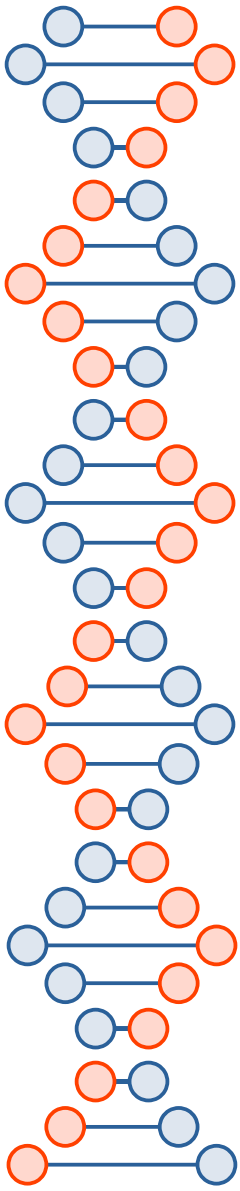


DIGITAL Communications for the Uninitiated

Dennis Egan W1UE



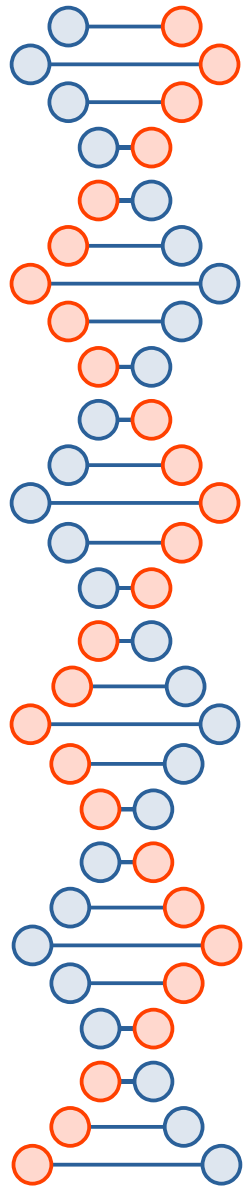
Scope of Presentation

RTTY- A Legacy Digital Mode. Not discussed here.

PSK31/63- Legacy Digital Modes. Minimal Discussion here.

FT8, FT4- Main topics of presentation

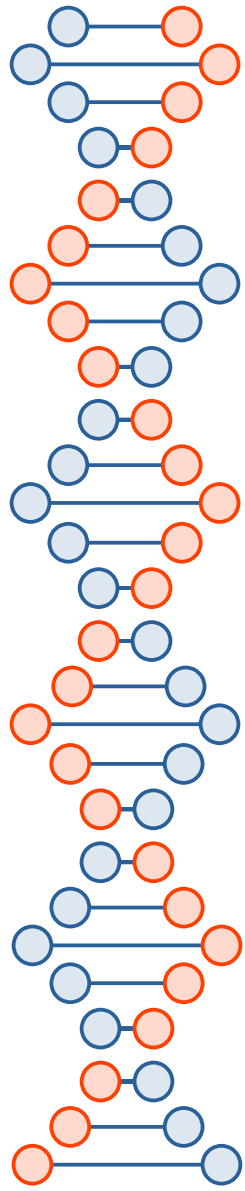
WSJT-x: only program discussed at any length here



WSJT was originally released in 2001 by Joe Taylor K1JT and a small group.

Their desire was to use advanced techniques to improve the readability of Weak Signals, hence the WSJT- “Weak Signal by K1JT”. EME, tropo, and Other weak signal modes could now be decoded better than any other Mode.

In 2017, FT8 was released. Steve Franke K9AN joined K1JT for the Development and release. FT8 was named “Franke-Taylor 8-FSK Modulation”. It is described as being designed for “multi-hop Es where Signals may be weak and fading, openings may be short, and you want Fast completion of reliable, confirmable QSOs”. Its acceptance by the amateur community was immediate and striking. Regardless what each of us might think of the mode and its protocols, 80% of all amateur QSOs are now made using one of the FT modes.



Important Characteristics of FT8:

T/R sequence length: 15 s

Message length: 75 bits + 12-bit CRC (cyclic Redundancy Check- error cor)

FEC code: (174,87) LDPC (low density parity check- error cor)

Modulation: 8-FSK, keying rate = 6.25 baud; tone spacing = 6.25 Hz

Waveform: Continuous phase, constant envelope

Occupied bandwidth: 50 Hz

Synchronization: three 7x7 Costas arrays (start, middle, end of transmission)

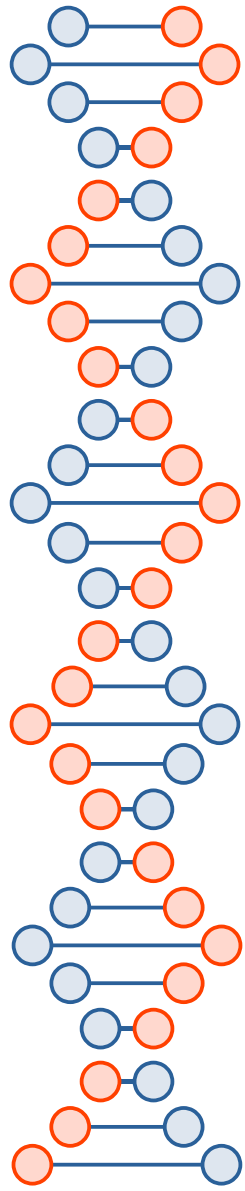
Transmission duration: $79 \times 1920 / 12000 = 12.64$ s

Decoding threshold: -24 dB (with a priori decoding)(uses prior decoded info
To predict current decoded info)

Operational behavior: similar to HF usage of JT9, JT65

Multi-decoder: finds and decodes all FT8 signals in passband

Auto-sequencing after manual start of QSO



In 2019, a “faster” version was released with FT4- designed for contesting.

