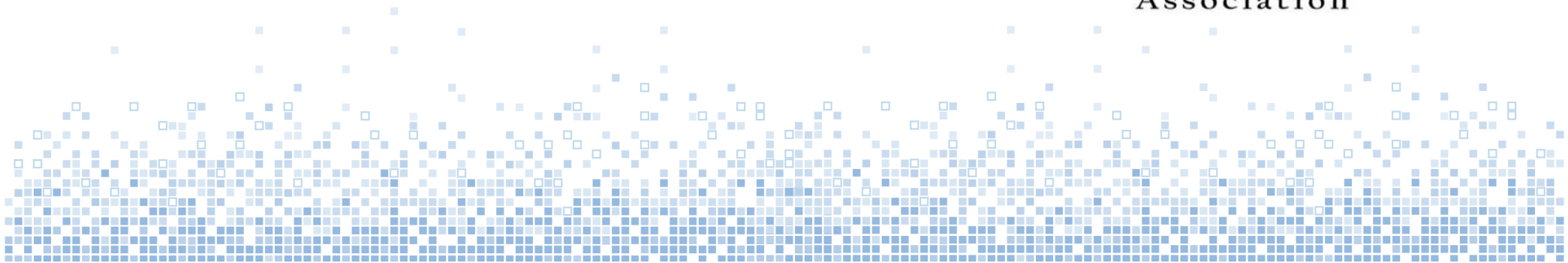# ELoran and Amateur Radio - A Study in Co-existence

Dr Paul Williams (The GLAs of the UK and Ireland)
Professor David Last (Consultant to the GLAs)
Dr Nick Ward (The GLAs of the UK and Ireland)

$$y_2(t) = \frac{1}{16N} \sum_{n=1}^{N} \left\{ \sum_{m=1}^{16} [x_{int}(t) * \delta(t + t_m + t_n) \, pc(m)] \right\} \qquad (8)$$

