

Introduction to ...

DIGITAL DATA MODES



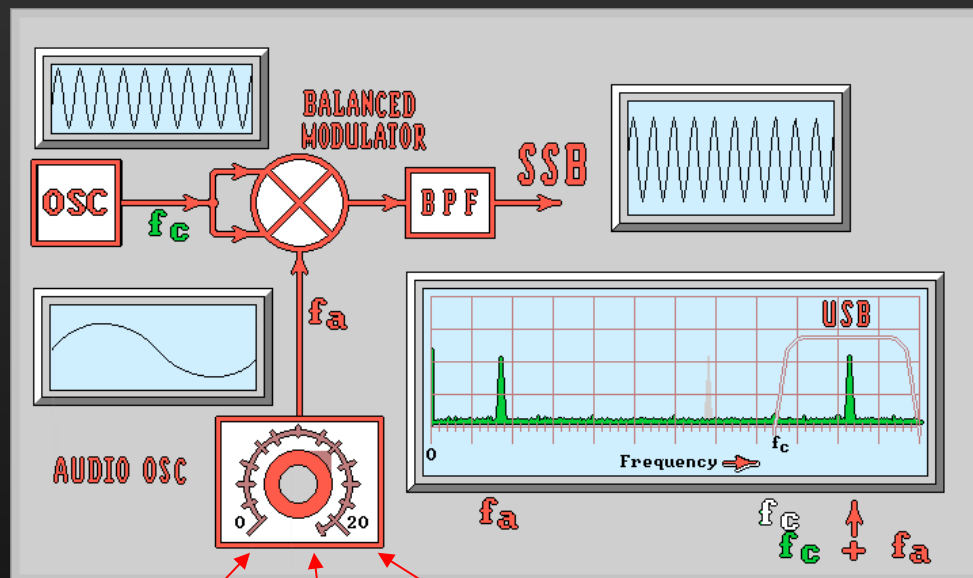
George Heron, N2APB



WHAT WE'LL COVER

- So just what is “Digital Mode Communication?” ... *Modulation, Demodulation, then Tribulation!*
- Survey of some popular digital modes ... “What the heck are all those weird-sounding stations I hear as I tune around the bands?”
- Setting up your station for using the Digital Modes ... *SSB rig + Sound Card + PC + Software = A Brave New World*
- An alternative to that darned PC ... *Hardware-based, embedded digital modem!*
- So what's holding you back?!

WHAT IS DIGITAL COMMUNICATION?



Voice

Yada
Yada
Yada



CW

Tone ON
Tone OFF

Tones

1, 0, 1, 1, 1, 0, ...



Digital

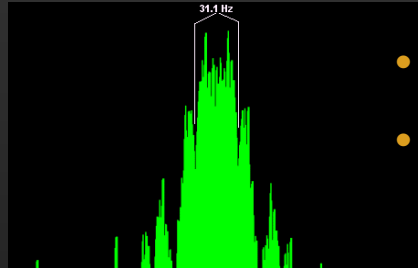
SO MANY MODES, SO LITTLE TIME



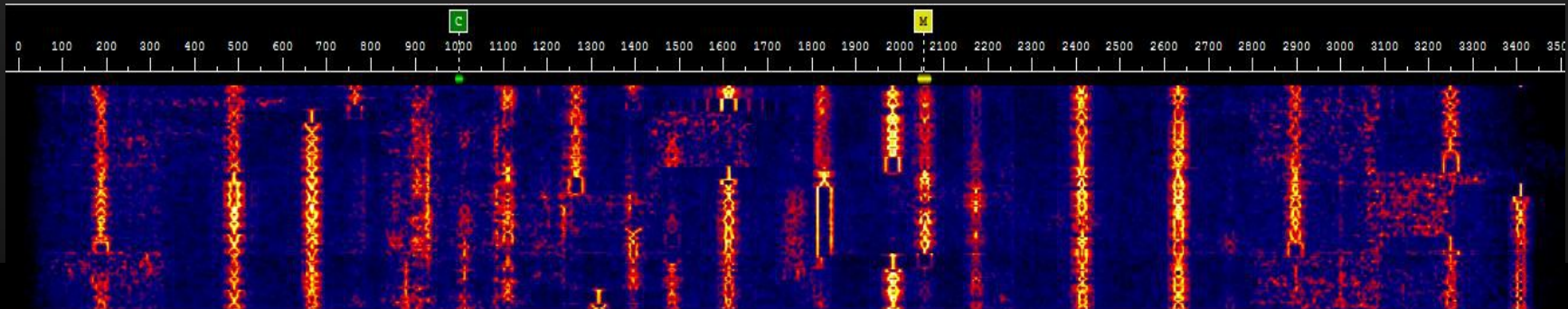
PSK31, PSK63, SSTV, HD SSTV, RTTY,
MFSK16, MFSK32, MT63, Hellschreiber,
Olivia, Packet, PACTOR, Throb,
Contestia, JT6M, Ham DRM, Domino,
DominoEX, DominoF, WSPR, ROS,
SITOR, SITOR-A, SITOR-B, Swedish
ARQ, Clover, CHIP, ALE, PAX, PAX-2,
STANAG, HFDL, NAVTEX, SYNOP,
COQUELET, AOR, WinDRM

The Undisputed King!

