PSK31

and other sound card digital radio modes

Alan J. Masson, GM3PSP / K6PSP

Lothians Radio Society, 24 March 2010

Summary

- PSK31 description
- Other digital sound-card modes
- Sound clips

PSK31

- Invented in 1998 by Peter Martinez, G3PLX (also responsible for introduction of AmTor)
  - RSGB *RadCom* December 1998.
  - “A New Radio-Teletype Mode - Improving on RTTY”
- Without disadvantages of some digital modes:
  - Avoids need for error correction / latency, which he believes make some modes unsuitable for live QSOs
  - No need to send faster than can be typed by hand
  - High frequency stability of modern transceivers allows use of much narrower bandwidth
  - Powerful modern digital processors allow better coding
- PSK31 is now the most popular digital mode

PSK31 Technical Summary

- Symbol rate — 31.25 baud (~ 50 wpm)
  - considered a reasonable typing speed
  - easily derived from common 8kHz sample rate used in many DSP systems
- Bandwidth — 62.5 Hz
- Modulation — Differential 2-PSK (BPSK)
  Binary Phase-Shift Keying
- Average power — 80%
- Protocol — Asynchronous unconnected chat mode (!)
- Character set — Varicode, ASCII user interface

PSK31 Uses Varicode Coding

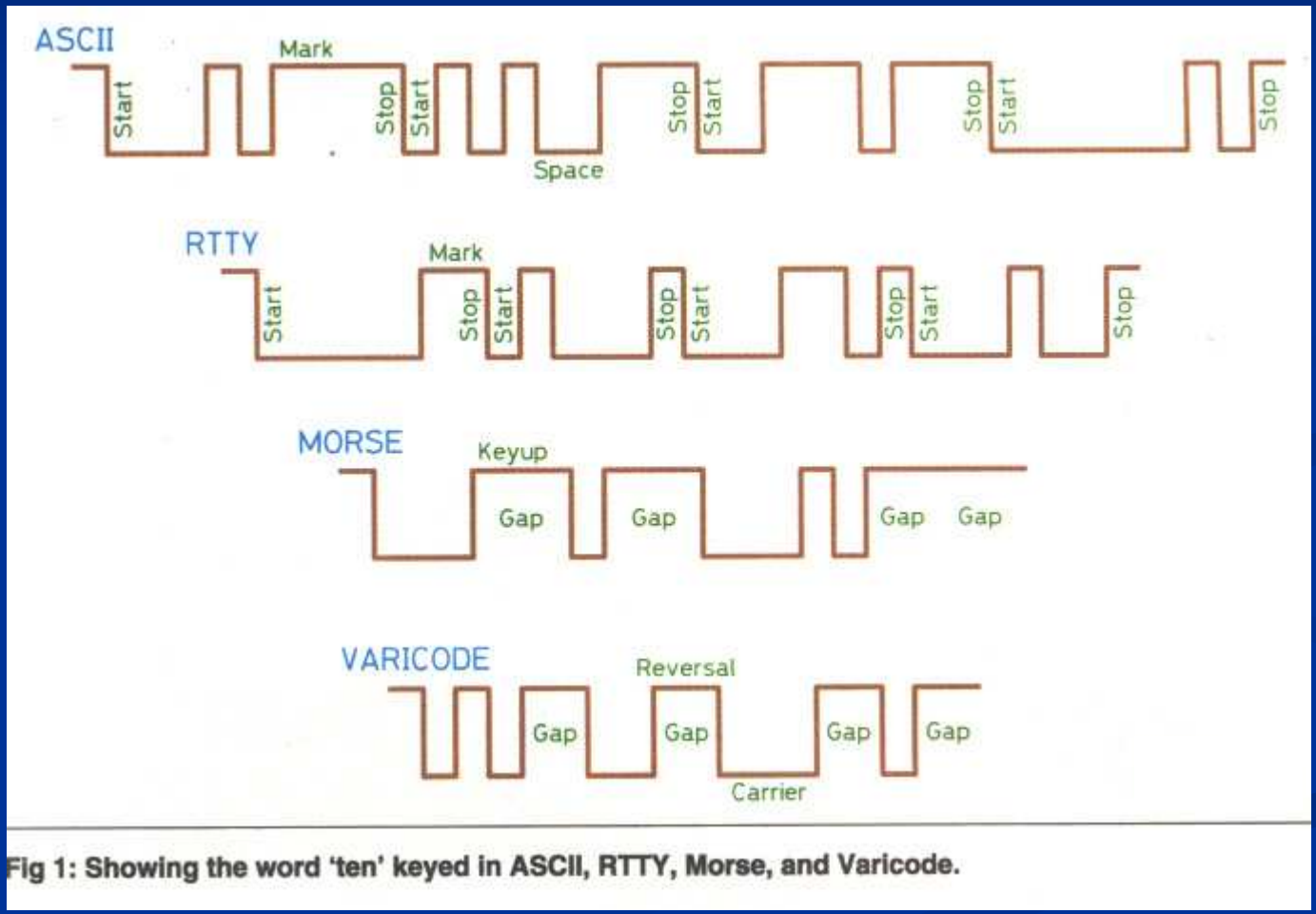


Fig 1: Showing the word 'ten' keyed in ASCII, RTTY, Morse, and Varicode.

Varicode – examples

- a 1011
- b 1011111
- c 10111
- d 101101
- e 11
- i 1101
- o 111
- t 101

- 0 10110111
- 1 10111101
- 2 11101101
- 3 11111111
- 4 101110111
- 5 101011011

- Complete 128-character ASCII set with 10 bits

- A 1111101
- B 11101011
- C 10101101
- D 10110101
- E 1110111
- Space: 1

- CODE DEFINITIONS:
- 0 = PSK phase reversal
- 1 = No phase change
- Every character starts and ends with a 1
- Shorter codes for most common characters, like Morse Code
- At least two 0s are inserted between characters (“letter gap”)
- No character contains two 0s

