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?
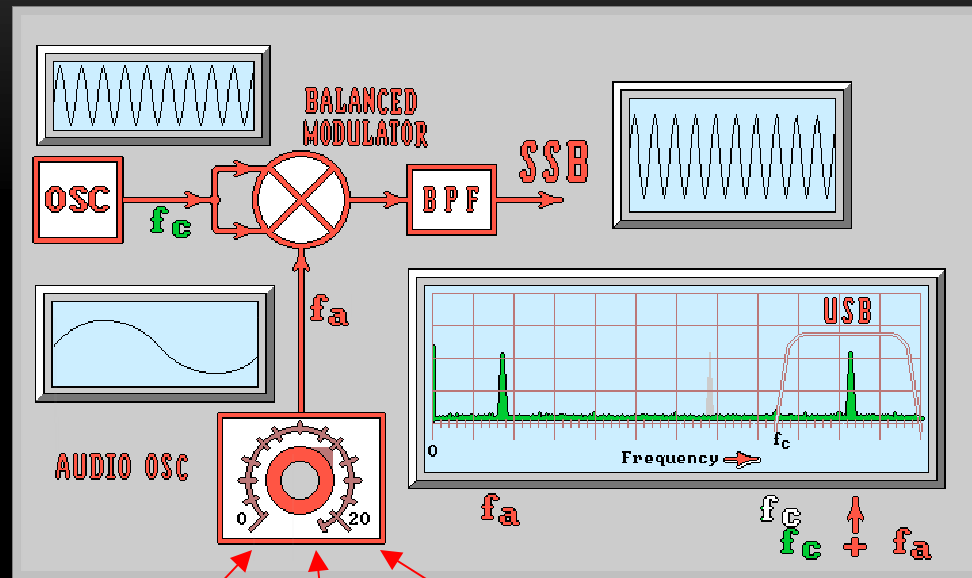
Voice

Yada
Yada
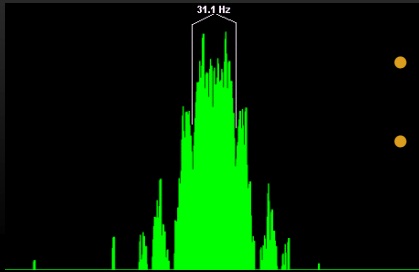Yada

Tone ON
Tone OFF

Tones

1, 0, 1, 1, 1, 0 , …

CW

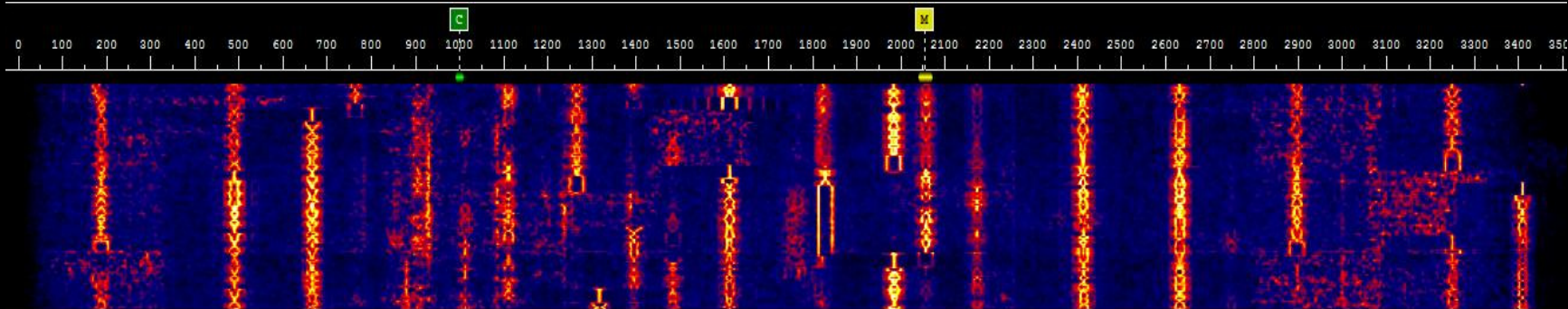Digital

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

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 display.