PSK31

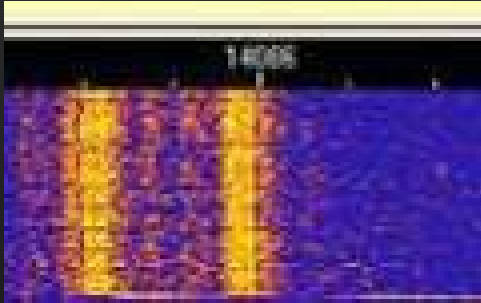


- Debuted in 1999
- Most popular HF digital mode
- Heard near: 3.580, 7.070, 14.070, 21.070 MHz

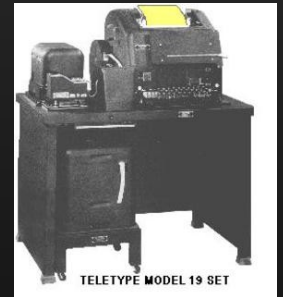


- “Phase Shift Keying” is the the most popular of the newer digital modes.
- Wealth of information on the web regarding BPSK (Binary PSK) and QPSK (Quadrature PSK)
- Because bandwidth only 31Hz, many signals can fit into the same bandwidth occupied by an SSB signal (2.4kHz approx.).
- Quite common to see 15 or more signals on a 2.5kHz waterfall

RTTY

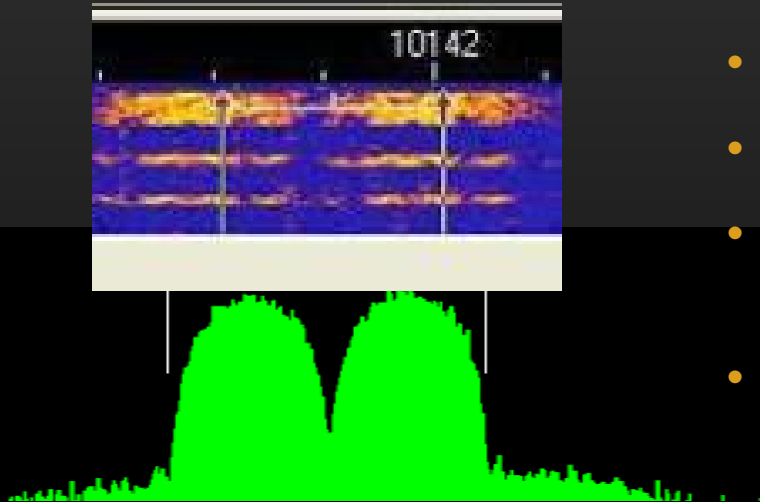


- One of the oldest HF digital modes—Hams began using it immediately after WW II.
- Most popular contest and DX mode.
- Heard near: 7.040, 14.090, 21.090 MHz



- Been around for many, many years and is still just as popular.
- Years ago the only way to get on RTTY was to use a mechanical terminal unit such as the Creed 7 series, which were big, noisy and messy.
- Today virtually all RTTY is done by the computer/soundcard combination.
- Hams use 45 baud (the speed) with 170Hz shift (between mark and space).
- Commercial stations use 50 or 100 baud with shifts of 425 or even 250 Hz.

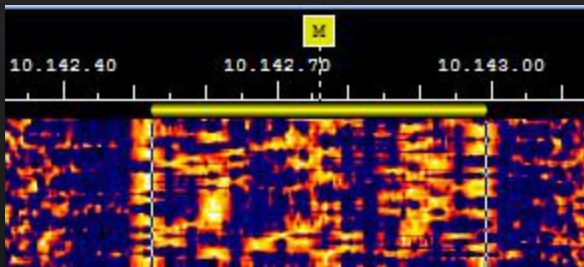
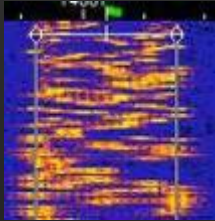
PACTOR



- Developed in 1991
- Three versions: 1, 2 and 3
- PACTOR 2 and 3 are the most popular today
- Error-free burst mode
- Used primarily to exchange data, such as in the Winlink 2000 system.
- 400 Hz bandwidth ... ~ 2x 100 baud PSK

- HF mailboxes use PACTOR to forward messages to users.
- Lots of bad press recently, mainly due to the actions of a few inconsiderate operators who are apparently causing interference deliberately to existing users of the digital sub bands.
- Because it uses error correction, it can take quite a time to send a message particularly over a less than perfect path—but the transmitting station will keep trying until the message is received perfectly

