Amateur Digital Communications the Easy Way

presented to:

W4BUG

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2015 May 26

Easy Digi Easy RTTY Workshop

- The original digital mode was Morse telegraphy – still effective, still popular
- Among the first “keyboard to keyboard” modes was two-tone amateur RTTY
- Then the Personal Computer changed EVERYTHING!

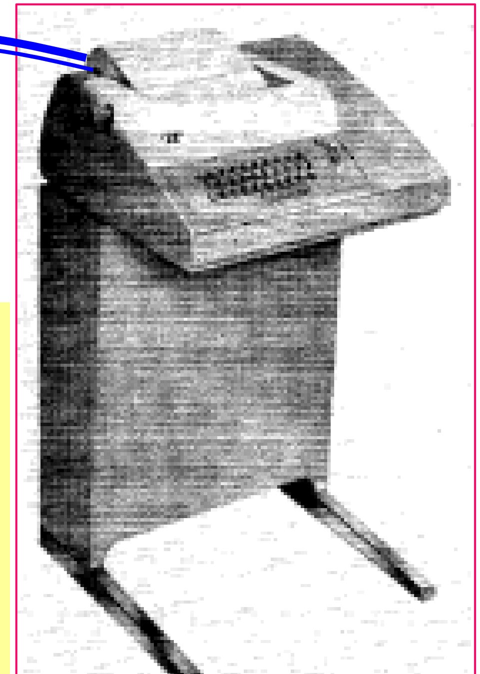
Basic Early Digital Communications

Model 15

Source: www.radioblvd.com/rtty_teletype.htm

Two Alternating Audio Tones on Wire Line

- <u>WIRE LINE</u> carried two alternating <u>AUDIO TONES</u>
- 1 start bit + 5 Baudot coded bits + 1 to 2 stop bits = 7 to 8 bits per symbol
- Electro-mechanical timing
- Used audio filters (remember surplus 88 mH inductors?)
- Tones in the 2+ kHz range

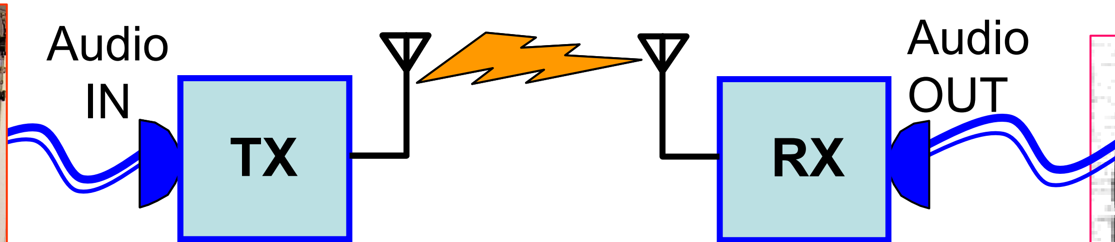


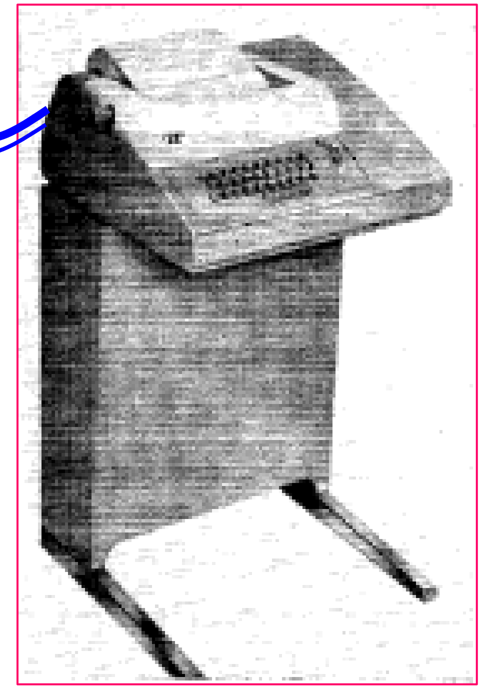
<u>Model 32</u>

“ … modestly priced at $532 [1965]” … [$3,848 in 2012 dollars]