PSK31 Waveform

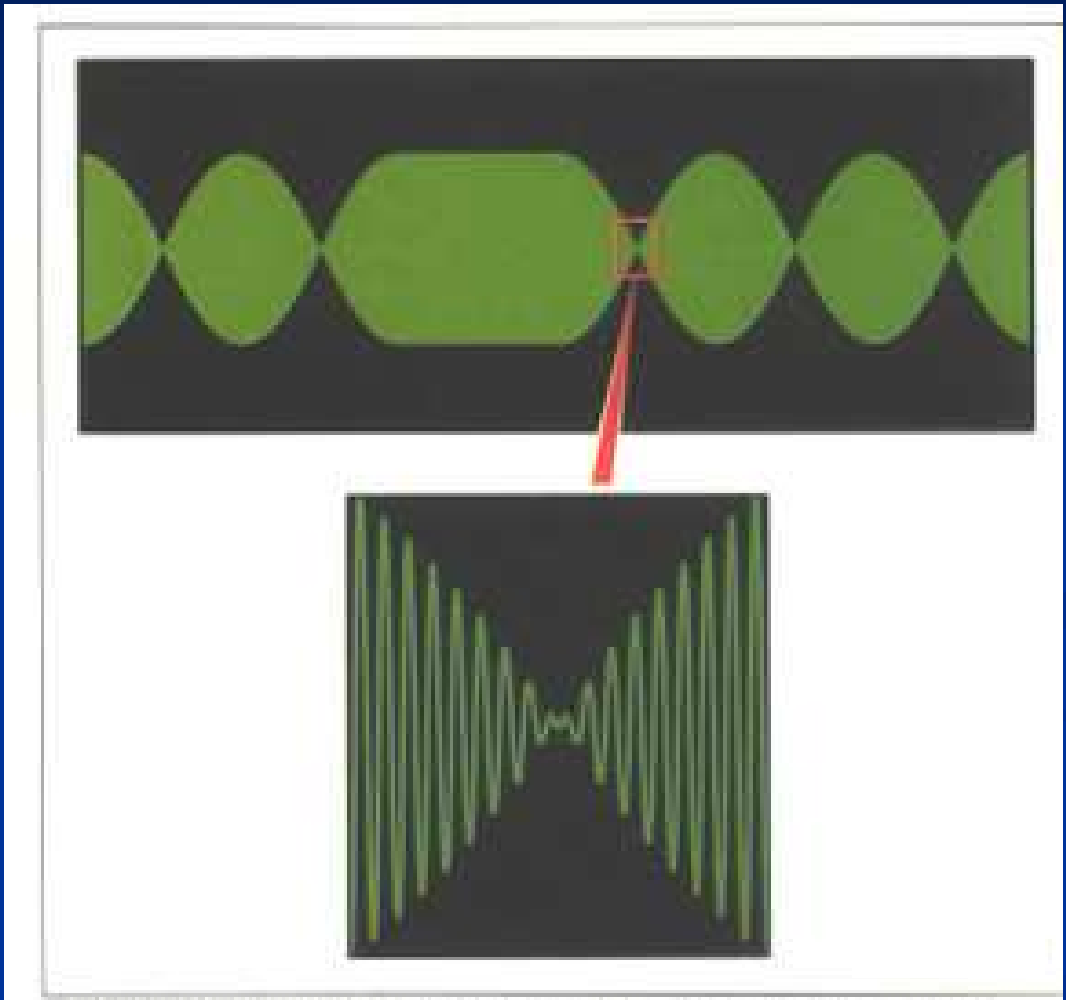


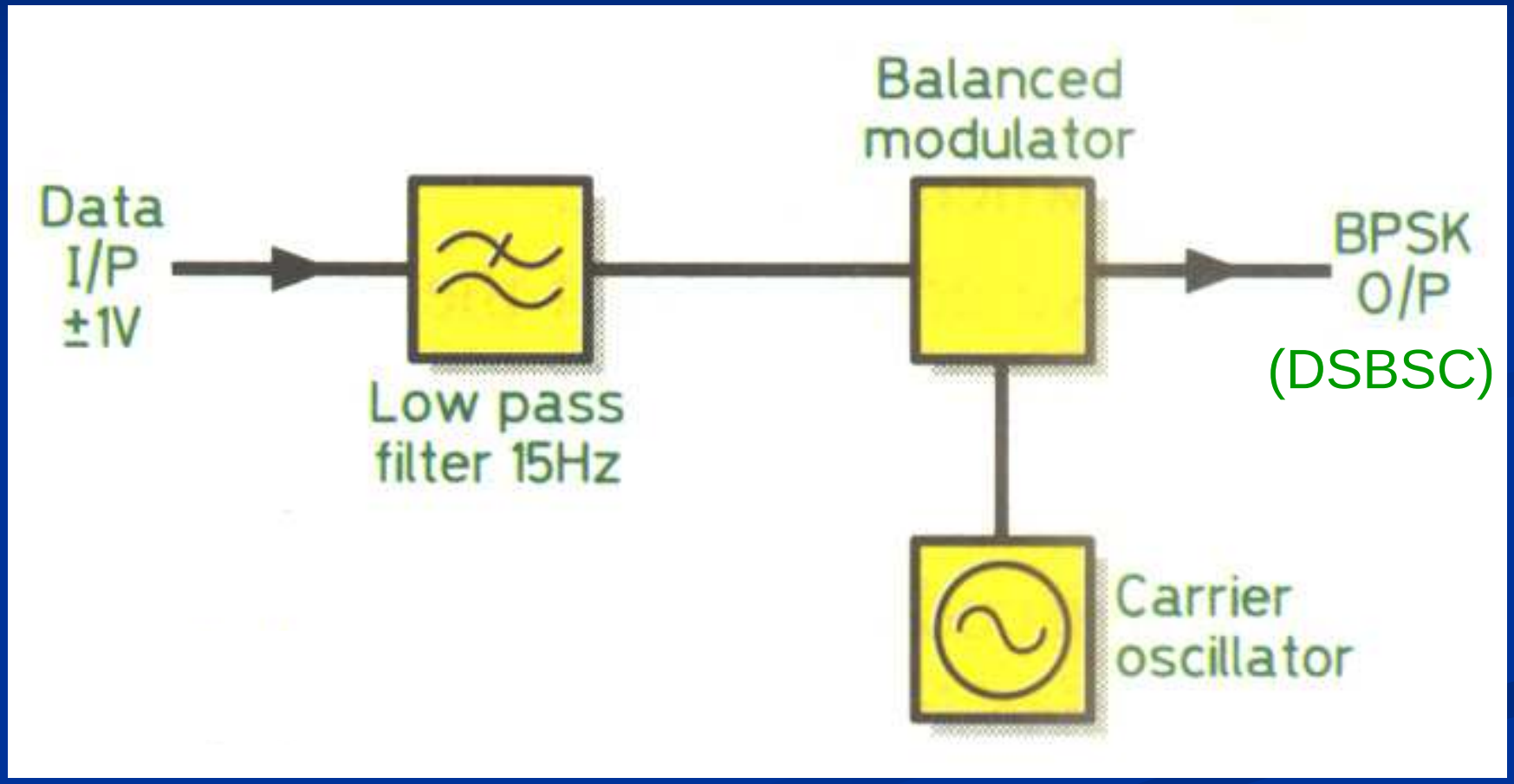
Fig 2: Showing the waveform of BPSK sending the Varicode 'space' symbol.

Raised Cosine waveform - smoothly changes from 0 to 1 like a cosine wave, avoiding square-wave switching-noise on phase-change being transmitted.

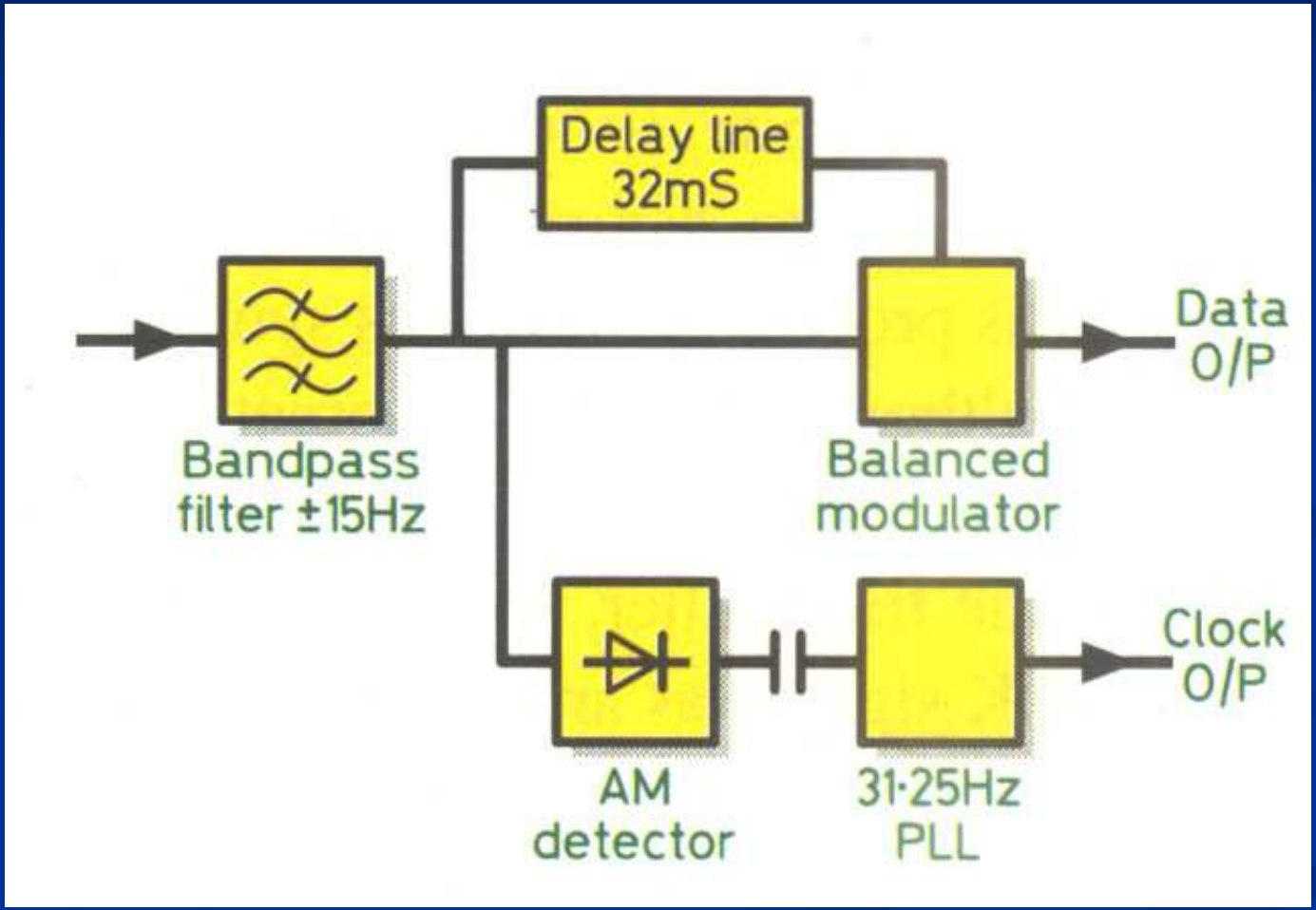
This provides minimum bandwidth properties

