



Digitální módy v provozu

2022-10-25 David OK4DJ pro OK2K0J



Obsah

- Úvod
- Přehled digitálních módů
- Motivace, kde a jak se realizovat
- Požadavky a co je ke spojení třeba
- FT8 - základy spojení
- Příklady relací
- Ukázky (https://hfradio.org.uk/html/digital_modes.html)

Úvod

- „There are 10 types of people: those who understand binary and those who don't“
- Digitální mód používá na některé přenosové vrstvě digitální reprezentaci dat
- Pojmy
 - interpretace dat, kód
 - modulace
 - vrstvy
 - protokol

Zpracování a distribuce signálů

- kopírování x kódování/dekódování
- Rekonstrukce signálu, digitální zpracování
- Význam přenášených dat
 - text
 - zvuk
 - obraz
 - TV (DATV)
- Směr přenášených dat: jednosměrné (maják) x obousměrné
- Infrastruktura

Přehled digitálních módů

- „Nekonečně mnoho“
- Textové: RTTY, Hellschreiber, PSK, ...
- Packetové sítě: např. APRS (protokol nad modulací AFSK)
- Zvuk/data: D-STAR, C4FM, DMR, FreeDV, ...
- Pro „slabé“ signály:
 - Majáky: WSPR
 - Protokol spojení: FT8, FT4, JT65, ...

Přenos slabých signálů



- FT8 kontroverze
 - „Podšumové“ módy, „vesmírná technologie“
 - „Počítače si vše vyřídí mezi sebou“
 - piráti, vidláci
- WSPR - Weak Signal Propagation Reporter
- <https://pskreporter.info>

Meteory / EME



- QRP - 1.5 kW
- Meteory - MSK144
- <https://www.mmmmonvhf.de/ctestinfo.php>

Motivace pro digitální módy



The screenshot shows a mobile browser interface with the address bar displaying 'ariss.net'. The main content is a table with four columns: a call sign with a small icon, a status indicator, a longitude, and a latitude. The table lists various stations and their coordinates.

Call Sign	Status	Longitude	Latitude
K3PJ	-	54.3525	38.28
IW3RGK	*	45.80633	13.44
OE5RPP-1	*	.	.
OE5RPP	*	47.9395	13.48
SP7DAD-6	*	51.8075	19.45
SP7G-9	*	50.43917	21.28
EB3FWC	*	.	.
OK7SE-7	*	49.35933	15.20
G4DCQ-2	*	52.9175	1.331
PC1L-2	*	50.84133	5.724
IK3ZGB-2	*	45.7125	11.7
EA6WQ-6	*	39.56567	3.217
IZ5HQB	*	43.76917	11.12
ON7BRT	*	51.05567	3.747
M0CFV	*	51.51433	-0.33
PA3ESS	*	52.4565	6.001
2E0HDV	*	54.76617	-1.33
PE1NTN	*	52.49967	4.823
OK4DJ	*	49.23433	16.56
EA7KR	*	36.4845	-4.99

- APRS - majáky, meteostanice, telemetrie, sledování polohy, komunikace přes ISS
 - <https://aprs.fi>
 - <http://ariss.net/>
- Hlas - síť převaděčů, infrastruktura

Provoz, expedice



- Expediční provoz
- Příležitostné značky
- Lovení stanic
- <https://dxheat.com/dxc/>
- RTTY, PSK - BPSK31 (63), FT8, FT4

Expedice



URE - Avda. Monte Igueldo 162 - 78053 - Madrid - Spain - www.ure.es
<https://qsl.ure.es>
 Print and confirm your QSOs in just two clicks

On April 18, 2020 is the 95th anniversary of International Amateur Radio Union and we celebrate the World Amateur Radio Day.
 To commemorate this important event, the URE, member society of the IARU, is promoted this special event from 15 to 30 April, 2020. More info at <https://iaru95.ure.es>

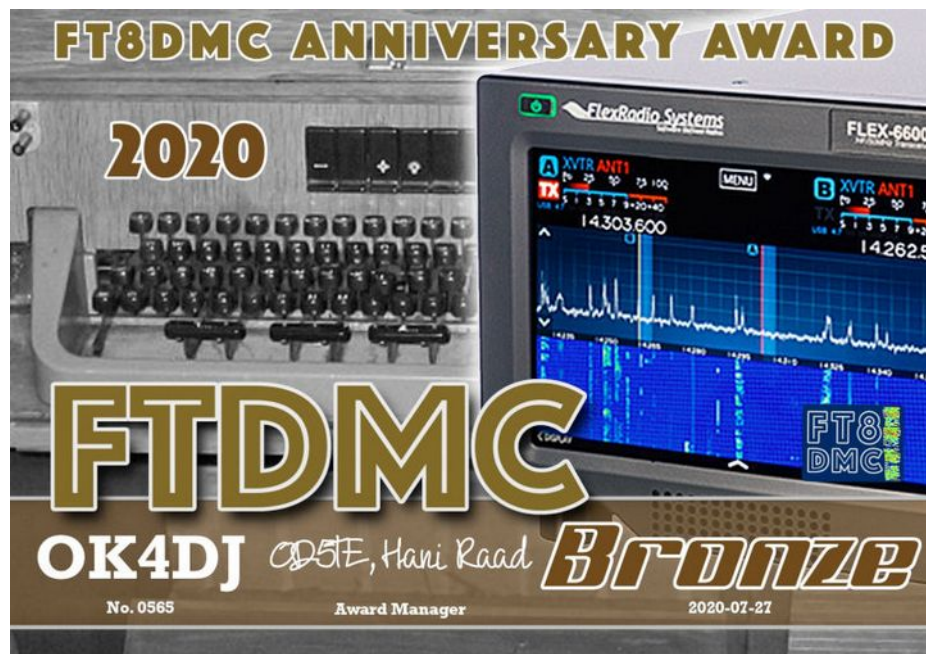
World Amateur Radio Day
 Día Mundial del Radioaficionado
 Всемирный День радиолюбителя
 Journée mondiale de la radio amateur
 اليوم العالمي لراديو الهواة
 世界业余无线电日