Source: K8DKC, Jan. 1965 *QST*

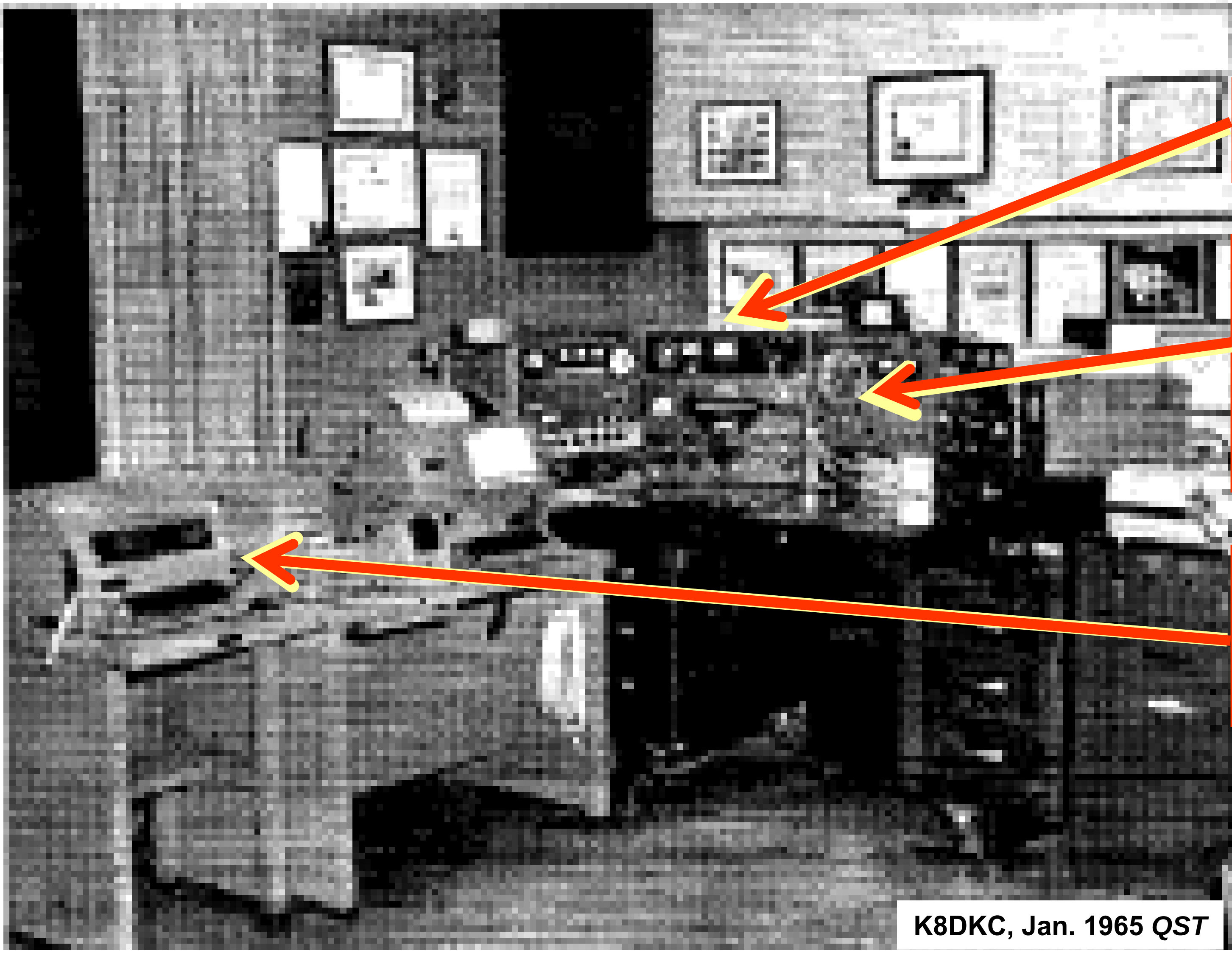
Adapted to Ham Radio circa 1960





- Tones entered the microphone input of a transmitter, latter homebrew FSK input
- Tones supplied by the speaker output of a receiver
- Adapted to AM, FM audio, then FSK and SSB

1965 Vintage Digital Station

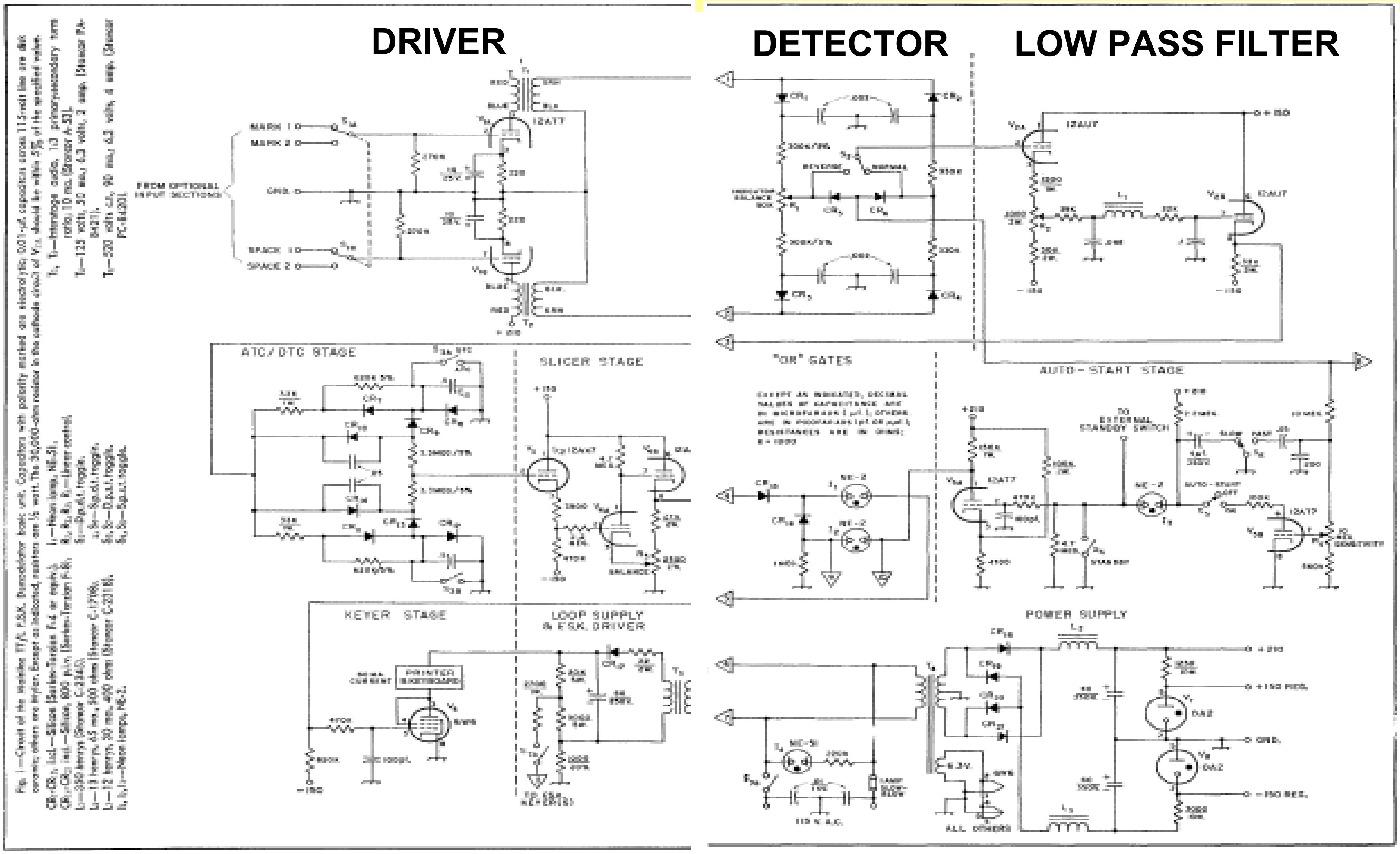


Radio

Memory: Perforated paper tape

I/O: teletype

… not for the faint of heart!