T/R sequence length: 7.5 s

Message length: 75 bits + 12-bit CRC (cyclic Redundancy Check- error cor)

FEC code: (174,87) LDPC (low density parity check- error cor)

Modulation: 4-FSK, keying rate = 12.25 baud; tone spacing = 12.25 Hz

Waveform: Continuous phase, constant envelope

Occupied bandwidth: 90 Hz

Synchronization: three 7x7 Costas arrays (start, middle, end of transmission)

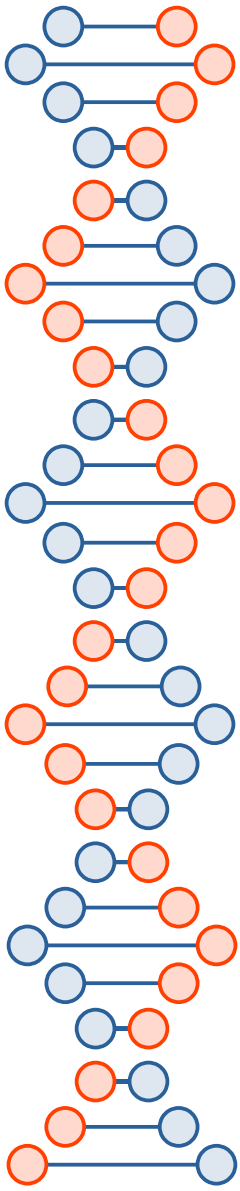
Transmission duration: $79 \times 1920 / 12000 = 6.32$ s

Decoding threshold: -21 dB (with a priori decoding)(uses prior decoded info
To predict current decoded info)

Operational behavior: similar to HF usage of FT8

Multi-decoder: finds and decodes all FT4 signals in passband

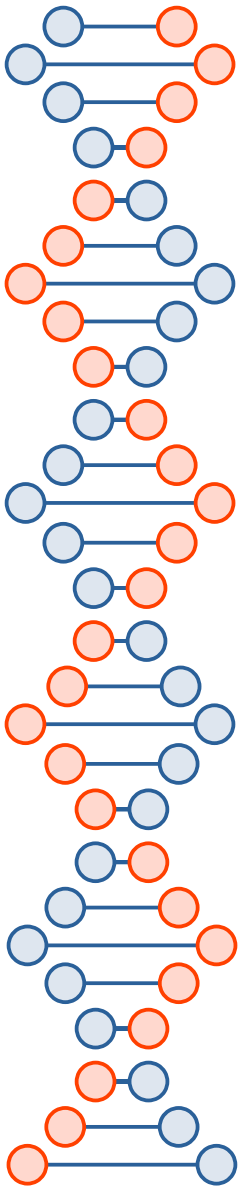
Auto-sequencing after manual start of QSO



What's the big difference between FT4/8 and prior modes?

CW, SSB, RTTY, PSK31- all are character based modes.
Each bit of information, i.e. each letter, is sent one at a time.
I send "W" "1" "U" "E" in Morse Code

For FT4/8, the entire message is encoded to a specific formula,
Transmitted, then decoded at the receiving end. Along the way,
There is a LOT of error checking. For my call, the encoded
Message may be "110110010110011000100100..01" for 77
Characters long.



Key Concepts for FT4/8:

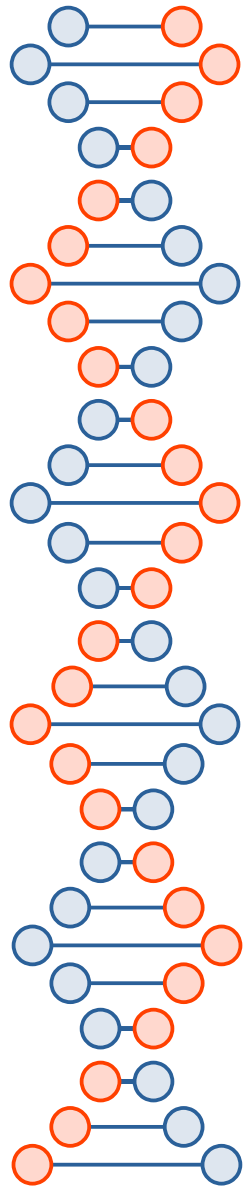
FT8 transmissions are each 15 seconds long; FT4 is 7.5 seconds.

FT4 transmissions are twice as fast as FT8.

FT8 transmission decoding is 3-4dB more sensitive than FT4.

Most FT8 “waterhole” frequencies end with “.074”

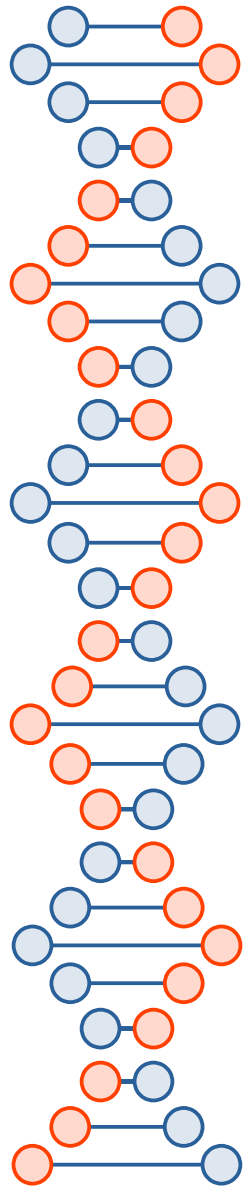
There are universal “waterhole” frequencies for FT4, but they Aren’t typified as easily as FT8.