RTTY
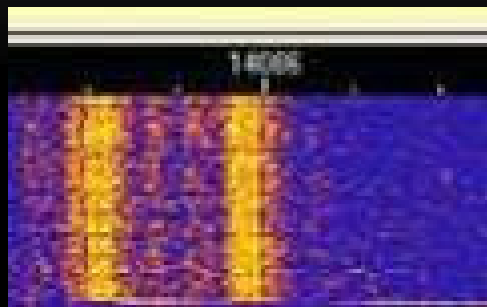
- One of the oldest HF digital modes—Hams began using it immediately after WW II.

- Most popular contest and DX mode.

- Heard near: 7.040, 14.090, 21.090 MHz

TELETYPE MODEL 19 SET
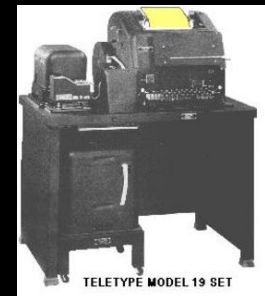
- Been around for many, many years and is still just as popular.
- Years ago the only way to get on RTTY was to use a mechanical terminal unit such as the Creed 7 series, which were big, noisy and messy.
- Today virtually all RTTY is done by the computer/soundcard combination.
- Hams use 45 baud (the speed) with 170Hz shift (between mark and space).
- Commercial stations use 50 or 100 baud with shifts of 425 or even 850Hz.
- Most software caters for differing speeds and shifts.
- Unlike most digital modes, RTTY is transmitted on LSB.

PACTOR
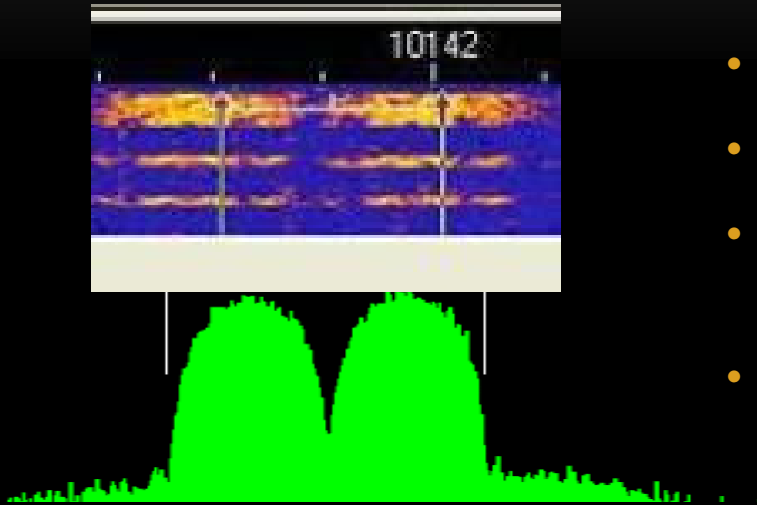
- Developed in 1991

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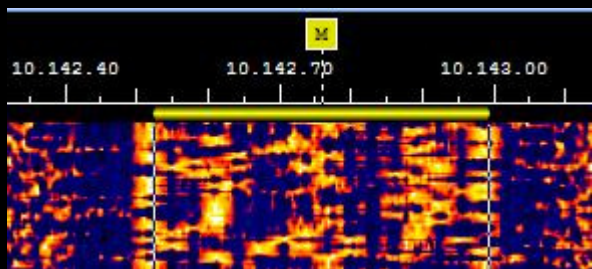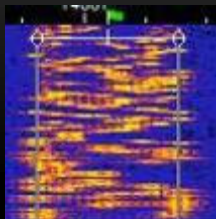
- Introduced in 2000 by IZ8BLY
- Uses 16 tones
- Good performance in poor signal conditions
- Heard near 14.080 MHz

- 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
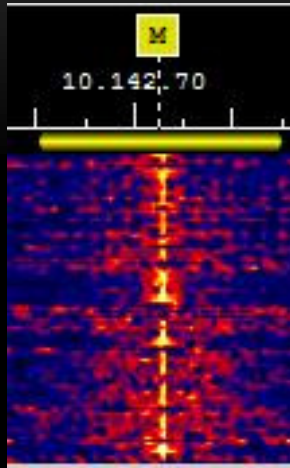
- Oldest digital mode; created in 1929