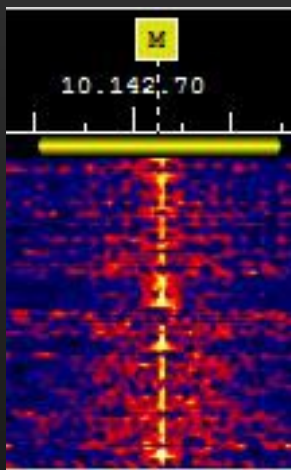
MFSK16



- Introduced in 2000 by IZ8BLY
- Uses 16 tones
- Good performance in poor signal conditions
- Heard near 14.080 MHz

- Usual variant is MFSK 16, but other types such as MFSK 8.
- MFSK is sideband dependent ... must have receiver set to the correct sideband in order to decode it properly.
- Tuning is quite critical, although AFC helps somewhat.
- Top image is of an MFSK16 signal and the lower image is of an MFSK32 signal (which is nearly 500Hz wide, twice as wide as an MFSK16 signal).

HELLSCHREIBER



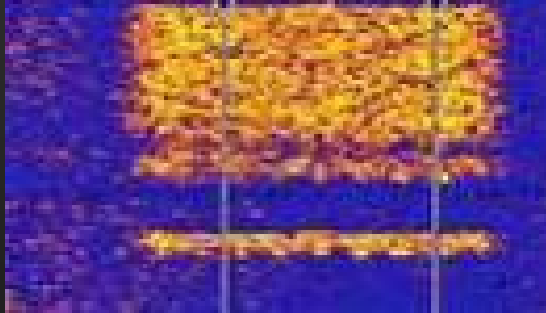
- Oldest digital mode; created in 1929
- Fax-type mode where text is “painted” on the screen for direct reading—not decoded by software.
- Heard between 14.075 and 14.080 MHz

A horizontal Hellschreiber display showing a ticker tape with text. The text is displayed in a series of lines, with some characters appearing as red and yellow dots on a dark background. The text includes "CALL UR RST 579 579 QSB NAME" and "HAMBURG QRA JO53AR JO53AR".

CALL UR RST 579 579 QSB NAME
CALL UR RST 579 579 QSB NAME
HAMBURG QRA JO53AR JO53AR
HAMBURG QRA JO53AR JO53AR

- Your eyes do the filtering!
- Decoded text displayed on a ‘ticker tape’ display.
- Very distinctive ‘grating’ sound and is a narrow band mode.
- Even weak signals can be decoded as your eye/brain combination can ‘fill in the blanks’ where the signal fades.

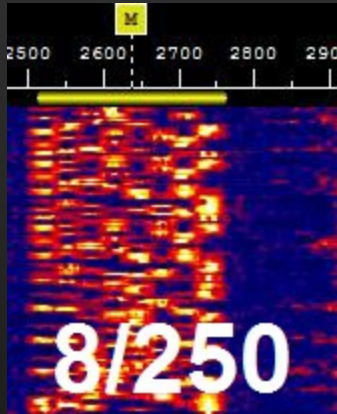
PACKET



- Declining popularity, but still heard
- Used for message forwarding, APRS and some “live” keyboard-to-keyboard QSOs.
- HF forwarding heard near 14.095 MHz
- APRS near 10.150 MHz
- Live QSOs at 14.105 MHz

- HF mailboxes etc. use packet to forward messages to users.
- Usual data rate on HF is 300 baud, with 1200 and 9600 baud being common place at VHF and UHF.
- Picture shows a mailbox/BBS in Turkey negotiating with a BBS in the UK.
- Short burst at the bottom of the picture is header and callsign information.
- Longer burst is the actual data.
- Packet BBS/mailboxes can be heard chirping around 14.1MHz.

OLIVIA



- New HF digital mode introduced in 2005
- Selectable bandwidth
- Heard between 14.105 and 14.109 MHz

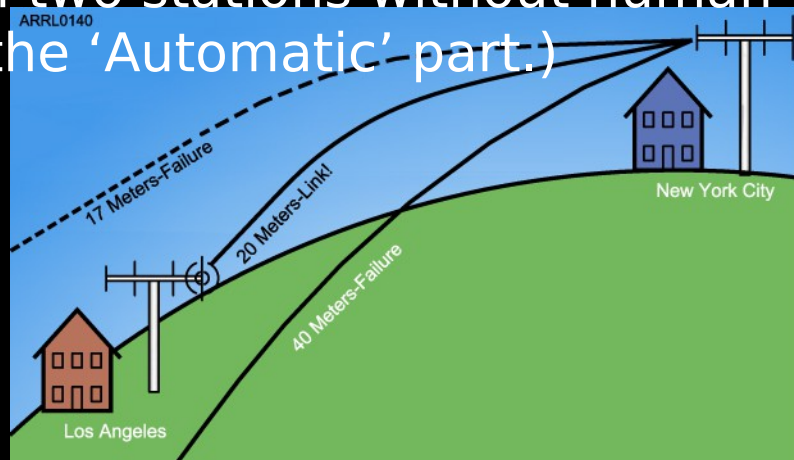
8 tones over a 250Hz bandwidth

- Extremely resistant to fading and QRM.
- Can get full copy on stations that are barely audible ... even ones that fade down to almost zero seem to still print well.
- Has different variants each having a different bandwidth (from 500Hz to 2kHz) and different number of tones.
- Can be very slow (2-3 characters per second) but a slow contact is better than none at all!
- To avoid interference to other stations is it usual to start an Olivia transmission on a full kHz (i.e. 14.108.0 rather than 14.108.3 for instance).

