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COMMUNICATIONS & TECHNOLOGY
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G8JMO
Brian

Technology Special!

On the Cover: Brian Justin, WA1ZMS, of Forest, Virginia, prepares for a 122-GHz QSO attempt during the 2018 Microwave Update conference in southwestern Ohio. Details on pages 4 and 86.

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86 COVER: VHF PLUS
Microwave Update 2018

By Tony Emanuele, K8ZR

Here's some high-tech hamming for you! Brian Justin, WA1ZMS, of Forest, Virginia, checks out his 122-GHz transverter prior to a QSO attempt with Mike Seguin, N1JEZ, over a 1.5-kilometer (~1-mile) path during the 2018 Microwave Update conference in Ohio. Brian currently holds the only "Worked All Bands" award for confirmed contacts on every amateur band from 136 kHz through 300 GHz! Details in "VHF Plus" on page 86. *(Cover photo by Tony Emanuele, K8ZR).*
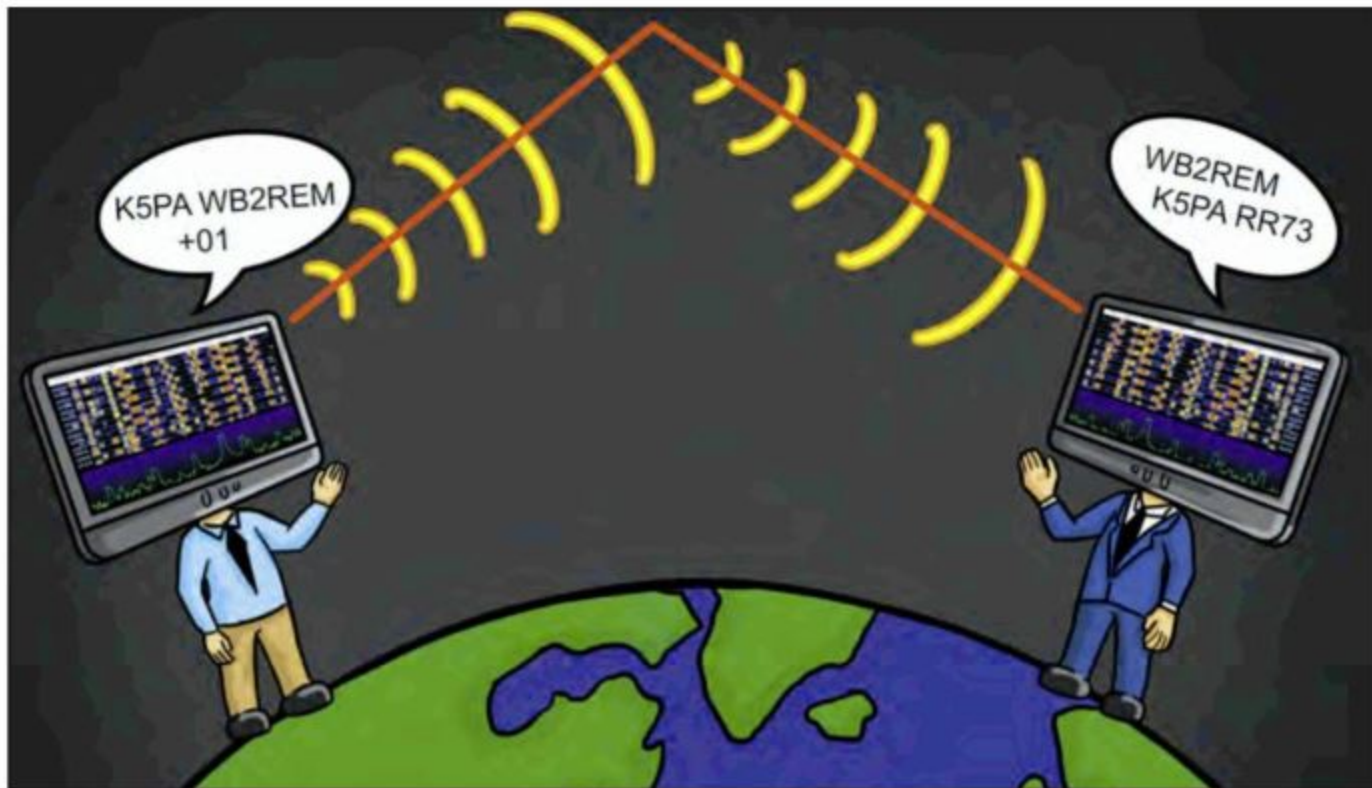
FEATURES