The amplitude changes are used to synchronize the receiver clock

PSK31 Modulator



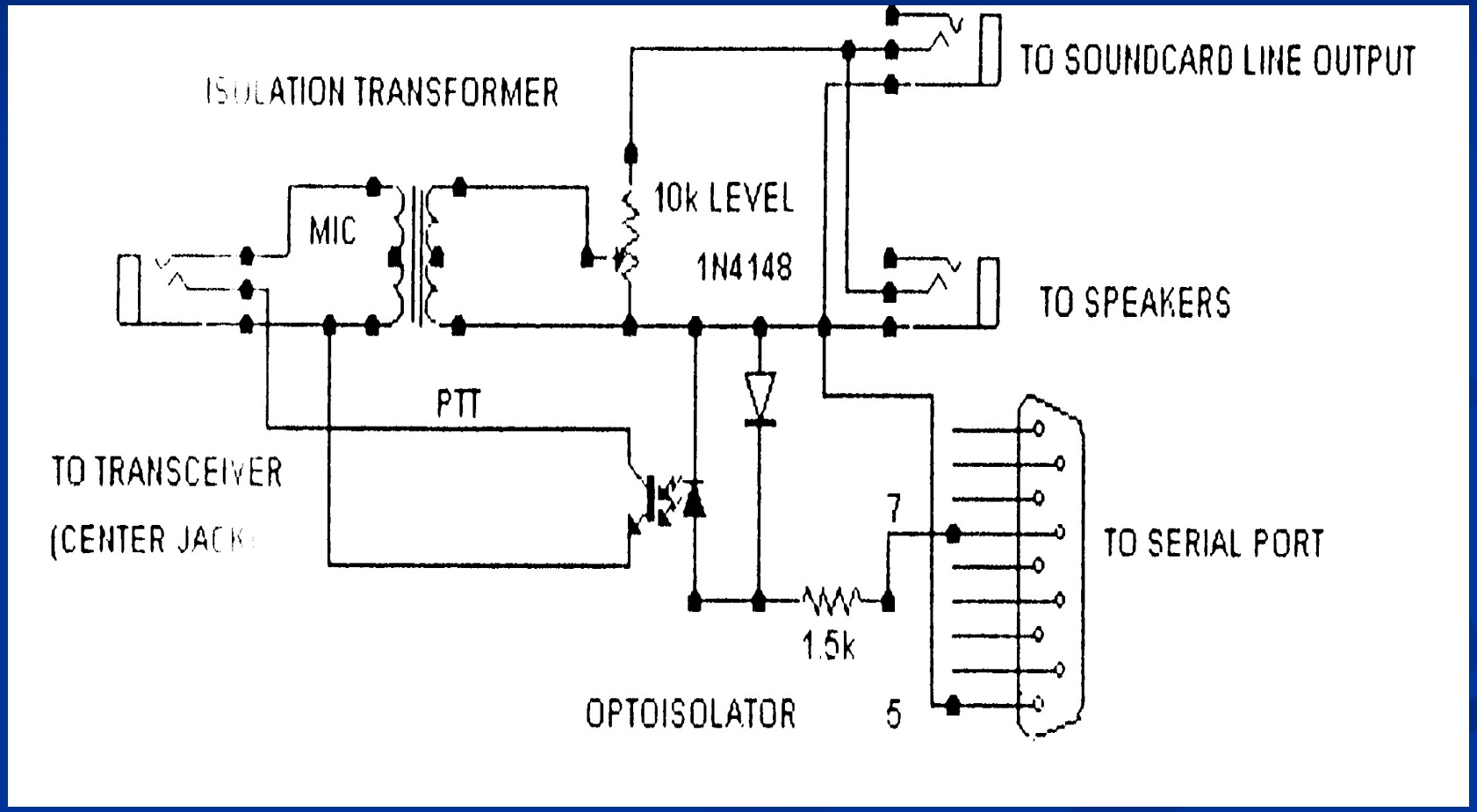
PSK31 Demodulator



Interfacing Transceiver & Computer

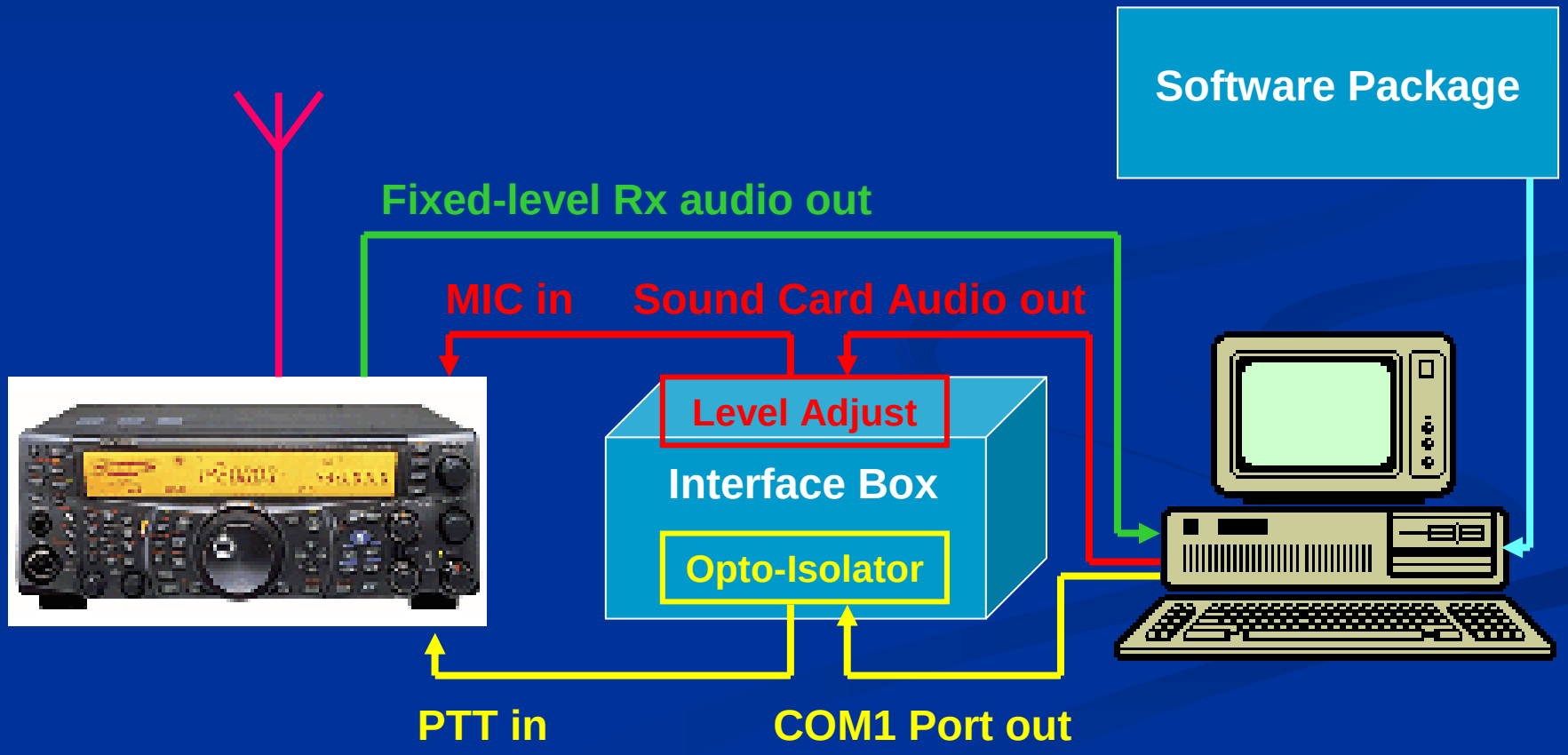
- Fixed-level audio output from transceiver to sound card Line input
- Sound card Line output via level-adjust pot to microphone input.
- Serial port via opto-isolator to mic PTT
- (Use of VOX tends to be unreliable)
- Various interface boxes are available to organize these inter-connections

DIGIPAN Isolating Interface for PSK31



Interfacing Transceiver & Computer

for PSK31 and many other digital modes



“PSK This Weekend”

PSK31 This Weekend

Explore a new world in five easy steps.

Steve Ford, WB8IMY

Have you ever tuned your transceiver across 14.070 MHz and wondered about those odd, warbling sounds? They're the same sounds you're likely to hear in the vicinity of 7.070 and 3.580 MHz. They could be stray emissions from your neighbor's coffee pot, or they might be signals from alien starships using the HF airwaves to coordinate an invasion of our planet.

As entertaining as the prospect of an alien invasion may be, I'd prefer to put my money on something more down to earth. In reality, what you are hearing is the music of digital conversations, specifically conversations taking place with a mode known as *PSK31*.

The Short Story

The short story of PSK31 is that it is a popular digital communication mode invented by Peter Martinez, G3PLX, in the late 1990s. The new mode arrived just in time to take advantage of the sudden proliferation of computer sound devices. PSK31 exploits the ability of a computer sound card (device, chipset...whatever) to act as a digital-to-analog or analog-to-digital converter.

PSK31 operation is about as straightforward as it gets, at least in the digital universe. With PSK31 software running in your station computer, you simply type on your keyboard. Your deathless prose is then translated into narrow (about 50 Hz or less) phase-shifting audio signals by your sound device. The dulcet tones are applied to your SSB transceiver, either at the microphone or rear-panel accessory input, and launched into the ether.