526.024 QSO - 59.653 Uniques - 220 DXCC Worked

To Radio: **OK4DJ**
 AM6WARD confirms the following QSO(s):

DATE	UTC	BAND	2-WAY	RST	NOTES
2020-04-27	14:55	20m	SSB	59	OP EA6SX-DME:07031(IB)-GRID:JM19IK-DXCC:EA6
2020-04-29	11:43	10m	FT8	-04	OP EA6VQ-DME:07035(IB)-GRID:JM19MP-DXCC:EA6

Soutěže



- Pro FTDMC:
<https://epc-mc.eu/>
- Pro stažení diplomu UltimateAAC
<https://epc-mc.eu/ft8dmc.php>
- Žádost z programu
- Download ID - přijde mailem
- Moon contest, NAC-MGM
- RTTY - často v ostatních závodech (CQ WW RTTY)



Kluby, diplomy

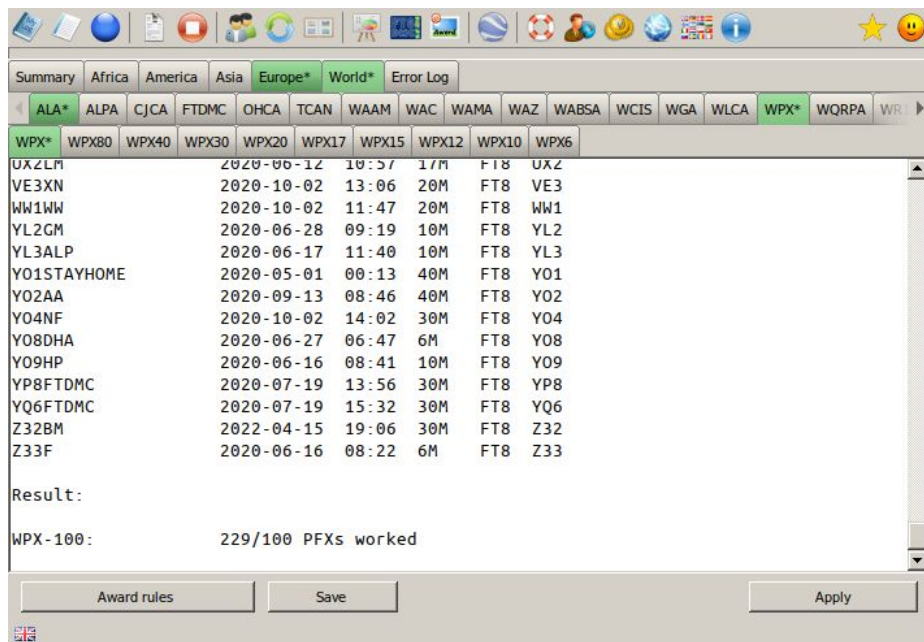
- UltimateAAC: <https://epc-mc.eu/ft8dmc.php>
- Download ID: <https://ft8dmc.eu/download/>
- EPC: European PSK club
- EPC CZ
- CDG: Croatian Digital Group
- NDG: Natal Digital Group (Brazilie)



Kluby, diplomy

- FT8DMC: FT8 Digital Mode Group
- ERC: European ROS Club (původ Španělsko)
- AGB: Activity Group of Belarus
- BCS: Belgium Club Sstv
- YB6_DXCDM: YB6 DX Community Digital Modes (Indonésie)

• UltimateAAC



The screenshot shows the UltimateAAC software interface. At the top, there is a toolbar with various icons. Below it, a menu bar includes 'Summary', 'Africa', 'America', 'Asia', 'Europe*', 'World*', and 'Error Log'. A sub-menu bar shows 'ALA*', 'ALPA', 'CJCA', 'FTDMC', 'OHCA', 'TCAN', 'WAAM', 'WAC', 'WAMA', 'WAZ', 'WABSA', 'WCIS', 'WGA', 'WLCA', 'WPX*', 'WORPA', and 'WR'. The 'WPX*' menu is currently selected, displaying a table of awards.