- 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

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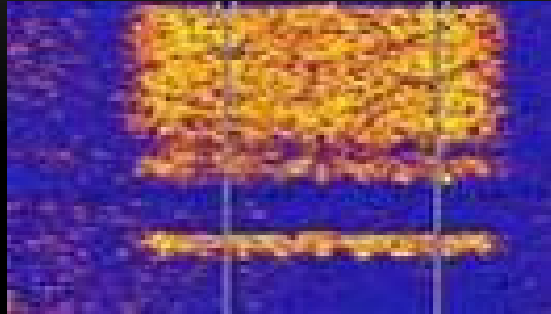
- Declining popularity, but still heard
- Used for message forwarding, APRS and some "live" keyboard-to-keyboard QSOs.
- HF forwarding heard near 14.095 MHz
- APRS near 10.150 MHz
- Live QSOs at 14.105 MHz

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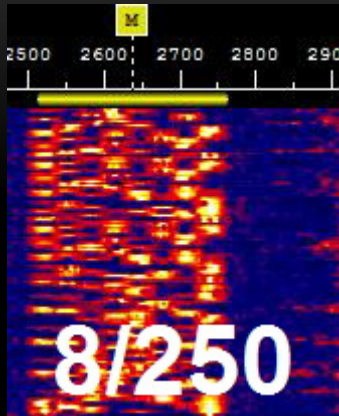
- New HF digital mode introduced in 2005
- Selectable bandwidth
- Heard between 14.105 and 14.109 MHz

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.)
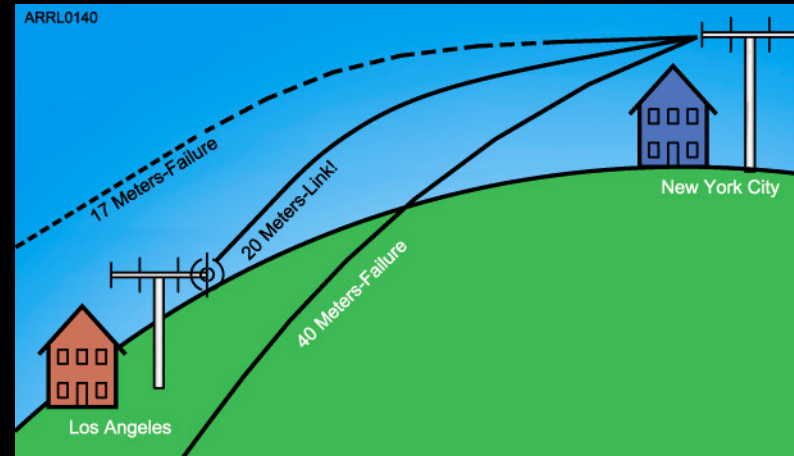
JT65
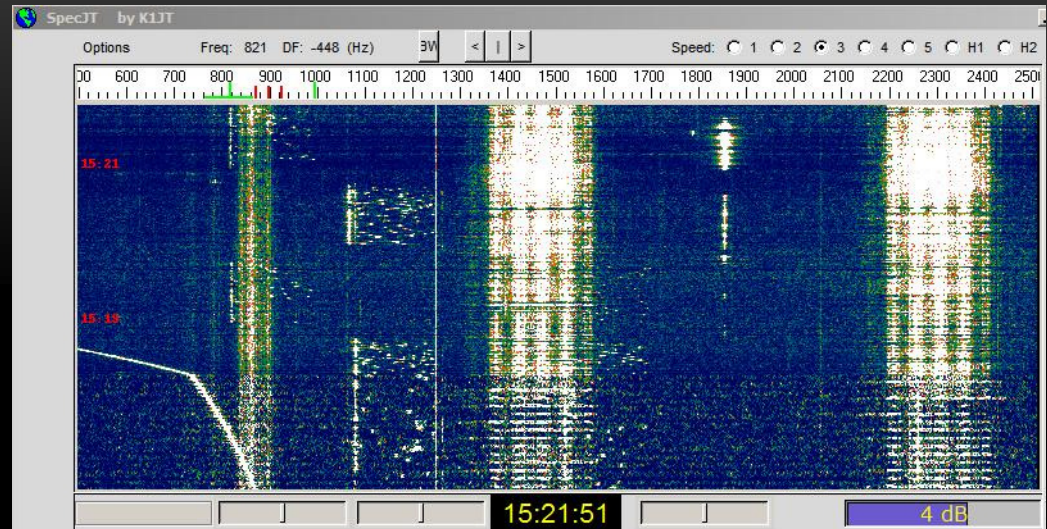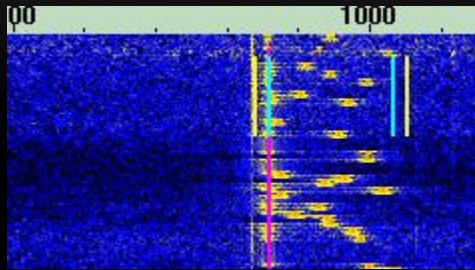
- Developed originally as part of the WSJT weak signal modes software package by Joe K1JT.

