

INTRODUCTION TO SOME POPULAR HAM RADIO DIGITAL MODES

With Comments on Their Use on Flex-6000 Series Radios

Presented at the Vienna Wireless Society

by
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About this Presentation

- Many club members have expressed interest in digital modes, Flex-6000 series radios, or both.
- This presentation will describe some digital mode capabilities available to anyone with an SSB radio and also briefly discuss the additional capabilities provided by Flex radios.
- For live demos and a chance to try digital modes hands-on using a Flex-6500, come to the Digital Workshop tomorrow, April 23, 2-6 p.m. More information and directions are available on the club web site: <http://viennawireless.net>.

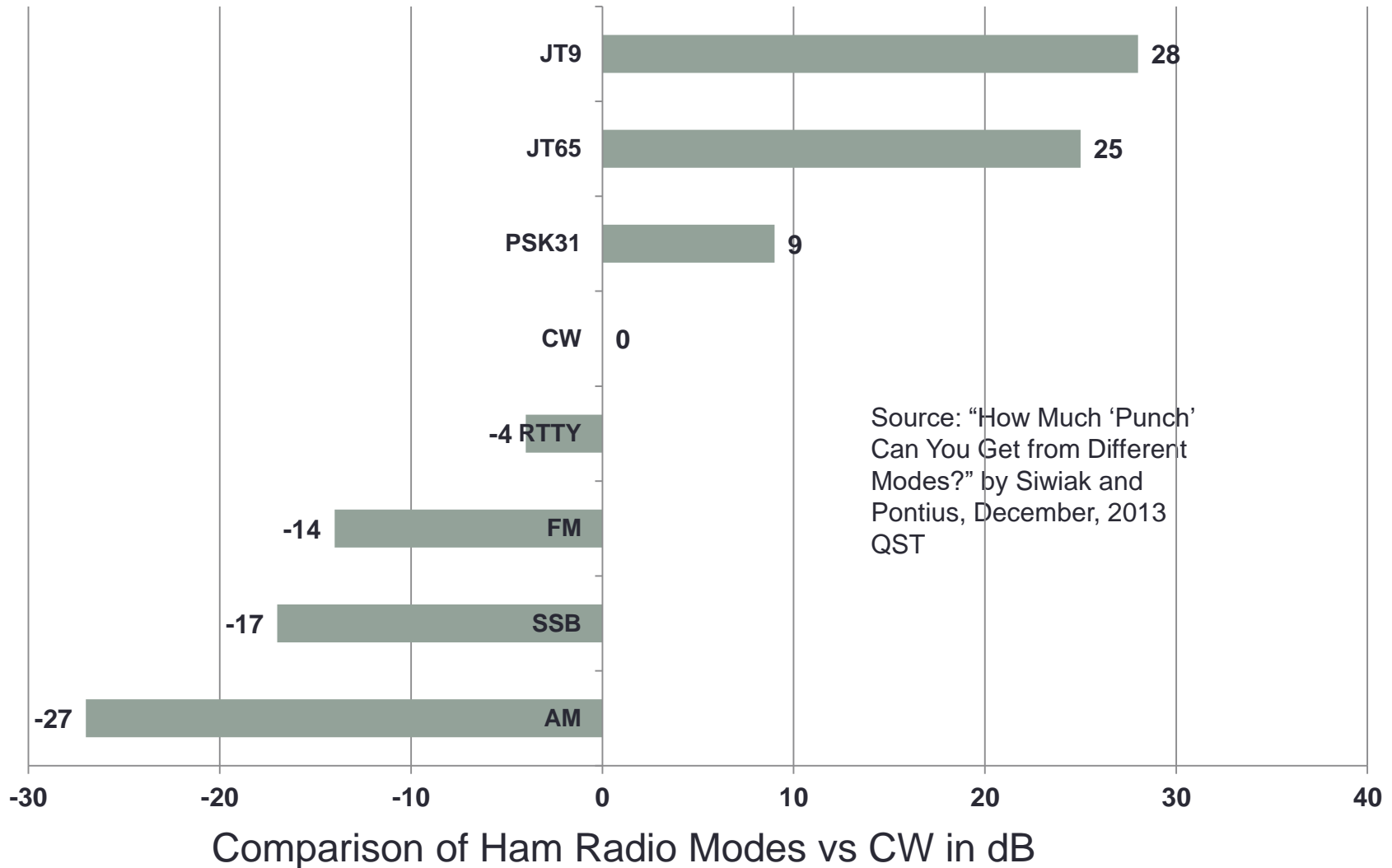
Presentation Outline

- Digital Modes in General
 - Why digital modes?
 - How digital modes work
 - Operating digital
- Some popular/interesting modes
 - JT65/JT9
 - PSK31/PSK63
 - Olivia
 - RTTY
 - CW as a Digital Mode
 - Others
- Skimmers (Flex and other SDR radios only)

Why Digital Modes-1?