TECHNOLOGY SPECIAL:

Radio amateurs have always been on the forefront of new technology. From Marconi to today's wireless technology, hams embrace and work toward a future of possibilities. **See pages: 10, 18, 24, 32, 38, 44, 49, 52, 64, 67, 80, and 86!**

COLUMNS

DEPARTMENTS

You've almost definitely heard of FT8, the digital mode that caught fire the week it was introduced … and you've probably heard and read lots of things about it, both good and bad. But you might not have actually tried it yet. K5PA and WB2REM explain why you should give it a try in their FT8 Top Ten list (with apologies to David Letterman).

The FT8 Top Ten List

The Signal Rising Above the Noise

BY GENE HINKLE,* K5PA AND JIM MILLNER,# WB2REM

In just one year, the WSJT-X FT8 mode[1] has become the most popular digital mode in amateur radio. What is the magic behind FT8 and what are the reasons for its rise to stardom? Its usage ranges from making everyday QSOs, working DX and DXpeditions, to utilizing FT8 as a Field Day mode. Although FT8 has such a diverse worldwide following, there are amateur radio operators who for a number of reasons have not fully embraced FT8. The authors thought a review of some of the key FT8 concepts might be helpful for new users to understand the principles behind this operating mode. Thus, the FT8 Top Ten list was born.

The authors have been using FT8 since its inception and have followed its development as new features and enhancements have been added. To them, FT8 is the essence of ham radio, where new concepts can be developed and introduced to the amateur radio community for real-world testing and usage.

So let us introduce you to our top ten key concepts that we believe can provide insights into why FT8 is such a great mode. The rank order of each topic is not meant to impart a particular importance to the topic for we realize that each reader has his/her own particular interest and would undoubtedly rank these differently than we do.

#1: FT8 is an Ideal Low Sunspot Cycle Mode

Operating conditions on the HF frequencies have been fair-to-poor as we near the bottom of the sunspot cycle (*Figure 1*). However, this has not been true on FT8. As a result of FT8's ability to decode low-level signals, this digital mode

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# <wb2rem@verizon.net>

has flourished on all bands from 160-6 meters. Adding to the excitement of the relatively new mode is the apparent acceptance of FT8 on DXpeditions to rare locations. Many expeditions have embraced the mode, especially when using the Fox and Hound option that allows them to work up to 500 contacts per hour in ideal conditions. When the sunspot cycle improves, it will provide day and night accessibility on all bands — especially 10, 12, and 15 meters — with stations using low power or less elaborate antenna setups.

One appeal of the mode is the lack of language barrier. Given the standard messaging built into the program, speakers of most languages can communicate on this mode without difficulty. This motivates non-English speaking stations to participate. In addition, it is a perfect mode of communication for amateurs who are hearing impaired. Besides WSJT-X, there are a few other programs that allow you to operate FT8. JTDX[2] is similar to WSJT-X and interfaces in a similar manner to JTAlert[3]. JTDX has some additional operational shortcuts and provides more options for the number of passes and depth of decoders.

MSHV[4], developed by LZ2MV, supports FT8 and a number of other digital modes. Its FT8 mode is comparable to WSJT-X with a "Multi Answering Auto Seq Protocol" or DXpedition mode. In the creation of JTDX and MSHV, the authors have adapted K1JT's (WSJT-X FT8) open source code to produce their programs.