WPX*	WPX80	WPX40	WPX30	WPX20	WPX17	WPX15	WPX12	WPX10	WPX6
UXZLM			2020-06-12	10:57	17M	F18	UXZ		
VE3XN			2020-10-02	13:06	20M	FT8	VE3		
WW1WW			2020-10-02	11:47	20M	FT8	WW1		
YL2GM			2020-06-28	09:19	10M	FT8	YL2		
YL3ALP			2020-06-17	11:40	10M	FT8	YL3		
Y01STAYHOME			2020-05-01	00:13	40M	FT8	Y01		
Y02AA			2020-09-13	08:46	40M	FT8	Y02		
Y04NF			2020-10-02	14:02	30M	FT8	Y04		
Y08DHA			2020-06-27	06:47	6M	FT8	Y08		
Y09HP			2020-06-16	08:41	10M	FT8	Y09		
YP8FTDMC			2020-07-19	13:56	30M	FT8	YP8		
YQ6FTDMC			2020-07-19	15:32	30M	FT8	YQ6		
Z32BM			2022-04-15	19:06	30M	FT8	Z32		
Z33F			2020-06-16	08:22	6M	FT8	Z33		

Result:

WPX-100: 229/100 PFXs worked

Buttons: Award rules, Save, Apply

7 new FT8DMC awards:
CSA, WAAZA, WAE, WASCA, WDSA,
WESA, WR1A

46 new AGB awards:
BlackSea_BASIC, BlackSea_FT8, Countries_10M,
Countries_30M, Countries_BASIC,
Countries_FT8, Europe_10M, Europe_12M,
Europe_20M, Europe_2M,
Europe_30M, Europe_40M, Europe_6M,
Europe_FT4, Europe_FT8,
FT8_Europe, Locators_10M, Locators_12M,
Locators_20M, Locators_30M,
Locators_40M, Locators_6M, Locators_80M,
Locators_BASIC, Locators_FT4,
Locators_FT8, Prefixes_10M, Prefixes_BASIC,
Prefixes_FT8, Zone14_10M,
Zone14_12M, Zone14_20M, Zone14_30M,
Zone14_6M, Zone14_BASIC,
Zone14_FT8, Zone15_10M, Zone15_2M,
Zone15_80M, Zone15_BASIC,
Zone15_FT8, Zone16_BASIC, Zone20_10M,
Zone20_30M, Zone20_BASIC,
Zone20_FT8

OK

Požadavky

- APRS: vhodná stanice, stanice s modemem nebo FM stanice a SW typu <https://aprsdroid.org/>
- Hlas:
 - D*, C4FM, DMR - podpora ve stanici
 - FreeDV - <https://freedv.org/>
- RTTY, HELL, PSK atd: fldigi <http://www.w1hkj.com/index.html>
- Weak signal (FT8, FT4, WSPR):
 - WSJT-X <https://physics.princeton.edu/pulsar/k1jt/wshtx.html>
 - JTDX <https://www.jtdx.tech/en/>

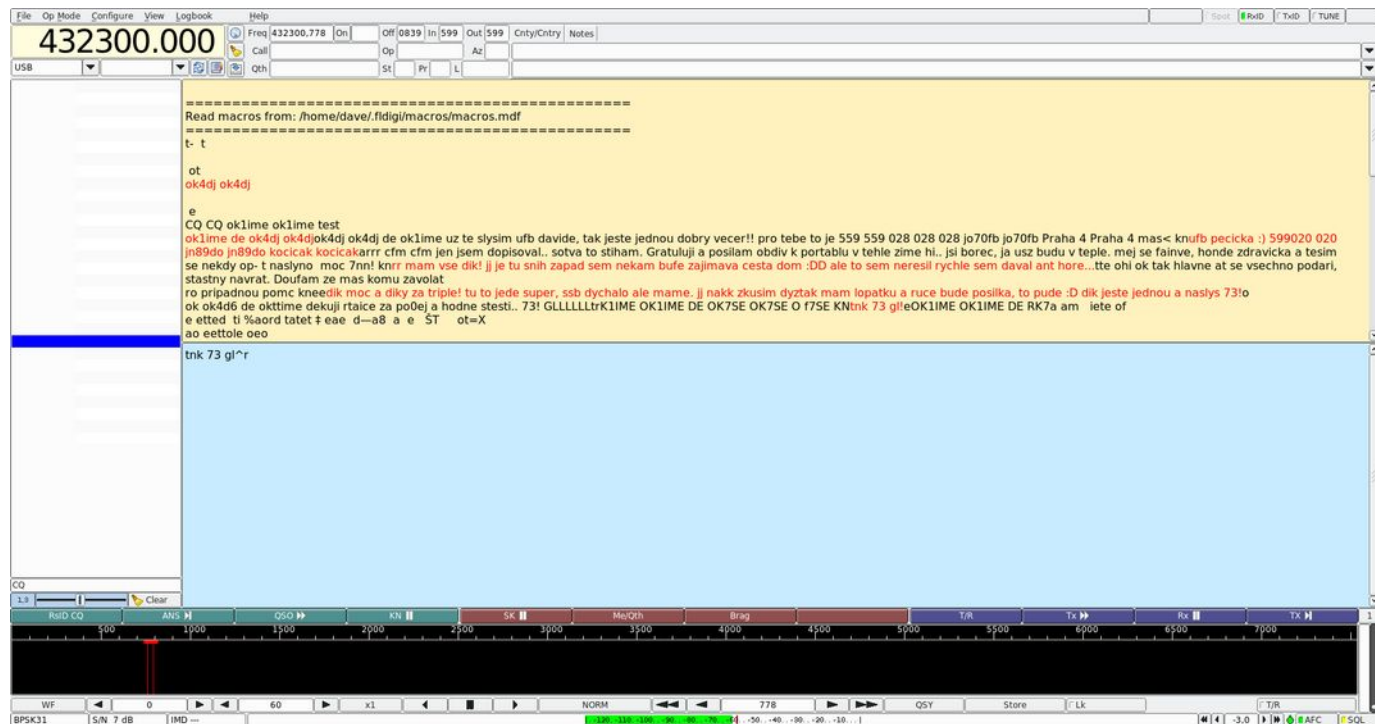
Požadavky

- Propojení PC s TRX
 - Zvuk: přes (virtuální) zvukovou kartu, oddělení. Routování!
 - Klíčování a ideálně ovládání - CAT interface. Porty!
- Nové TRX - vše přes USB, jednodušší
- Ostatní - mezi zvukovku a mikrofon/reproduktor
- Klíčování po drátech z I/O portu nebo přes CAT - převodníky USB na RS232 atd.
- Google: <můj-TRX> FT8 setup
- Přesné hodiny: ideálně NTP - např. tik.cesnet.cz tak.cesnet.cz

