RADIO ON THE FT8 ERA: Adapting to the Shift in Operating Styles

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Contents in Brief

- Outline the technical features of the FT8 and the reasons for its popularity

- Describe the typical message flow in the different FT8 submodes and critical details for the QSO completion in these submodes

- Some examples of how to identify the different FT8 submodes

Background (1/2)

- Today, many DX-peditions spend most of their time working on digital modes
  - A radical shift in mode priorities over the last 5 years
- From the DX-pedition operator's point of view, FT8 (and FT4) are "easy", because one operator can operate many bands simultaneously

  => Higher QSO rates with more modest station equipment

  => More $$$ from those who want a QSO confirmation ☺

Background (2/2)

- In general, FT8 offers a better chance of a successful QSO than CW and SSB because it requires a lower signal-to-noise ratio (SNR) than CW and especially SSB

- FT8 will force all operators to use the same 15 second periods

  => Less QRM, although there will always be operators who call DX-pedition in the wrong period

| Lowest copiable signal-to-noise ratios in 2.5 kHz bandwidth	
SSB	+10ish dB
MSK144	-8 dB
CW	-15 dB
FT4	**-17½ dB**
FT8	-21 dB
JT4	-23 dB
JT65	-25 dB
JT9	-27 dB
QRA64	-27 dB
WSPR	-31 dB

FT8 in a Nutshell

- FT8 (Franke & Taylor 8) is a frequency shift keying mode with 8 tones (in other words frequencies)

- The bandwidth, i.e. the width of a single stream, is 50 Hz

- Period length is 15 s
  - The transmission lasts 12.64 seconds

- FT8 transmits 77 bits of information, which means a data rate of only 6.09 bits/s

- The clocks on the sender's and receiver's computers must be synchronised to the same (global) time
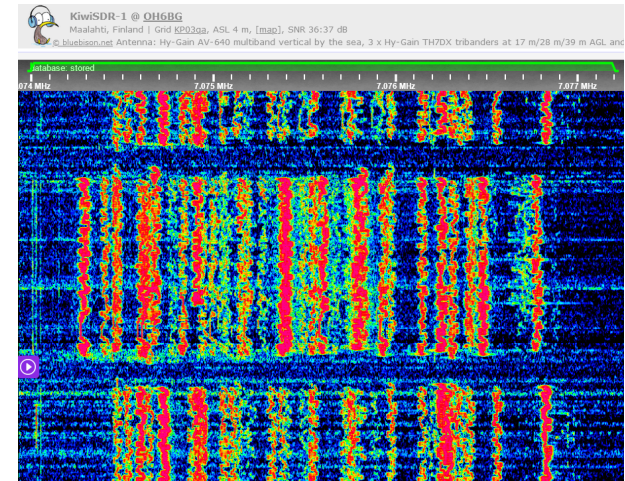
FT8 Submodes

- In addition to the standard FT8, four variations have been developed which may require consideration when using these submodes
  - FT8 with Multi Answering
  - FT8 Multistream
  - FT8 Fox & Hound
  - FT8 SuperFox & Hound

Standard FT8

- In general, standard FT8 is used on standard frequencies dedicated to FT8, such as 3573 kHz, 14074 kHz or 50313 kHz

- In this case, the DX-pedition uses a single 50 Hz stream where QSOs are made with one station at a time

  => The theoretical maximum QSO rate is only 60 QSOs/h

160m	1.840
80m	3.573
60m	5.357
40m	7.074
30m	10.136
20m	14.074
17m	18.100
15m	21.074
12m	24.915
10m	28.074
6m	50.313

Message Flow in the Standard FT8

Standard FT8:

Calling DX-pedition with your locator

CQ D68Z LH18

          D68Z OH6QU KP03

OH6QU D68Z -12

          D68Z OH6QU R-08

OH6QU D68Z RR73

          D68Z OH6QU 73

Standard FT8:

Calling DX-pedition directly with a report

(preferred method with standard FT8)

CQ D68Z LH18

          D68Z OH6QU -08

OH6QU D68Z R-12

          D68Z OH6QU RR73

OH6QU D68Z 73 (or RR73)