Let's setup a FT8 station from scratch.

Things needed:

1. Computer
2. Sound Card of some sort (or, maybe not..)
3. Receiver and transmitter (Transceiver)
4. WSJT-x program
5. Method of radio control
6. Method of PTT control
7. Method of updating time for the computer

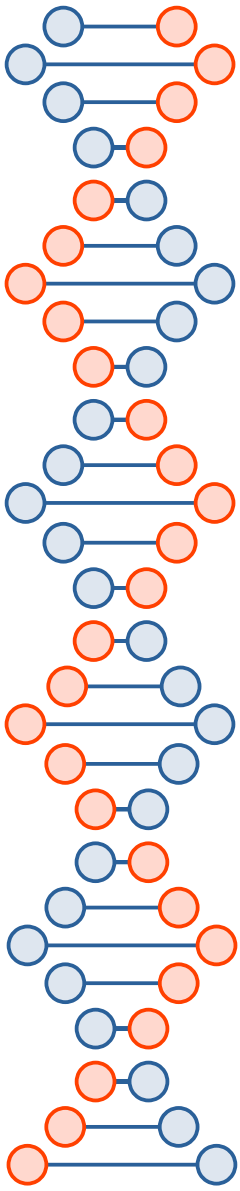


Computer requirements- Any computer running Win 10 or better, and many computers running Win 7, should do for the computer. If you keep getting late decodes, your computer may need to be updated.

I did a test with 4 computers here at home. I tested them, 2 at a time, using the same soundcard (but different units) for the test. None of them were clear winners on quantity of decodes; even the strongest of the computers (an I9) occasionally had fewer decodes than the I3.

What the computer strength DID do was produce the decodes faster- I could get decodes up to ½ second quicker using the I9 rather than the I3.

YMMV



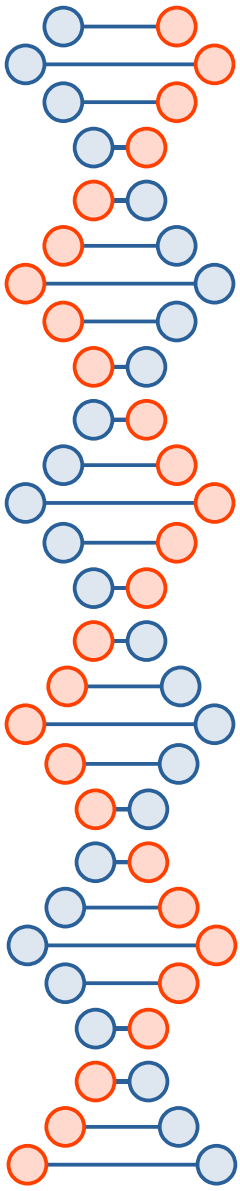
Computer Requirements

New, nice fast computer is good to have, but it is NOT required.

Windows 7 or later is nice (Win 10 or 11 preferred)

Mac and various flavors of Linux versions of programs are available

Laptops or desktops, doesn't matter



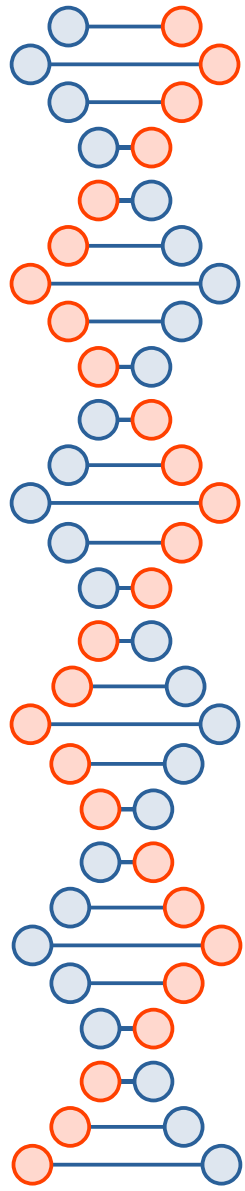
Sound Card Requirement

The Sound Card functions to decode the transmitted audio tones into computer bits for the program to decode.

Preferred is a sound card that will handle 48000Hz 16 bit

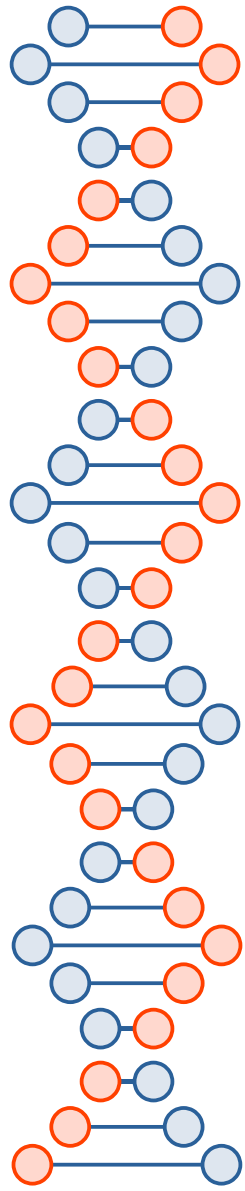
Preferred is a sound card that has Line In and Line Out jacks
More immune to hum and overload

If you have a USB Codec built into your radio (IC7300) you
Don't need a soundcard



Sound cards- A big expensive sound card is not needed. I've spent many hours trying to get Laptop sound cards to work- a simple dongle that plugs into a USB port works fine every time. My suggestion is not mess with the splitters for the combo mike/speaker jacks- just get one of these \$7 on Amazon.