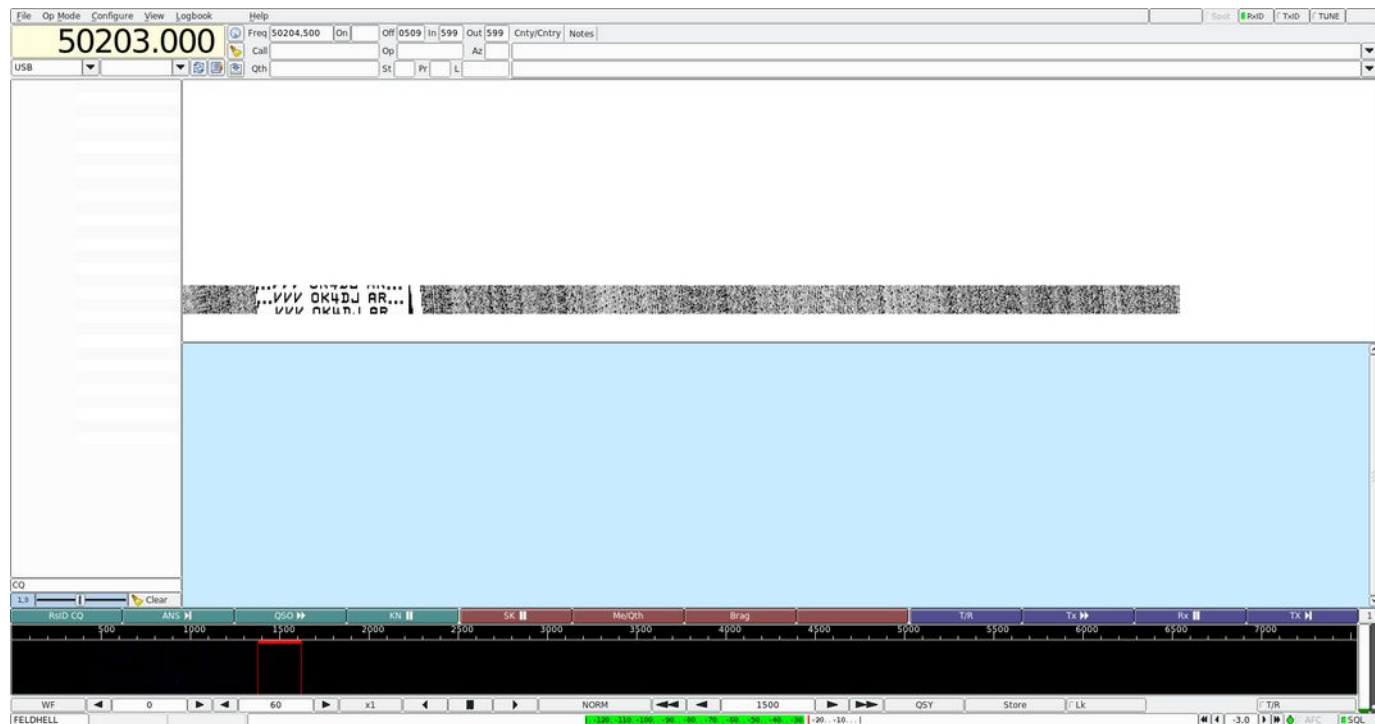
Interface PC - TRX

- USB isolator
 - Oddělení datových linek
 - Ideálně i napájení (zem)
 - Ferity na USB kabel
- Tovární interface
 - Digirig <https://digirig.net/>
 - MicroHAM <https://www.microham.com/>
 - Klíčování a ideálně ovládání - CAT interface
- Návody, Google :-)

Fldigi - PSK (BPSK31)



Fldigi - Feldhellschreiber (FELDHELL)



WSJT-X nastavení

- Funkční
 - My Call, My Grid
 - Radio - Rig, Port, PTT, Mode, Split
 - Audio - Vstup/výstup, zvukovka, porty (!)
- Nefunkční
 - ovládání, vylepšení
- Speciální
 - závodní/expediční módy atd.