- 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
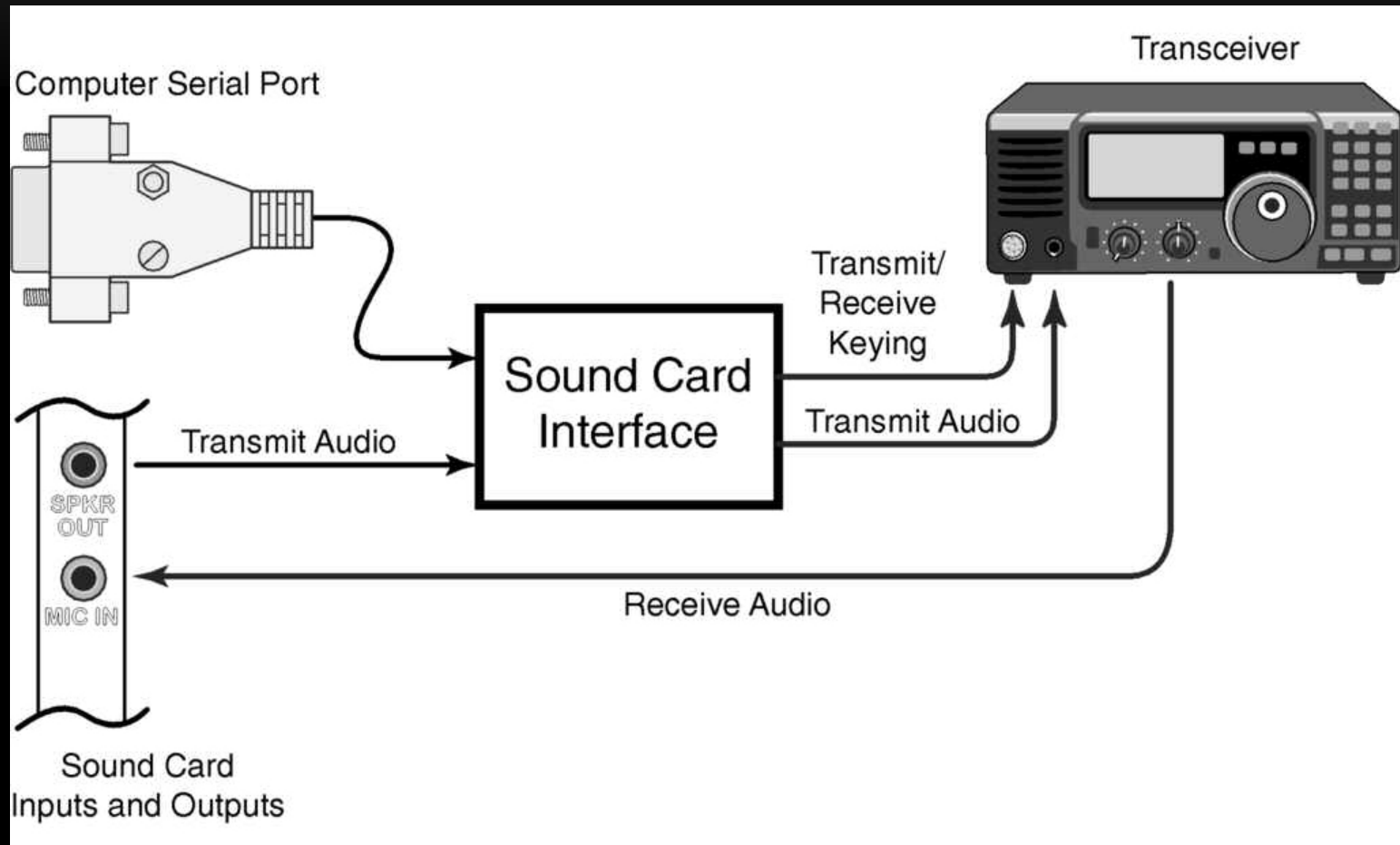
YOU CAN ALSO MAKE YOUR OWN INTERFACE
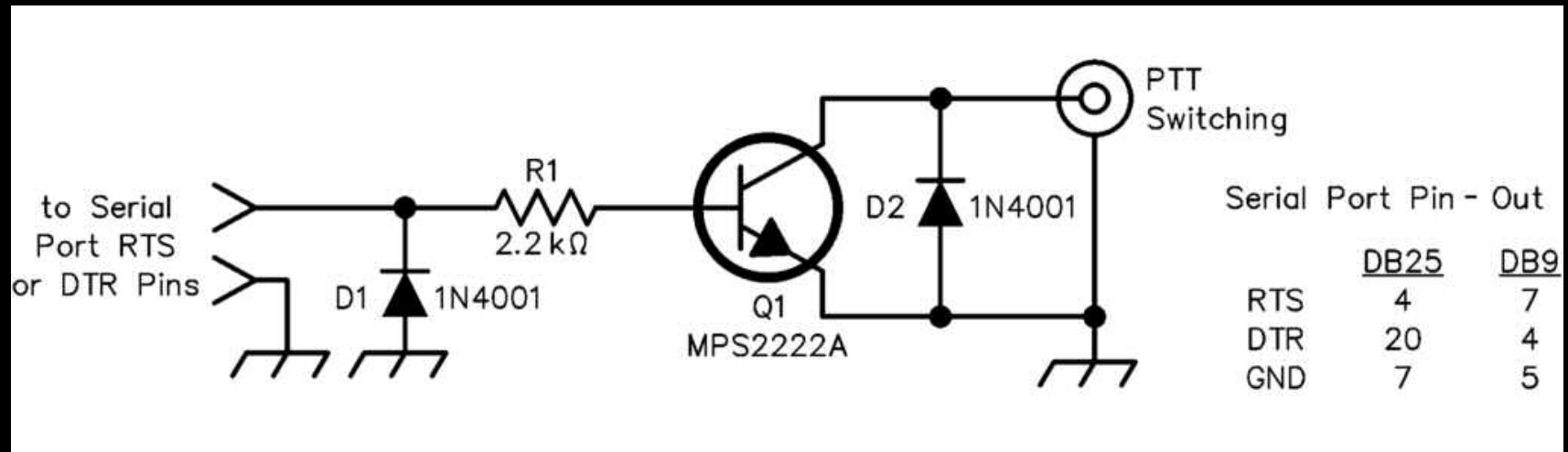
A CORNUCOPIA OF SOFTWARE

