K1SIX 6M FT8 INTERFERENCE COMPLAINTS RECEIVED FROM OTHERS and 6M FT8 INTERFERENCE EXPERIENCED BY K1SIX WITH ANALYSIS

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This document is presently under construction and will take some time to complete!

Introduction (K1SIX as the Interferer)

When you place a tool like a Spectrum Analyzer in the hands of someone who doesn't fully understand what they may be seeing, it may be possible to create an Anal Spectrumizer.

This document contains embedded hyperlinks to reference material and is designed to be read over the Internet by simply clicking on the links provided. Required reading is the latest WSJT-X manual and highly recommended reading is the latest FT8 Operating Guide by Gary Hinson, ZL2IFB. Although the primary focus of Gary's guide is HF, there are many portions that the 6M and up VHF operator will find of value, particularly under strong signal conditions.

Due to the propagation characteristics on six meters, a blend of VHF and HF propagation and the likely lower overall spectrum occupancy vs. HF, a special set of circumstances for what one may see in the WSJT-X waterfall applies and due to this lower occupancy that on HF may otherwise mask some of this subtlety, ***extreme caution is advised before jumping to conclusions as to what the waterfall is actually depicting***. This is especially true considering the fact that unlike HF operators, many serious VHFers are running very high ERP, some with 100 kW or more. So between a transmitter and a distant receiver, we can essentially have a quite efficient bistatic radar system.

In the perfect world of a clean transmitter and receiving system, the expected occupied bandwidth of the trace seen on the WSJT-X waterfall will be 50 Hz as shown to the left in ***Figure 1*** below. One of the signals, shown using the same sequence as me occupies ~ 1000 – 1050 Hz of USB audio spectrum (the markers are in 100 Hz increments for this user's receiver WSJT-X wide graph preferred settings). Strangely, my signal which is highlighted shows about the same occupied bandwidth for the ***main*** signal but two fuzzy extra signals show up, one on each side. For now, let's just call those two fuzzy signals "ghosts". The result is that my occupied bandwidth is much wider than the expected 50 Hz. In fact, the complainant claimed I was 400 Hz wide on a social media chat page and was very angry about it, spewing forth name calling and personal insults! What is going on here?

Does anyone remember the term "ghosts" or "ghosting" from way back when TV reception was mostly over the air? Folks in city (clutter) environments would experience this often and it could be dynamic like when a large truck drove by on a nearby overhead freeway. Click HERE to learn a little more about the term "ghosting".

So the term "ghosting" mostly refers to multipath distortion and not a defective high powered transmitter. There can be many contributors to multipath distortion, it can be quite dynamic and I will attempt to address some of them here as they may apply to typical amateur operations.

MULTIPATH (General)

Multipath can be either constructive or destructive. Some telecommunications systems utilize special designs to leverage upon the more positive aspects of signals being enhanced by different phase and amplitude arrival. These designs may include space and/or frequency diversity. Further discussion is beyond the scope of this document. Let's try to keep it simple…

MULTIPATH due to terrain and clutter

This is probably the most common form of distortion that will be experienced by a receiver from an amateur transmitter in the VHF+ bands. The amount of distortion experienced is simply a function of the link budgets over the paths of interest and reflection/absorption characteristics on the band of interest. The ERP from the transmit site is certainly an influencing factor. I pluralized "paths" and "budgets" because the terrain and clutter contributions can vary depending upon the ***net impact*** from any directional antenna bearings at both the transmitter and receiver sites and is therefore dynamic. Note how the "ghosts" on my main signal in ***Figure 1*** are frequency spaced images of my main signal but at less amplitude and appear to show fading. There is no sign of the spillover shown in Gary Hinson's document, caused by transmitter distortion. These "ghosts" could be from terrain multipath or something else over this 183 mile path which is a very nice view to my northeast. I believe it was something else.

I will frequently see "ghosts" on Randy, N1KWF when we are beamed away from each other on 6M. More often if we are both beamed northwest where there are some mountains in the distance. If I turn the antenna in his direction, the ghosting is greatly reduced or sometimes eliminated depending upon his beam heading. Randy runs 1,250 watts output into a 6M9KHW at 100' AGL from a hilltop location and effectively illuminates "stuff" in the distance very well. We are only 20 miles apart with some terrain between us and no real building clutter of concern. There is significant forested land between us. I see this same effect on many others but it all depends upon individual antenna bearings. For paths where there is significant metro area build up on either or both ends of the path, clutter becomes a very significant factor to consider, even on six meters. Systems engineers use a Land Use and Land Cover database to assist with their coverage designs to account for clutter. Terrain is a separate database.