WSJT-X nastavení

General | Radio | Audio | Tx Macros | Reporting | Frequencies | Colors | Advanced

Station Details

My Call: My Grid: ☐ AutoGrid IARU Region:

Message generation for type 2 compound callsign holders:

Display

☐ Start new period decodes at top

☒ Blank line between decoding periods

☐ Display distance in miles

☒ Tx messages to Rx frequency window

☒ Show DXCC, grid, and worked-before status ☐ Show principal prefix instead of country name

Behavior

☐ Monitor off at startup ☒ Enable VHF and submode features

☐ Monitor returns to last used frequency ☒ Allow Tx frequency changes while transmitting

☒ Double-click on call sets Tx enable ☐ Single decode

☒ Disable Tx after sending 73 ☐ Decode after EME delay

☐ Calling CQ forces Call 1st

☐ Alternate F1-F6 bindings

☐ CW ID after 73

Tx watchdog:

Periodic CW ID Interval:

WSJT-X nastavení

The screenshot shows the 'Radio' tab of the WSJT-X configuration window. The 'Rig' is set to 'Yaesu FT-991' and the 'Poll Interval' is '1 s'. The 'CAT Control' section on the left includes a 'Serial Port' dropdown set to '/dev/ttyUSB0', 'Serial Port Parameters' with a 'Baud Rate' of 4800, 'Data Bits' (Default selected), 'Stop Bits' (Default selected), 'Handshake' (Default selected), and 'Force Control Lines' with 'DTR' and 'RTS' dropdowns. The 'PTT Method' section on the right has 'VOX', 'DTR', 'CAT' (selected), and 'RTS' options, with a 'Port' dropdown set to '/dev/ttyUSB0'. Below this is 'Transmit Audio Source' (Front/Mic selected) and 'Mode' (Data/Pkt selected). The 'Split Operation' section has 'None', 'Rig' (selected), and 'Fake It' options. At the bottom are 'Test CAT' and 'Test PTT' buttons. The window has tabs for General, Radio, Audio, Tx Macros, Reporting, Frequencies, Colors, and Advanced. At the bottom right are 'OK' and 'Zrušit' buttons.

General Radio Audio Tx Macros Reporting Frequencies Colors Advanced

Rig: Yaesu FT-991 Poll Interval: 1 s

CAT Control

Serial Port: /dev/ttyUSB0

Serial Port Parameters

Baud Rate: 4800

Data Bits

☒ Default ☐ Seven ☐ Eight

Stop Bits

☒ Default ☐ One ☐ Two

Handshake

☒ Default ☐ None

☐ XON/XOFF ☐ Hardware

Force Control Lines

DTR: RTS:

PTT Method

☐ VOX ☐ DTR

☒ CAT ☐ RTS

Port: /dev/ttyUSB0

Transmit Audio Source

☐ Rear/Data ☒ Front/Mic

Mode

☐ None ☐ USB ☒ Data/Pkt

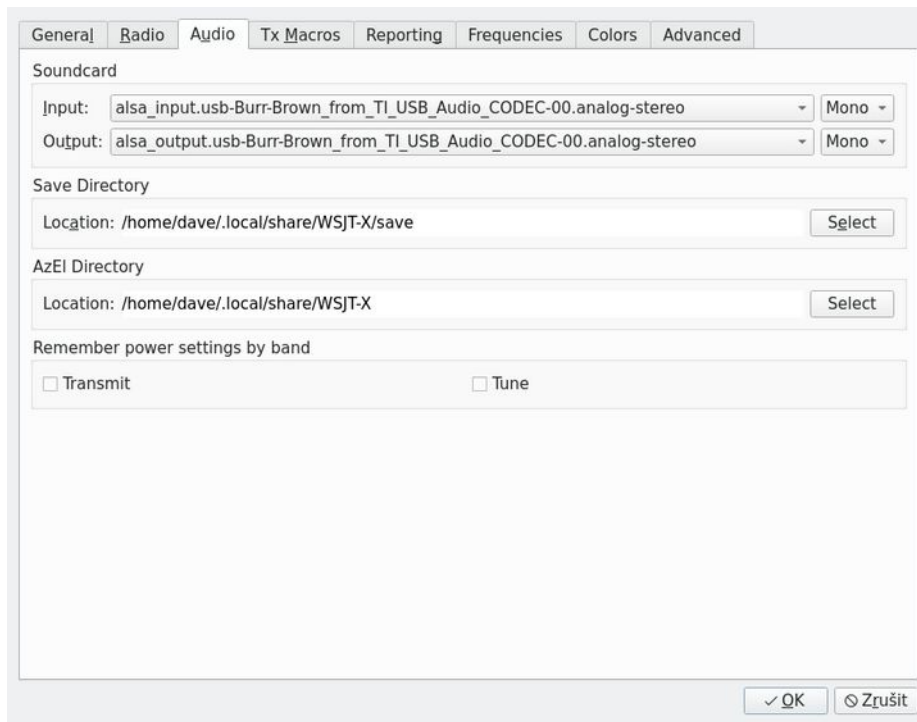
Split Operation

☐ None ☒ Rig ☐ Fake It

Test CAT Test PTT

OK Zrušit

WSJT-X nastavení



The screenshot shows the 'Audio' tab of the WSJT-X configuration window. The 'Soundcard' section has 'Input' and 'Output' both set to 'alsa_input.usb-Burr-Brown_from_TI_USB_Audio_CODEC-00.analog-stereo' with 'Mono' selected for each. The 'Save Directory' section shows the path '/home/dave/.local/share/WSJT-X/save' with a 'Select' button. The 'AzEl Directory' section shows the path '/home/dave/.local/share/WSJT-X' with a 'Select' button. The 'Remember power settings by band' section has two checkboxes, 'Transmit' and 'Tune', both of which are unchecked. At the bottom right are 'OK' and 'Zrušit' (Cancel) buttons.