- Work the world with a modest station
- Low learning curve
- Some modes provide enhanced message reliability – good for emergency communications
- My experience:
 - Recent (March, April 2016) DXCC entities worked include:
The Gambia, Fiji, Monaco, Kazakhstan, Grenada, Kaliningrad, Turkey, Qatar, Gabon, French Guiana, Hawaii, Israel

Why Digital Modes? – More Punch!



How Digital Modes Work

- Data (text, voice, image) is represented as a string of binary numbers
- Coding schemes can improve reliability – at the expense of time and/or bandwidth. They work by adding carefully crafted redundant data, allowing errors to be detected and possibly corrected.
- Data is typically transmitted as a series of audio tones via radio's SSB circuitry
- Translation between audio tones and digital data stream may be accomplished by radio circuitry or computer sound card plus computer software

Operating Digital

- Requirements
 - Transceiver capable of SSB
 - Computer with digital software
 - For JT65/JT9 only, need (free) software to sync computer clock with time standard
 - Interface
 - Commercial or home brew
 - May be as simple as two cables and two resistors
 - See resources page
- Take precautions to get a clean signal
 - Turn off any compression circuitry used for voice SSB
 - Keep signal levels well below threshold for ALC limiting
 - You only need at most a few tens of watts for digital modes
 - Good idea to get an on-air signal check

JT65 and JT9 Modes - Overview

- JT65 originally developed for earth-moon-earth
- Stations transmit 13 character messages on alternate minutes
- Suitable for DXing and QRP
- JT65/JT9 messages are almost always decoded completely correctly or not at all.
- Tune to standard frequency on each band
- Almost always signals on at least 20M or 40M
- Very easy to operate this mode
- Newer JT9 mode designed for HF communications
 - +3 db over JT65
 - Narrower bandwidth -> less crowded

JT65/JT9 – Typical QSO

- As originally designed

UTC	dB	DT	Freq	Message
0035	-23	0.5	1550	# CQ YO2LAU KN05
0036	Tx		1550	# YO2LAU AK4AO FM18
0037	-22	0.5	1550	# AK4AO YO2LAU -13
0038	Tx		1550	# YO2LAU AK4AO R-23
0039	-22	0.4	1550	# AK4AO YO2LAU RRR
0040	Tx		1550	# YO2LAU AK4AO 73
0041	-23	0.4	1554	# AK4AO YO2LAU RRR
0042	Tx		1550	# YO2LAU AK4AO 73
0043	-22	0.4	1557	# AK4AO YO2LAU 73