At the receiving end, the audio from the radio goes to the sound device, which converts the eerie warbles back into digital data. The PSK31 software then generates visual representations of the signals, usually as ghostly traces on so-called *waterfall* displays. You click your mouse cursor on one of the traces and — *voilà!*— text begins crawling across your monitor.

An inexpensive computer microphone will let you eavesdrop on the PSK31 world.

Quite a few amateurs have picked up the PSK31 bug because it offers excellent performance in otherwise lousy conditions, the kinds of conditions we tend to find on the air these days. Many believe that PSK31 even rivals CW when it comes to its ability to be decoded long after the voice modes have thrown in the towel.

PSK31 is particularly attractive to amateurs who find themselves in “antenna restricted environments.” Hams living in apartments and condos are making contacts every day with PSK31 and indoor antennas; they'd otherwise be off the air entirely.

Get a Glimpse This Weekend

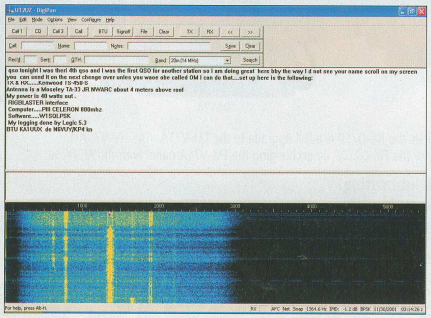
You can catch a glimpse of the PSK31 world this weekend, or even this evening.

Before we get started, I'll take the liberty of assuming that you own an HF SSB transceiver and a computer with Internet access and some sort of sound device (look for the ⅛ inch jacks in the front or back of the computer). Even a laptop will do the job. If you are nodding your head vertically, read on.

Step 1: Do you own one of those appallingly cheap computer microphones? The kind with the ⅛ inch stereo plugs? If not, go to your nearest RadioShack, Staples, etc and buy one. You'll probably have to spend between $10 and $20.

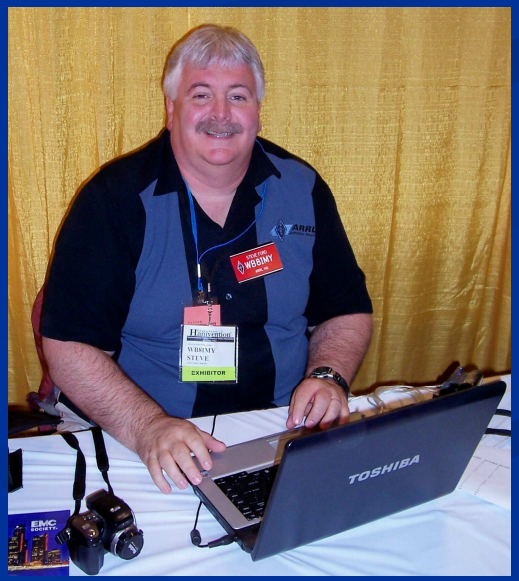
Step 2: Get on the Internet and go to the *DigiPan* site at **www.digipan.net**. Download the latest version of *DigiPan* for *Windows*. This is the PSK31 software and it is free. If you own a Mac, go to W7AY's *Cocoamodem* site at **http://homepage.mac.com/chen/w7ay/cocoaModem/index.html**. This program not only does PSK31, but a host of other digital modes. If you're a *Linux* user, try *Fldigi* at **www.w1hkj.com/Fldigi.html**.