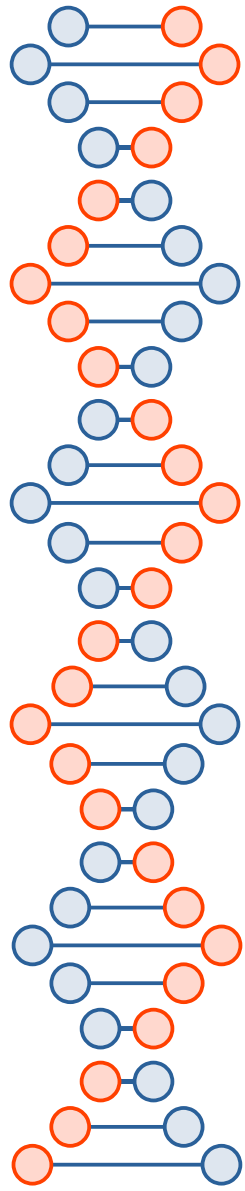


Will a big, expensive sound card improve my operations?

Not that I've found. It will get you more bells and whistles, may have a Line In and a Line out jack, but my experimenting with various sound cards and computers has not shown that professional sound cards give one any more decodes than cheap ones.

The recommendation is for a sound card that handles 48000 Hz and 16 bits. The testing that I've done indicates that bigger, more expensive sound cards just cost more.

And Hams are cheap anyway.



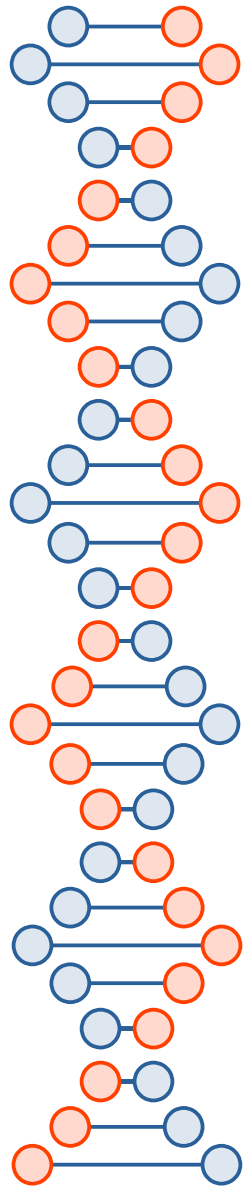
Receiver and Transmitter

ANY receiver or Transmitter will suffice, as long as SSB transmission/ Reception is possible. An audio bandpass of 3000Hz is preferred.

Having the Radio controlled by the program is nice but NOT a requirement

One can use the Mike In and the Speaker Out for connection to the Sound card. Line In and Line Out, or an Audio Codec, are nice but Again, NOT a requirement.

Many newer rigs have a special setup for Digital modes.

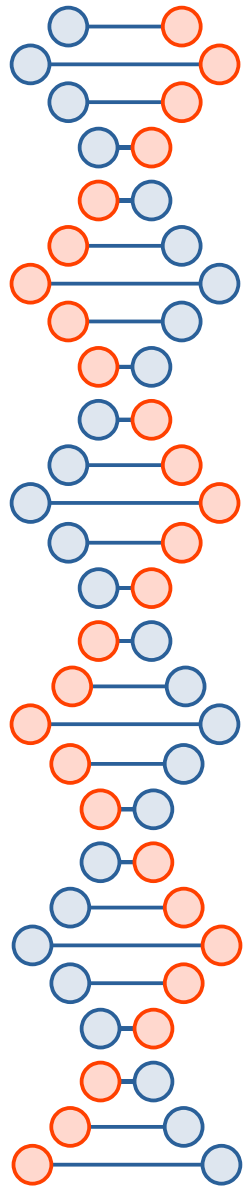


WSJT-x program is readily available over the Internet.
Recommendation: WSJT-X Improved version 2.8.0

You can usually find WSJT-x it here:
<https://sourceforge.net/projects/wsjt/>

It is available in Windows 32 and 64-bit versions, several
Flavors of Linux, and MacIntosh straight from the web page

There are other WSJT-x “clones”- MSHV and WSJT-z being
Two of them. I have tried all 3, and I keep coming back to
The original WSJT-x

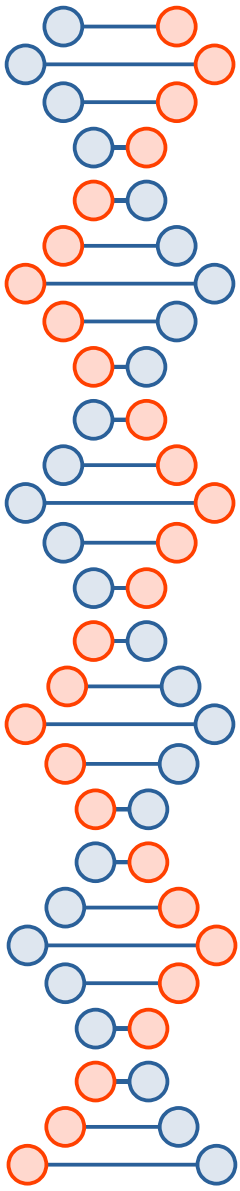


Method of Radio Control

If you can control your radio with a serial port, and your computer has a Serial port available, you can connect the two together. While this is NOT a requirement, its nice to have. If you have one of the newer radios (IC7300, for example), you have radio control via a USB cable.