Maidenhead Grid Square Locations

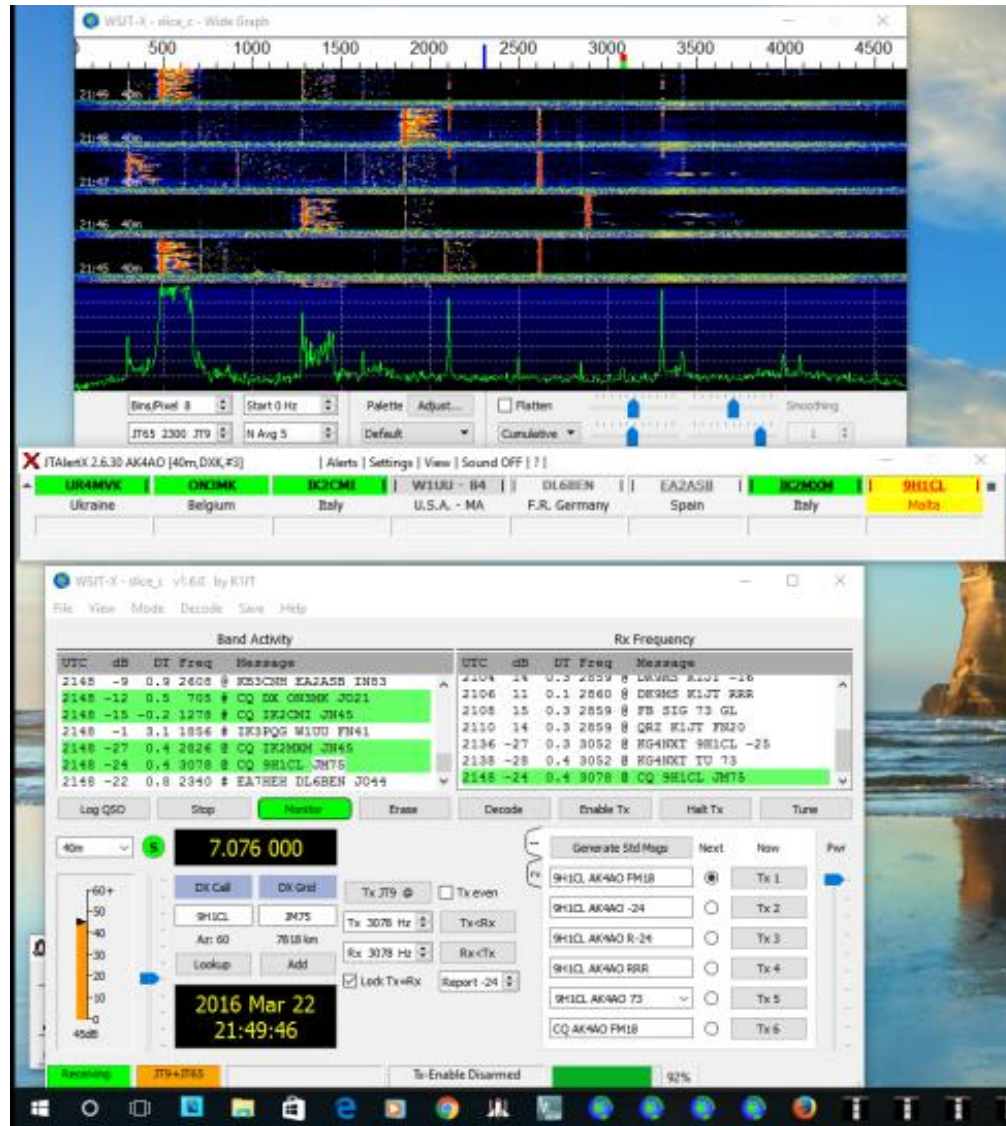
Signal Reports

Roger, Roger, Roger

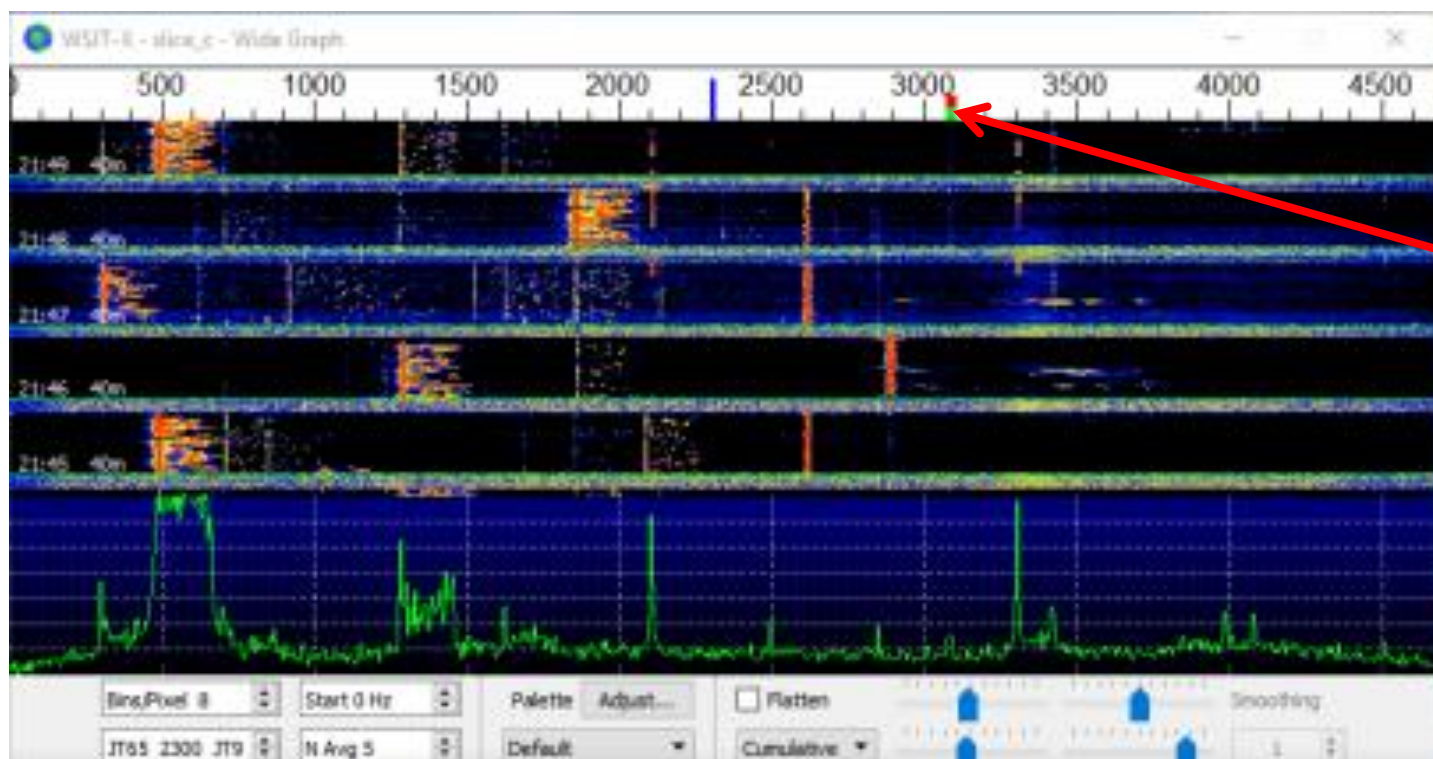
Repeated message means my last transmission was not decoded.