Step 3: Install the software. Read the

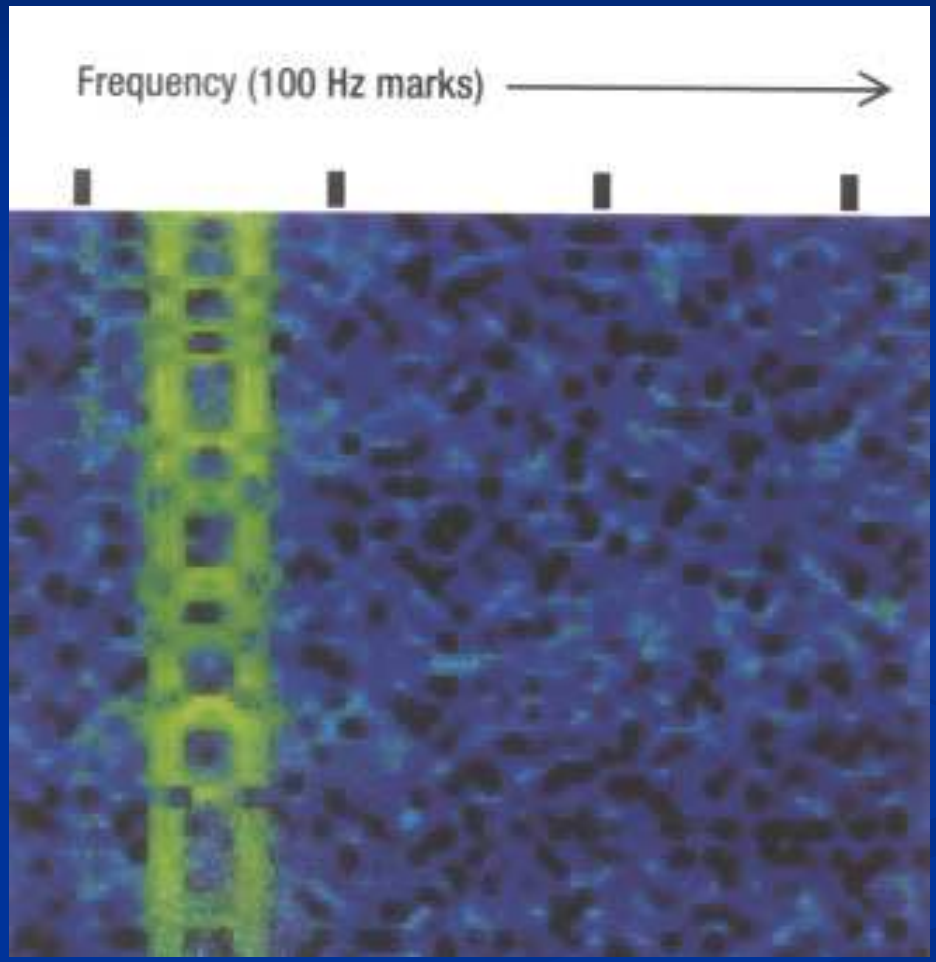


DigiPan for *Windows* is free PSK31 software available at www.digipan.net. Each line in the waterfall display represents a PSK31 signal.

- QST Article, Jan 2010
- Steve Ford WB8IMY
- Receive-only
- Audio input to computer via desk microphone
- Free Digipan software



PSK31 Signal on Waterfall Display



Spectrum of PSK31 Signal

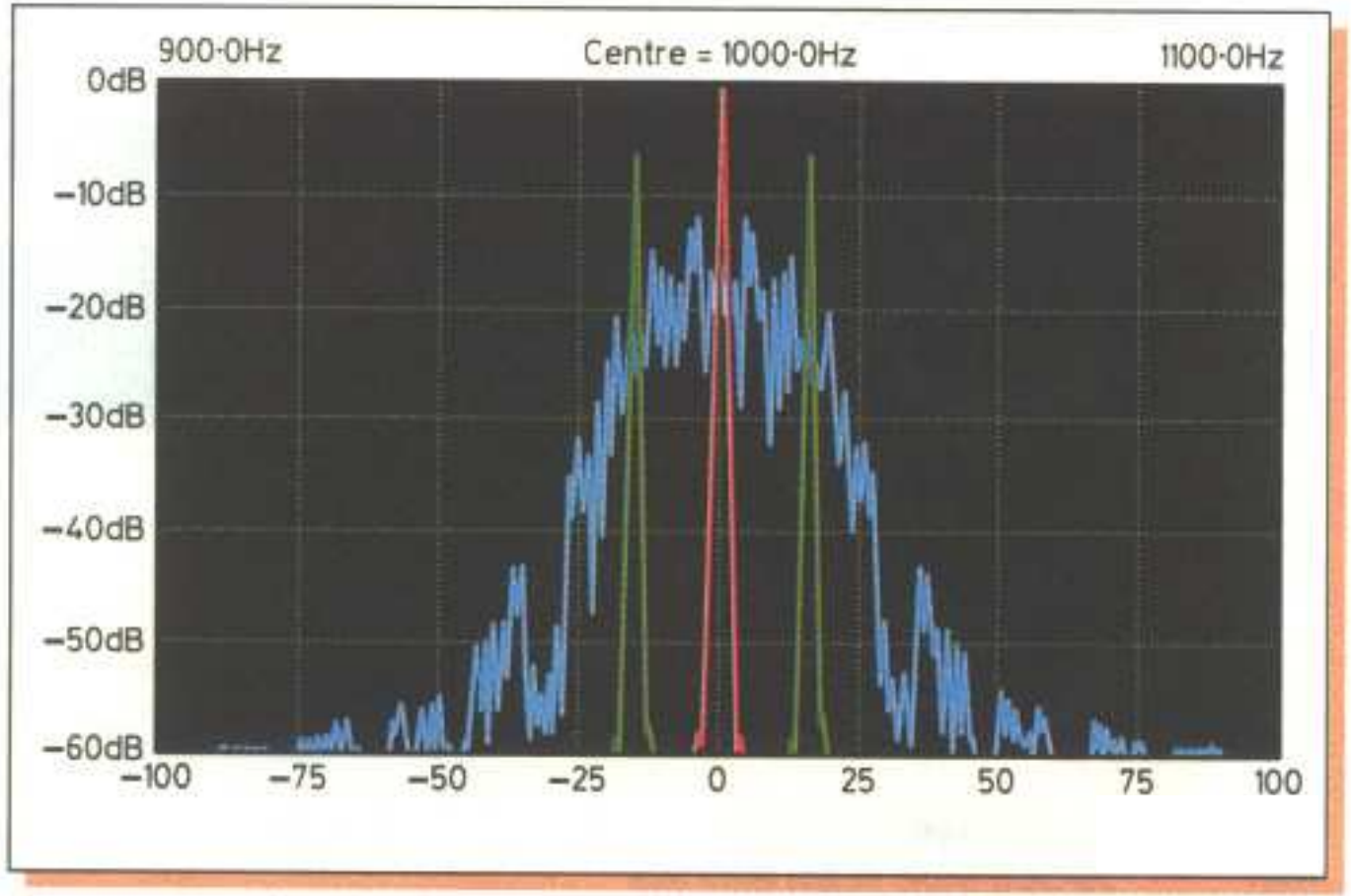


Fig 4: Showing the spectrum of the BPSK signal, idling and sending data, compared with an unmodulated carrier at the same signal level.