There are many other possible contributions that can create multipath from surface of the earth sources such as paths traversing water bodies, etc. The above two paragraphs cover only the most common to be expected at 50 MHz. Let's try to keep it simple…

MULTIPATH due to atmospheric sources

Keeping in mind that ***MULTI***path implies signal arrivals from two or more sources such as the main source and secondary source(s), sources from the atmosphere can be contributors. There can be many atmospheric sources but from a practical standpoint and to keep it simple, aircraft scatter can qualify even at frequencies below 50 MHz! Aircraft scatter will be relatively short lived but can last for several sequences. Aircraft scatter will result in a relatively slow and variable Doppler shifted frequency from the reflecting source.

The effects from aircraft scatter contribution will be worst when the aircraft is located at approximately the path midpoint and depend upon altitude, antenna vertical patterns at both ends of the path of interest and radar cross-section (RCS) of the aircraft.

It is entirely possible that the ghosting shown in ***Figure 1*** could have been due to aircraft scatter contribution but there is insufficient information to really support this theory. However, the complainant did say there was a change from one sequence to another (which is not entirely clear) over this 183 mile path but never indicated how long the effect was noticeable. So we don't have sufficient evidence to go by. Let's try to keep it simple…

MULTIPATH due to ionospheric sources- METEORS

I have tried to keep this simple from the start but it just keeps getting better. I have "lumped" meteors into the ionospheric category although some may argue that they belong in the atmospheric category which is fine by me. The forward scatter MS effects are typically modeled at ~ 95 km altitude, a bit lower than the typical 105 km Es altitude but the actual altitude for ionization can vary considerably. Meteor ionization can and will contribute to multipath and during some bursts, with MUFs rising into the several hundred MHz range, backscatter from meteor ionization can also contribute to multipath distortion at local ranges. Typically, it is expected that the meteor contribution will be short lived and in the range of a few milliseconds to several seconds. However, during major meteor showers there are times when the ionization can appear to be almost continuous from multiple sources. Sometimes this constant bombardment may raise the electron counts in portions of the E- region to cause mini 1 hop Es openings. Click HERE to view my most recent 50 MHz meteor range results. Of particular interest are the results under ~ 550 miles which are NOT forward scatter and at ranges less than a few hundred miles would be expected to be a contributor to multipath assuming the main signal could be detected via direct path. So I think we can rule out MS backscatter as the reason for my wide signal in ***Figure 1*** and I know the complainant and I know he knows better. Let's try, real hard, to keep it simple…

MULTIPATH due to ionospheric sources- AURORA and TEP

I have eliminated Aurora and TEP from the focus for obvious reasons. Both should be expected to show a distorted trace on the wide graph FT8 waterfall. I am told that TEP flutter does show a widened trace but FT8 still can be used for making contacts. During aurora conditions, expect a distorted trace. To date I am unaware of any FT8 aurora contacts that have been completed on 6M via aurora propagation. However, it may be possible to complete Aurora-E using FT8 as sometimes the distortion may be minimal. I am not aware of any 6M FT8 Auroral-E QSOs to date.

MULTIPATH due to ionospheric sources- E and F Layer Backscatter

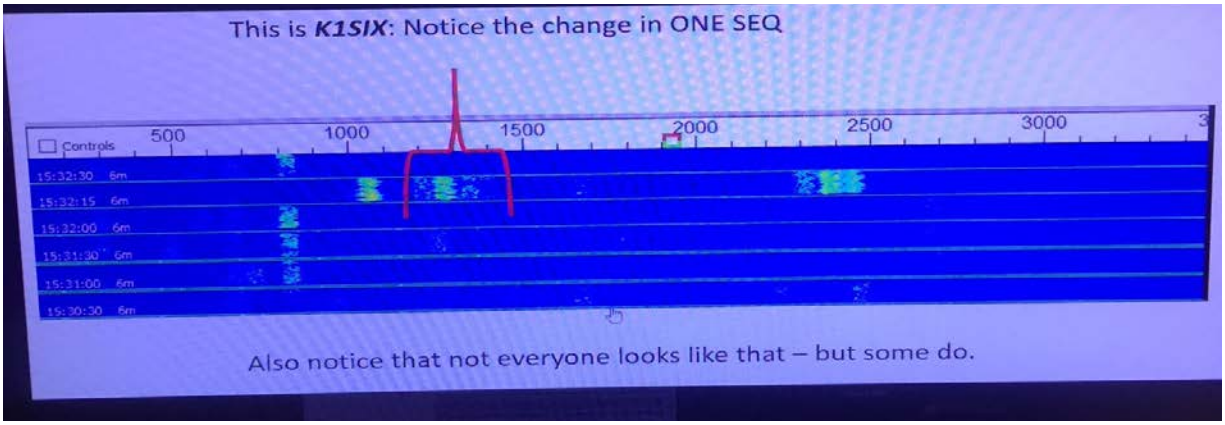
To date, I have not experienced any 6M F-Layer backscatter since FT8 was introduced. However, I have experienced significant Es backscatter on six meters. It's that hollow sound that many of us can recall and I'm sure this effect will be similar during times of either E-Layer or F-Layer intense propagation. The hollow sound is usually due to the different arrival times of a direct path local (but not always local) signal and a delayed ionospheric return signal. An echo. A clear case of multiple signal arrival times and likely phase shifting that will distort and widen an otherwise "clean" 50 Hz wide FT8 when viewed in the WSJT-X wide graph.