Much Ado About Filtering …

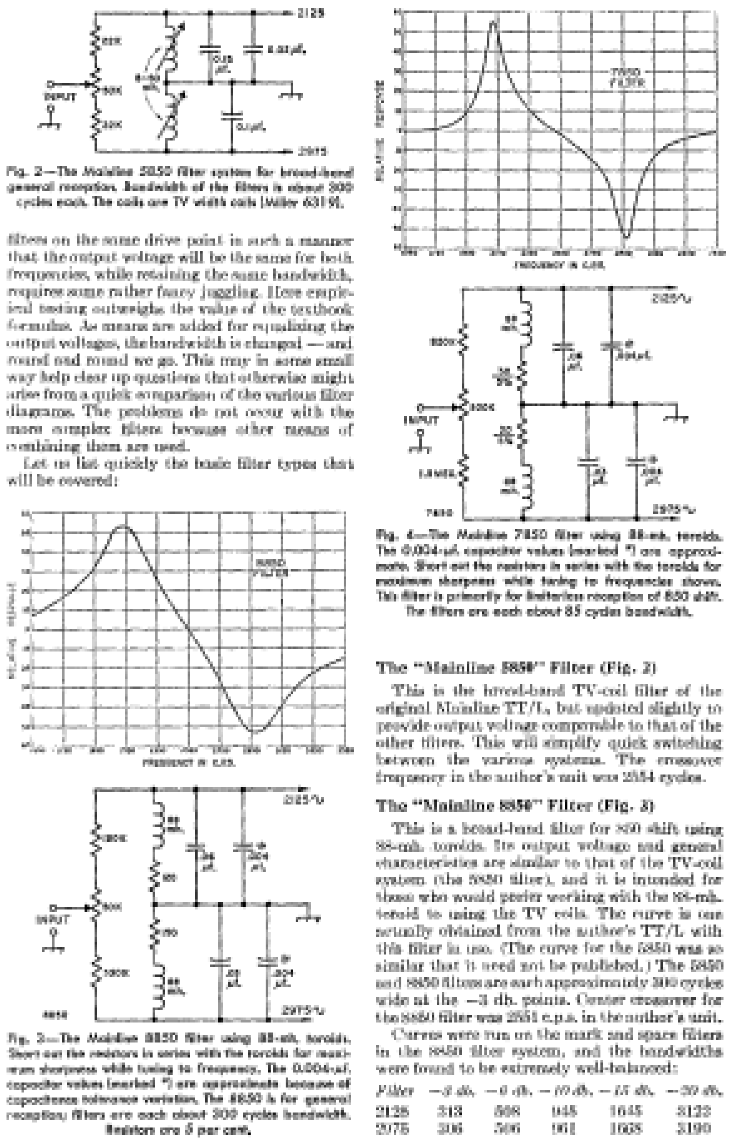


Fig. 2—The Mainline 5850 filter system for broad-band general reception. Bandwidth of the filters is about 300 cycles each. The coils are TV width coils (Miller 6319).

filters on the same drive point in such a manner that the output voltage will be the same for both frequencies, while retaining the same bandwidth, requires some rather fancy juggling. Here empirical testing outweighs the value of the textbook formulas. As means are added for equalizing the output voltages, the bandwidth is changed — and round and round we go. This may in some small way help clear up questions that otherwise might arise from a quick comparison of the various filter diagrams. The problems do not occur with the more complex filters because other means of combining them are used.

Let us list quickly the basic filter types that will be covered:

Fig. 4—The Mainline 7850 filter using 88-mh. toroids. The 0.004-µf. capacitor values (marked *) are approximate. Short out the resistors in series with the toroids for maximum sharpness while tuning to frequencies shown. This filter is primarily for limiterless reception of 850 shift. The filters are each about 85 cycles bandwidth.

The "Mainline 5850" Filter (Fig. 2)

This is the broad-band TV-coil filter of the original Mainline TT/L, but updated slightly to provide output voltage comparable to that of the other filters. This will simplify quick switching between the various systems. The crossover frequency in the author's unit was 2554 cycles.

The "Mainline 8850" Filter (Fig. 3)

This is a broad-band filter for 850 shift using 88-mh. toroids. Its output voltage and general characteristics are similar to that of the TV-coil system (the 5850 filter), and it is intended for those who would prefer working with the 88-mh. toroid to using the TV coils. The curve is one actually obtained from the author's TT/L with this filter in use. (The curve for the 5850 was so similar that it need not be published.) The 5850 and 8850 filters are each approximately 300 cycles wide at the −3 db. points. Center crossover for the 8850 filter was 2551 c.p.s. in the author's unit.

Curves were run on the mark and space filters in the 8850 filter system, and the bandwidths were found to be extremely well-balanced:

Filter	*−3 db.*	*−6 db.*	*−10 db.*	*−15 db.*	*−20 db.*
2125	313	508	945	1645	3122
2975	306	506	961	1668	3190

Fig. 3—The Mainline 8850 filter using 88-mh. toroids. Short out the resistors in series with the toroids for maximum sharpness while tuning to frequency. The 0.004-µf. capacitor values (marked *) are approximate because of capacitance tolerance variation. The 8850 is for general reception; filters are each about 300 cycles bandwidth. Resistors are 5 per cent.

- demodulator performance depends on signal filtering
- … everything was analog
- upgrades required a soldering iron!

Then Came the Portable Computer

United States Patent [19]
Paulsen et al.

[11] **Patent Number: 4,571,456**
[45] **Date of Patent: Feb. 18, 1986**

[54] **PORTABLE COMPUTER**

[75] Inventors: **David C. Paulsen,** Santa Clara; **Glenn T. Edens,** Menlo Park; **Karl S. Nakamura,** Santa Clara; **David M. Gallatin,** San Jose; **Stephen R. Hobson; William G. Moggridge,** both of Palo Alto, all of Calif.

[73] Assignee: **Grid Systems Corporation,** Mountain View, Calif.