In order to evaluate $y_2(t)$, we take the Fourier Transform of both sides of equation (8) (see [18] for details). The attenuation of the CWI due to phase-decoding and integration can therefore be obtained by taking the modulus of the division of $Y_2(f)$ by $X_{int}(f)$
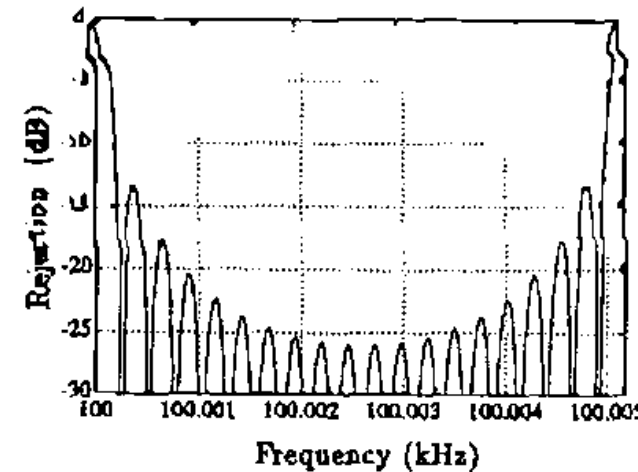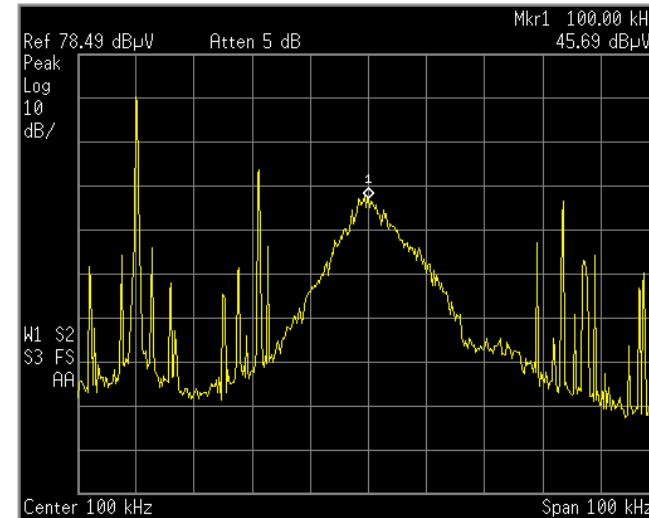
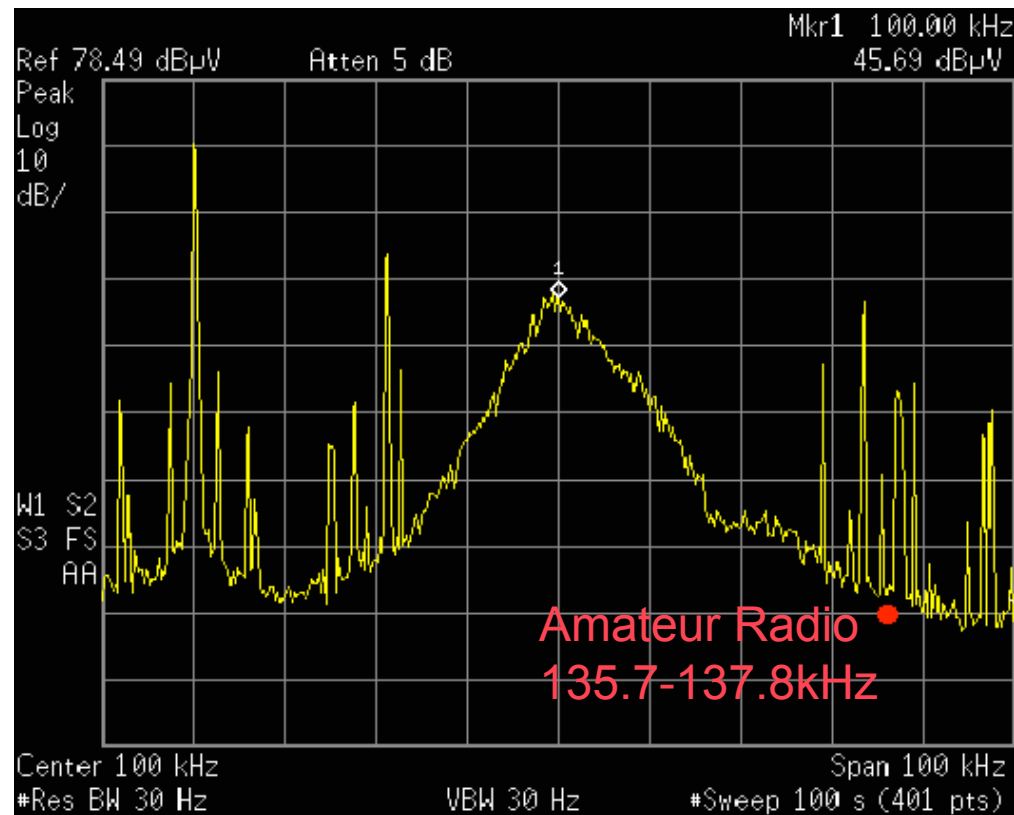$$Rejection(f_{int}) = R_1(f_{int}) \, R_2(f_{int}) \qquad (9)$$

$$R_1(f_{int}) = \left| \frac{1}{N} \sum_{n=1}^{N} \exp(+j2\pi f_{int} t_n) \right| \qquad (10)$$