FLDIGI

DIGIPAN

# 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
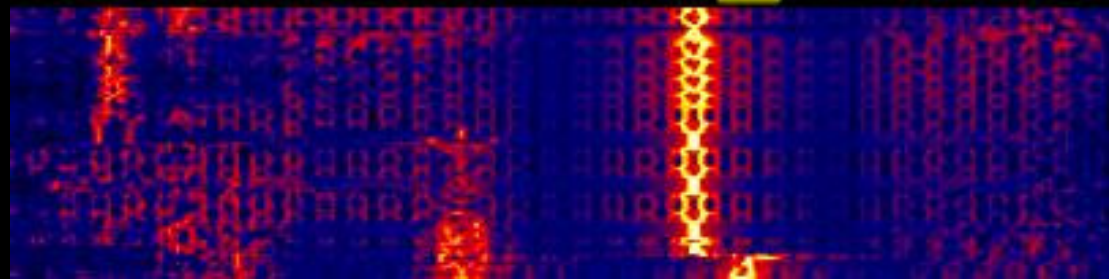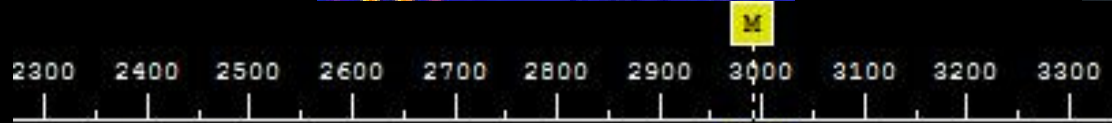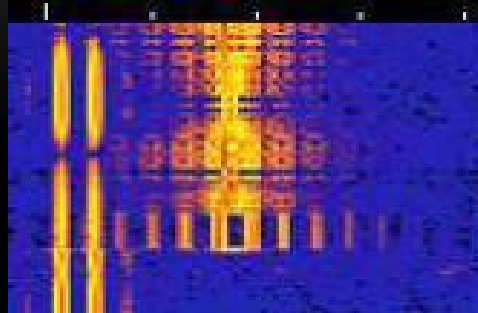

"We don't need no stinkin' PC!"