[21] Appl. No.: **435,126**

[22] Filed: **Oct. 18, 1982**

[51] **Int. Cl.**[4] **H04M 11/00;** A47B 88/00; G09G 1/00

[52] **U.S. Cl.** .... **179/2 C;** 312/327; 248/455; 361/386; 340/700

[58] **Field of Search** .... 179/2 C, 2 DP; 358/248, 358/249, 254; 340/700, 705; 248/447, 454–457; 312/198, 327, 328, 208, 294; 174/86; 49/167; 339/4; 361/383, 386, 387, 395, 399; 108/35, 39, 133; D14/100–106, 113, 115

[56] **References Cited**

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4,140,357	2/1979	Wolz et al.	174/86 X
4,206,559	6/1980	Brown	248/455
4,291,198	9/1981	Anderson et al.	179/2 DP
4,367,374	1/1983	Serrano	179/2 C
4,409,641	10/1983	Jakob et al.	361/399 X

OTHER PUBLICATIONS

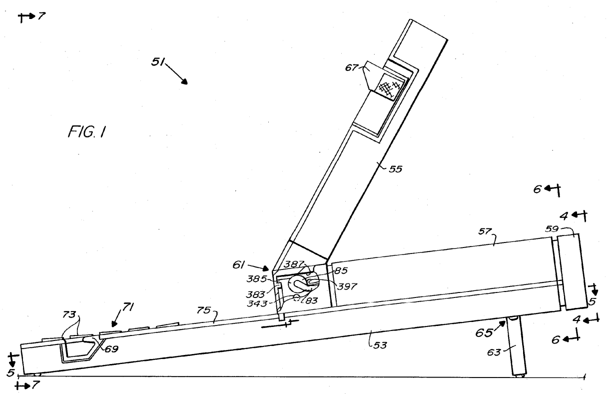
Gokuraku I, Encyclopedia ASCII, vol. 2, Jul. 1978, pp. 256–258.

Primary Examiner—W. J. Brady
Attorney, Agent, or Firm—Donald C. Feix

[57] **ABSTRACT**

A portable computer is contained within an outer metal case which physically encapsulates and protects the working components of the computer in the closed, portable configuration. The metal case includes a base which serves as a heat sink for transferring waste heat from heat producing electrical components to the surroundings in the open, operating configuration of the computer. The heat producing components are mounted and located in the base to maximize the transfer of heat to the base. A display housing is pivotally mounted on the base by hinge assemblies for swinging movement between a closed and latched position on the base and an upward and rearwardly inclined angle for viewing by an operator positioned in front of the computer. Stop pins coact with the hinge assemblies for holding the display housing at the desired angle of view, and torsion springs are associated with the hinge assemblies for preventing inadvertent slamming of the display housing against the base during closing. Electrical cables are guided from the base through the hinge assemblies and to the display by cable guides which protect the cables against snagging and unnecessary flexure. A single connector connects an audio circuit on a modem to use either a standard hand set for voice communications or a passive speaker and microphone as an acoustic coupler for data communications.

19 Claims, 34 Drawing Figures

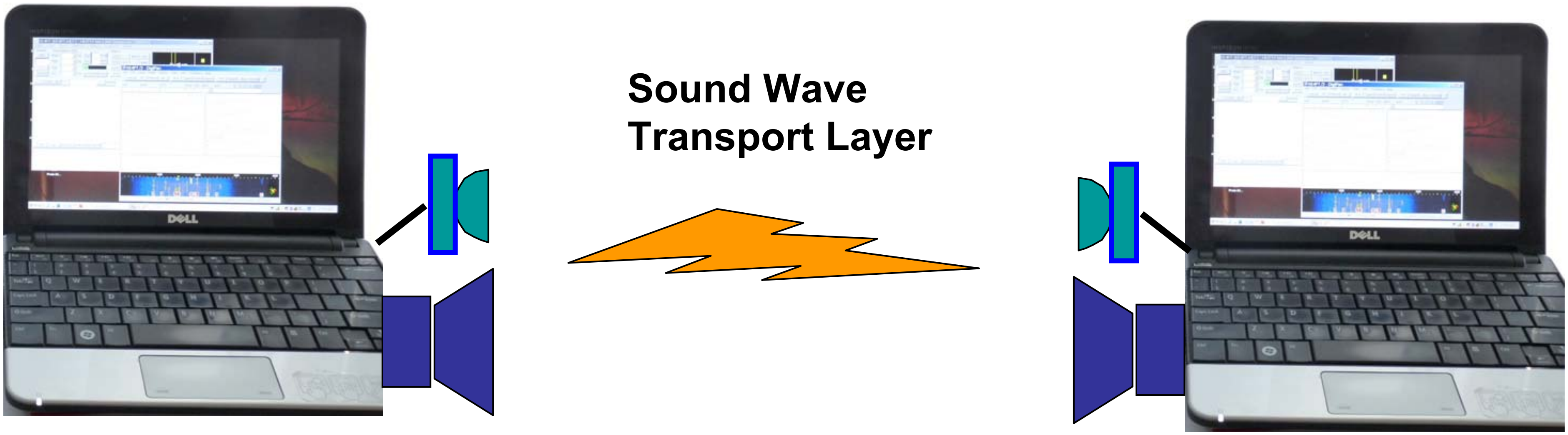


U.S. Patent Feb. 18, 1986 Sheet 1 of 19 4,571,456

June 18, 1985, STS-55 Astronaut John Creighton with GRID computer (patent filed 1982).

Source: http://www.miamiherald.com/2012/09/09/2993452/early-laptop-designer-moggridge.html#storylink=cpy

The Personal Computer Changed EVERYTHING!



- Personal Computer Software encodes and decodes all manner of digital modes
- Simplest I/O is via the built-in audio sound card
- Range is limited to the audio sensitivity

DEMO!

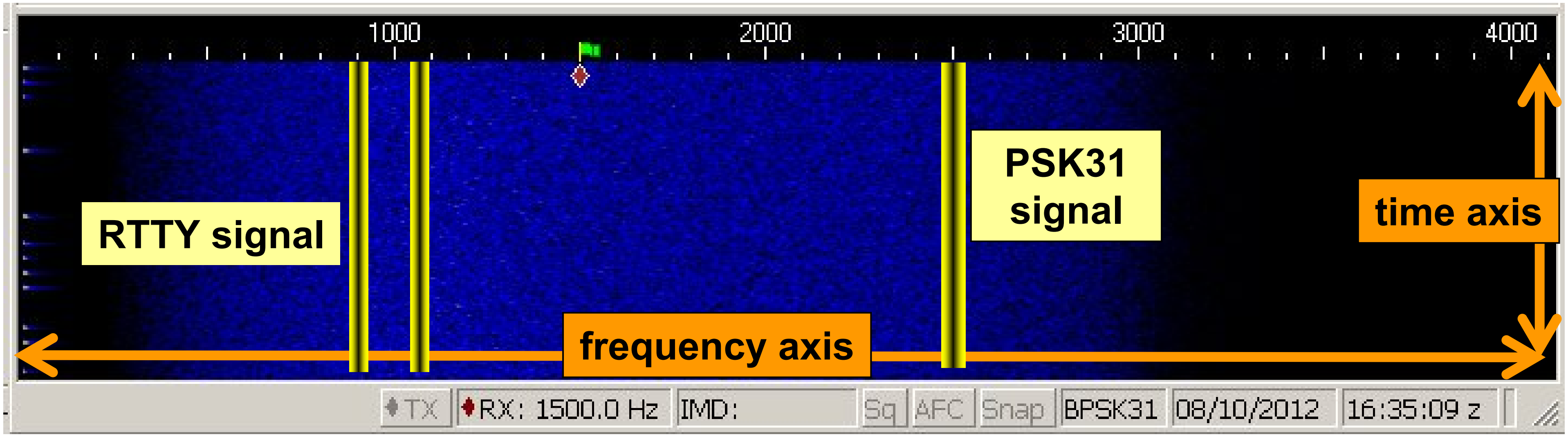
Setting up "THE SOFTWARE"