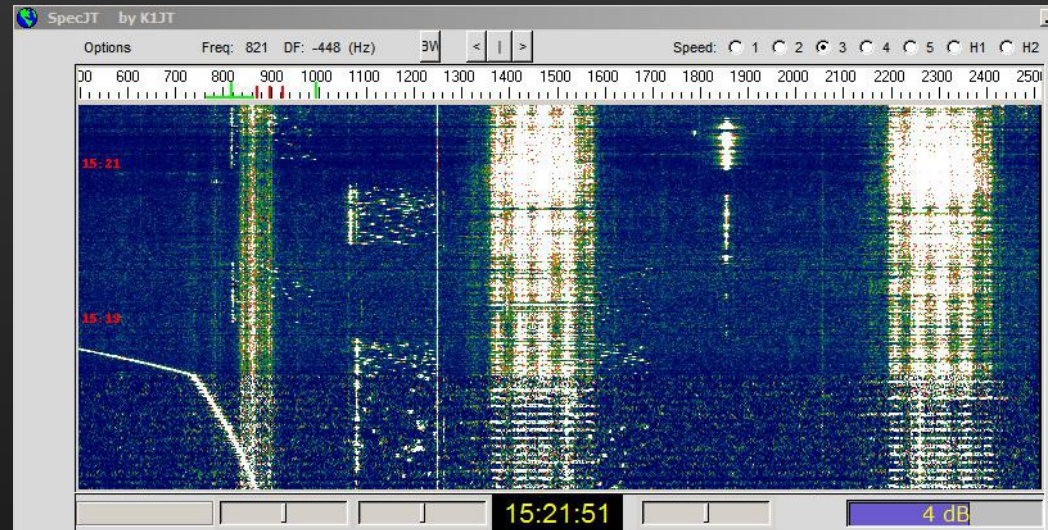
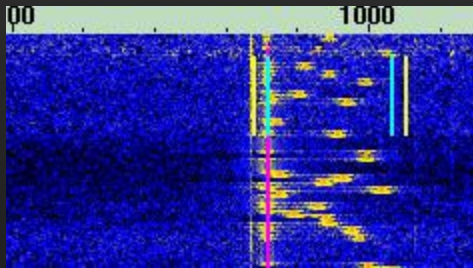
ALE

- Automatic Link Establishment
- Automatically determines the best band for communication between two stations.
- Will alert operators when path is determined

- Now finding more use in amateur circles, thanks to the efforts of the writers of some of the multimode decoders, such as MultiPSK.
- When running correctly, can initiate and establish connections between two stations without human intervention (hence the 'Automatic' part.)



JT65



- Developed originally as part of the WSJT weak signal modes software package by Joe K1JT.
- Can also be decoded by other packages, such as MultiPSK.
- Has found a use on HF and can be found around 14.076MHz and 21.076MHz amongst others.
- Signals that are virtually inaudible can give perfect copy so its performance is excellent on the noisy HF bands.
- Transfer rate is slow, as are most modes that excel in low signal decoding.

DESIGNING AN HF DIGITAL STATION

- With the exception of PACTOR and AOR digital voice, all other amateur HF digital modes are sound-card based.
- The sound card advantage: Once you've wired your station for one HF mode, you can work another by just selecting a different mode in the software.



SSB transceiver



A (good) Sound Card
(An external USB sound card is most flexible)



Software:
- FLDIGI, ...

A (fast) PC

THE COMPUTER

- For *Windows XP*, should be at least a 500 MHz Pentium. Ditto for *Linux*. For *Windows Vista*, invest in a 1 GHz machine
- For Macs, a modern iMac
- Of course, faster is always better!
- Don't rely on the built-in sound card ... use an external USB sound card *



* If you use a desktop workstation, an internal high-performance sound card PCB may easily be used (M-Audio, etc.).

THE SOUND CARD

- The heart of your HF digital station
- Converts received audio to data
- Converts data to transmit audio
- Stereo, if you wish to do SDR with I & Q channels
- Connects to PC over USB
- Higher sampling rates are better (e.g., 24-bit, 96 kHz or better)