Comparison of PSK31 and FSK

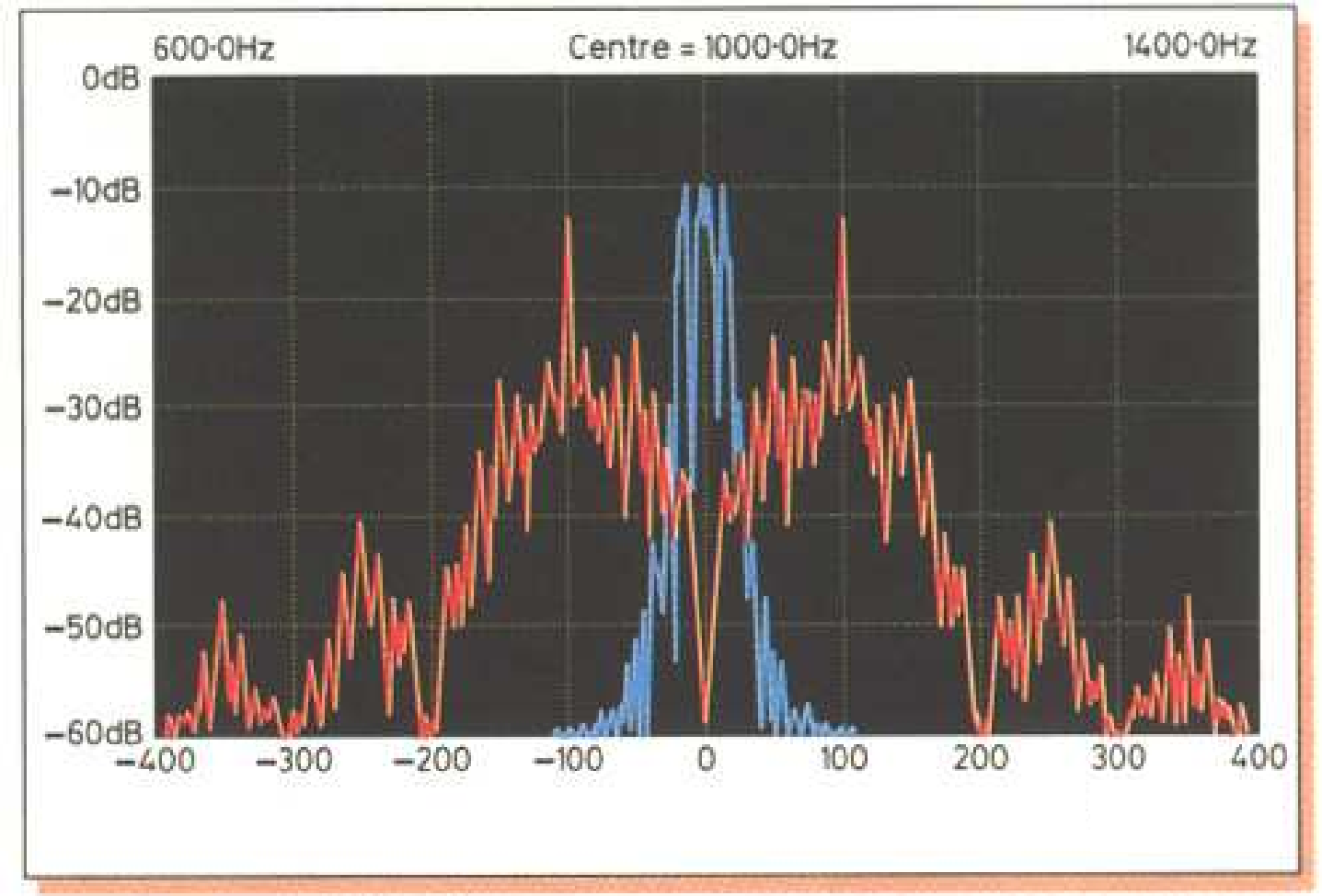
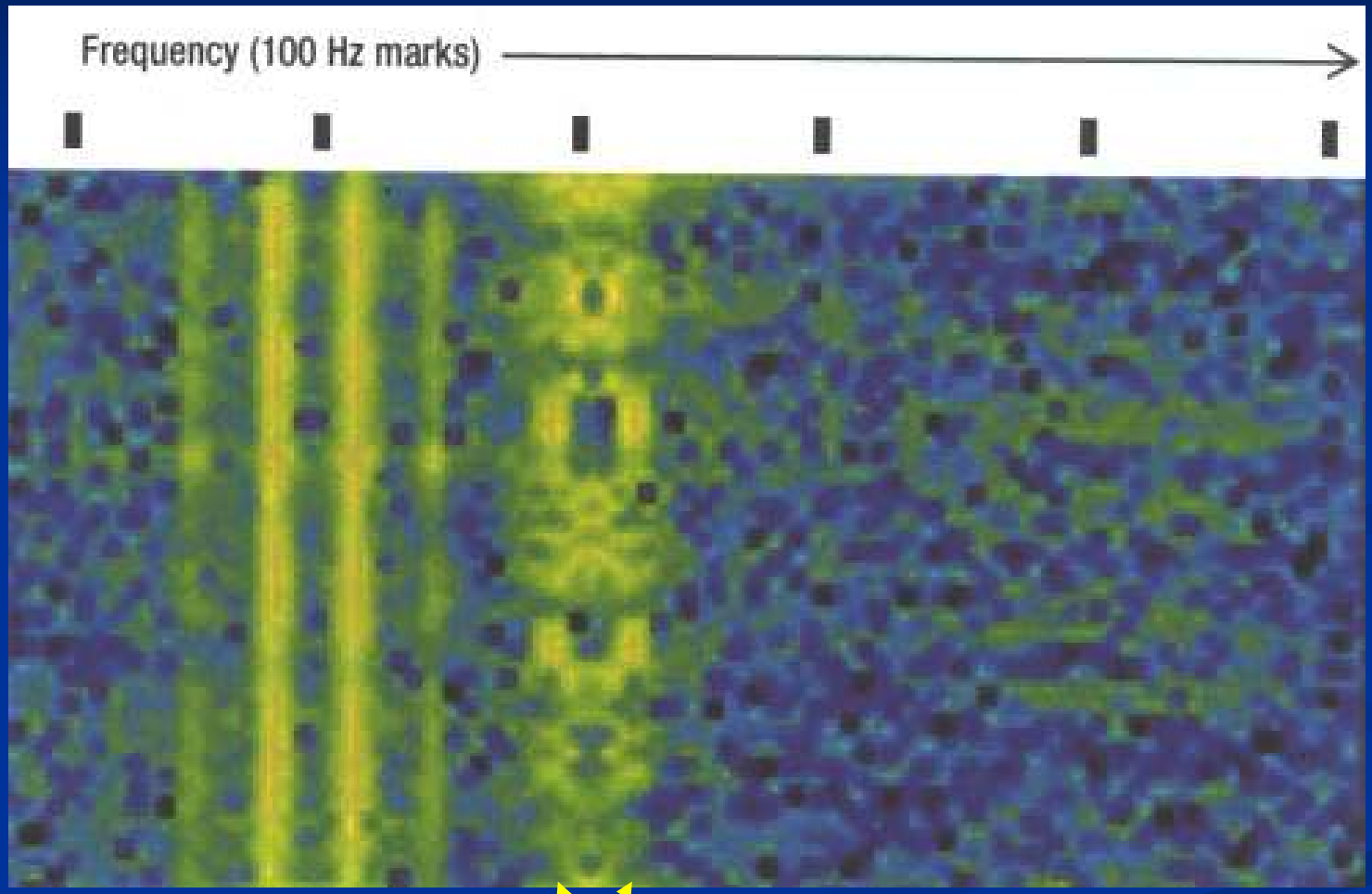