FT8 with Multi Answering

- FT8 Multi Answering allows two simultaneous QSOs to be held on a single 50 Hz wide stream
- One of the other stations receives a report (not an R-report) and the other receives an acknowledgement, i.e. the QSOs must be in different phases
  => The theoretical maximum QSO rate is 120 QSOs/h
- At least LZ2HV's MSHV program can produce a stream in Multi Answering format
- Can be fully used at standard FT8 frequencies, as the transmission only needs one 50 Hz stream

Message Flow in the FT8 Multi Answering

FT8 Multi Answering:

DX-pedition must be called with your locator

JA1QAT RR73; JH7OTG <TO1P> -02

TO1P OH6QU KP03

JH7OTG RR73; OH6QU <TO1P> +04

TO1P OH6QU R-03

OH6QU RR73; KB8DRK <TO1P> -06

TO1P OH6QU 73

FT8 Multistream (MSHV)

- FT8 Multistream allows an unlimited number of simultaneous Multi Answering streams
  - A reasonable maximum number is 5-6, **as the more streams are deployed, the weaker the signal gets**

    => The theoretical maximum QSO rate is over 600 QSOs/h
- FT8 Multistream should not be used on FT8 standard frequencies, but on FT8 special frequencies dedicated to DX-peditions, e.g. 3567 kHz, 14091 kHz or 50323 kHz
  - Despite this, some well-known DX-pedition operators are using time after time Multistream at the standard FT8 frequencies

FT8 Multistream (MSHV)

- The basic idea is that the DX-pedition and the stations calling it can use any frequency on that frequency segment
  - In principle, the DX-pedition can choose either an even or odd period for transmitting
- Standard FT8 is fully suitable for working with a DX-pedition using Multistream
  - If DX-pedition is using Multistream with Multi Answering, you should call them with locator
- Since FT8 Multistream is usually produced using LZ2HV's MSHV software, FT8 Multistream is also referred to as MSHV

Message Flow in the FT8 Multistream (MSHV)

FT8 Multistream:

Preferrably the DX-pedition shall be called with your locator

IK0XBX RR73; PA0VLY <3B9DJ> -02	(345 Hz)
SP9MRO RR73; UT4EO <3B9DJ> +06	(405 Hz)
HL4GAV 3B9DJ -04	(465 Hz)
3B9DJ OH6QU KP03	(967 Hz)
UT4EO RR73; HL4GAV <3B9DJ> -02	(345 Hz)
PA0VLY RR73; OH6QU <3B9DJ> +06	(405 Hz)
HL5BLI 3B9DJ +01	(465 Hz)
3B9DJ OH6QU R+12	(967 Hz)
HL5BLI RR73; UA3IKR <3B9DJ> +00	(345 Hz)
HL4GAV RR73; OE1PMD <3B9DJ> -05	(405 Hz)
OH6QU RR73; RA6ANN 3B9DJ +01	(465 Hz)
3B9DJ OH6QU 73	(967 Hz)

NOTE! – The last transmission of 73 may not be needed but it is a good way to indicate that the RR73 sent by DX-pedition has been received.

FT8 Fox & Hound (F/H)

