

# **SYSTEM FUSION FREQUENTLY ASKED QUESTIONS – rev 2016/01/20**

## **What is System Fusion?**

System Fusion is a digital communications methodology for voice and data communications, including pictures. It utilizes a customized – yet open – standard that utilizes C4FM FDMA – an advanced form of audio frequency shift keying (AFSK).

## **Is it like D-STAR?**

It is like D-STAR, in that it is a digital methodology designed by hams, for hams. Other common digital methodologies used by hams - such as DMR, NXDN and P25 - are borrowed from commercial Land Mobile Radio products. None of these are directly compatible with any of the others. While there are some proprietary elements to each, they all have published specifications, so that third-party developers can produce hardware and software for each.

D-STAR uses GMSK encoding, different than the C4FM FDMA designs of all but DMR – which uses TDMA. The networking aspects of System Fusion are just now being exploited, with the connection of Nodes and Rooms, via transceivers attached to a WIRES-X interface (HRI-200) and computer. In the coming months, it will be possible to link and networking our repeaters with the increasing number of other System Fusion repeaters around the planet - in a manner similar to the reflectors that support D-STAR.

Also like D-STAR, the sound of digital voice has similar characteristics, although most users feel the clarity and fidelity of System Fusion is an improvement over D-STAR. The list of comparisons could go on in some lengthy detail, far beyond the scope of this page. Your personal research is encouraged.

## **You mentioned that System Fusion is an open standard, but isn't it just proprietary to Yaesu?**

While Yaesu developed System Fusion and continues to expand the product line further, they took steps early on to publish the specifications. This means that those interested in developing hardware and software independently can do so with the specifications and parameters laid out for them.

Already, one company is working on a multi-personality portable - that is being advertised as eventually supporting D-STAR, DMR, System Fusion and more. Now shipping - the DV4mini allows you to set up a node and support networked operation with D-STAR, System Fusion, DMR and P25 – using a Raspberry Pi single-board computer. It will be interesting to see what else is announced and demonstrated at the upcoming Dayton Hamvention.

## **Do System Fusion radios support APRS?**

Yes. Each transceiver contains a robust APRS feature set. The display capabilities vary with the different models, but the core settings are similar. Of note, preset text messages can be established, as well as “on the fly” messaging.

## **What radios are System Fusion capable and where can I find them?**

Yaesu produces a number of transceivers, which have been on the market for some time. The FTM-400 is a dual-band mobile that features a color screen. It can display a variety of information regarding frequencies, GPS information, location of other digital stations, plus pictures and more. The FT1 is a dual-band portable that has many of the same features, without the color screen. There's also the new FT2 – an upgraded portable with monochrome touch screen - and the FTM-100, which is a basic dual band (single VFO) mobile.

The portables and FTM400 mobile can accept the optional camera microphone and be used to transmit pictures. Also, all support “good old” analog FM communications as well as digital.

In addition, the FT-991 HF/VHF/UHF transceiver supports System Fusion operation. In the year it's been available, it's proven to be a popular transceiver. Along with 2M and 70cm, System Fusion activity can be found on 10M, between 29.440 and 29.480 MHz – giving you digital clarity on HF. With an external antenna, the FT1 and FT2 portables can allow you to listen in to this activity, by virtue of their extended receive capabilities.

These products are available from a variety of amateur radio retailers, such as Ham Radio Outlet, DX Engineering and Universal Radio.

### **Can I use any 2M or Dual-Band FM amplifier if I want more power from the portable(s)?**

If you purchase a portable and want to start using it as a mobile, you'll be happy to know that any Class C (FM/CW) amplifier with an input in the 5W (or less) range will work just fine. Many of us have at least one of these at home, so that may make them even more attractive for the budget-conscious ham. For any mobile use, please configure things so that your eyes can stay on the road.

### **When someone is using the digital mode on the repeater, I hear sounds like a high-speed modem. Is there some way to silence that sound on my radio?**

System Fusion allows state of the art digital C4FM users and legacy analog FM users to share the same repeater. All recent transceivers have a “tone squelch” or “CTCSS tone decode” option that can be enabled. When the repeater is used for FM, a tone of 103.5 Hz is transmitted – the same as the one required to access it. Setting this function on your radio(s) will silence the audio until it receives a signal containing that tone. That way, you won't hear the digital signals.

### **I don't want to interfere, but if I can't hear the digital transmissions, how will I know when the repeater is being used?**

In addition to listening for the frequency to be clear before transmitting, look at your activity indicator. It may be a light, meter display or both.

Likewise, the digital transceivers have indicators that let users know if there's an analog conversation in progress. SF digital radios can be configured to automatically switch to analog, so that conversation can be heard.

If you haven't seen or heard anything for a few minutes, it's a fairly safe bet that the repeater isn't in use.

## **When other hams are in a digital voice QSO and I need to use the repeater for something with some urgency, is there a way to break into the conversation or talk to them?**

Automatic Mode Select is a feature that is on all of the digital radios. With AMS set, digital users can hold a digital conversation, yet still allow for an analog user to break in. In digital mode, there is no long squelch tail, just a quarter-second conversion delay – noticeable when a transmission stops. A scenario of “best practices” is followed when a few seconds are allowed in between transmissions for ANY station to get the attention of those already communicating – whether digital or analog. That’s not something related to technology, just good operating technique.

## **Is there a commonly used simplex frequency for digital use, when I don’t want to use the repeater or it’s being used already?**

The frequency of 147.525 MHz as the “watering hole” for System Fusion simplex activity has been popular in the east, since the technology became widely available. This is becoming something of a national standard.