Pick the appropriate digital mode software:

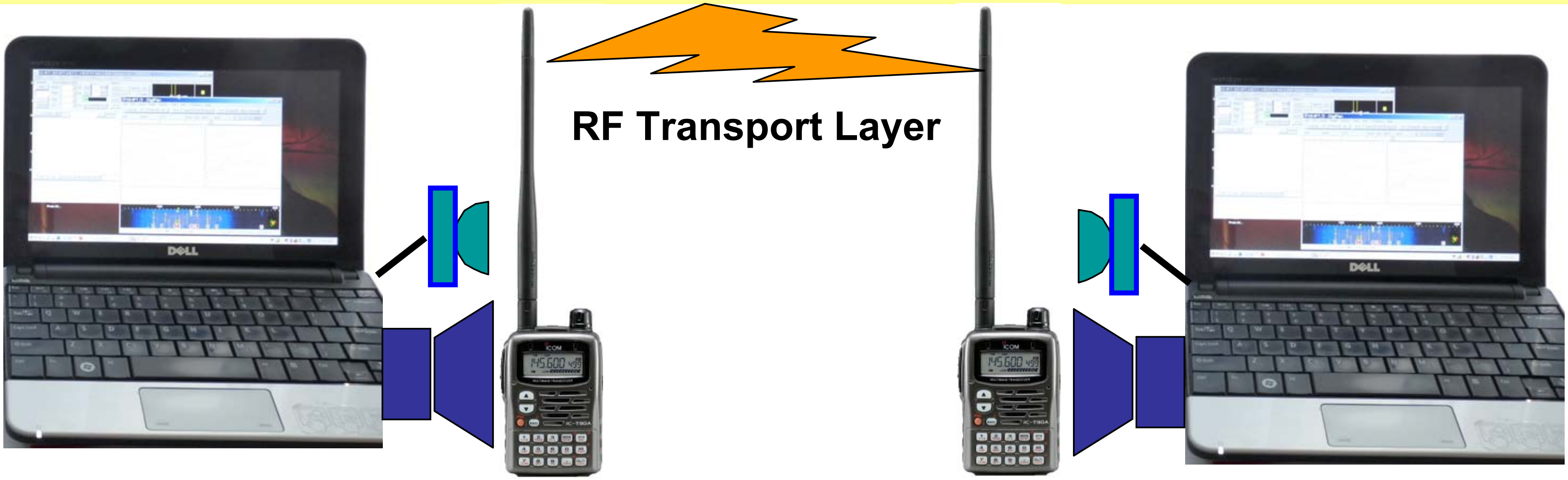
- MMTTY, Fldigi for ham-RTTY
- Digipan, Fldigi, and others, for PSK modes
- JT65, JT9 for HF and JT65 for Moon-bounce

… … also slow scan TV, ACTOR, AMTOR, … …

All the action happens in the audio passband:



Easy to Add RF Transport Layer



- **Acoustically Coupled** FM transceivers
- I/O is via the built-in audio sound card
- Range is extended to transceiver RF range.

DEMO!

Full Evolution: Confine the Audio to Cables

Digital and audio signals confined to cable

Analog audio and PTT signals confined to cable

Antenna

Computer: Encodes / decodes digital signals

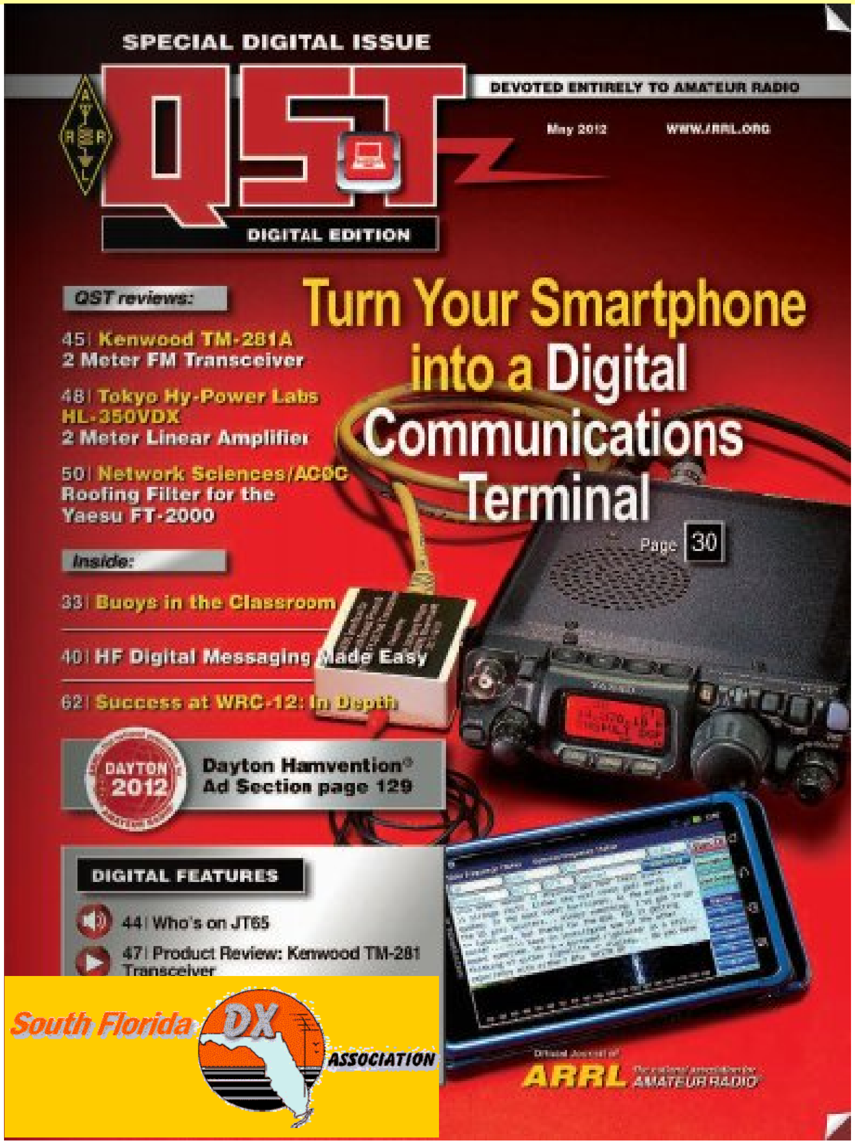
Soundcard: Interface between computer and radio