- FT8 Fox & Hound Multistream allows up to five (5) simultaneous Multi Answering streams
  - **The more streams are deployed, the weaker the signal gets**
  - The theoretical maximum QSO rate is up to 600 QSOs/h
- Under no circumstances should FT8 F/H be used on FT8 standard frequencies. It must only be used on special FT8 frequencies dedicated to DX-peditions, such as 3567 kHz, 14091 kHz, or 50323 kHz.
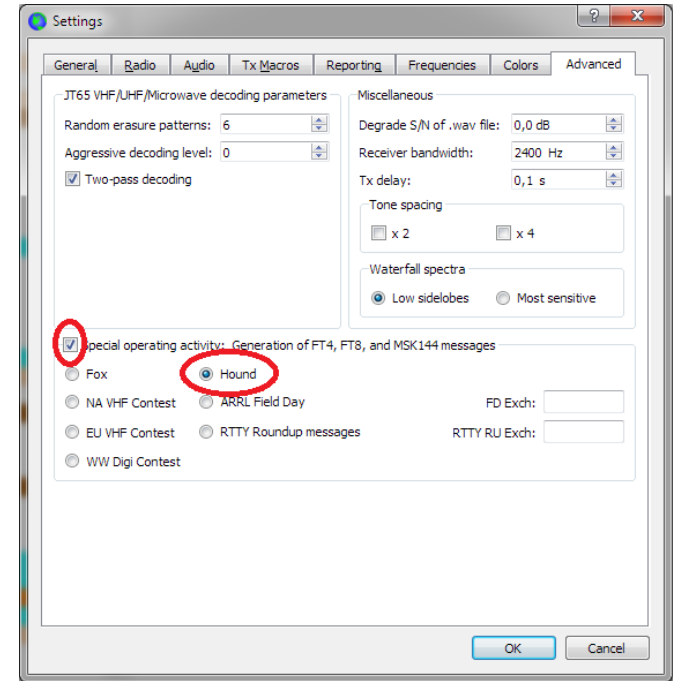
FT8 Fox & Hound (F/H)

- The basic idea is that the DX (Fox) transmits on the 0-1000 Hz frequency segment (typically around 300-600 Hz)

- The stations chasing the DX (Hounds) call him on the 1000-3000 (4000) Hz frequency segment

- When the DX (Fox) responds to a particular Hound, the QSO is completed either on the Hound's original calling frequency or Hound moves his TX to the DX's (Fox) frequency
  - Hound's frequency hop to the Fox's frequency is no longer mandatory

FT8 Fox & Hound (F/H)

- In FT8 Fox & Hound mode, DX (Fox) always transmits in even or 1st period and fox chasers (Hounds) in odd or 2nd period

- In WSJT-X, Hound mode is enabled as shown in the figure
  - This option is no longer mandatory as Fox can also be worked with standard FT8 as long as Hound transmits >1000 Hz

Message Flow in the FT8 Fox & Hound (F/H)

FT8 Fox & Hound:

DX-pedition must be called >1000 Hz with your locator

JR3VXR RR73; JH3EDG <FP/KV1J> -02	(421 Hz)
<HI8HRD> FP/KV1J RR73	(481 Hz)
FP/KV1J OH6QU KP03	(1272 Hz)
JH3EDG RR73; OH6QU <FP/KV1J> -16	(421 Hz)
CO8MCL <FP/KV1J> +08	(481 Hz)
FP/KV1J OH6QU R-10	(421 Hz or 1272 Hz)
CO8MCL RR73; NI5M <FP/KV1J> +04	(421 Hz)
OH6QU RR73; ZL3JT <FP/KV1J> -06	(481 Hz)

NOTE - In FT8 Fox & Hound mode, fox chasers (Hounds) do not need to transmit 73!

FT8 Fox & Hound (F/H)