- In practice, the RRR message is often skipped, and the 73 message is sent, or some variant like
 - AK4AO RR TU73

JT65/JT9 Operating Environment



WSJT-X “Wide Graph” Window



Tuned
Frequency

WSJT-X Main Window

WSJT-X - dloc_c v1.6.0 by K1UT

File View Mode Decode Save Help

Band Activity

UTC	dB	DT	Freq	Message
2148	-9	0.9	2808	# W3SCNH KAJA5B INB3
2148	-12	0.5	705	# CQ DX ON30K J021
2148	-15	-0.2	1278	# CQ IK2CHI JN45
2148	-1	3.1	1856	# IK3POG W1UU FN41
2148	-27	0.4	2826	# CQ IK2H0H JN45
2148	-24	0.4	3078	# CQ 9H1CL JN75
2148	-22	0.8	2340	# EA7RH DL6BEN J044

Rx Frequency

UTC	dB	DT	Freq	Message
2104	14	0.3	2859	# DL3RS K1J1 -16
2106	11	0.1	2860	# DL3MS K1JT RRR
2108	15	0.3	2859	# FB SIG 73 GL
2110	14	0.3	2859	# QRZ K1JT FN20
2136	-27	0.3	3052	# HG4KXT 9H1CL -25
2138	-28	0.4	3052	# HG4KXT TU 73
2148	-24	0.4	3078	# CQ 9H1CL JN75

Log QSO
Stop
Monitor
Erase
Decode
Enable Tx
Halt Tx
Tune

40m

S

7.076 000

DX Call

9H1CL

Ar: 60

Lookup

DX Grid

JN75

7818 km

Add

Tx JT9

Tx 3078 Hz

Rx 3078 Hz

Lock Tx=Rx

Tx even

Tx<Rx

Rx<Tx

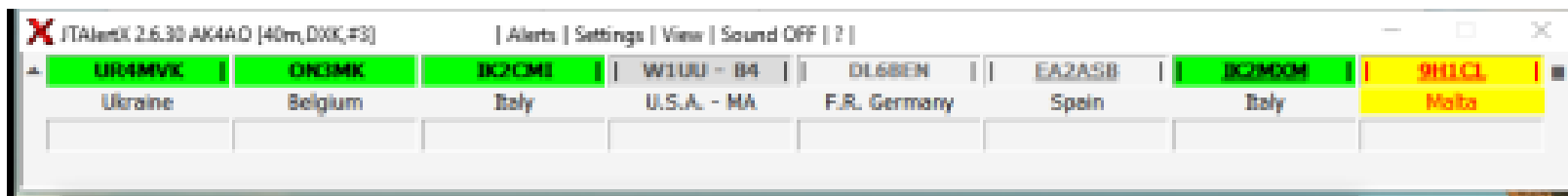
Report -24

Generate Std Msgs	Next	Now	Pwr
9H1CL AK4AO FM18	<input checked="" type="radio"/>	Tx 1	[Slider]
9H1CL AK4AO -24	<input type="radio"/>	Tx 2	
9H1CL AK4AO R-24	<input type="radio"/>	Tx 3	
9H1CL AK4AO RRR	<input type="radio"/>	Tx 4	
9H1CL AK4AO 73	<input type="radio"/>	Tx 5	
CQ AK4AO FM18	<input type="radio"/>	Tx 6	