General Radio **Audio** Tx Macros Reporting Frequencies Colors Advanced

Soundcard

Input: alsa_input.usb-Burr-Brown_from_TI_USB_Audio_CODEC-00.analog-stereo Mono

Output: alsa_output.usb-Burr-Brown_from_TI_USB_Audio_CODEC-00.analog-stereo Mono

Save Directory

Location: /home/dave/.local/share/WSJT-X/save Select

AzEl Directory

Location: /home/dave/.local/share/WSJT-X Select

Remember power settings by band

☐ Transmit ☐ Tune

OK Zrušit

WSJT-X nastavení

The screenshot shows the 'Advanced' tab of the WSJT-X configuration window. It is divided into two main sections: 'JT65 VHF/UHF/Microwave decoding parameters' on the left and 'Miscellaneous' on the right. The left section includes sliders for 'Random erasure patterns' (set to 6) and 'Aggressive decoding level' (set to 0), a checked checkbox for 'Two-pass decoding', and a section for 'Special operating activity' with radio buttons for various contests and activities. The right section includes sliders for 'Degrade S/N of .wav file' (0,0 dB), 'Receiver bandwidth' (2500 Hz), and 'Tx delay' (0,2 s), as well as checkboxes for 'Tone spacing' (x 2 and x 4) and 'Waterfall spectra' (Low sidelobes and Most sensitive). At the bottom right are 'OK' and 'Zrušit' buttons.

General Radio Audio Tx Macros Reporting Frequencies Colors Advanced

JT65 VHF/UHF/Microwave decoding parameters

Random erasure patterns: 6

Aggressive decoding level: 0

☒ Two-pass decoding

Miscellaneous

Degrade S/N of .wav file: 0,0 dB

Receiver bandwidth: 2500 Hz

Tx delay: 0,2 s

Tone spacing

☐ x 2 ☐ x 4

Waterfall spectra

☒ Low sidelobes ☐ Most sensitive

☐ Special operating activity: Generation of FT4, FT8, and MSK144 messages

☐ Fox ☐ Hound

☐ NA VHF Contest ☐ ARRL Field Day

☒ EU VHF Contest ☐ RTTY Roundup messages

☐ WW Digi Contest

FD Exch:

RTTY RU Exch:

✓ OK ⓧ Zrušit



FT8, FT4

- 2017 Joe Taylor, K1JT & Steve Franke, K9AN
- „Franke-Taylor design, 8-FSK modulation“ (FT4 GFSK)
- 50 Hz, 6.25 Bd (FT4 90 Hz)
- 15 s (FT4 7.5 s)
- 75 bits payload, 12 bits CRC

FT8 - Wsjtx

WSJT-X v2.4.0 by K1JT, G4WJS, K9AN, and IV3NWW

File Configurations View Mode Decode Save Tools Help

Band Activity

UTC	dB	DT	Freq	Message
174900	-11	0.5	1476	K0BUEY G3ZRN I083
174900	-15	0.2	1299	G6HUI N0NMY RR73
----- 20m				
174915	-4	0.0	2074	OK4DJ K3ZK -10
174915	-10	0.2	1221	LB8MG S078FC -07
174915	-13	0.4	1475	KD8DEY G3ZRN I083
----- 20m				
174930	0	0.0	2074	OK4DJ K3ZK RR73
174930	0	0.0	741	DL2HUC K1WY +05
174930	-5	0.0	847	LB8MG N3HR R-09
----- 20m				
174945	4	0.0	741	DL2HUC K1WY RR73

Rx Frequency

UTC	dB	DT	Freq	Message
174926	Tx	1626	+	K3ZK OK4DJ JN89
174800	-2	0.0	2075	M7KEV K3ZK RR73
174807	Tx	1626	+	K3ZK OK4DJ JN89
174815	0	0.0	2073	J0 K3ZK JN11
174837	Tx	1626	+	K3ZK OK4DJ -06
174852	Tx	1626	+	K3ZK OK4DJ JN89
174907	Tx	1626	+	K3ZK OK4DJ JN89
174915	-4	0.0	2074	OK4DJ K3ZK -10
174922	Tx	1626	+	K3ZK OK4DJ R-04
174930	0	0.0	2074	OK4DJ K3ZK RR73
174937	Tx	1626	+	K3ZK OK4DJ 73
175015	-4	0.0	2074	CQ K3ZK FN21 U.S.A.