- The DX-pedition (Fox) tries to receive the report sent by Hound 3 times by sending the report again and again
  - If Fox does not receive a report from the Hound within three periods, the QSO is not completed and Fox moves to a next caller
  - You can keep on sending an R-Report to Fox anywhere in the frequency segment (200 - 3000 Hz) and hope that Fox hears it and confirms the QSO with RR73
    - Depending on the situation, you should stop sending the R-report within 5-10 minutes and start the QSO from the beginning
    - The frequency segment 200 - 1000 Hz has less QRM than >1000 Hz so it is worth moving the R-report sending to this frequency segment
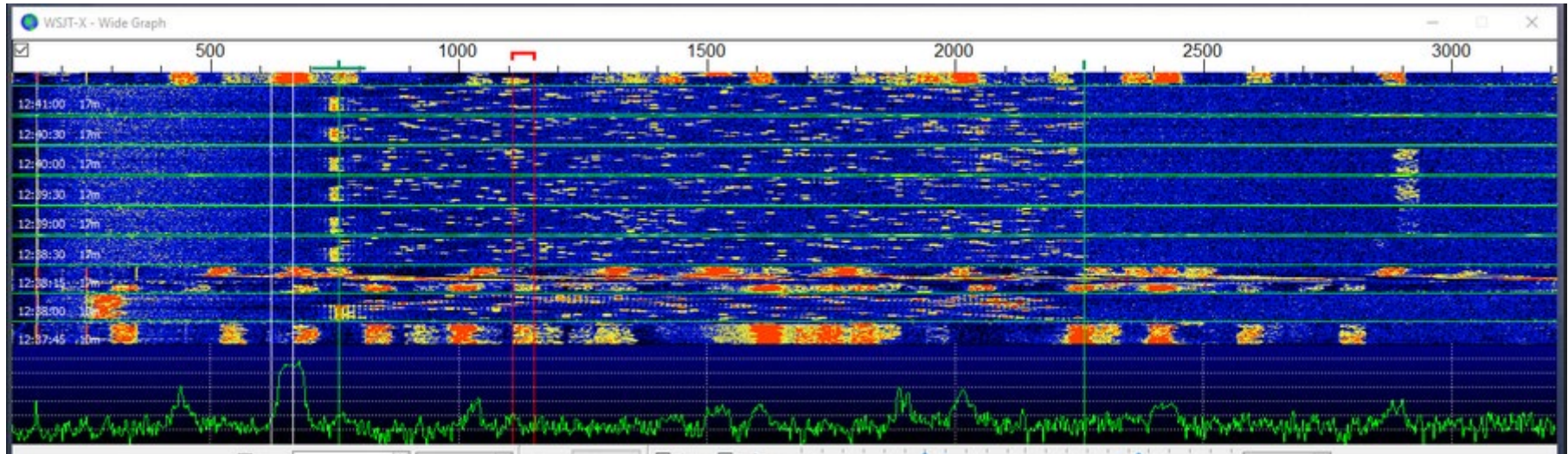
FT8 SuperFox & Hound (SF/H)

- SuperFox sounds and looks in the waterfall completely different from the other FT8 submodes

- SuperFox's transmission is 1512 Hz wide (750 – 2262 Hz) and it can contain up to nine simultaneous QSOs with Hounds

- **There is no signal-strength penalty for simultaneously transmitting to the maximum number of Hounds**

- The stations chasing the SuperFox (Hounds) call him anywhere between 200-3000 (4000) Hz frequency segment with standard FT8

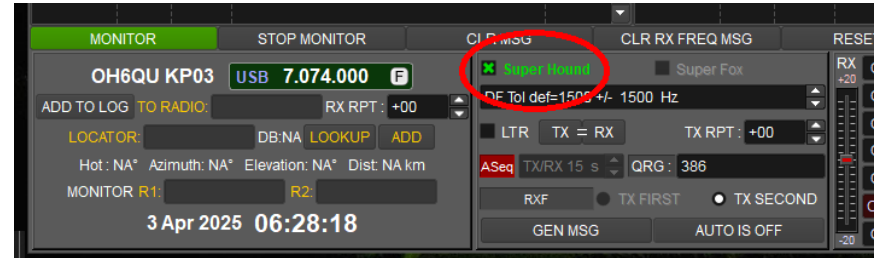# FT8 SuperFox & Hound (SF/H)

FT8 SuperFox seen in the waterfall (between 750 Hz and 2262 Hz)

FT8 SuperFox & Hound (SF/H)

- FT8 SuperFox requires a fairly recent version of WSJT-X or MSHV to decode
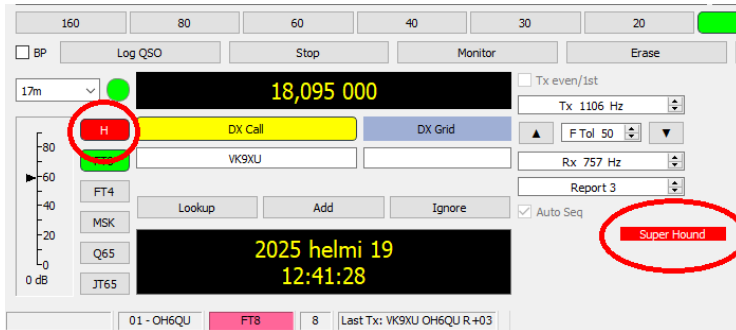
Activating the SuperFox & Hound submode in WSJT-X 2.7.0 or later