The goal of this document is provide informational content and not to be defensive. This requires providing supporting evidence of any theory presented and that theory for my widened signal shown in ***Figure 1*** is it was simply Es backscatter multipath based upon the following supporting evidence:

- Very soon after the complaint, I requested a "check" from local N1KWF, 20 miles away with our antennas pointed at each other. There was no report of any distortion.
- As we were discussing this on the ON4KST chat site, a station 1,000 miles away "chimed in" and reported my 1 hop Es signal to be free of any distortion.
- The complainant is in coastal Maine, 183 miles distant with a very good location for Es to Europe and is just as aware of our mutual 6M ***seasonal probability*** of potential European paths as I am. My location is excellent for Europe even though I am a long distance from the coast and with a clear path to the complainant so my direct path signal would be detectable. Many of us in this area will leverage upon this ***SEASONAL PROBABILITY*** information for potential transatlantic contacts on 6M. The date/time on the ***Figure 1*** screen shot is 26 August 2018 at 1439 UTC (10:39 AM Local).
- The time shown for my distorted signal in ***Figure 1*** is 15:32 ***assumed*** to be UTC. In this area, many of us are familiar with and leverage upon the well documented **DIURNAL CHARACTERISTICS** vs. 6M Es path probability of transatlantic success. The complainant is well aware of this and so am I. The timing of the complaint is a good fit for where we would both be expected to be beaming on this particular date and time.

Based upon the foundation of the evidence above, I can only conclude that my ***Figure 1*** distorted signal was nothing more than the multipath combination of a direct path signal and Es backscatter due to both individuals, with very effective systems and my high ERP, beaming to a common Es "hot spot" somewhere out over the Atlantic Ocean. Situations like this should be no great revelation. Can we please try to keep this simple?

Figure 1 (from an August 2018 blog published on the Internet)



PREVIOUS COMPLAINTS OF INTERFERENCE RECEIVED

Since the inception of the FT8 mode and prior to the August 2018 complaint shown in ***Figure 1*** above, I would estimate that I had received approximately 4 complaints. In all cases, my input was via e-mail and in all cases that input was totally respectful. In some cases a screen shot was provided and in some cases the complaint was a multiple decode during a single FT8 transmission sequence. I've lost count on the amount of times I have noted multiple same sequence decodes on others when I have also noted

multipath on their signals. I could add screen shots but that would just make this document larger than it really needs to be. I was not the only one receiving these complaints as at least two friendly locals received them in addition to me.

In all cases of previous complaints, the complaints were from stations that were either local to me or local to the others receiving them and in all those cases, all three of us are QRO, high ERP installations with an interest in extreme six meter DXing. In all cases, including the two friendly locals that received complaints, I became personally involved to respond. I consider this as an obligation as we are supposed to be self-governing which also means helping each other out. My response to the complainants was ***as direct communications as practical*** and sometimes via land line on my dime (I have poor cell phone coverage here). This strategy worked well as I have received no duplicate complaints and hopefully neither have my friendly locals. The strategy is a simple one: for each and every ***legitimate complaint***, check each other's signals through on-the-air tests and respond to the complaint accordingly. It's a team thing. Things change, equipment problems can develop. So this is all part of the responsibility of trying to be a good neighbor. In all cases, after locally ensuring that our signals were "clean", was to explain that WSJT (Weak Signal JT) was primarily designed for weak signal work and that under strong signal conditions, a new set of circumstances may and will apply. The folks using FT8 on HF may know this well but for VHFers only, this may not be so obvious. The new set of circumstances is how the receive side of the system is reacting to strong signals.