#2: Newer Rigs with Internal Sound Cards Make FT8 a Snap

With the advent of sound cards being built into modern amateur radios, operating digital modes has become much easier. Some of the newer major amateur radio equipment manufacturers' radios have built-in sound cards accessible through the radios' USB port (*Figure 2*). If your radio does not support USB audio, there are a number of external sound card interfaces available. For example, Tigertronics[5] makes the SignaLink USB. It has a built-in sound card and PTT circuitry. Tigertronics also sells ready-made cables and jumper modules for each radio. West Mountain's RIGblaster Advantage[6], Unified Microsystems SCI-6 PC Sound Card Interface Kit[7], and Rig Expert TI-5000[8] are also good alternatives. Yaesu produces its own interface, the SCU-17, which works on many of its radios that do not have built-in digital USB audio. Lastly, you can roll your own. There are many interface projects that can be found on the web. Just perform a search on Google or your favorite search engine for these keywords: Sound card interface ham radio.

#3: FT8 Automatic Features Make QSOs Easy But Not Dumb

FT8 is especially appealing because of its ability to make rapid contacts. WSJT-X has a little-known shortcut that can reduce a contact to around 2 minutes. By double-clicking Tx 1 and Tx 4 found in tab 1, WSJT-X eliminates sending the grid square and combines the RRR statement with 73. Therefore, a typical QSO with both stations using the shortcuts may look like:

CQ K5PA EM10
K5PA WB2REM +05
WB2REM K5PA R-01
K5PA WB2REM RR73
WB2REM K5PA 73

Figure 1. The current sunspot cycle is nearing an 11-year low.

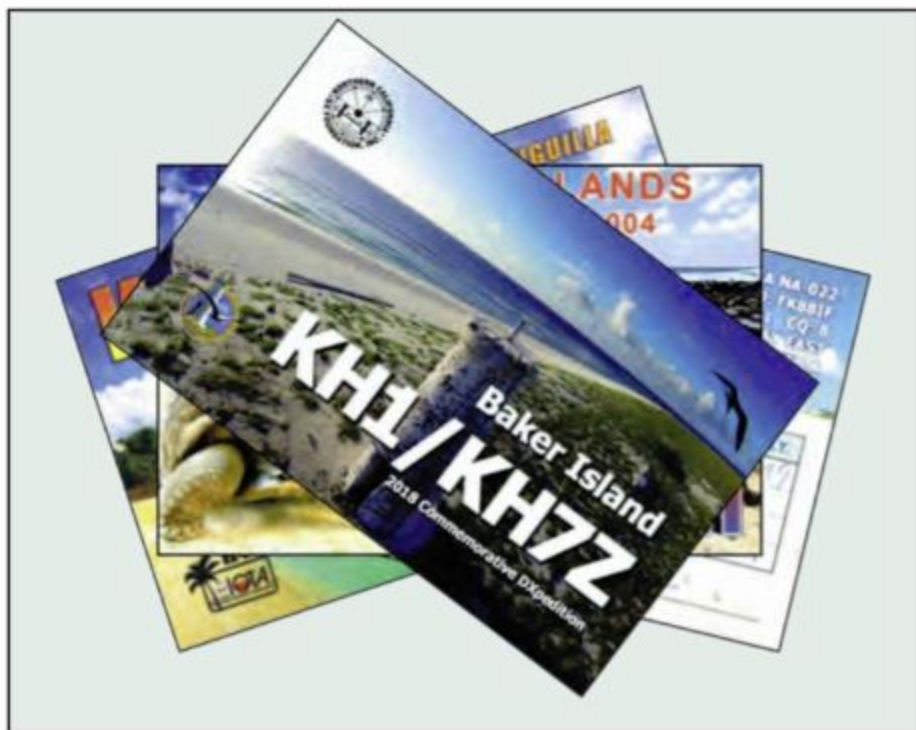Figure 2. Many modern transceivers come with built-in soundcards.

Figure 3. QSL cards from various DXpeditions.

pends on the received SNR levels at the destination you are trying to work. For fairly local, in-country contacts, many stations are transmitting 25-50 watts. If you watch the SNR levels for the station you want to work, and you see they are relatively high, say -10 to 0 dB, then you most likely will be able to work it with similar transmit power. However, when attempting to work a rare DX location, or if the SNR levels are -20 dB and lower, you may need to increase your transmitter power to provide a corresponding SNR increase at the distant location.