☐ CQ only ☒ Menus

20m ☒ 14,080 000 ☐ Tx even/1st ☒ Hold Tx Freq

2021 fj 26 17:52:09

☒ Auto Seq ☐ Call 1st

Best S+P

Generate Std Msgs Next Now

☐ Tx 1

☐ Tx 2

☐ Tx 3

☐ Tx 4

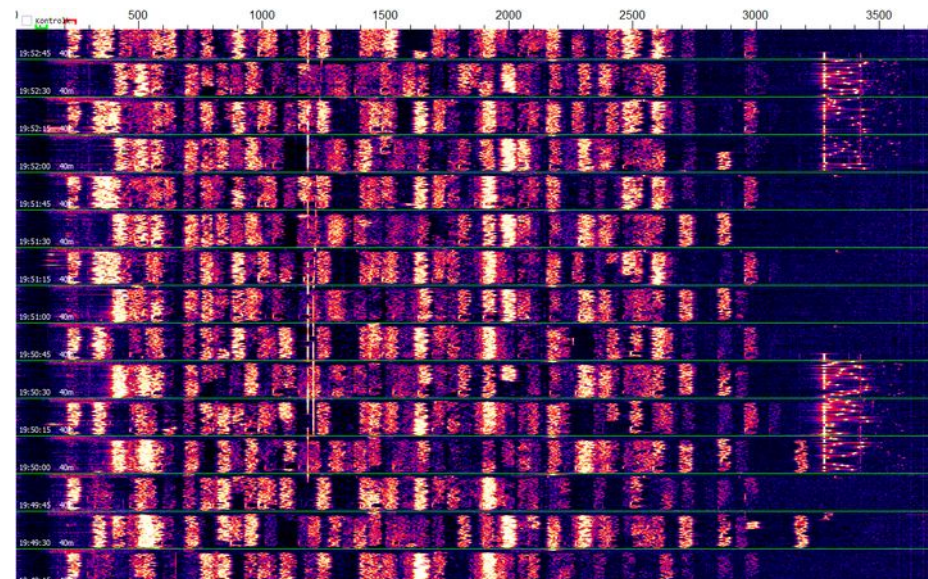
☐ Tx 5

☐ Tx 6

K3ZK OK4DJ 73

CQ OK4DJ JN89

Receiving FT4 Last Tx: K3ZK OK4DJ 73 4 1/7.5 WD:4m



FT8 spojení

- Vrstvy
 - Krátké zprávy
 - Protokol pro QSO
- Princip spojení
 - Časové cykly: sudá/lichá
 - Předávání zpráv během cyklu
 - Výzva - odpověď

FT8 spojení

- Standardní protokol pro QSO:

1) → CQ G0JHC IO83

2) ← G0JHC OK4DJ JN89

3) → OK4DJ G0JHC +01

4) ← G0JHC OK4DJ R+13

5) → OK4DJ G0JHC R73

6) ← G0JHC OK4DJ 73

FT8 závodní spojení

- 1) ← CQ TEST OK4DJ JN89
 - 2) → OK4DJ OK7SE JN79
 - 3) ← <OK7SE> <OK4DJ> 560013 JN89EG
 - 4) → <OK4DJ> <OK7SE> R 540008 JN79OI
 - 5) ← OK7SE OK4DJ RR73
 - 6) → OK4DJ OK7SE 73
- ← KRAJINA
 - QTH CELISTNA
 - ← TNX 73GL

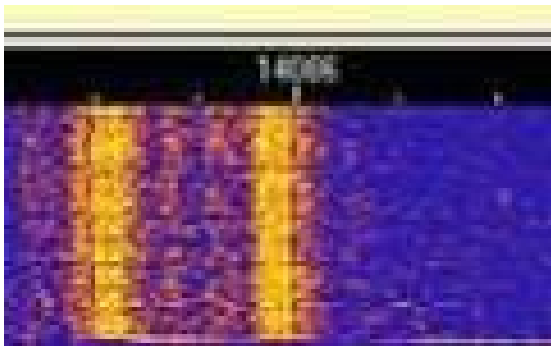
FT8 tipy, triky

- Přesné hodiny, kontrola úrovní
- Bandplan! (<https://uksmg.org/ft8-code-of-practice.php>)
- Důkladný poslech, kontrola spektra, najít si volné místo
- Striktně se držet své frekvence - interference
- Střídat sudá/lichá, poslech!
- Blacklisty
- Situace u protistrany může být zcela odlišná - cestovat pokud se spojení nedaří

FT8 tipy, triky

- Krátké značky
- Nikdy nevolat dlouhé značky dlouhou značkou
- Expedice
 - Nespoléhat na CQ
 - Neposílat co nikoho nezajímá
- Poslouchat co protistrana dělá
- Úschova relevantních částí z ALL.TXT logu

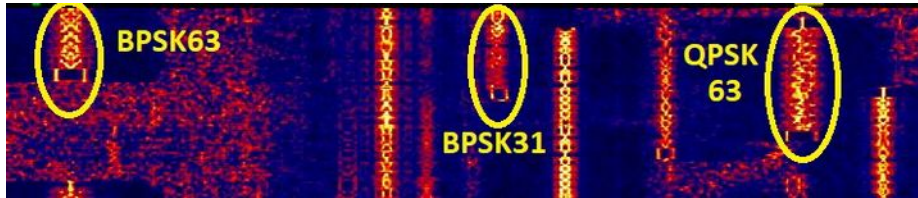
RTTY (RTTY 45)



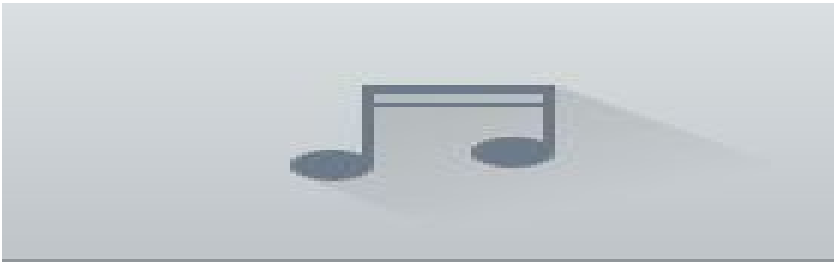
- AFSK
- 45.45 Bd
- 170 Hz shift



PSK (BPSK63)