The common denominator on the receive side of the equation may very well be the use of receive AGC. Several that I have communicated with have AGC turned off when using WSJT modes and I generally have AGC turned off also. However, AGC is a wonderful invention and will reduce receive distortion under strong signal conditions. If one turns off AGC when listening to strong SSB signals isn't it expected that the strong signals will sound distorted? So why would such distortion not be presented to the sound card of a WSJT interface as it is a function of the receiver itself? Without the use of receiver AGC, the receiver linear chain will be disrupted. Strong signals will drive these linear circuits near the power supply rails and when that occurs, closer to a square wave output which will be rich with ODD harmonics. I have turned on my AGC, typically to a fast setting, and have witnessed the third audio harmonic disappear a few times under strong signal conditions (***show a screen shot example***). So the operator must be interactive with their system rather than just sitting back and expecting perfection. It is possible that a strong second audio harmonic could be an indication of an issue at the transmitter end of the communications link. These harmonics can bury weak signals. This link to the FT8 Operating Guide by Gary Hinson, ZL2IFB includes suggestions on the use of receiver AGC. Use the Adobe Acrobat **EDIT**- **FIND** "AGC" feature to zero in to the document areas that pertain. Multiple decodes within a same FT8 sequence are believed to be from the fundamental signal transmit distortion or multipath and not harmonics due to the multiplication factors, by the order of the harmonic, easily recognizable in the waterfall display. Under the conditions of multiple strong signals, there is no reason not to expect receiver intermodulation even at the audio interface level. So to analyze the receiver linear chain interference is a totally dynamic and complicated process requiring answers to multiple questions. Without these answers, there can be no path to a resolution.

AN ALARMING NEW TREND?

At some point during 2019, after the ***Figure 1*** complaint, things began to change here. The first indication was an e-mail from an unidentified party that stated "Fix your transmitter". This came across as an order with no callsign or identification and was deleted with no response to the sender. I'm under the impression that others may have sent e-mails regarding interference along with attached pdfs but these were unidentified individuals and the e-mails were deleted at the server level to prevent possible computer contamination.

Exhibit X shows yet another form of an interference complaint noted from an anonymous individual posting on a 50 MHz chat site which is essentially social media. This one I did respond to but probably should not have. This particular method of presenting an interference complaint to anyone is particularly alarming and may carry legal ramifications for LIBEL. This may be a reason why the author remained anonymous. So one may wish to consider approaching an interference complaint to another individual in a different manner as it could result in legal penalties. ***DIRECT COMMUNICATIONS BETWEEN THE PARTIES is always the best path to any possible resolution.*** The very last resort is to allow an interference issue between parties to elevate to a legal issue or to the FCC /ARRL VM Program level. Such problems should first be attempted to be resolved at the local level by open communications between all parties concerned and making anonymous complaints is not an option to resolve an interference complaint unless the goal of that complaint is defamation. The beauty of the WSJT-X suite is that sequencing and timing are built in to mitigate interference. So there should never be a need to even see such topics as shown in ***Exhibit X*** as long as all parties are following a coordinated sequencing plan.

Interference is a complicated subject. As a Systems Engineer and National Engineering Manager I have conducted Interference Mitigation Seminars all over the USA, built teams and personally participated with some of those teams to seek out and eliminate interference. My best advice is: ***Be careful and don't jump to conclusions!*** I am also a professionally trained instructor and as crazy as this may appear, ***Exhibit X*** actually represented a golden opportunity to communicate to others what NOT to do if one is really searching for a solution to an interference problem. If the goal is defamation then fire away. Don't be afraid to LEAN ON (Kit Conway/ STELLO, tempered lyrics or the **MØ ORIGINAL** Version) others for help including me. Choice is optional.

In some cases with locals, there may be no practical interference resolution possible. However, the built-in forced sequencing within the WSJT-X application along with reasonably accurate computer clock times, can be leveraged upon to mitigate interference as long as locals are all on the same transmit and receive sequences. The locals should never hear each other. I will address sequencing coordination later.

EXHIBIT X

EDITED & COMMENTED[1] TRANSCRIPT FROM THE 2019 50 MHZ PROP.LOGGER

Sep12 00:20 **YOur/friend** (FT8) **50.313** ***I'm not at all nervous about it. What am I supposed to clean up? Specifics?*** - **K1SIX** (FN43) **Comment[1]:** No comment.

Sep11 18:02 K1six (Ft8) 50.313 ***It seems you are really nervous about your signal. Maybe just clean it up and relax....*** - **Y0ur/friend** (Fn42) [remote.mwavellc.com *69.193.67.146*] **Comment[1]:** Clean up what?