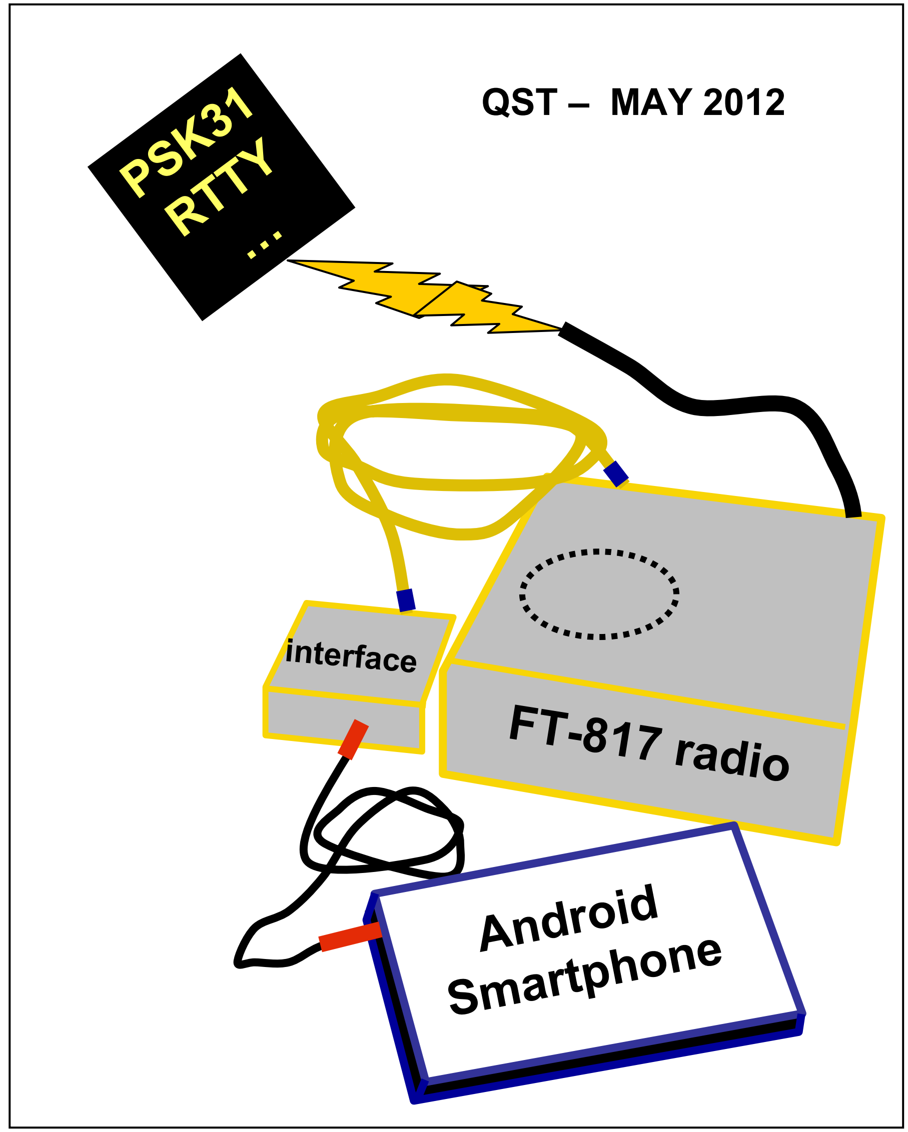
Radio: Upper SSB is "Last IF" for signals

Evolution of Digital Radio

- **Three major things happened between 1960s and today:**
  - Personal computers came on the scene
  - Frequency and phase stability of radios improved dramatically
  - millisecond range timing became routine
- **These improvements:**
  - Made ham-RTTY easy, even trivial
  - Enabled many new highly capable modes