2016 Mar 22
21:49:46

Receiving
JT9+JT65
Tx-Enable Disabled
92%

JT-Alert Window



JT Alert provides information about each call sign decoded during the last minute

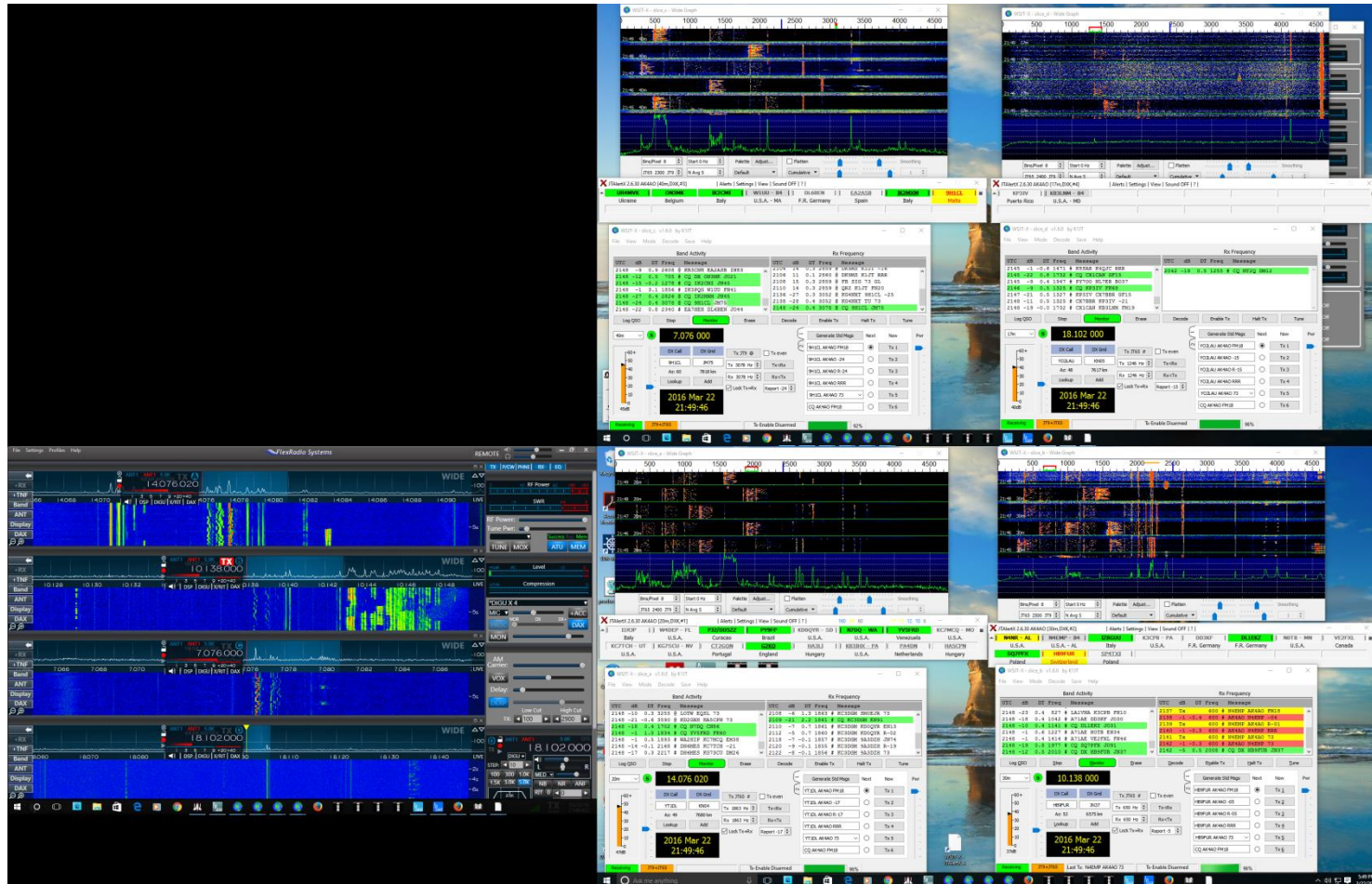
- DXCC Entity and state for US Stations
- Calling CQ (Green)
- Not calling CQ and not needed (Gray)
- Worked before (B4 after call sign)
- Needed DXCC (Orange/Yellow)
- LoTW User (left bar)
- eQSL.cc User (right bar)