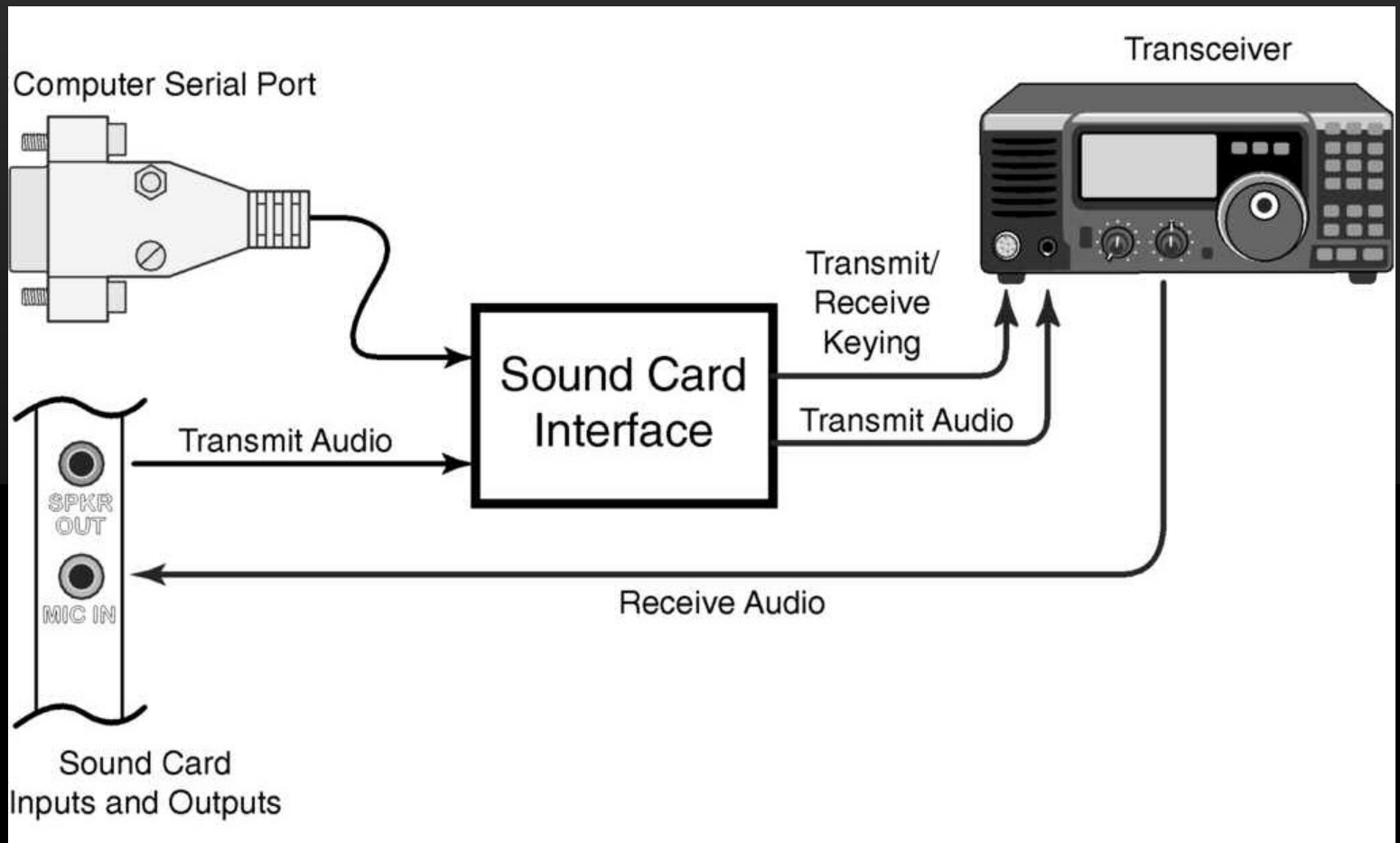


<http://us.store.creative.com/Creative-Sound-Blaster-XFi-Surround-5.1/M/B0044DEDCA.htm>

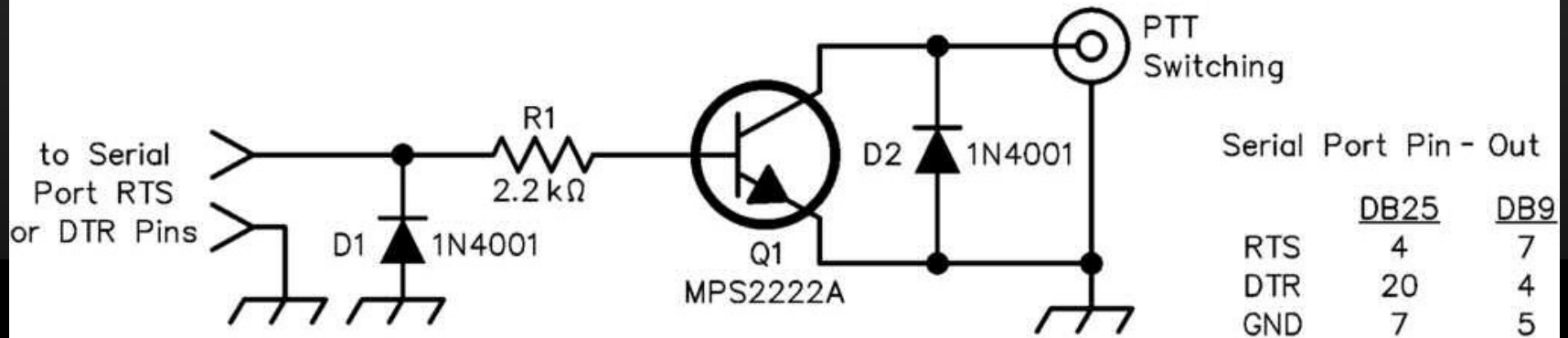
EXTERNAL SOUND CARDS & INTERFCES MADE BY MFJ, TIGERTRONICS, WEST MOUNTAIN RADIO AND OTHERS