It's so simple an Android can do it

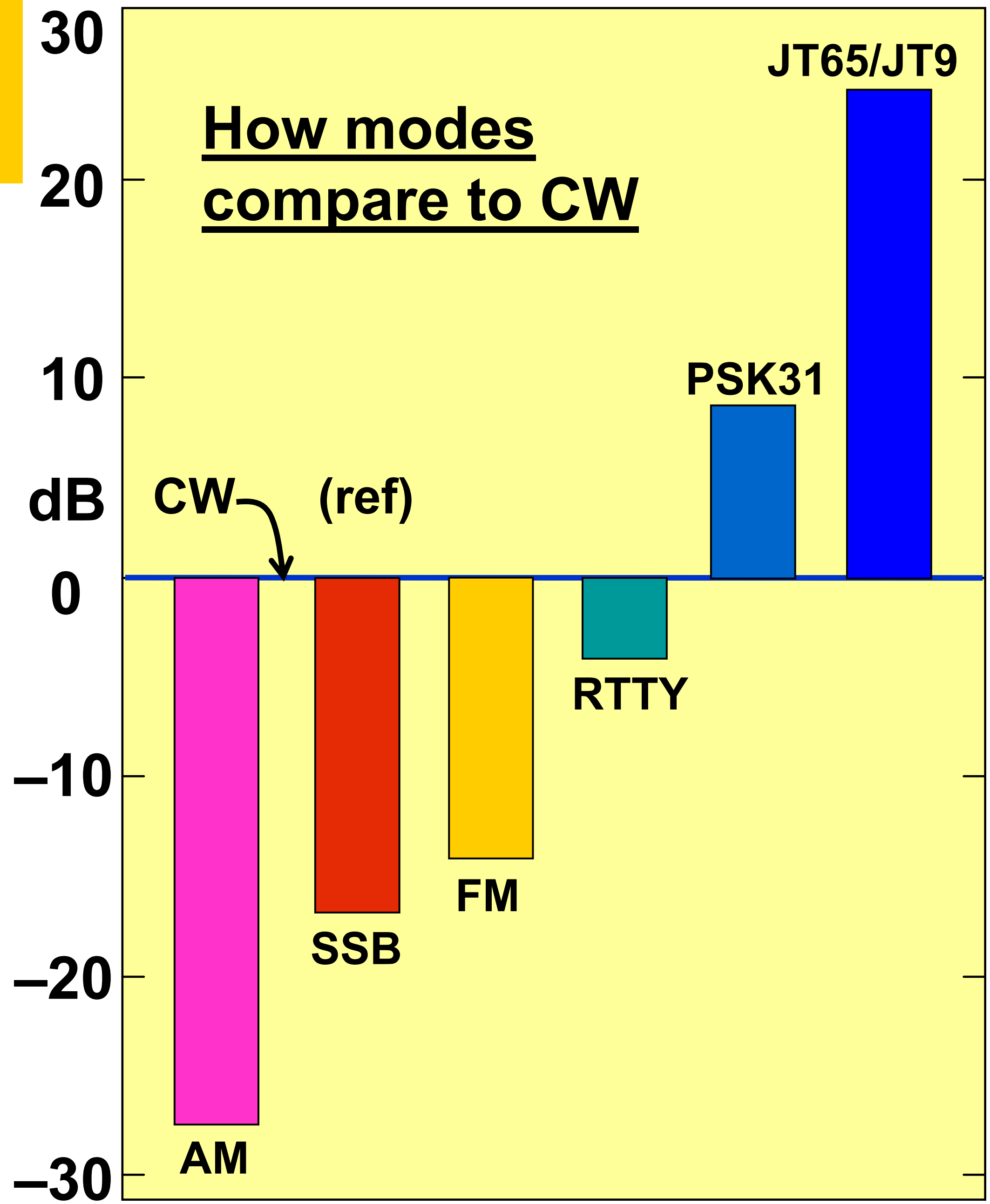




Why use Digi?

Digital modes "talk" further than phone

Some digital modes talk further than CW



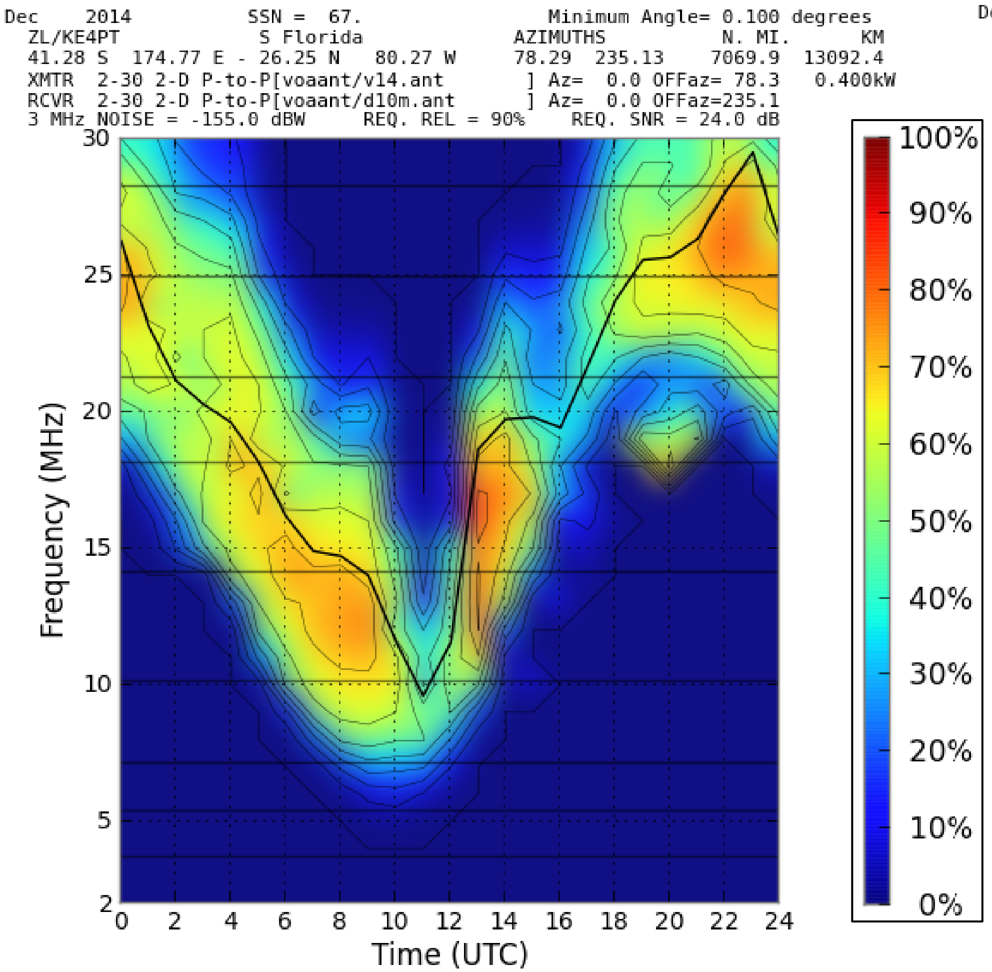
From: K. Siwiak, KE4PT and B. Pontius, NØADL, "*How much "punch" can you get from different operating modes?*" *QST* Dec 2013.

Digital modes Talk Further!!