Making JT65/JT9 Contacts

- Don't transmit on top of someone else's QSO (of course)
- But...
 - OK to answer a CQ on calling station's frequency or any open frequency
 - OK to call a station on an open frequency after it has sent the 73 message
 - OK to call a station that has tried unsuccessfully to answer a CQ on an open frequency
 - And, of course, you can call CQ on an open frequency

JT65/JT9 on the Flex-6500

Work up to four bands at once



PSK31/PSK 63

- Popular for casual Dxing, rag chewing, QRP
- Like RTTY except
 - Normally operated in a standard 3K subband on each band
 - Narrow band width (31 or 63Hz)
 - Full character set, not limited to upper case
- QSOs conducted by some combination of Macros pre-programmed with standard messages and typing

A Short PSK QSO

CQ CQ CQ de HP1AVS .. HP1AVS ... Pse K

HP1AVS de AK4AO AK4AO kn

* *

GE Doug

AK4AO AK4AO

Op. Victor

QTH: Panama

Loc:... Grid Sq. FJ08

RST(Q) 599 599

BTU Doug AK4AO de HP1AVS ... Kn

HP1AVS de AK4AO

Hi Victor

RSQ 599 599

Name: Doug Doug

QTH: Annandale, VA

LOC: FM18ju

Btu Victor HP1AVS de AK4AO kn

RST(Q) ... 599 599

....

TU Doug

Live Long and Prosper!

($\bar{\cdot}$ * \cdot bye bye \cdot $\bar{\cdot}$) 73

AK4AO de .- HP1AVS-.