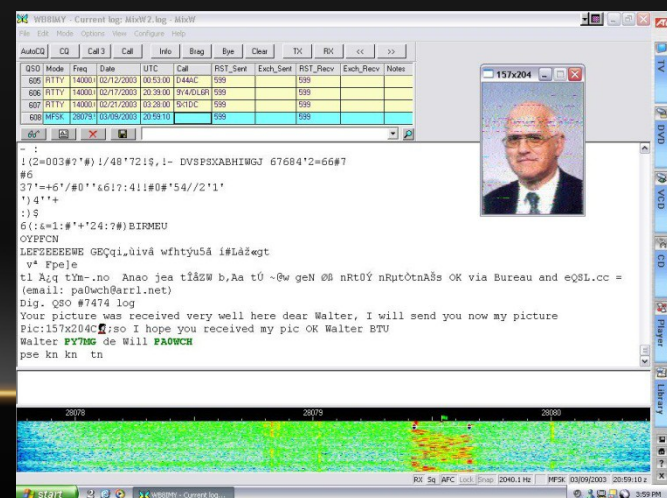
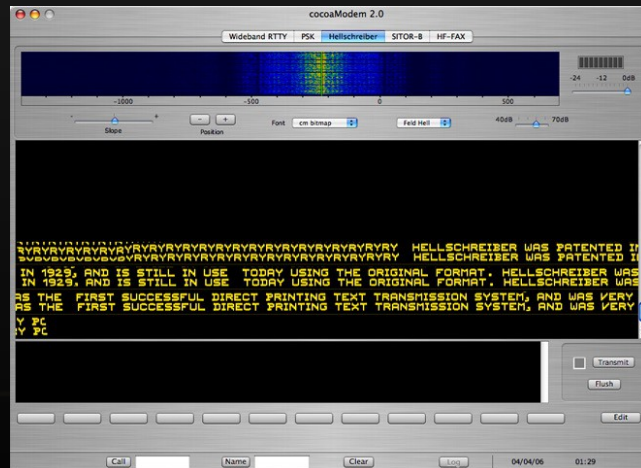
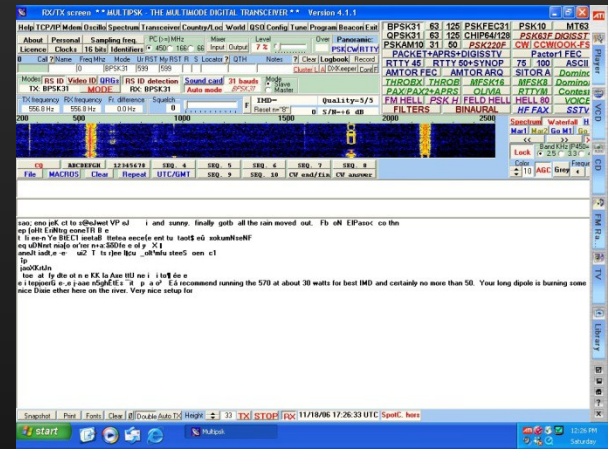
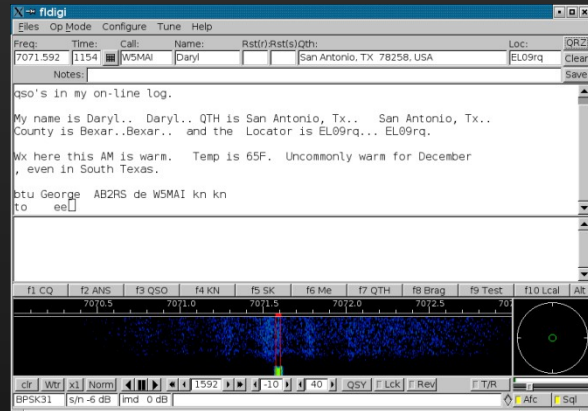
MEET THE SOUND CARD INTERFACE



YOU CAN ALSO MAKE YOUR OWN INTERFACE



A CORNUCOPIA OF SOFTWARE



FLDIGI

The screenshot shows a Windows XP desktop with a taskbar at the bottom. The desktop background is a green and blue abstract image. The taskbar includes the Start button and several open applications: fldigi - W1HKJ, Scope, Psk Viewer, Logbook - logbook.adi, and Event log. The system tray shows the time as 5:46 AM and the date as 1/15/2009.

The desktop contains several icons: Recycle Bin, Try Microsoft Office for 60 days, kompozer - Shortcut, Adobe Reader 8, Windows Media Center, Quicken 2006 Deluxe, Shop for HP Supplies, Help and Support, Windows Media Player, HP Total Care Advisor, Run QRZ!, Internet Explorer, Google Earth, MSN, HP Photosmart, fldigi, fl_logbook, Norton Internet Security, WorldWide Telescope, HP Solution Center, and FileZilla Client.