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.
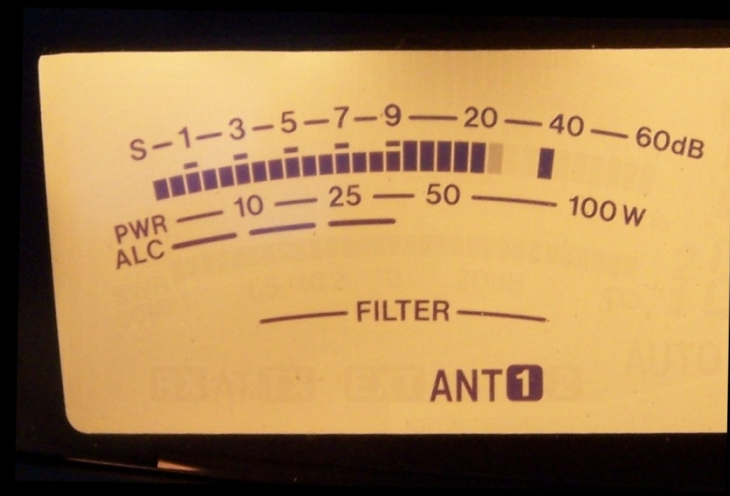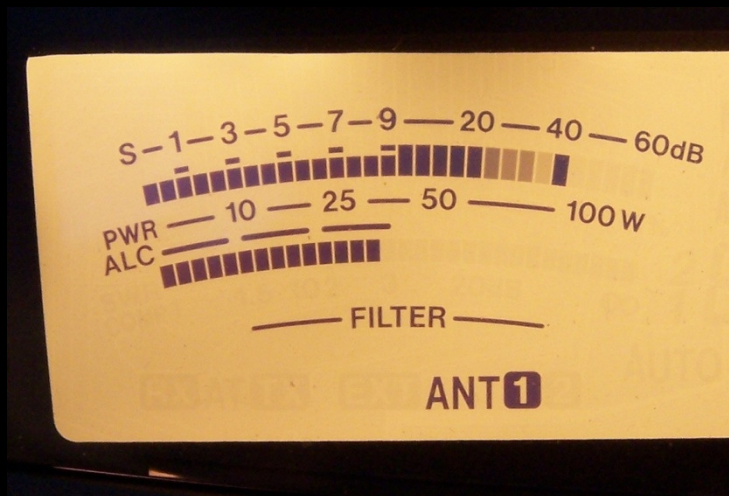
# THE WORST PSK31 SIGNALS ... *EVER!*

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
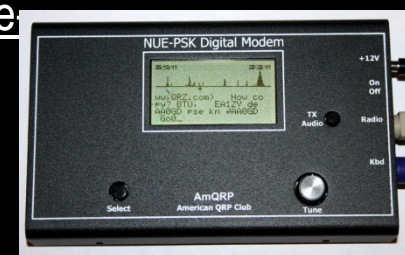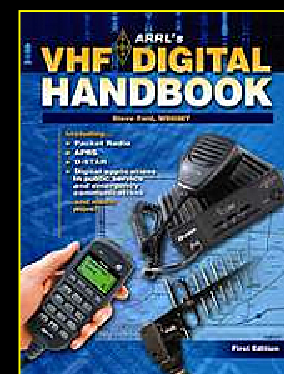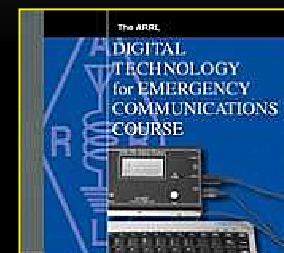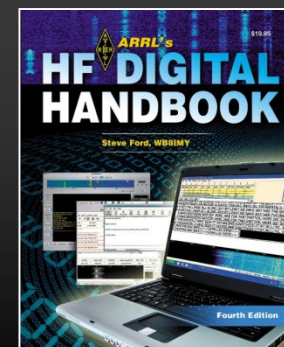
THANKS, AND HAVE FUN!

George Heron, N2APB
2419 Feather Mae Ct
Forest Hill, MD 21050
n2apb@MidnightDesignSolutions.com