Activating the SuperFox & Hound submode in MSHV 2.76.1 or later

Message Flow in the FT8 SuperFox & Hound

FT8 SuperFox & Hound:

DX-pedition must be called with your locator

AA1V VK9XU RR73	(750 Hz)
WB2CLL VK9XU +04	(750 Hz)
OZ6CM VK9XU -12	(750 Hz)
VK9XU OH6QU KP03	(1106 Hz)
OZ6CM VK9XU RR73	(750 Hz)
WB2CLL VK9XU +04	(750 Hz)
OH6QU VK9XU +06	(750 Hz)
JF2DJV VK9XU +08	(750 Hz)
VK9XU OH6QU R+03	(1106 Hz)
JF2DJV VK9XU RR73	(750 Hz)
OH6QU VK9XU RR73	(750 Hz)
RN1ON VK9XU +05	(750 Hz)
WF4DX VK9XU -01	(750 Hz)

NOTE - In FT8 SuperFox & Hound mode, fox chasers (Hounds) do not need to transmit 73!

How to Identify FT8 Submodes?

- Identifying the FT8 submode used by a DX-pedition usually requires briefly monitoring the message flow

- It's important to note that the FT8 submodes reported on the DX Cluster are often incorrect

  – Very often even the DX-peditions themselves confuse Fox & Hound and Multistream submodes and falsely state, for example, that we are using is Fox & Hound, when in fact they are using Multistream

    • In principle, the FT8 program used by DX-pedition will tell you which submode they are using (WSJT-X = Fox & Hound, MSHV = Multistream or Multistream with Multi Answering)

How to Succeed Without Knowing the FT8 Submode the DX is Using?

If you don't have time to monitor the message flow or are unsure how to interpret it, following these simple rules of thumb will ensure success in all FT8 submodes

1. At standard frequencies for FT8, **call with a locator** and follow the standard message flow format (page 8, left example)

2. On FT8 special frequencies dedicated for DX-peditions, **call with the locator above 1000 Hz** and, after receiving a report, continue QSO on the same frequency (page 17)

9N7CI – which FT8 submode?

Odd period (2. period) => it can't be Fox & Hound submode

Standard FT8 freq => it can't be Fox & Hound submode

Single stream, two QSOs => Multi Answering submode

```
220519_054915   24.915 Rx FT8   -10  0.2  421 ON8SAT RR73; PA2RU <9N7CI> -16
220519_054930   24.915 Rx FT8    -8  0.2 1164 9N7CI OZ1AKZ JO57
220519_054930   24.915 Rx FT8   -12  0.8  421 9N7CI SP8ADU KO11
220519_054930   24.915 Rx FT8   -15  0.2 2396 9N7CI I2XCH JN45
220519_054930   24.915 Rx FT8   -15  0.3  686 9N7CI ES1JA KO29
220519_054930   24.915 Rx FT8   -12  0.3  857 9N7CI ES5EP +16
```

ES5EP incorrectly calls with a report. The DX station using FT8 Multi Answering submode must be called with a locator. A QSO is still likely to be made, but 9N7CI responds to ES5EP with a QSO initiating report instead of an R-report.

VU4W – which FT8 submode?

Odd period (2. period) => it can't be Fox & Hound submode

Special FT8 frequency dedicated to DX-peditions

Two streams, two QSOs => Multistream submode, which isn't using Multi Answering

```
220507_125745   24.911 Rx FT8    -12  0.8 1056 F5BZB VU4W R-01
220507_125745   24.911 Rx FT8    -12  0.8  996 RZ6HNP VU4W RR73
220507_125800   24.911 Rx FT8      2 -0.0 1403 VU4W OH6VC KP10
220507_125800   24.911 Rx FT8     -1  0.2 2009 VU4W OH1EB -08
220507_125800   24.911 Rx FT8    -10  0.1  799 VU4W F5BZB RR73
220507_125800   24.911 Rx FT8     -5  0.1 1829 VU4W OH1NDA KP10
220507_125800   24.911 Rx FT8    -11  0.2 2594 VU4W RZ6HNP 73
220507_125800   24.911 Rx FT8     -7  0.2 2422 VU4W OH1MRR -10
```

Since Multi Answering is not enabled, DX can be called directly with a report

Sending 73 not mandatory, but for acknowledgement purposes it is recommended

4U1ITU – which FT8 submode?