The open applications are:

- Logbook - logbook.adi**: A window showing a log of contacts. It includes fields for Date/Time, On, Off, Call, Name, Freq., Mode, In, and Out. A table lists contacts with columns for Date, Time, Callsign, Name, Frequency, and Mode. The table shows contacts from 20081208 to 20081226.
- Event log**: A window showing log sources and a warning message: "Warning: 0: main: fldigi 3.1preC log started on Thu Jan 15 05:41:20 2009".
- Scope**: A window showing a circular scope display with a green vertical line in the center.
- Psk Viewer**: A window showing a list of PSK signals. The list includes frequencies and callsigns, such as 3583.000, 3582.900, 3582.800, 3582.700, 3582.600, 3582.500, 3582.400, 3582.300, 3582.200, 3582.100, 3582.000, 3581.900, 3581.800, 3581.700, 3581.600, 3581.492, 3581.300, 3581.200, 3581.100, 3581.000, 3580.900, 3580.800, 3580.700, 3580.600, 3580.500, 3580.400, and 3580.300.
- fldigi - W1HKJ**: The main FLDIGI window. It shows a rig control section with a frequency of 3580.000. It includes a QSO log with columns for QSO Freq, On, Off, Call, Name, In, Out, and Comment. The log shows a contact with callsign WA4KBD and name WILLIAM. The window also displays a large text area with a message from BTU Rick - VE3FMC.

DIGIPAN

WM2U - DigiPan

File Edit Clear Mode Options View Channel Lock Configure Help

CQ 2 de 1 Ernie BTU CQ DX QRZ loc:10x Brag T/R Clear 070 Club internet ^

Call: Name: QTH: Rec'd: Sent: Band: Notes: * [Save] [Print] [Link]

DJ8RP Harald Germany 599 599 20m

NAME is Harald Harald and
my QTH is Moenchweiler JN48FC Moenchweiler JN48FC
south west DL, near the boe der to FRANCE and SWISS.
BTU Ernie, WM2U DE DJ8RP pse K Ke o ee

KK5LQ DE KA5FJA Ke oeeelica tael leat yol with the beaet seÅe. You are pretty wide on the signabut I
thought it was the distance that was tte cause. BTU KA5FJA DE KK5LQ 1oes, eOK...I'mt tuning

DJ8RP de WM2U hello name here is Ernie Ernie. QTH is Ballston Lake, NY. Saratoga County. loc: FN32cv.
10x 54583. □so btu DJ8RP DE WM2U@

DJ8RP de WM2U hello Harald good to cu in new York today. ur 599 599 and sigs look excellent.

14070 14071 14072

* DJ8RP (Harald) TX RX: 1402.6 Hz Swap IMD: Sq AFC Snap BPSK 02/24/2001 18:14:42 z

BUT YOU DON'T NECESSARILY NEED A COMPUTER, SOUND CARD OR SOFTWARE!

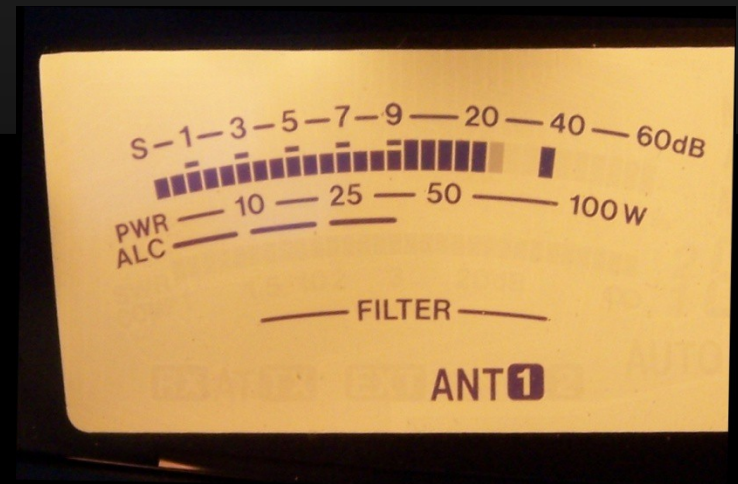
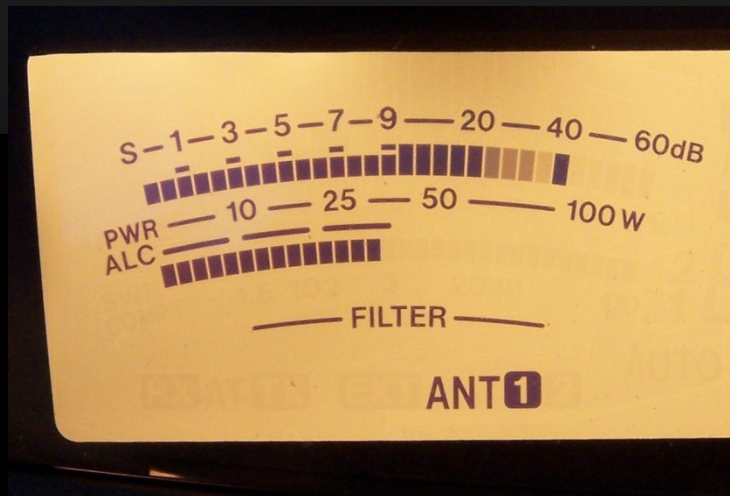
- NUE-PSK combines everything into a single battery operated device.
- PSK31, RTTY and CW now ... more modes late