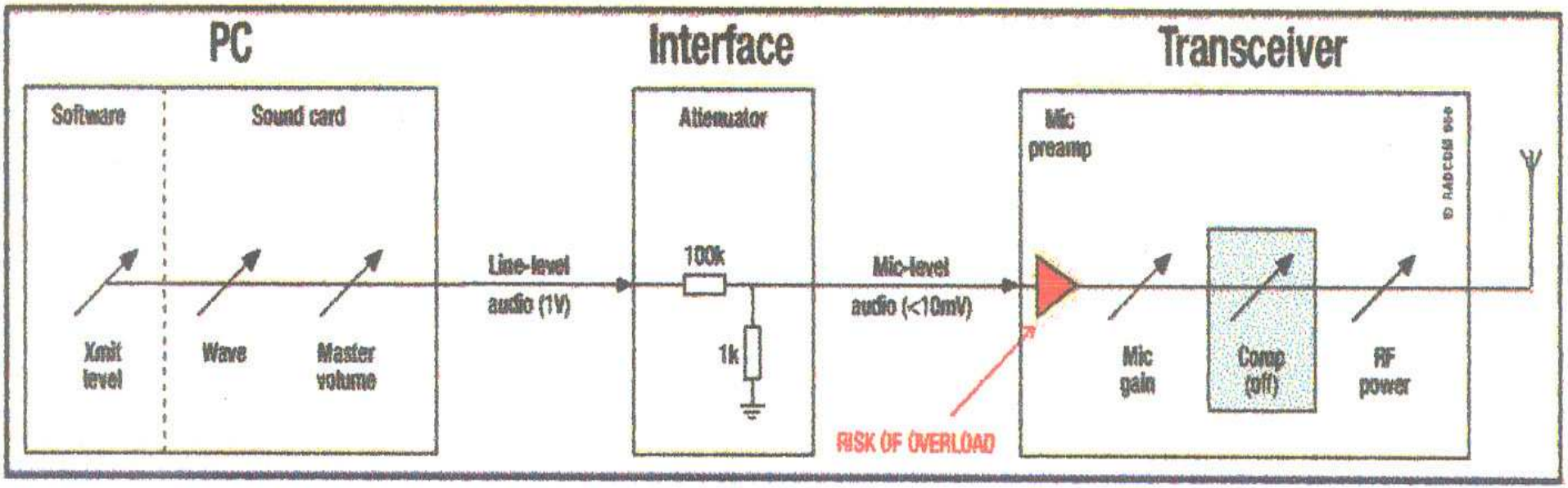
Fig 5: Comparison of PSK31 spectrum with 100 baud, 200Hz shift FSK.

Over-Driven PSK31 Signal



A GROSSLY over-driven signal can have multiple unwanted sidebands

BPSK Signal Level Control



- Audio signal level must be adjusted to operate in a completely linear manner
- Overload of MIC pre-amp is most likely cause of non-linearity
- This cannot be corrected using MIC Gain control
- Transmitted signal should have IMD < -25 dB
- IMD can be measured (Rx) in Digipan or using PSKMeter accessory in Tx mode

Frequencies for PSK31

1838
3580
7035 - Regions 1 and 3
7070 - Region 2
10139
14070
18100
21070
24920
28120

The activity of multiple stations occupies the bandwidth of a single SSB channel with the above carrier frequencies

Related BPSK Modes

- PSK31 General use (most common)
- QPSK31 Low-signal / error correction
- PSK63 Higher-speed
- PSK125F Higher speed
- PSK250F Higher speed
- FSK31 Similar to PSK31

PSK31 Software

- **Digipan V.2** PSK31, QPSK31, PSK63, FSK31, Pactor Rx
  - including Multichannel receive screen
- **MixW** (Reg. fee) PSK31, PSK63, QPSK, FSK31, RTTY, Packet, Pactor RX, AMTOR RX & FEC TX, MFSK/Graphics Color/BW, Olivia, Contestia, RTTY, Throb, MT63, Hell, FAX, SSTV
- **Stream** PSK31, PSK63, PSK125, PSK250, MFSK16/8
- **Hamscope** PSK31, QPSK31, CW, RTTY, MFSK16, Packet
- **PocketDigi** PSK31, CW, RTTY – for programmable PDAs
- **MMVARI** PSK31, RTTY, MFSK16, FSK31
  - linked to N1MM contest logging software

PSK31 Demo - Rx

- Kenwood TS-850 in USB mode
- Fixed-level audio into sound card
- Digipan Ver.2 - multimode
- 14.070 MHz

Other Digital Sound-Card Modes

- that I have used

- **RTTY**
- **MFSK16**
- **MT63**
- **Hellschreiber**
- **Throb**
- **Analog SSTV - Scottie 1**
- **Digital SSTV – DIGTRX**
- All these modes use same basic hardware + free software
- Frequencies: 10 kHz above PSK31 (not SSTV)

PSK31 and PSK63

- PSK31 demo (35 sec): 
- QPSK16 demo (17 sec): 
- PSK63 demo (35 sec): 

RTTY

- Sound-card modes use AFSK
- Software: MMTTY, MMVARI, MixW etc
- Audio Demo (25 sec): 

MFSK16

- Invented by Murray Greenman, ZL1BPU (1999)
- Developed for Windows - Nino Porcino IZ8BLY
- 16 tones spaced at 15.625 Hz; 4 char/sec
- Full-time Error Correction (FEC)
- Designed for long-haul Dx conversations
- Software: IZ8BLY-Stream, Hamscope; MixW
- MFSK16 demo (32 sec): 
- MFSK8 demo (55 sec): 
- FSK441 (by K1JT) for meteor-scatter
  4 tones at 147 cps; 1470 wpm; b/w 2205 Hz

MT63

- Developed by Pawel Jalocha, SP9VRC, 1998
- 64 tones spaced at 15.625 Hz; 10 char/sec
- Powerful FEC
- Designed as a chat mode, esp. multi-station
- Sounds like broad-band noise
- Software: IZ8BLY-MT63, MixW
- Superimposed CW ID:
- MT63 500 Hz demo (40 sec): 
- MT63 1000 Hz demo (22 sec): 
- MT63 2000 Hz demo (12 sec): 

Hellschreiber

- Derived from mechanical system (Dr Rudolf Hell, Germany, 1927)
- DSP system developed by G3PLX in 1997
- Columns of 14 dots / 5 columns per character
- 2.5 characters / sec (25 wpm)
- On / Off keying of transmitter; bandwidth 350 Hz
- Software: IZ8BLY-Hell, MixW
- Feld Hell demo (35 sec): 
- FM Hell 105 baud demo (35 sec): 

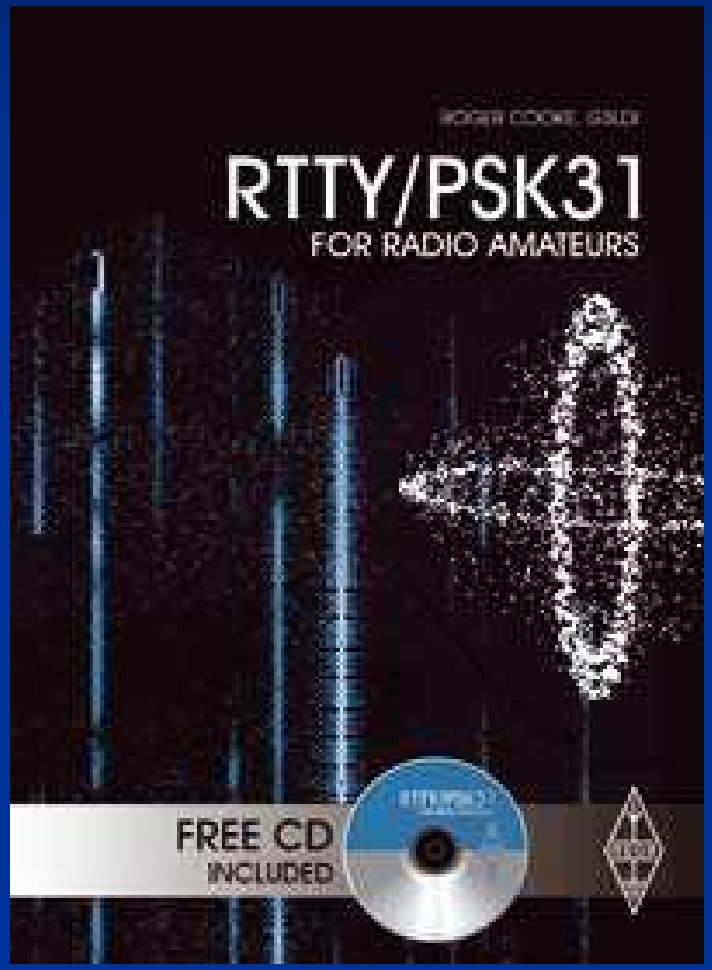
THROB

- Invented by Lionel Sear, G3PPT in 2000
- MFSK system; 9 tones
- 1, 2 or 4 tones / sec
- Bandwidth 100 or 200 Hz
- Software: Throb, MixW
- 1 Throb / sec demo (60 sec): 
- 2 Throb / sec demo (35 sec): 
- 4 Throb / sec demo (19 sec): 