Sep02 20:29 **K1NK** (FT8) **50.313** ***There are LEGAL methods at your avail to have me shut down. You know what they are but I would suggest you make sure you are correct.*** - **K1SIX** (FN43) **Comment[1]:** There is really no other alternative at this point. With Liberty and Justice for ***ALL***.

Sep02 20:17 **rtc (UNKNOWN)** FT8) **50.313** ***Ain't gonna happen pal.*** - **K1SIX** (FN43) **Comment[1]:** But I won't.

Sep02 14:48 **6**(rtc.) **51.313** ***You could shut it off.*** - **K1NK** (FN83) [stcton1302w-lp130-01-65-95-250-7.dsl.bell.ca *65.95.250.7*] **Comment[1]:** I could.

Sep02 11:45 **UNKNOWN** FT8) **50.313** ***If you think about it, there may be a very simple solution to your woes other than for me to fix my alleged defective signal. Ball is in your court.*** - **K1SIX** (FN43) **Comment[1]:** If one operates on my same sequences they won't even know I'm there! In addition, this is WEAK SIGNAL JT (WSJT). If I am overloading someone's receive system, there's nothing I can do about it on my end.

Aug31 21:31 **UNKNOWN** (FT8) **50.313** ***Then I could dump the BEKO kW and buy an untamed pair of 4CX250 which would help the cause tremendously.*** - **K1SIX** (FN43) **Comment[1]:** This is an error. I could probably run FT8 with a Class C amplifier. There is no more than a single tone generated in an instant of time. Thus there is no in-band IMD generated but of course out of band harmonics COULD be an issue if not properly controlled by the design.

Aug31 21:29 **UNKNOWN** (FT8) **50.313** ***For starters, I could disconnect my interface from a flat data port on the FTDX5000MP- which bypasses mic compression and equalization. That cud make me wider.*** - **K1SIX** (FN43) **Comment[1]:** I have some technical background and this is a true statement.

Aug31 21:04 **UNKNOWN** (FT8) **50.313** ***I could if you want me to.*** - **K1SIX** (FN43) **Comment[1]:** If you're nice, I can be accommodating.

Aug28 13:02 k1six (ft8) 50.313 ***could you get any wider?!!!!!!*** - **k1lling/me** () [remote.mwavellc.com *69.193.67.146*] **Comment[1]:** This anonymous individual is obviously addressing an "audience" other than me with a possible motive of defamation. I haven't been on this site in over a decade and just "happened" upon this. ***This is not the way to access me if my assistance is required.***

Under construction. Many more screen shots and explanations to follow…

CO-CHANNEL INTERFERENCE MSK144 MODE

I have only been alleged to be interfering with others once when using meteor scatter modes. In this case back in the days of FSK441. Someone on a local Boston Area SSB net was hearing something like a tone or perhaps even a birdie. The Net Control Station recommended that all parties point their antennas northwest (in my direction) knowing that I was an active WSJT user. Suddenly other stations were heard stating "I hear it too!" This net insists on operating their SSB net right in the middle of WSJT high activity zones and Net Control was simply trying to incite trouble. The entire situation was quite comical as I was only listening at the time. However, it did highlight the fact that there is significant conflict, resistance and rage by some associated with using WSJT modes on the amateur bands. More about this later.

The sweep type display used for meteor scatter modes, now MSK144, is less susceptible to scrutiny than the waterfall, a form of an audio spectrum analyzer, used for FT8 from those looking for something wrong. The Anal Spectrumizers. So complaints when using MSK144 should be expected to be minimized.

I have received e-mails from some indicating that "the meteor scatter channel", now 50.260 in North America, is nothing more than a mess of a bunch of folks all calling over each other and it may indeed sound like that by ear. However, in reality this is not the case.

Back in the "good old days" of SSB, it was expected that someone would hop on a common calling frequency and monopolize it during a meteor shower. Using WSJT-X, monopolize away. It's a whole different ballgame now! ***EXHIBIT Y***, an experiment that I requested, illustrates the capability of multi-user traffic handling capability within a narrow bandwidth when using MSK144. Think of it as a form of TDMA.

The traffic handling capability is made possible by a multitude of factors but the short 72 millisecond payload frames in MSK144 are what really makes this come together. 208 72 millisecond continuously repeating frames carrying intended data can fit into a 15 second sequence but we have to remove a few due to TX Delay and de-key time. With these very fast payload frames, subtle differences in user's computer clocks help to promote collision avoidance. Some strive for absolute perfect clock time but this may be overkill and possibly detract from the load sharing potential of MSK144. Other factors that contribute to load sharing on a meteor circuit are propagation delays and accessing differing meteor trail ionization.

