTTY and **data emissions using unspecified digital codes must not be transmitted for the purpose of obscuring the meaning of any communication.** When deemed necessary by a District Director to assure compliance with the FCC Rules, a station must:***

- (1) Cease the transmission using the unspecified digital code;***
- (2) Restrict transmissions of any digital code to the extent instructed;***
- (3) Maintain a record, convertible to the original information, of all digital communications transmitted.***

To date, the FCC has not required anyone using D-STAR, P25, or DMR to cease transmission. All three methods have been utilized on-air for several years now, have come under FCC scrutiny in

various venues and during numerous questions to the FCC, and, in no case, have any of the restrictions of 97.309 (b) been imposed upon the amateur community.

In conclusion, the use of all three digital modes, P25, D-STAR, and DMR, all seem to meet the current rules already in place. Reaction from the FCC to questions posed over the legality of these systems also bear out concurrence with this statement. Furthermore, the use of a public standard for the transmission standard qualifies it as a legitimate data transmission mode. The use of bandwidth-efficient methods further works in the spirit of amateur radio, as does the basic preface of utilizing and experimenting with new modes. From an occupied bandwidth specification, all three modes are at least as efficient as analog FM voice. None of the systems, when properly utilized in the amateur service, utilize encryption with the intent to disallow open listening of conversation by others.

The situation today is reminiscent of the transition from AM with full carrier to SSB in the 1950's and 1960's. In no way is anyone trying to remove analog FM from the tool box of the radio amateur operator. In contrast, each of these modes expands that tool box, allows amateurs to experiment with various modes and interconnection methods. It is up to each ham operator to figure out what tools he wants to invest in. By the same token, all of the tools should be made available by state and regional coordination bodies. Some have already embraced these new modes; it is the hope that, in time, all will. It expands the hobby, offers new and interesting areas to more potential hams as well as seasoned operators, and also expands our arsenal in the event that amateur radio is called upon for emergency communications.