SSTV

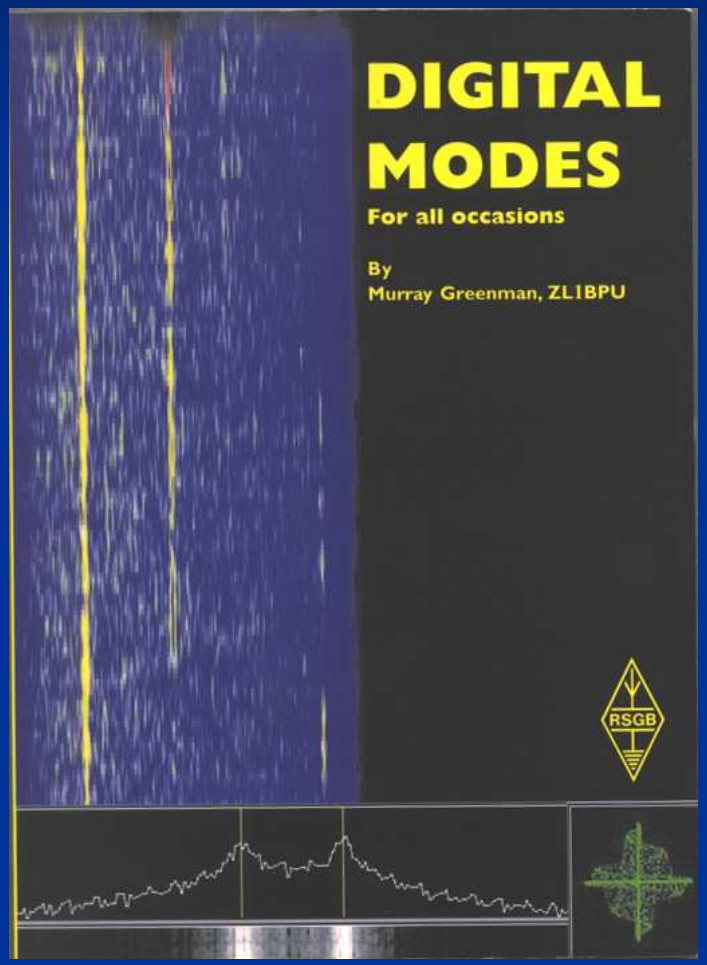
- Analog SSTV – Scottie-1 demo (30 sec): 
- Digital SSTV – DIGTRX demo (30 sec): 

Further Reading



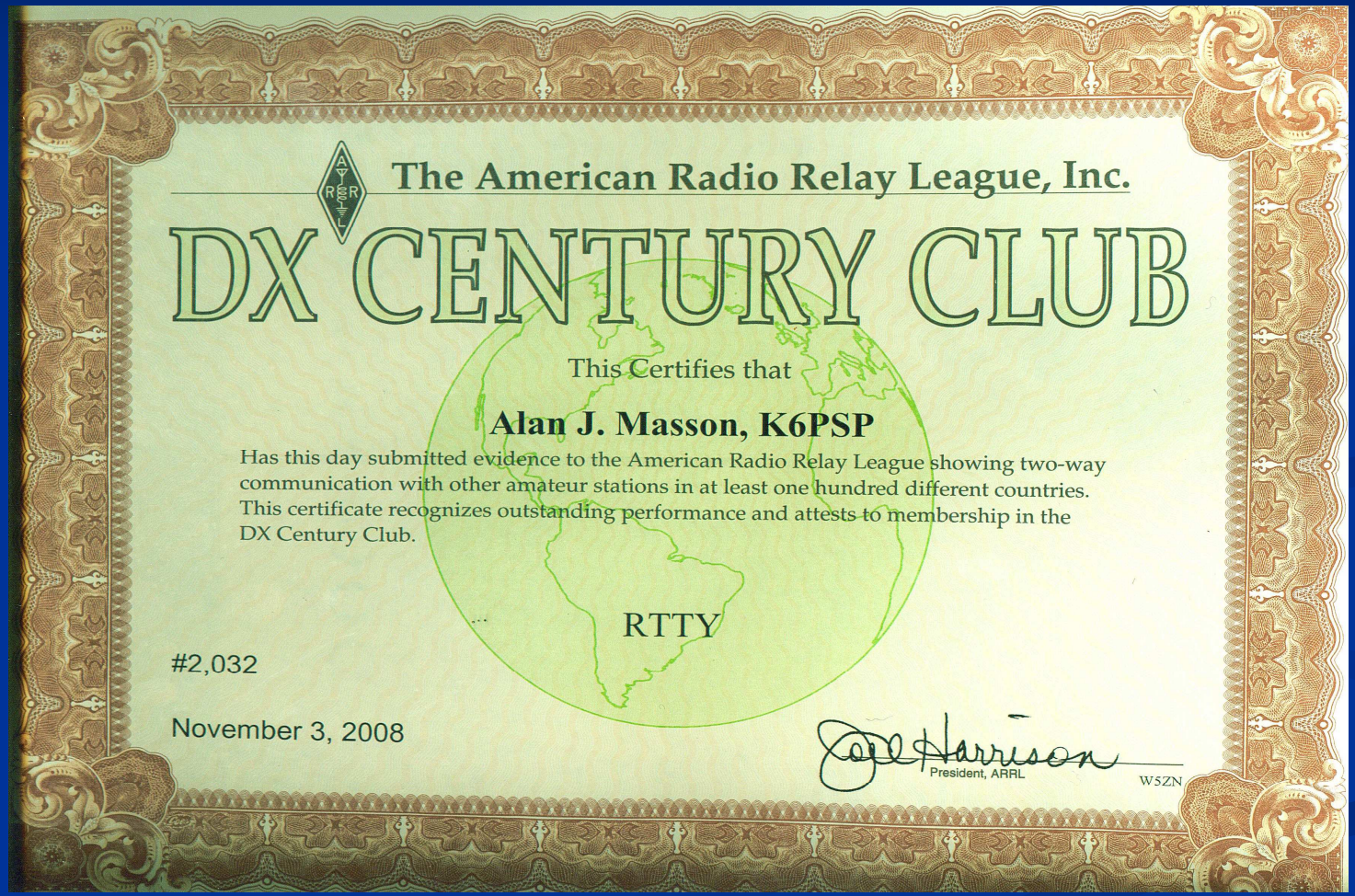
- ***RTTY/PSK31 for Radio Amateurs***
- By Roger Cook G3LDI
- RSGB
- Includes free CD of amateur programs

Further Reading



- ***Digital Modes for All Occasions***
- By Murray Greenman, ZL1BPU
- RSGB, 2002

PSK31 DXCC but it says “RTTY” !



The American Radio Relay League, Inc.

DX CENTURY CLUB

This Certifies that

Alan J. Masson, K6PSP

Has this day submitted evidence to the American Radio Relay League showing two-way communication with other amateur stations in at least one hundred different countries. This certificate recognizes outstanding performance and attests to membership in the DX Century Club.

RTTY

#2,032

November 3, 2008

Joel Harrison
President, ARRL

W5ZN


That's all Folks!

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and other sound card digital radio modes

ANY QUESTIONS?

Alan J. Masson, GM3PSP / K6PSP

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