## **Is there a net or roundtable specifically for those of us with System Fusion gear?**

While you can operate digitally on the repeater at any time, we could be setting up a weekly roundtable as more and more digital users join in on the fun. Many times, this happens during “drive time” as the number of digital users increases. Please note too, that use of the MWA repeaters is not limited to its members. All of our repeaters are open. All we ask is for good amateur practice to be maintained and priority be immediately given for emergency situations and exercises.

As the first repeater is being put on the air, about 6 of our members appear to own System Fusion radios. With the implementation of the club’s repeaters and more becoming active in the surrounding WVA, WPA and OH sections, adoption of this technology is expected to grow significantly in the coming months..

## **So what’s the big deal with digital voice? Why is it better than good ol’ FM?**

Analog FM has been popular on the ham bands since the late 1960’s. The real explosion of growth and activity took place a few years later – in the mid to late 1970’s. While there are now ways of bridging and networking analog repeaters, audio levels are typically less than desirable and a lot of associated cue tones and underlying announcements can be heard. After a while, this has proven to be “tiring” to many hams. Digital networking is noise-free, with a higher efficacy to the voice intelligence. It also is more noise immune – such that you can transmit and talk next to a running fire engine, generator or crowd and be heard more clearly by those on the receiving end.

In addition, it’s possible to transfer data with these radios – while staying in the digital domain. D-STAR users have been doing this for many years. We should see this feature being implemented for System Fusion, sometime this year. Moving data like ICS and HICS forms for agencies we serve in an EMCOMM or public service capacity gives them what they are used to seeing everyday and also encourages closer relationships and support for funding infrastructures and related communications resources.

## **What about networking or some way to link to other System Fusion users and repeaters?**

As Yaesu rounded out the product line, they introduced WIRES-X and the HRI-200 interface as a high-speed way of interconnecting repeaters and users. WIRES-X has been on-line in Japan for some time. Recently, units have become available in North America and other continents. The list of

users is regularly being updated. Already, some members of the MWA and other area clubs have purchased these units and set up nodes.

It is possible now to network via the nodes, with a POP (Point of Presence) at the repeater or at someone's home – with a node transceiver (such as the FTM-100) plus HRI-200 and basic computer.

This aspect of digital communications is exciting and developing rapidly. Those of us with WIRES-X can talk, exchange messages and pictures. A demonstration of this will be upcoming at one of the club's meetings.

Interestingly, certain analog FM transceivers can be used with WIRES-X, allowing you to communicate verbally with other hams on the network. While you won't get the clarity and other benefits of being digital, it is a way for you to join the fun.

### **Are there other System Fusion repeaters in the area or is this the only one?**

The list is steadily growing! Check [www.repeaterbook.com](http://www.repeaterbook.com) for the most recent updates.

### **I understand that my callsign is sent as a part of every transmission. Does that mean I don't need to verbally ID?**

As with D-STAR, your call is sent with each transmission. The receiving radios will display this (and other) information, so you don't "need" to verbally ID in order to comply with regulations. However – as a courtesy to others – it is good idea to ID as you normally would. This keeps you in practice for non-digital voice modes and keeps others from having to look at their radio displays – especially when driving.

### **Sometimes, the digital audio breaks up and there are odd sounds when a person goes into a bad area. What's that about?**

Analog audio progressively degrades, until we hear what's commonly referred to as "fried eggs", then nothing. Digital holds its high quality until it gets to the "cliff" and the embedded FEC (forward error correction) is inadequate to maintain an intelligible signal. Depending on the method of FEC and modulation used, high error conditions can manifest themselves as silence or audible artifacts. D-STAR users refer to this as "R2-D2", DMR users call it "Turkey Talk" and System Fusion users refer to the anomaly as "Godzilla" – with a poor signal area known as "Jurassic Park".

### **I understand there may be a way for a System Fusion repeater to also support D-STAR. Is that true?**

The short answer is "yes and no". The DR-1X repeater already provides an output from the receiver's discriminator and an input for "raw" audio. These and PTT control are used with the HRI-200 for networking. Likewise, these connections could be used to interface with other FDMA methodologies, such as Phase I P25 and NXDN.

NW Digital is demonstrating a board at the Dayton Hamvention that is designed to accommodate D-STAR traffic and allow for connections to the network of reflectors. According to information provided by them, it would cost the club less than \$150 to add this capability to one of the DR-1X repeaters – with the UHF machine as the most likely candidate. We could eventually operate this repeater as a

“digital only” asset, or keep it in AMS, thus providing ad-hoc, tri-mode operation. More information on this exciting possibility should be available in late May - when the Hamvention is in full swing.

**Some of these new terms and the “alphabet soup” of abbreviations are making my brain hurt, plus I have other questions. Where can I get the answers?**

Yes, hearing C4FM, GMSK, FDMA, TDMA and all this other “stuff” can make the learning curve seem like a brick wall. Along with the web sites mentioned and other resources that are searchable on the Infobahn, you are welcome to ask questions via email. Contact Cory Sickles – WA3UVV <at> gmail <dot> com. Plus, there are reviews of System Fusion and/or its components, starting with QST (August 2014) and CQ (August 2014 & September 2014) as well as a monthly column on digital voice in a popular online magazine – The Spectrum Monitor. We’ll also be conducting some updates along the way as refreshers and when new features – like networking or support for additional methodologies – are going to be implemented.

**Additions and revisions to this list will be made as time progresses. Please enjoy the Monongalia Wireless Association’s resources and give System Fusion a try!**