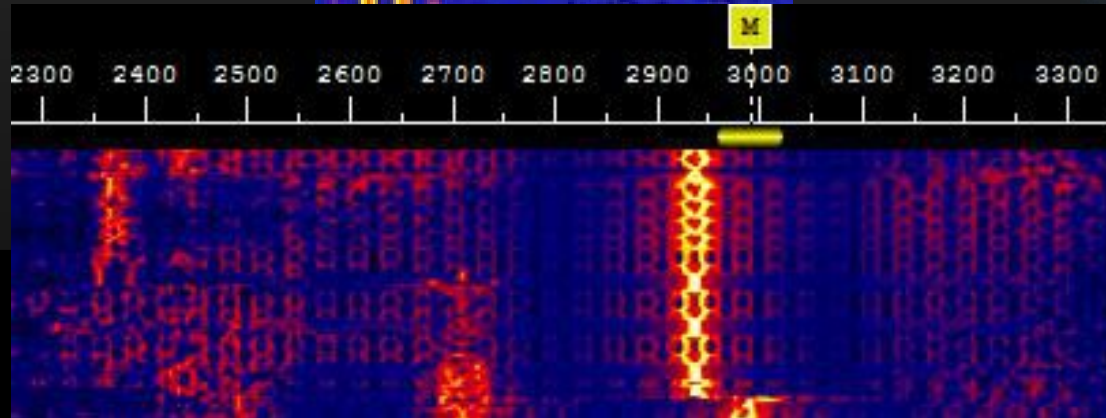
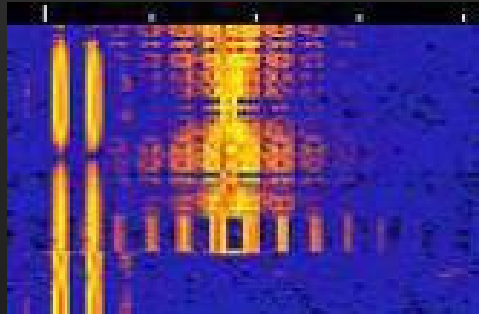
*“We don’t need
no stinkin’ PC!”*

BE CAREFUL WITH AUDIO LEVELS

- Too much transmit audio will distort your signal, especially with PSK31.
- Increase the sound output from your computer or interface until you see ALC activity, then reduce ALC to zero.



THE WORST PSK31 SIGNALS ... *EVER!*

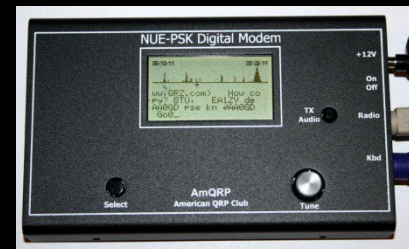
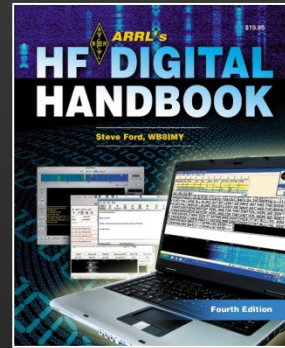


SO WHAT'S STOPPING YOU?!

- Join the thousands of hams using digital modes daily
- Another way to provide help in emergency communication situations
- Expand your own horizons with new opportunities: Digital contests, awards, ragchewing, swap nets, EmComm,
- Help to push the technology envelope by using one of the emerging modes
- More fun than sitting all night doing email, Facebook or Internet surfing

REFERENCES

- **ARRL HF Digital Handbook, 4th Edition** ... Available on-line at ... <http://www.arrl.org/shop/ARRL-s-HF-Digital-Handbook/>
- **Digital Technology For Emergency Communications Course** ... <http://www.arrl.org/shop/ARRL-Digital-Technology-for-Emergency-Communications-Course/>
- **VHF Digital Handbook** ... <http://www.arrl.org/shop/ARRL-s-VHF-Digital-Handbook/>
- **G4UCJ website** ... http://www.hfradio.org.uk/html/digital_modes.html
- **Steve Ford, WB8IMY** ... Inspiration, championing and contributions to this presentation
- **NUE-PSK Digital Modem** ... *"We don't need no stinkin' PC!"* ... <http://www.nue-psk.com> (W8NUE, N2APB, AD7JT)
- **FLDIGI** ... <http://www.w1hkj.com/download.html>



THANKS, AND HAVE FUN!



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