To make all of this work from a user perspective and to mitigate interference to/from one's local neighbors, two things are required: Coordinated Sequencing and a ***relatively accurate*** computer clock. Sequencing coordination is imperative and a no-brainer. One should (mostly) be on the same T/R sequences as their locals otherwise they will be CQing in each other's face. Clock accuracy is important for several reasons. Most importantly, you don't want to spill over into your neighbor's receive sequence and steal away their potential payload frames. Secondly, if the clock is considerably off, you may appear to a distant station, to be on a different sequence than you actually are. That could and has killed a QSO.

EXHIBIT Y shows the remarkable capability for channel sharing on a non-interfering basis enjoyed by MSK144 users provided that locals are on the same transmit sequences. This is largely possible due to the small clock differences in the computers of the two stations transmitting simultaneously and the fast and repeating 72 millisecond MSK144 payload frames. Propagation delays for these two individuals separated by only 20 miles should be considered insignificant. It is possible that different meteor trails also contributed to the results. This could not be possible on a shared frequency using SSB.

It's OK to go off sequence from time to time for short periods. In my case, I like to try to work local stations on backscatter but then I return to the "normal sequence" for my area as soon as possible so as to not create prolonged interference to the locals. Folks should adhere to any standardized sequencing plans so all can live in harmony. Those that operate off-sequence should show sensitivity for how their operations could negatively impact areas that have high population density. For my local area, I keep an updated inventory of active six meter locals worked and < 250 miles range, shown in the upper right of this chart. So I have to try to be nice.

During contests, MSK144 should be avoided when trying to work local stations. Other modes are better suited for this. MSK144 should be used primarily for meteor scatter and working locals can only cause unnecessary interference to others attempting longer range QSOs. MSK144 also has a proven track record for multi-hop Es out to at least 3 hops but is not as sensitive as FT8. However, in a fast fading environment it can work very well. This could include MS linkage into Es, F2 and even TEP. So this possibility should not be overlooked.

EXHIBIT Y. MSK144 TRAFFIC LOAD SHARING ON METEOR BURST PROPAGATION

Edited transcript of an experiment to prove how well *simultaneous operation* on MSK144 can work. As decoded by N0AN at ~ 1,100 mile range. Frequency was 50.280 MHz. N1KWF and K1SIX are separated by only 20 miles in distance and testing in the *same 15 second transmit sequence*. Both stations are within 2.5 dB ERP and utilize similar antenna systems.

Sequence #1 BOTH DECODED but at slightly different time offsets which was expected:

100915 -2 2.9 1534 & CQ N1KWF FN32 ~U.S.A.

100915 9 9.1 1528 & CQ N1KWF FN32 ~U.S.A.

100915 23 13.3 1523 & N0AN K1SIX FN43 2 5 -0.5

Sequence #3

BOTH Decoded but ***amazingly both in the same + 12.2 second frame set!*** I marked with ***

Many multiple decodes during this single 15 second sequence (usually offset in time slightly):

101015 2 2.3 1534 & N0AN N1KWF +02 2 12 -0.9

101015 11 12.2*** 1531 & N0AN N1KWF +02 1 2 -0.4

101015 11 12.2*** 1522 & N0AN K1SIX FN43 1 6 -0.5

Sequence #4 BOTH individuals were decoded 3x times each:

101045 6 0.5 1516 & N0AN K1SIX R+07 1 0 0.2

101045 19 3.8 1534 & N0AN N1KWF +02 1 0 0.4

Sequence #5

Same as Sequence #4, both decoded but at slightly different times during the sequence.

Sequence #6

Same thing, both decoded but at slightly different times during the sequence.

Some of these time differences were in the subtle millisecond range.

Sequences # 7, 8, 9 (Ditto)

Later sequences 10 & 11 K1SIX likely stopped TX prior to N1KWF:

101345 3 14.2 1535 & N0AN N1KWF RRR 2 4 -1.1

101415 17 7.7 1534 & N0AN N1KWF RRR 1 6 -0.4

********** OVERALL ANALYSIS **********

1. K1SIX was beamed direct and N1KWF ~ 15° north of direct.
2. For the 9 sequences (1-9) analyzed, both parties were decoded in 8 of the 9 15 second sequences (88.9% efficiency) and were transmitting simultaneously.

Respectfully submitted by K1SIX thanks to the efforts and cooperation of Randy, N1KWF and Hasan, N0AN 29 April 2017 Random (sporadic) 50 MHz Meteor Scatter.