... SK SK

HP1AVS de AK4AO

Best to you and your
family

tnx fer QSO Victor, 73,

HP1AVS de AK4AO sk

Operating PSK using Fldigi

fldigi / SmartSDR:FLEX-6000 [Slice D] (serial) - AK4AO

File Op Mode Configure View Logbook Help

7070.000

Frq 7071.009 On Off 0108 In Out

Call Op Az

DIGU Filter 2x3 Qth St Pr Loc

Solid Copy into 40 miles North of Indianapolis BTU KI1U DE KC9RQI <=

KC9RQI de KI1U
QSL Steve FB CPY here.
Thanks for the QSO and very nice to meet y

7072.61 XN de ABH Than

7072.20 E YOSVANY CO2YT

7071.80 , my station
7071.62 e W4YPW pse kn

7071.50 YDA KC5YDA de W
7071.30 Q CQ de W4BIX W

7071.01 nice to meet y

CQ

3.0 Clear

CQ ANS QSO KN SK Me/Qth Brag T/R Tx Rx TX 1

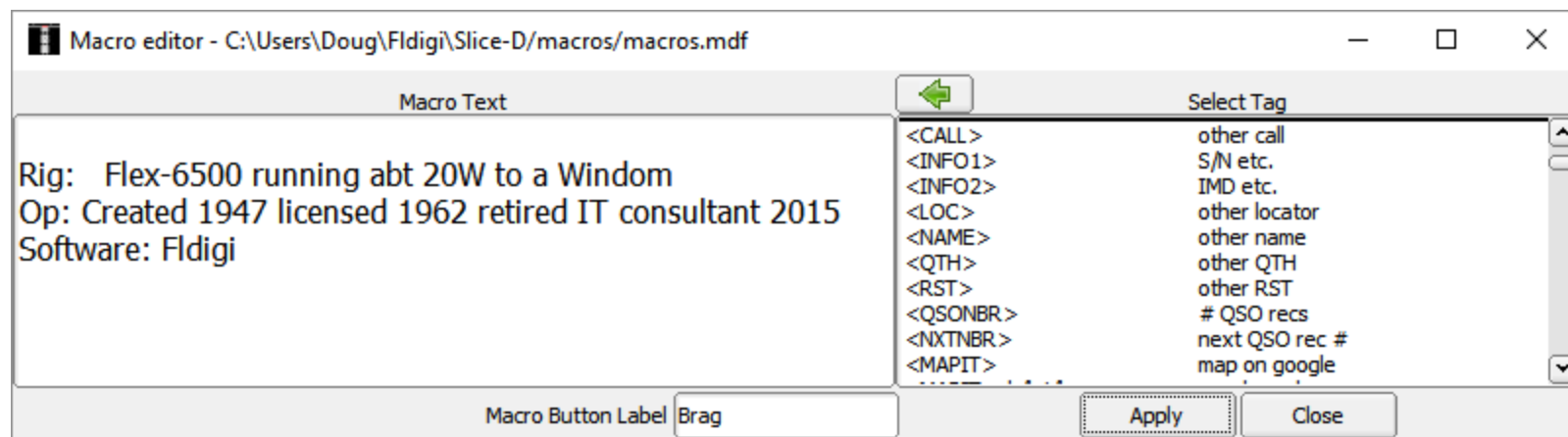
500 1000 1500 2000 2500 3000

WF -20 70 x1 NORM 1009 QSY Store Lk Rv T/R

BPSK31 s/n 23 dB imd -26 dB -3.0 AFC SQL KPSQL

Set up Macros for PSK and RTTY

- My Brag macro



RTTY

- Outside of contests, RTTY is used for DXing and, sometimes, ragchewing
- Popular with Dxpedititions and DX stations
- Typical DX QSO is very brief:

CQ DX DE TG9AHM TG9AHM

CQ DX DE TG9AHM TG9AHM

PSE K

DE AK4AO AK4AO

AK4AO DE TG9AHM

599 599 TU DOUG KN

599 599 TU 73 AK4AO

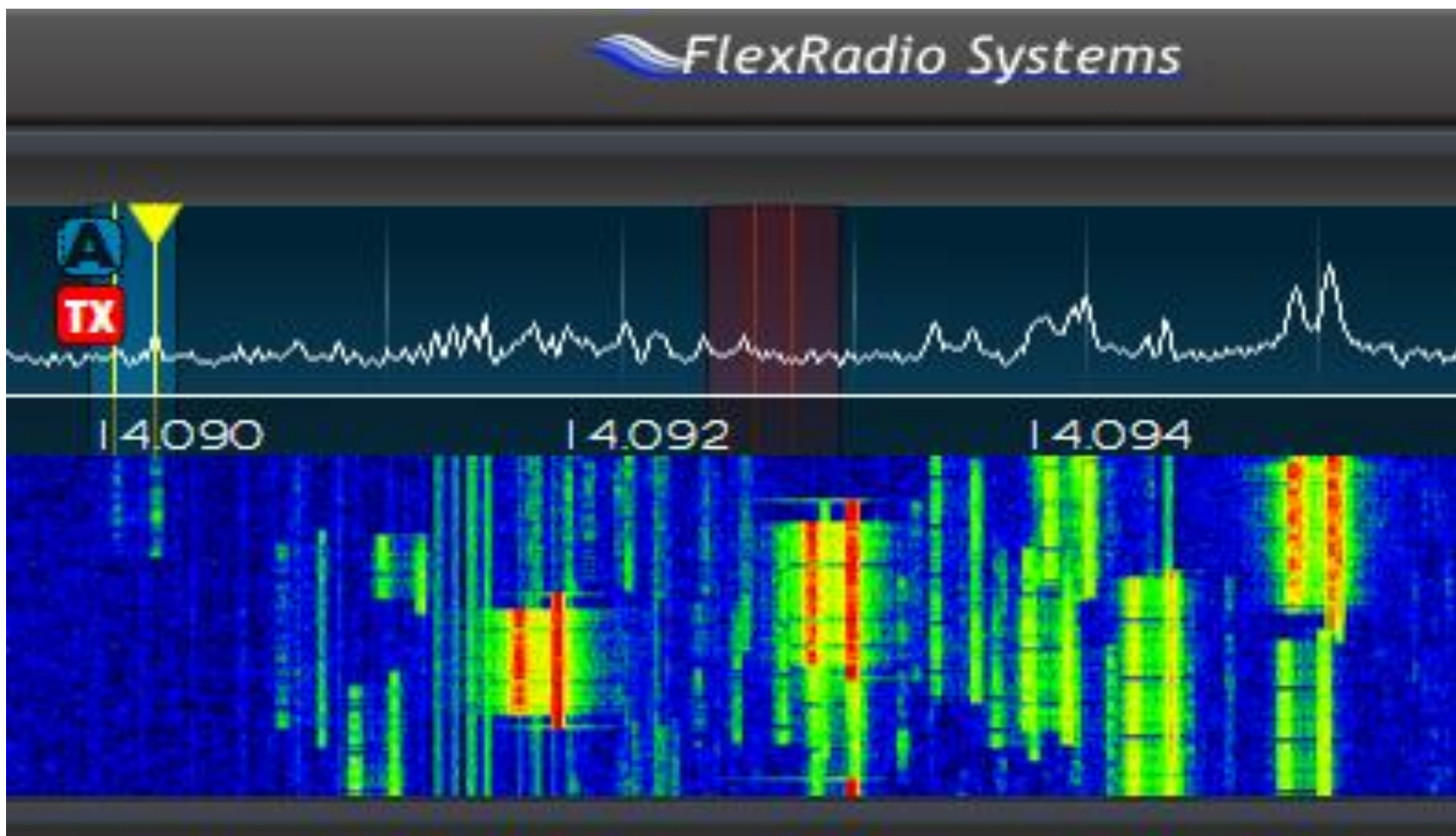
TU GL DOUG 73

CQ DX DE TG9AHM TG9AHM...

Operating RTTY

- Can use Fldigi – same software as PSK
- MMTTY reputed to be outstanding at weak signal decoding. I use it for contests.
- DX stations will often work split, especially if they expect a pileup
 - E.g., “CQ CX/N3BNA CX/N3BNA UP 1-3”
 - Means that N3BNA is operating in Uruguay and will listen for responses at frequencies 1-3 kHz higher than his calling frequency.
 - Technique for working split depends on rig: Use XIT function, second VFO, or RTTY software to achieve the split

RTTY Split on Flex-6000 Radios



Olivia

- Conversational like PSK, RTTY, but designed to decode well under adverse conditions
- Trades speed and bandwidth for improved reliability
- Good choice when reliable messaging is needed, e.g. for emergency communications
- Several Olivia formats described by bandwidth/(# of tones)
- VWS Tuesday night digital net typically starts out with Olivia 500/16

CW as a Digital Mode

- Machine sending of CW is built in to many rigs (including Flex). Used by VWS at Field Day 2015.
- Software for machine decoding of CW includes Fldigi and CWGet, both of which can be integrated with N1MM+ contest software
 - OK for machine sent CW. May not decode hand sent code very well.

Some Other Digital Modes

- FreeDV – An open source alternative for digitized voice
- FSQ – Designed for NVIS operation in public service scenarios
- Many more – See Resources Pages

Skimmers – Flex and other SDR Radios only

- Skimmers provide the ability to monitor a wider portion of selected bands than can be monitored via audio – up to 96K on the Flex-6000 radios using I/Q interface.
- Two notable products are CWSkimmer and RTTYSkimmer
 - Configure for multiple bands (4 on Flex-6500)
 - Can limit to stations sending CQ or other selected messages
 - Presents results in same format as a DX Cluster spotting site
 - Can use with programs like DXLab Spot Collector to ID and notify of needed stations on the air
 - Or integrate with N1MM+ Band Map to provide easy navigation to unworked stations or unworked multiplier stations

Summary of Flex-6000 Capabilities

- Multiple receivers – work multiple bands and/or multiple modes simultaneously
- Variable filters – set to 4.5K, e.g. for JT65/JT9 and change as desired
- Digital mode interface is built in to Flex software
- Flex can be programmed to enhance support for modes such as RTTY and FreeDV
- Wide band I/Q feeds support skimmer software for modes like RTTY and CW

Why Not Flex?

- Radio capabilities can change with software releases, resulting in a new learning curve
- Both radio and computer software can be subject to software glitches and bugs
- Software setup, especially for Flex-specific features, can be complex and time consuming.

Resources – Digital Mode Software

Some Software for operating digital modes

WSJT-X: <http://physics.princeton.edu/pulsar/K1JT/wsjtx.html>

JT-Alert: <http://hamapps.com/>

Fldigi:

Home Page: <http://www.w1hkj.com/>

Downloads: <https://sourceforge.net/projects/fldigi/files/>

MMTTY: <http://hamsoft.ca/pages/mmtty.php>

N1MM+: <http://n1mm.hamdocs.com/tiki-index.php>

CWGet: <http://www.dxsoft.com/en/products/cwget/>

Skimmer software

CWSkimmer: <http://www.dxatlas.com/CwSkimmer/>

RTTYSkimmer: <http://www.dxatlas.com/RttySkimServ/>

SDR-Bridge (for Flex): <http://www.qrv.com/sdrbridge.html>

Resources - Reference

- ARRL page on digital data modes:
<http://www.arrl.org/digital-data-modes>
- Good web page on digital modes:
<http://wb8nut.com/digital/>
- Instructions for setting up popular digital mode software on Flex-6000 series radios:
<http://viennawireless.net/wp/wp-content/uploads/2016/03/Setting-Up-Digital-Mode-Software-on-the-Flex.pdf>