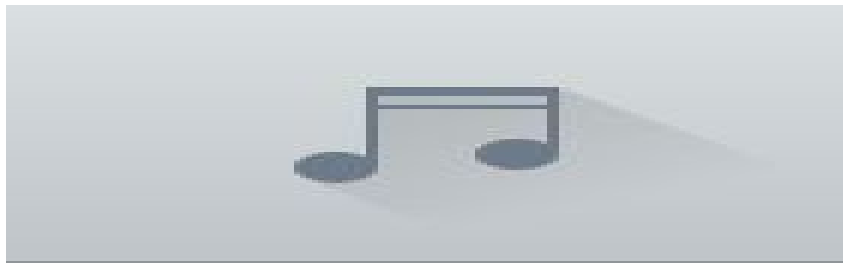
- Binary Phase Shift Keying
- 63 Bd
- 63 Hz
- BPSK31: 30.5 Bd, 30.5 Hz



Feld Hell

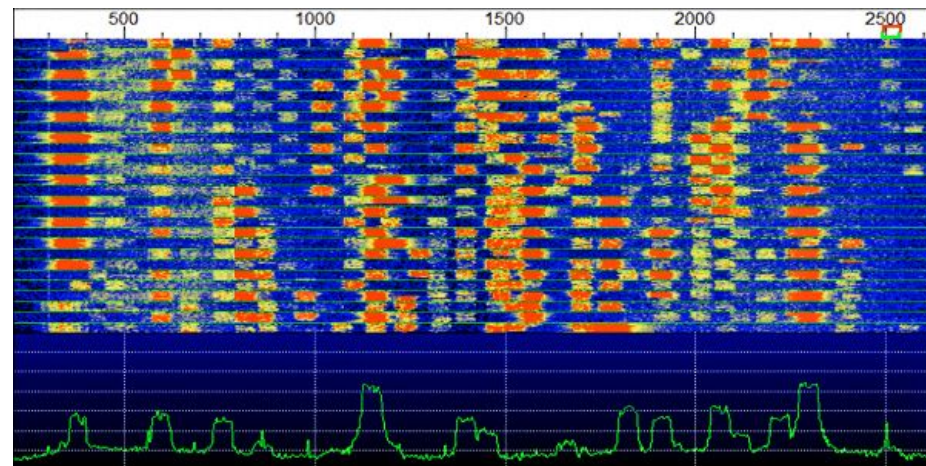
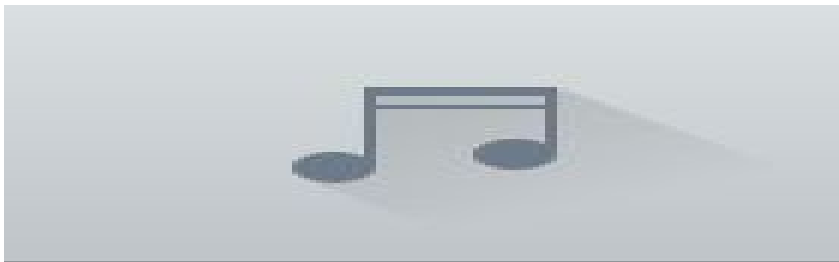
CALL UR RST 579 579 QSB NAME
CALL UR RST 579 579 QSB NAME
HAMBURG QRA JD53AR JD53AR
HAMBURG QRA JD53AR JD53AR

- Obrázkový, dekodování „okometricky“
- Obrázky na „páskách“



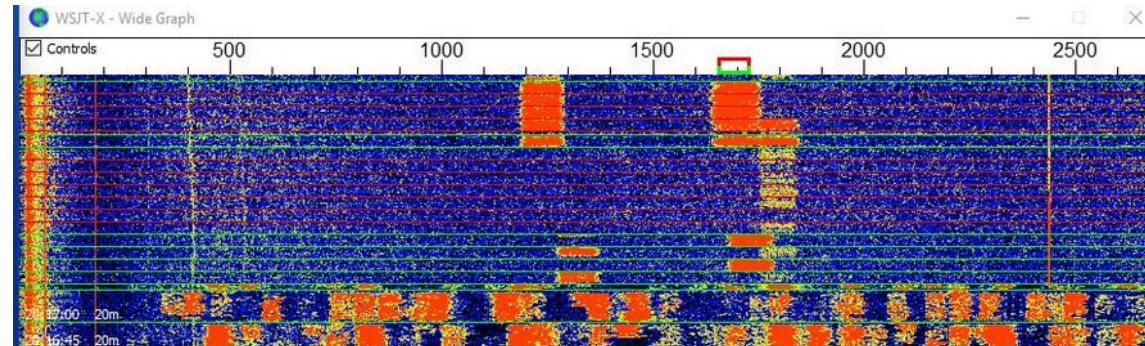
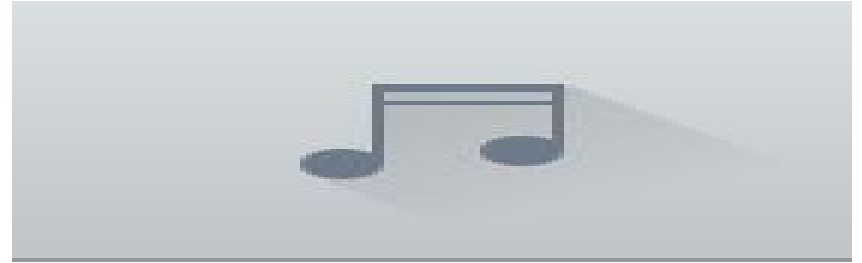
FT8

- 50 Hz
- 15 s okna



FT4

- 90 Hz
- 7.5 s okna



Ukázky