JT65 at 5 W

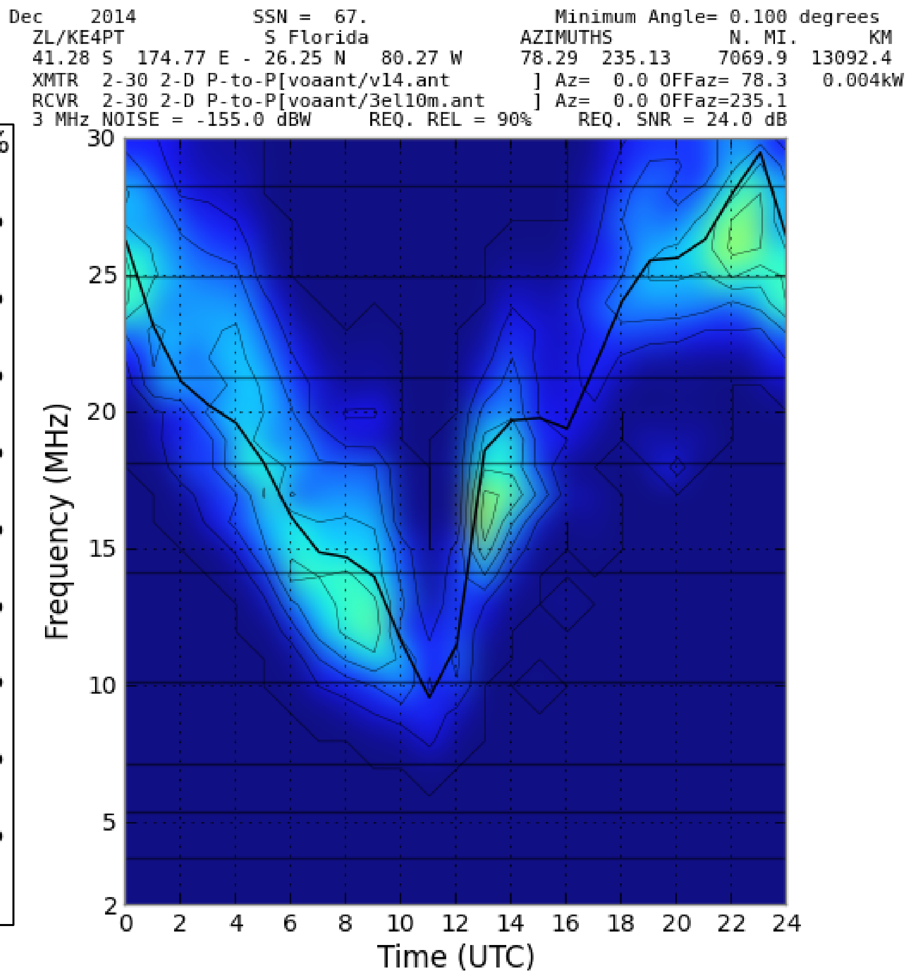
Circuit Reliability (%)

ZL→FL path

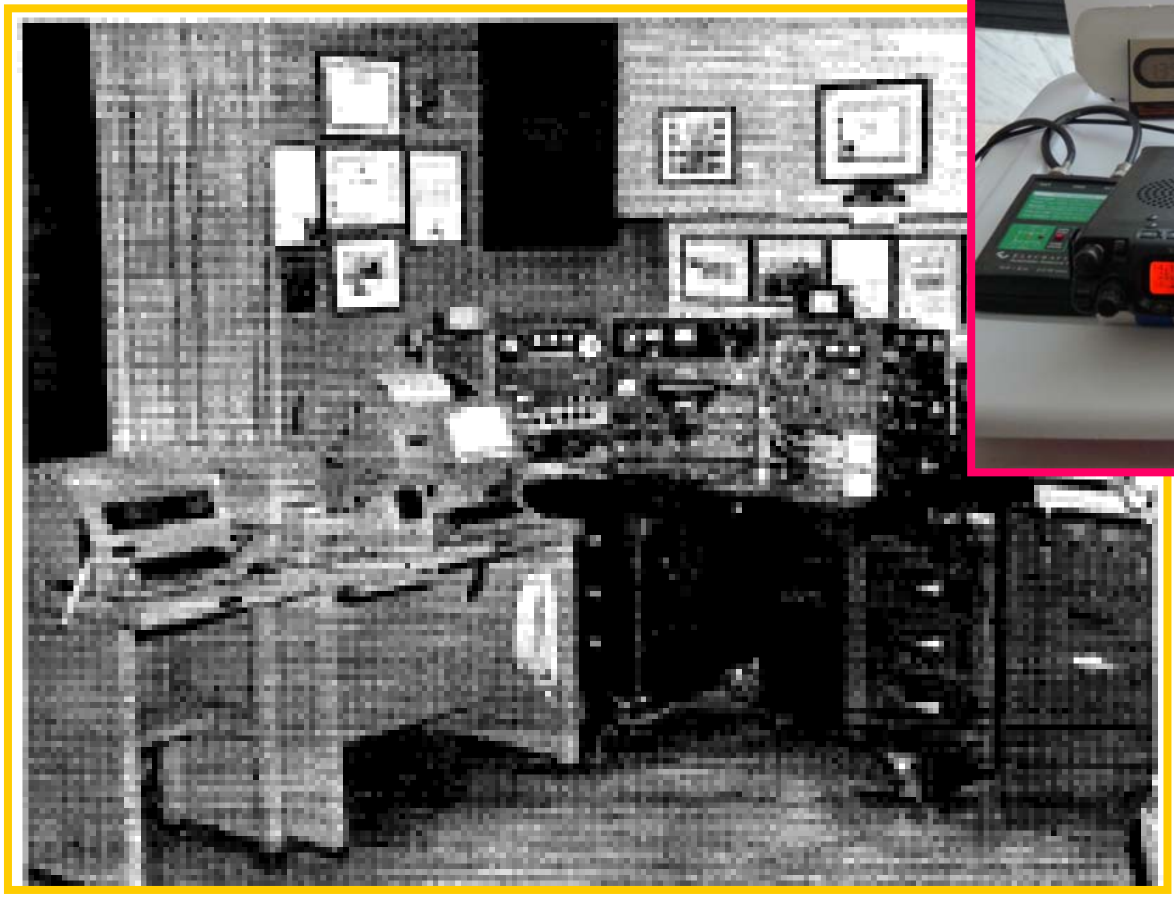


CW at 5 W

Circuit Reliability (%)



YesterYear *to* Today



Thanks for your attention!!