The authors routinely operate FT8 using 50-watt transmissions, but when rare DX is being worked, they may have to temporarily increase their power to several hundred watts to complete a QSO. This is why we say FT8 is a low SNR operating mode, but not necessarily a low power mode. Best practices require the amateur use the least power necessary to achieve communications. Watching and interpreting the receive SNR levels is one way to do just that.

#5: DXpedition Mode Exclusively for DX Expeditions

FT8's DXpedition mode was designed to allow legitimate rare DXpedition stations, acting as the fox signal, to work a large number of stations, the *hounds*, at a high QSO rate, expected to be in the hundreds per hour (*Figure 4*). The DXpedition mode is highly automated and orchestrates the QSOs among a number of howling hounds. What is interesting is the concept that the fox can select between one and five carriers on which to transmit simultaneously, increasing the ability to keep the QSO rate high. In addition, all hounds make their calls to the fox outside a protected portion of the FT8 frequency range, so interference is kept very low. This frequency assignment protection is built-into the DXpedition code base.

FT8 DXpedition mode is a variant of FT8, but the two modes cannot share the same sub-band frequencies. FT8 DXpedition mode must use another start frequency, so interference does not exist. These frequencies are published in advance, so hounds know where to find the fox signals. This is accomplished via DXpedition website announcements for their overall frequency plan, by real-time spotting networks and other social media methods. It is important to note the frequency range from 300 to 1000 Hz above the stated RF frequency is used by the fox for calling CQ, calling specific callsigns of hounds, and permit-

Notice the grid square for WB2REM is not sent. Shortcuts should only be used when there is a high level of confidence that the messages will decode accurately, meaning high signal-to-noise ratio (SNR), low interference conditions, and that a grid locator is not needed. They should not be used in lower SNR conditions or when competing in activities that require exchange of grid squares.

JTAlert[3] and PSK Reporter[9] are two excellent helper programs that can assist in effectively using FT8. JTAlert easily integrates into WSJT-X and provides boxes at the bottom of the software that identify stations calling CQ. By clicking one of the boxes, a call is initiated to that station. In JTAlert's setup, color-coded information can be assigned to specific categories such as needed countries, zones, states, etc., which helps identify and work needed entities. It will also alert you to stations that have not been worked before. PSK Reporter is an online mapping system that identifies where, when, and how strong your FT8 signal is being heard. This gives the operator information on band propagation and MUF (maximum usable frequency).

Some operators complain that FT8 is boring and lacking in challenge. One suggestion to reduce boredom is to use shorter operating sessions. However, if you are like us, you do the opposite. It is possible to reduce boredom by running multiple FT8 stations simultaneously. Of course, this requires a computer loaded with FT8, radios, and antennae for each station.

#4: Low SNR Mode, Not Low Power

This almost seems a paradox. FT8 is a low signal-to-noise ratio (SNR) mode but not a low-power mode. What is implied in this statement is the amount of signal power required to receive, demodulate, and decode the signals can be very small compared with the total receiver bandwidth. The SNR is defined as the signal power divided by the total noise power in the receiver bandwidth. The SNR can be down as low as -24 dB (or 4 S-Units below the noise) for decoding the FT8 message. Finally, the receiver's SNR values are also related to the transmitted power and local noise conditions. So different receiver sites report different SNR values based on their own local conditions.

The transmitter can increase the SNR values at the receiver site by increasing the transmitted power. If the transmitter doubles its power, say from 25 to 50 watts, there should be a 3-dB increase in the receiver's SNR value.

An often-asked question is how much power is needed to operate FT8. The answer, as always, is: It depends. It de-

ting the orchestration of the selected hounds. The selected hounds will be automatically dropped into this frequency range to continue with the QSO confirmation. The frequency range from 1000 to 4000 Hz is dedicated to the hounds for calling the fox and waiting to be selected. This is confusing to first-time users of DXpedition mode since the hound's frequency automatically changes and appears to be interfering with the fox frequency. It is not.