Benefits:

1. Frequencies back and forth. Changing frequencies as easy as Picking a new frequency from a list.
2. WSJT-x will automatically change your radio transmit frequency To keep your audio in the “sweet Spot” of the transmitting frequencies

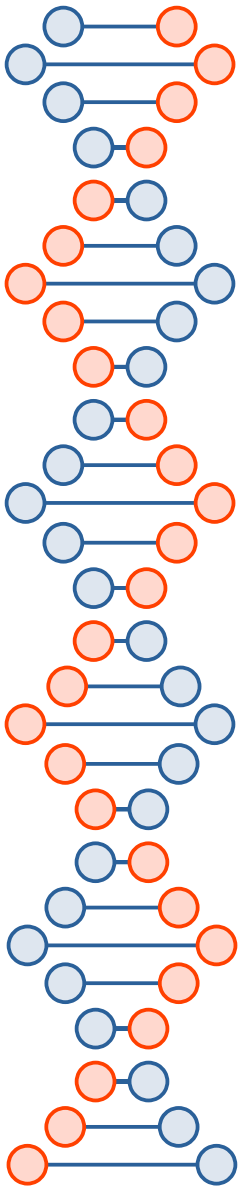


Method of PTT Control

You can use a serial port to command the radio to do this.

You can use VOX, depending on your radio's capability

If you have a newer radio, like an IC7300, you can use the USB cable
As a source for the PTT.



Method of updating time on the computer

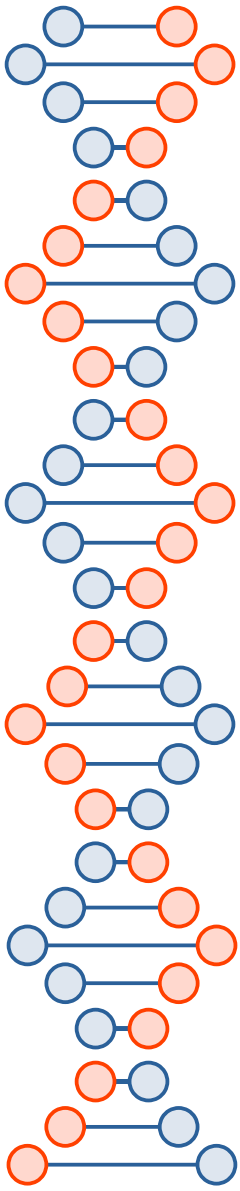
FT4 and FT8 are both time sensitive- you do have to sync your computer Time with a real clock. FT8 transmissions start every 15 seconds; your time Must be accurate to +/- 2 seconds (for FT4, +/- 1 second).

Meinberg FTP- Meinbergglobal.com/english/sw/ntp.htm

Dimension 4- Dimension-4.en.softonic.com

I use NetTime 3.14, available at www.timesnctool.com

There are others available, but the above are at no cost

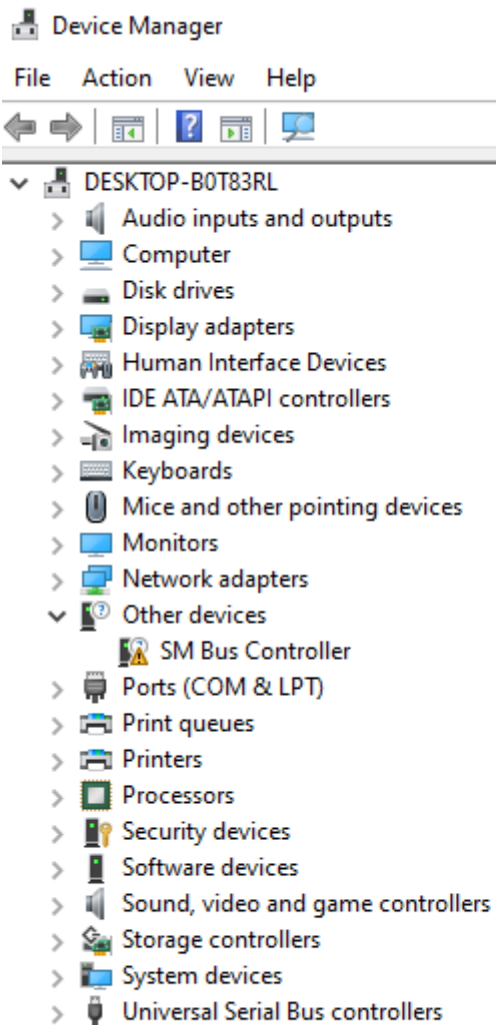
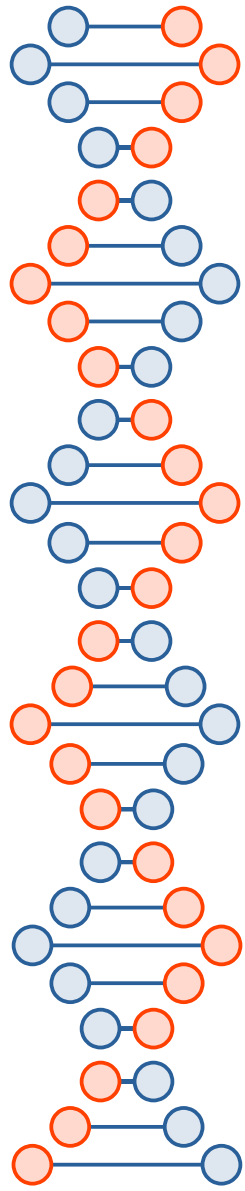