Even period (1. period) => either F/H or multistream submode

Special FT8 frequency

Three streams, six QSOs

```
220515_072300    10.131 Rx FT8     6  2.0  302 IV3CIS RR73; IZ0BYM <4U1ITU> +02
220515_072300    10.131 Rx FT8     7  2.0  422 SP7AM RR73; CT7APD <4U1ITU> -20
220515_072300    10.131 Rx FT8     7  2.0  362 OH6QU RR73; IU2ANW <4U1ITU> +00
220515_072315    10.131 Rx FT8     1  0.3  363 4U1ITU IU2ANW R+04
220515_072315    10.131 Rx FT8     1  0.1 1666 4U1ITU IK0PHY JN61
220515_072315    10.131 Rx FT8    -3  0.1  722 4U1ITU IV3CIS R-14
220515_072315    10.131 Rx FT8    18  0.1 1496 4U1ITU UA1OLM LP04
220515_072315    10.131 Rx FT8     6  0.1 2593 4U1ITU DM2GM JN49
220515_072315    10.131 Rx FT8     2  0.1  602 4U1ITU IZ0BYM R-03
220515_072315    10.131 Rx FT8   -13  0.2  424 4U1ITU CT7APD R-15
220515_072315    10.131 Rx FT8   -23  0.2  853 4U1ITU G0THF IO93
```

Since the callers give their R-reports below 1000 Hz, it might be a Fox & Hound submode

F/H Submode - Find Two Errors

4U1ITU's clock is +2.0 s ahead of global time. You can temporarily force your computer's clock to the same time, for example with JTSync or TimeFudge

```
220515_072300   10.131 Rx FT8    6  2.0  302 IV3CIS RR73; IZ0BYM <4U1ITU> +02
220515_072300   10.131 Rx FT8    7  2.0  422 SP7AM RR73; CT7APD <4U1ITU> -20
220515_072300   10.131 Rx FT8    7  2.0  362 OH6QU RR73; IU2ANW <4U1ITU> +00
220515_072315   10.131 Rx FT8    1  0.3  363 4U1ITU IU2ANW R+04
220515_072315   10.131 Rx FT8    1  0.1 1666 4U1ITU IK0PHY JN61
220515_072315   10.131 Rx FT8   -3  0.1  722 4U1ITU IV3CIS R-14
220515_072315   10.131 Rx FT8   18  0.1 1496 4U1ITU UA1OLM LP04
220515_072315   10.131 Rx FT8    6  0.1 2593 4U1ITU DM2GM JN49
220515_072315   10.131 Rx FT8    2  0.1  602 4U1ITU IZ0BYM R-03
220515_072315   10.131 Rx FT8  -13  0.2  424 4U1ITU CT7APD R-15
220515_072315   10.131 Rx FT8  -23  0.2  853 4U1ITU G0THF IO93
```

G0THF calls below 1000 Hz

General Guidelines for FT8

- **DO NOT** call DX unless you decode him/her at least every 2-3 periods! Possibly you will take a QSO opportunity from someone who can hear DX well

- **DO NOT** make "normal" QSOs on special FT8 frequencies dedicated for DX stations! Your strong signal will block the receivers of those chasing a weak DX. You will only get a reputation as a thoughtless idiot and DQRMer

And Finally about FT8

FT8 IS NOT a low power mode, but a WEAK SIGNAL mode

- Quite often, working DX in pileup requires the use of Legal Limit power to achieve a minimum SNR of -21 dB on the DX side
- For others, more important than power level used is to ensure the purity of your own signal
  - Adjust the audio levels so that the ALC does not move
  - For example, use a remote close-by SDR-receiver to make sure that no RF is entering your TX audio line to distort the signal
  - If you use an amplifier with tetrode, tune the amplifier so that at the desired drive power the screen current (I_{g2}/I_{screen}) is zero

THANK YOU!

QUESTIONS?