SYSTEM DESIGN

An updating tally of six meter WSJT ***local initial*** QSOs at under 250 mile range is shown in the highlighted upper right hand portion of this chart. These values are continuously increasing with the six meter WSJT activity growth rate that I have experienced to date shown here. With a high ERP system on a hilltop, it is essential that my system design approach protects others from my potential transmit interference.

My system design of choice is shown in this block diagram. ***It is specifically designed for low risk of interference to others***. The RIGblaster Advantage, used to interface the computer to the radio via a USB port, contains an internal sound card and the interface to the radio is via a data port (Packet) rather than a microphone connection. This is a particularly important consideration as a connection in this manner ***bypasses compression and microphone audio equalization settings*** that may be used when operating non-data modes while allowing these memory settings to be retained at the flick of the mode switch. ***If the radio has a data port- use it!*** Interface cables for many radios are available or can be homebrewed.

Another very important consideration is how the radio will be keyed (PTT). ***The lowest risk option when using WSJT is*** **ALWAYS** **POSITIVE PTT!** This option uses either the DTR (Data Terminal Ready) or RTS (Request to Send) control lines of a USB RS232 computer interface to directly provide an independent PTT signal to the radio interface device that interfaces the actual PTT to the radio, often via a relay but it doesn't have to be if the radio design can tolerate solid state PTT keying. In my case, the radio PTT line is via the Packet Data Port. The choice of the PTT Method for WSJT-X may be found under the ***Radio TAB*** under Settings. Mine is set for RTS to match the RIGblaster interface used. This method of providing PTT to the radio not only offers the lowest risk of interference to others but ***will prevent hot switching of relays for those with external amplifiers*** as the WSJT tones will not start until after the ***TX Delay*** user setting under the ***Advanced TAB***. My setting is .2 seconds (200 milliseconds) but may vary for others.

I also have a SignaLink USB but it is attached to another radio (FT857D) that is mostly used for 70 MHz meteor monitoring. This is a VOX device meaning that it detects when the WSJT tones or any sound card audio actually starts, then applies PTT to the radio. So with my QRO six meter amplifier, this would represent the risk of hot switching T/R relays without a sequencer and the positive PTT feature (TX Delay) within the WSJT application would do nothing. This type of device also runs the risk of forcing a random transmission if computer "chimes" like "You have mail" reaches it and are not disabled in the sound card settings. It does have a nice price point but must be used with ***extreme caution***.

My choice of six meter RF system design is a solid state amplifier with plenty of headroom to attain maximum legal output (1,500 watts) over prolonged key down periods. The amplifier takes all the heat and the 200 watt rated transceiver requires less than 20 watts output to drive it to legal limit. No ALC is utilized. See DX Commander on use of ALC.

With high activity jammed into narrow bandwidths, the overall system design should be rated 5 stars. Why settle for less?

CONFLICT AVOIDANCE- GENERAL

There are two wonderful settings within the WSJT-X application that will help to reduce or eliminate conflicts (QRM): Timing and Choice of Sequence (odd or even and period).

CONFLICT AVOIDANCE- TIMING

I have been jokingly referred to as "CLOCK COP" by others. It's an easy job that doesn't pay well. Please refer to the other links in this document to reference the importance of an accurate computer clock. Use Time.is to check your accuracy. I have spoken with others that only update their clocks once a day. This is not sufficient as the computer clock will typically drift if it is not disciplined frequently. This can cause QRM to others and perhaps a misinterpreted sequence by a potential caller. I have also witnessed clocks off by as much as 7-8 seconds which causes mayhem in a world of 15 second sequencing. I use Dimension 4 and have never had a problem with it. Other time synch applications are available. I have my time synch set for once every 15 minutes using the CO National Center for Atmospheric Research server but other servers are available. For those without a reliable Internet connection, GPS clock discipline systems are available. HERE IS MINE but I hardly ever use it these days as Dimension 4 has been extremely reliable. GPS disciplined systems are recommended for those DXpeditions that may not have reliable Internet access.

CONFLICT AVOIDANCE- SEQUENCING COORDINATION

Meteor Scatter (MSK144)

For starters, it's always a good idea to provide a little historical background to provide a foundation for where we are today. THIS PROCEDURES PAPER by Shelby, W8WN is a good starting point for ***MS procedures*** here in Region 2. Things have changed significantly (now 15 second sequencing) but the take-away is if you are in Region 2, ***westernmost transmits first period*** and this procedure has been in place since the 1950s. I would not recommend always CQing on the first period to avoid interference to your neighbors. The best choice is to CQ based upon antenna bearing. For me, here in W1, I should almost always be cqing on the second sequence on MSK144 to minimize potential conflicts. The following paper by GM4FVM confirms Shelby's claim that ***other regions may use sequences reversed from Region 2*** and includes the new ***15 second sequencing plan*** which has become nearly universal for MSK144.