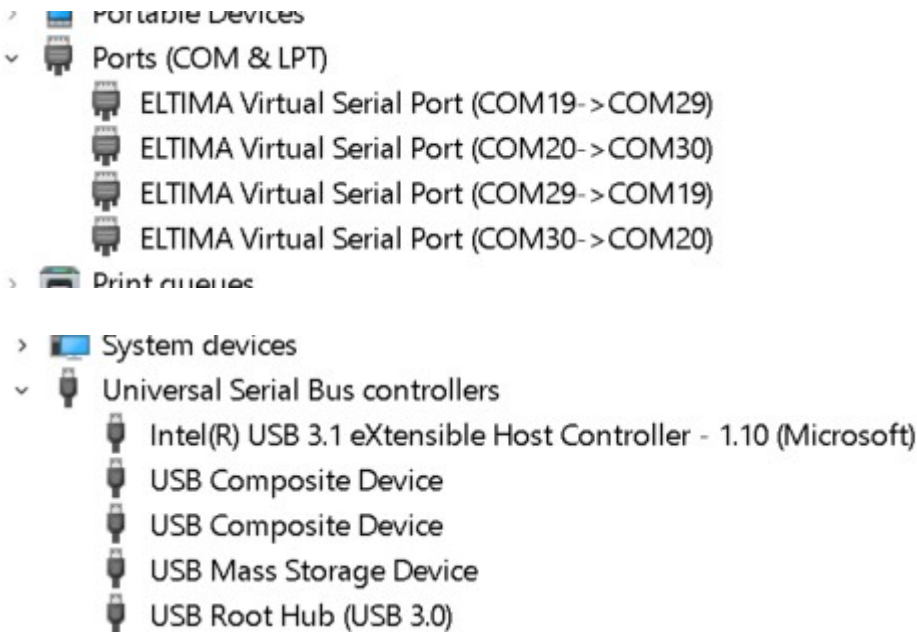
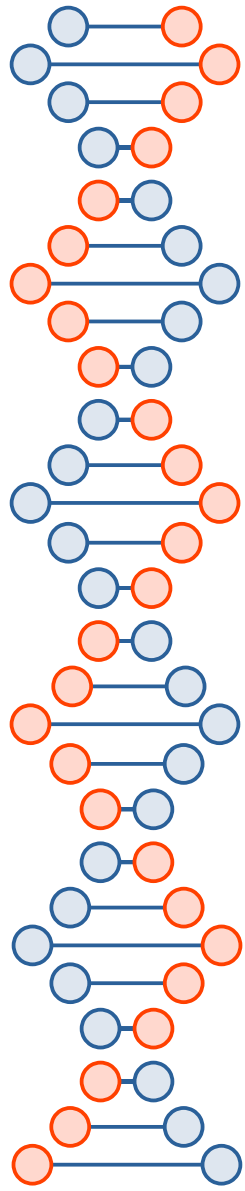
How do I get everything set up?

Some Windows Utilities that may be of help

Windows Settings and Windows Device Manager

Right Click the Windows Icon in the bottom left corner

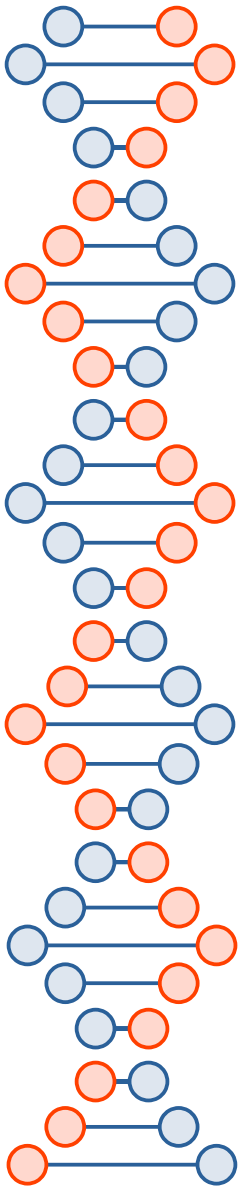




Two specific areas of Device Manager are highlighted- “Ports [COM & LPT]” and “Universal Serial Bus controllers”

; will show you the Comport number you will need to setup Radio Control.

“Universal Serial Bus Controllers” Will allow you to turn off certain Computer functions when you Are using sound cards



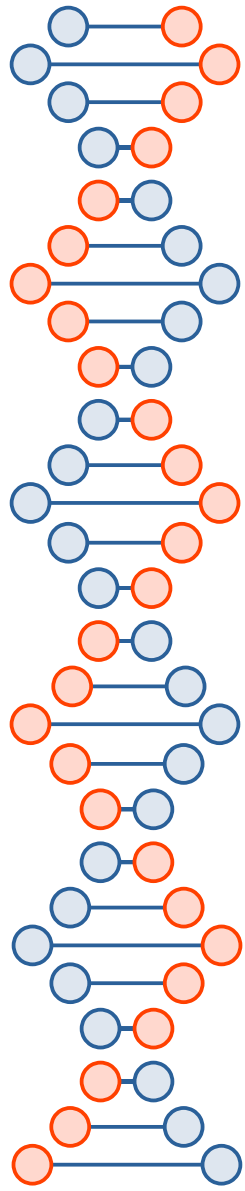
Another right click on the windows icon and select “settings”

Top left corner, “System”
On Left, click on “Sound”

Unfortunately, Windows has too many places to adjust the Sound levels, both recording and playback. This is one place; If you now scroll down the page, you’ll find a choice for “Sound Control Panel”. Click on that, and you’re given another place To adjust sound levels.

If you right click the speaker icon in the bottom right of your Display, my computer shows multiple methods of adjusting Sound levels.