Another concept is the ability of the fox to sort the list of hound signals heard by categories of callsign, grid square, SNR, distance, and continent. This sorting capability provides an opportunity for the fox to make selections for its QSO queue. It is also possible for the fox to sort the list of signals from low SNR to high SNR, thereby giving preference to weaker signals. This can be done with the other categories as well. The fox operator can also program in a Max dB value for not responding to high SNR signals at all, thus excluding powerful stations running high gain and high power, from selection. These choices are all up to the fox operator to make.

#6 Operating Hints

A key concept is that the whole FT8 sub-band, approximately 2500-Hz wide, is used by the signal processing algorithm during each 15-second listening period. That means that as long as your signal is somewhere within this bandwidth, the listening station will have an opportunity to decode your transmission if the SNR is sufficient. You can use this to your advantage. When answering a station calling CQ, you can stay on your current Tx frequency by adding a check in the box, Hold Tx Freq. (*Figure 4*).

During a QSO, you may find that another station has encroached on your transmitting frequency. This can be observed by watching the Wide Graph spectrum and finding the red Tx frequency symbol indicating your transmission frequency. If it appears this interference is decreasing your ability to complete your QSO, you can use the special mouse command shift-right-click to move the Tx frequency to an area where the frequency appears clear.

Another hint for FT8 and JTAlert is to select your CQ-calling transmit frequency to be lower in the FT8 sub-band. This means that, given a choice and a clear frequency, you should place your Tx frequency lower in the spectrum when calling CQ. Lower could be as low as 200 to 500 Hz. Again, you can use the special mouse command shift-right-click to move your transmission to a clear frequency. The rationale is that JTAlert populates the cells showing valid CQs starting with first decoded signals from lower to higher frequencies.

Another important feature is the CQ Only box on the middle left side of the WSJT-X program. This will have the program display, in the left window, only those stations calling CQ.

We cannot overemphasize the need to watch your synchronization to UTC time (*Figure 5*). There are a number of devices and tools available to help keep your time error less than a tenth of a second. You should monitor your error by watching the DT (Differential Time) value in WSJT-X Band Activity window. Tools we use to synchronize our computer time are Dimension 4 from Thinking Man Software (requires Internet[10]), GPS Time Synchronization (no Internet required[11]), and TimeFudge (no Internet required[12]).

#7 Multi-Transmitters Need Multi-Logs

If you choose to use multiple radios, computers, and antennae, it is possible to simultaneously run two or more FT8 sta-

tions. Under this type of operation, both computers will log contacts independently. When running JTAlert along with WSJT-X, your log is used to reference previous contacts. In JTAlert, if a duplicate station calls CQ and the condition is set up on JTAlert, the program produces a "worked before" (B4) statement. If you alternate between your FT8 stations and operate on the same bands, the computer log for station A will not know that you've already worked someone via station B. One method of addressing this problem is to network the logs. All contacts appearing in one log will automatically go into the other log. Most logging programs have this capability. However, for the less savvy operator, there is an easier way of doing this. We use N3FJP's Amateur Contact Log (AC Log), but other logs work similarly. Each evening, we export that day's contacts from each computer onto a USB stick or into Dropbox. We simply take the exported contacts

from one log and place them in the other computer's log and vice versa. The ".adi" files can also be independently uploaded into TQSL for LOTW credit or into QRZ log.

If you plan to use multiple stations, certain precautions need to be taken. The most obvious safety measure is to not transmit on the same band at the same time because there is a risk of damaging the front-end of the radio. It is helpful to use bandpass filters on both radios. This will reduce interference coming from antennae in close proximity to transmitters on different bands. If you sequence both transmitters to transmit on the same cycle (i.e., even or odd) and reduce power, you can eliminate the chance of receiver overload and double your FT8 pleasure. The transmitter's power level could also be reduced.

Setting up a complicated program like JTAlert can be cumbersome and time-consuming. However, once it is set up, there is an easy way to transfer your settings from one computer to another or to share your settings. The key is to locate the config.sqlite file on the computer. To find config.sqlite, you can search in your C: Drive file manager. It should be in a file similar to the one shown below. You will need to open the hidden files folder, if not already done: C:\Users**UserAccountName**\AppData\Local\HamApps**YOUR CALL**\config\JTAlertX.