Too many times I have seen new operators hop on the MSK144 calling frequency cqing on 30 second sequences. This may be a throwback to the old FSK441 days. This causes a complete mess of QRM in a 15 second world with no escape causing severe QRM to locals and confusion to distant callers. I have also seen some using 5 second sequencing on these calling frequencies with the same incompatible QRM results. ***It's a 15 second world right now*** and those wishing to test non-standard sequencing should do so on frequencies at least 3 kHz removed to avoid conflicts. The best way to say this is: think about how your operations may impact others. When in Rome…

5 second sequencing offers tremendous potential for meteor scatter communications because most of the bursts will be underdense. However any electromechanical relays inline must be considered for life expectancy. There are several lines of thinking on EMRs vs. SSRs. Do some research and consider risk.

FT8 Sequencing Preferences are INFORMAL

To date, there is no formal, INTERNATIONALLY accepted, UNIVERSAL sequencing plan that has been documented and can be linked to. A formal plan is needed for ***six meters*** and I consider this a priority to help avoid conflicts. Show me a link to such a document and I will place it here but it must be internationally accepted. VE1SKY (see his QRZ.com bio) has some ideas and so do others but so far we have not been able to put anything formal together. The goal must be to minimize potential conflicts on a band with high population with international DX possibilities from time to time at known certain antenna headings for limited times. This probably would not apply well on HF but I believe we can improve the situation on six meters. Steve, VE7SL illustrates the issue well here and prefers to not even call cq!

Here in the heavily populated northeast, we active DXers have adopted the following informal operating procedures. They contain RULES that are designed to minimize conflicts and these rules are complex. I've been told by west coasters that they are wrong but without a universal agreement in place how can they be wrong (Nico and Vinz [Envy])? Right? Here they are and ***during contests anything goes***:

RULE #1

For propagation within Region 2, we follow the same plan as for MS. Westernmost CQs 1st, easternmost CQs second period. If the beam headings to the "target" are 0- 180° you CQ 1st, from 181-359° you CQ 2nd. ***During contests expect to find locals working locals off-sequence. They have to!***

RULE #2 (For Transatlantic DX)

Europe is always first! This means that all of North America should be CQing 2nd period when trying to reach Europe or other transatlantic locations including Africa. Yes it's not perfect and conflicts will arise if there is Es within Region 2 and some don't have transatlantic DX. It is what it is.

RULE #3 (For Transpacific DX, JA, etc.)

Transpacific DX is always second! This means that all of North America should be CQing 1st period for these entities. This also means that **eastern US stations must switch** from their normal 2nd CQ sequence to 1st during these times of fleeting propagation. Further complicating matters is the fact that Eu and North Africa propagation may still be available to North America at the same times as shown in my 6M diurnals for Transatlantic and JA. There is a potential overlap. Are we having fun yet?

Some have suggested using 50.303 or 50.323 as alternates to 50.313 when the dx rolls in. There is no master plan. But if somehow we can organize ourselves to make most of this work on 50.313 we will all be better off. It's the best "beacon frequency" there ever was and will likely obsolete some CW beacons below 50.100. An internationally accepted master plan for 6 meters is needed.

I have noted new callsigns coming on six meters locally that seem to choose to transmit in the 1st period and insist on staying there. This will cause conflicts for them and others. It is best to monitor ***seasoned local operators*** and match their transmit sequences which may change with conditions. Due to this potential changing of sequences, it's a good idea to greatly limit the time one calls cq as one may miss something needed. Some seem to call cq forever. I typically cq 6-8 sequences on FT8, take a break, monitor then come back a little later. For MSK MS propagation I may call for a few more sequences. I am not saying do as I say but it's just the way I do it and it has worked well for me on these heavily used "channels".

IT MAY BE UNDERSTANDABLE

With all the new FT8 callsigns coming on six meters and the growth rate I have experienced with this relatively new WSJT-X mode, complaints to others may be the rule rather than the exception until things settle down. READ, READ, READ is my recommendation before hitting the "GO BUTTON" and watch how the locals are operating. Remember that the waterfall display is not a true audio spectrum analyzer and use caution before throwing stones.

When operating FT8 we are all crammed into a ~ 3 kHz bandwidth. So things are different than SSB/CW modes where we can just move the VFO away from QRM and let the IF selectivity, roofing filter, etc. help mitigate interference. This is not the case for FT8 where we want as many signals to fall within the passband as possible. Big difference!