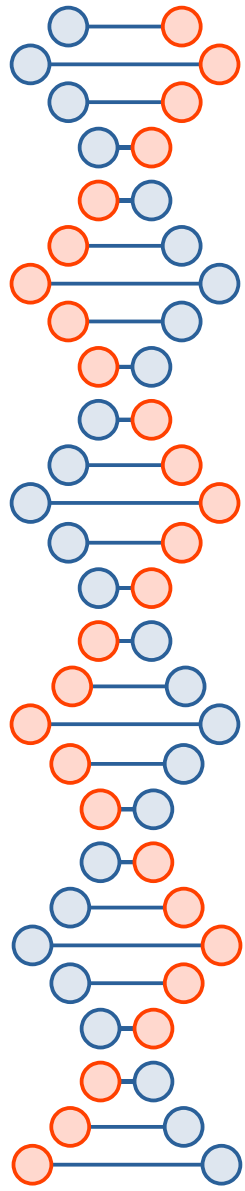
I’ve found that these sound levels all don’t track the same.



My best advice is to wire it up, and see if you can adjust the sound levels Properly using any one of the methods of level setting.

Unfortunately, I've had real funny things happen when updating Windows, And even when turning off the setup and then turning it back on. Comports Change, sound card selections change, both without warning. Sometimes, The sound card selected in settings won't match the soundcard selected in WSJT-x. So, this leads me to my next recommendation:

WHEN YOU HAVE IT WORKING, DOCUMENT YOUR SETUP!!!



Demos

Right Clicking Windows Icon, bottom left corner

Device Manager

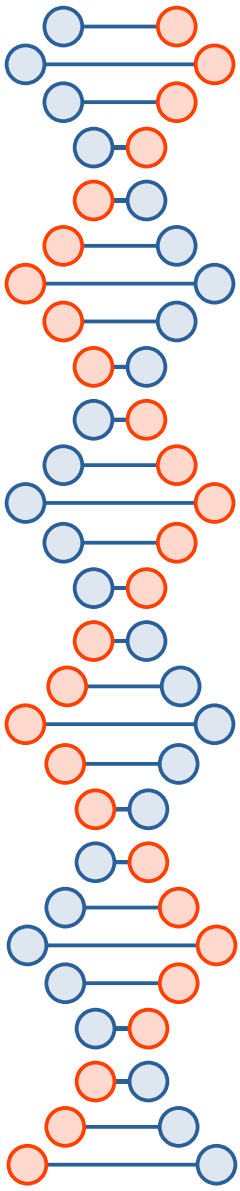
Settings

Control Panel

Right Click Speaker Icon, bottom right corner

FT8 Reception

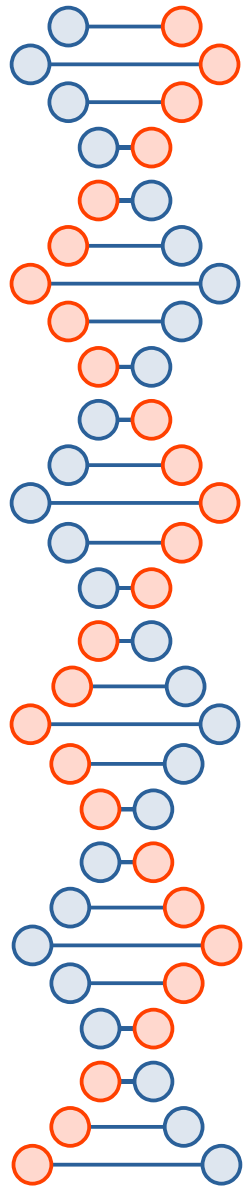
FT4 Reception



When you get a working environment-

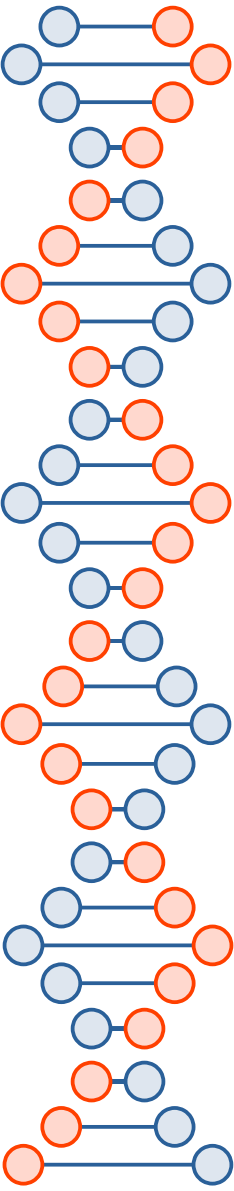
DOCUMENT IT!!!

Use Snipping Tool to take screenshots (Win+Shift+S).
Write down each setting in a document
So that you don't have to remember them.



Other tips:

1. In Windows Device Manager, turn off the “Power Down USB Ports”
2. For a USB cable that goes to any peripheral, always put it in the Same USB jack. Changing USB jacks could mean changing Com Port number or Sound card Assignment number.
3. Beware of Windows Updates! The complaints about Windows Updates changing settings are legendary! Particularly, sound card Settings seem to be changed quite a bit.
4. Once you have a working setup, DOCUMENT IT!