Copy the config.sqlite file and replace the file in the same location on the other computer. If you are sharing this file with a friend, when you bring up JTAlert, you will have to change the callsign and grid square to their settings.

Figure 4. "Hold Tx Freq" checkbox allows you to remain on your transmit frequency while working stations on other frequencies within the FT8 passband.

Figure 5. Keep your DT, or differential time, numbers low. Close time synchronization to UTC is very important.
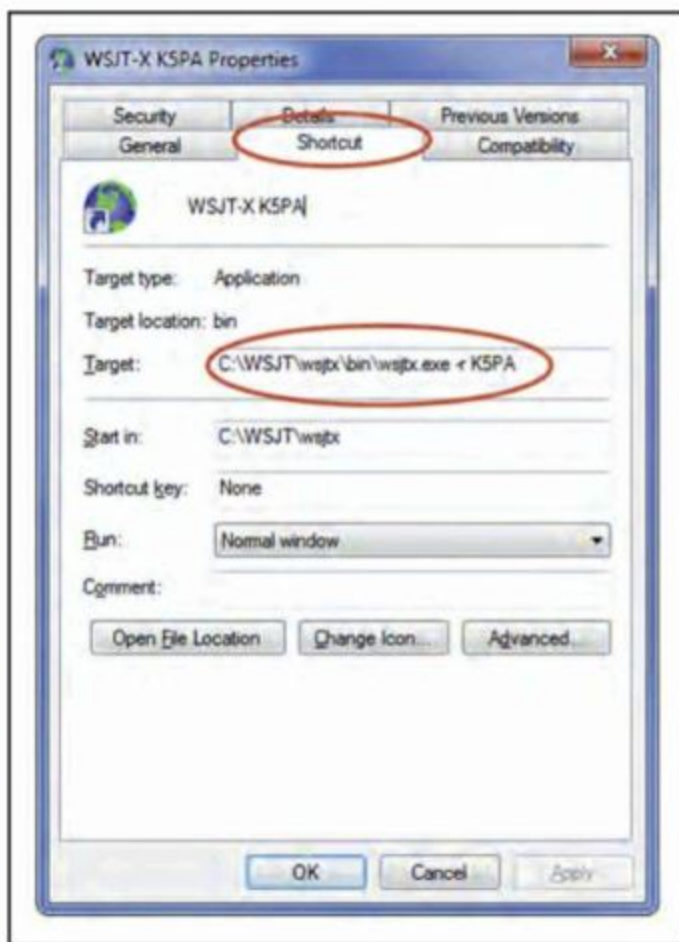

Figure 6. The WSJT-X shortcut settings. Use "-r (callsign)" as shown when setting up logs for more than one operator using a single station.

WSJT-X also keeps a log for all contacts made in a folder on your computer: C:\Users**UserAccountName**\AppData\Local\WSJT-X.

The log can be located by going to File on WSJT-X and "Open Log Directory." The log is listed as wsjtx_log.adi. If this file is imported into your regularly used log, you can view and sort your contacts.

JTAlert also offers the ability to create a standard ".adi" log file. Under logging, select Standard ".adi" and designate a destination folder. The standard ".adi" file can then be downloaded into your log. If you want to log directly into your existing log, in JTAlert, go to "Manage Settings" and select logging. Check the Enable box of your specific log and complete the requested information. For the AC Log, an additional step needs to be taken. In AC Log settings, under Applications Programs Interface (API), the TCP API Server (Enabled) box needs to be selected. JTAlert also supports other logging programs, including DXLab's DXKeeper, Ham Radio Deluxe, Log4OM, and MixW.

#8: Multi-Operators Need Separate Logs

A subtle issue appears when WSJT-X FT8 is being used by multiple operators. This occurs when a home station is shared with a family member, guest operators visit a club station and want to use their own calls, or a remotely located station is used by multiple operators. All of these cases have one thing in common: The desire to provide separate operating settings, including logs, based on individual callsigns. Otherwise, the FT8 log would duplicate contacts from numerous operating sessions as stated above.