Source Documents

WSJT Users Guide

<https://wsjt.sourceforge.io/wsjitx-doc/wsjitx-main-2.7.0.html>

ZL2IFB FT8 Guide-

<https://ve7scc.org/2021/06/ft8-operating-guide/>

W0YK FT4/8 Tips:

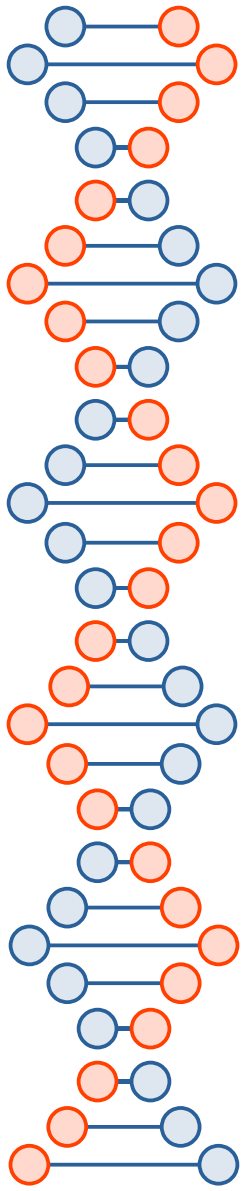
<https://va7st.ca/2020/10/ft8-ft4-from-a-contesters-perspective/>

W9MDB Audio Setup for FT4/8

[Dropbox.com/s/hlt50x44qs2ua1f/FT8Noise8.pdf?dl=0](https://www.dropbox.com/s/hlt50x44qs2ua1f/FT8Noise8.pdf?dl=0)

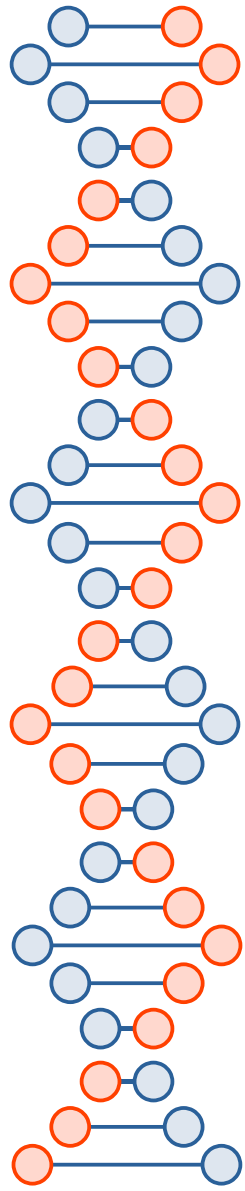
W3FPR- Setting Elecraft Transceivers for Soundcard Digital Modes

W3fpr.com/data_setup.htm



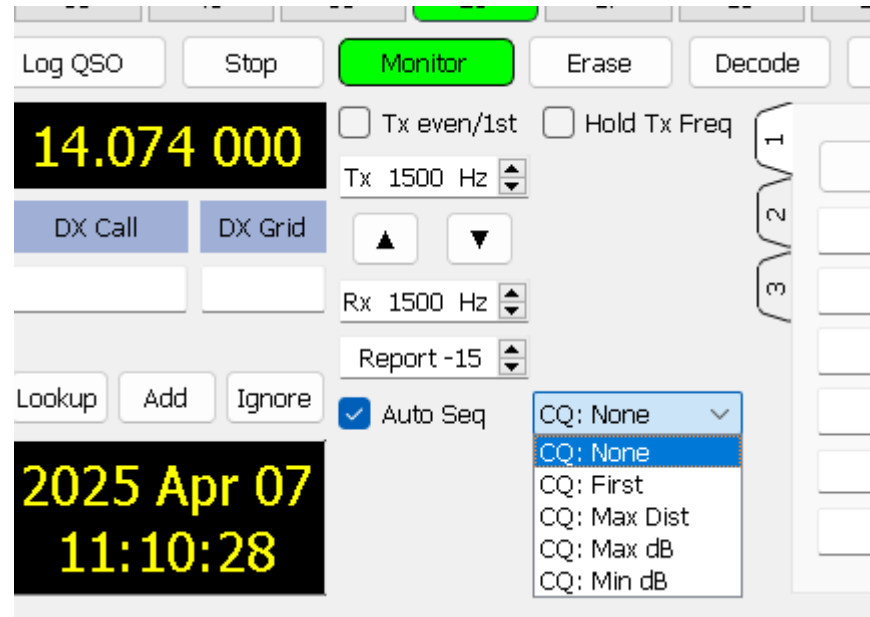
How FT4/8 Decodes

1. Your designated Rx frequency
2. Your designated Tx Frequency
3. From the bottom audio frequency to the top



You have 5 choices
For autosequencing:

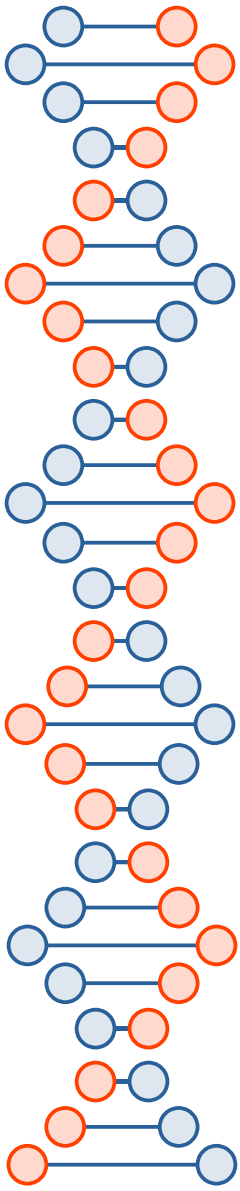
1. None
2. First
3. Max Dist
4. Max Db
5. Min Db



None means exactly what it says- there is no Autosequencing. You must Initiate all QSOs.

First- the station that is decoded first is replied to.

Max Dist- the station that is the max distance away is answered first. This Distance is calculated based on your Grid and his Grid. If someone replies Without a Grid, their distance is calculated as “zero”, so this choice does Discriminate against those that reply with a TX2 message.



Max Db- strongest Station
Min Db- Weakest Station

Ties are broken by whoever decodes first

I recommend using one of the choices and not "NONE".
You must react very fast when they are done transmitting
to make a QSO.