Fortunately, there are methods available to set up WSJT-X for using multiple call signs. This is explained in the WSJT-X User Guide, Chapter 16, Frequently Asked Questions[13]. The basic concept is to create or modify a shortcut for WSJT-X that includes the software switch -r callsign (typing in the actual callsign instead of callsign). This is accomplished by adding the -r callsign to the Target under the Shortcut tab as shown in *Figure 6*. Under the General tab, you can edit the name of the shortcut to identify the callsign that is being used with the program.

This was originally designed to allow different rigs to be set up with their own configurations but also works with different callsigns. When WSJT-X is started for the first time using the target C:\WSJT\wsjtx\bin\wsjtx.exe -r callsign parameter, a new directory is created using the directory name callsign.

Voila, all future settings, configurations, and logs will use this new directory with a directory name of the callsign.

Where are these new directories created? As with all parameters of the WSJT-X program, the directories are located following the path:

C:\Users**UserAccountName**\AppData\Local\WSJT-X - **callsign**

The bold words are unique to your setup under Windows and your callsign that was used. By the way, the AppData folder is initially set by Windows as a hidden folder. Therefore, if you do not see the AppData folder, you will need to set your directory parameters to display hidden files and folders.

#9: Remote Operation With FT8 is Easy

FT8 can be remotely operated by using *TeamViewer*[14]. This is a free program if used non-commercially. TeamViewer can automatically connect to your home station's computer using your cell phone, tablet, or another computer. If you are traveling in your local area, you can leave the ham radio turned on, so you would only need to remotely turn on JTAlert that can start WSJT-X and your log. Once all programs are loaded, you can operate FT8 as if you were home. Other approaches include using manufacturer-supplied software to turn on your radio remotely or by using a program, such as Ham Radio Deluxe, to turn the radio on or off. Lastly, an IP switch (i.e., Web Power Switch Pro through Amazon.com) could be used to remotely apply electricity to the power plug of the radio (Note: radio needs to be left on when power is disconnected). As in all remote operations, the control operator is responsible for the operation of the station. He/she needs to be able to monitor the station for problems and demonstrate the ability to shut it down if and when needed.

#10: Resources Abound on the Internet

With today's technologies and access to the internet, information can be easily found using a search engine such as Google or Yahoo. In addition to the references we have provided so far, three important documents that will help your understanding and use of the WSJT-X FT8 program are:

WSJT-X User Guide[15], FT8 DXpedition Mode User Guide[16], and FT8 Operating Guide, Gary Hinson, ZL2IFB[17].

Good luck with your newly-found information about WSJT-X FT8 and DXpedition mode. We look forward to seeing you on the waterfall!

Notes
1. WSJT-X: <https://tinyurl.com/hg6rnxm>
2. JTDX: <www.jtdx.tech/en>
3. JTAlert: <www.hamapps.com>
4. MSHV: <www.lz2hv.org/mshv>
5. Tigertronics SignaLink: <www.tigertronics.com>
6. West Mountain Advantage: <http://westmountainradio.com>
7. Unified Microsystems SCI-6 PC Sound Card Interface Kits: <www.unifiedmicro.com/sci6.htm>
8. Rig Expert TI-5000: <https://tinyurl.com/y9t3f7sw>
9. PSK Reporter: <www.pskreporter.info>
10. Dimension 4, Thinking Man Software,
11. Using GPS to Set Your Time in the Field, Gene Hinkle, K5PA, CQ Amateur Radio, Vol 73, Number 12, December 2017
12. TimeFudge, Michael Black: <www.qrz.com/db/W9MDB>
13. Multi User Setup, WSJT-X User Guide, Chapter 16. Frequently Asked Questions
14. TeamViewer: <www.teamviewer.com>
15. WSJT-X User Guide: <https://tinyurl.com/yaxqlx8q>
16. DXpedition Guide: <https://tinyurl.com/ya94kds7>
17. FT8 Operating Guide, Gary Hinson, ZL2IFB: <www.g4ifb.com>