where

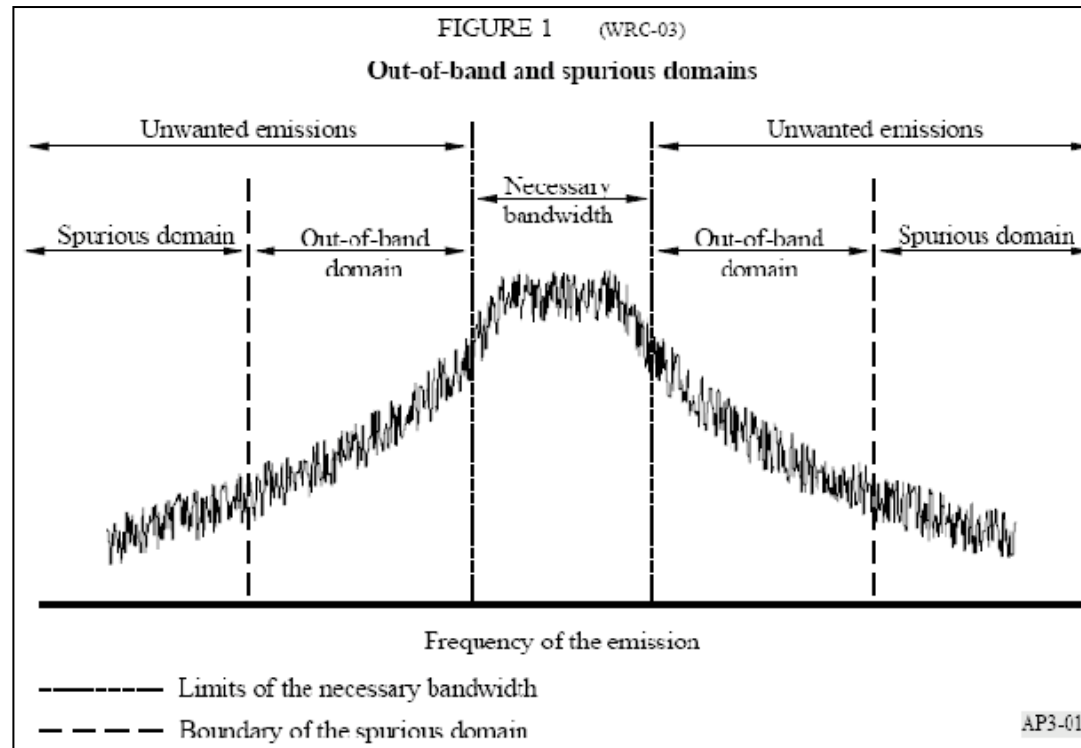$$R_2(f_{int}) = \left| \frac{1}{16} \sum_{m=1}^{16} \exp(+j2\pi f_{int} t_m) \, pc(m) \right| \qquad (11)$$
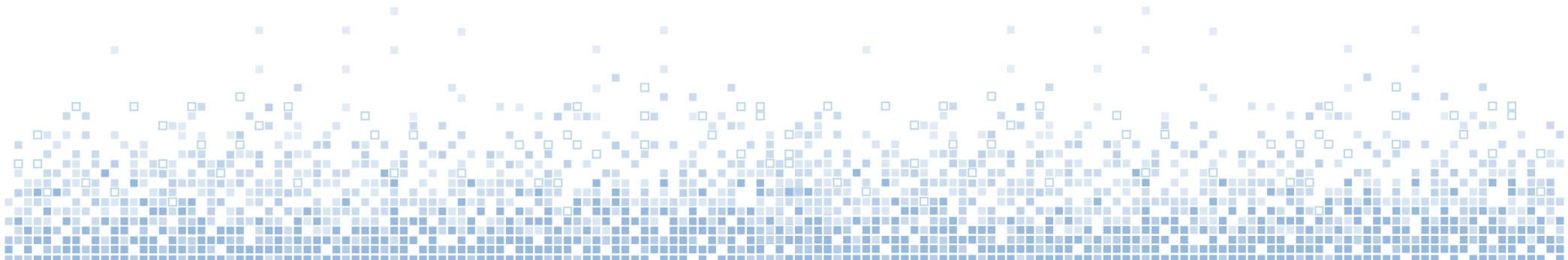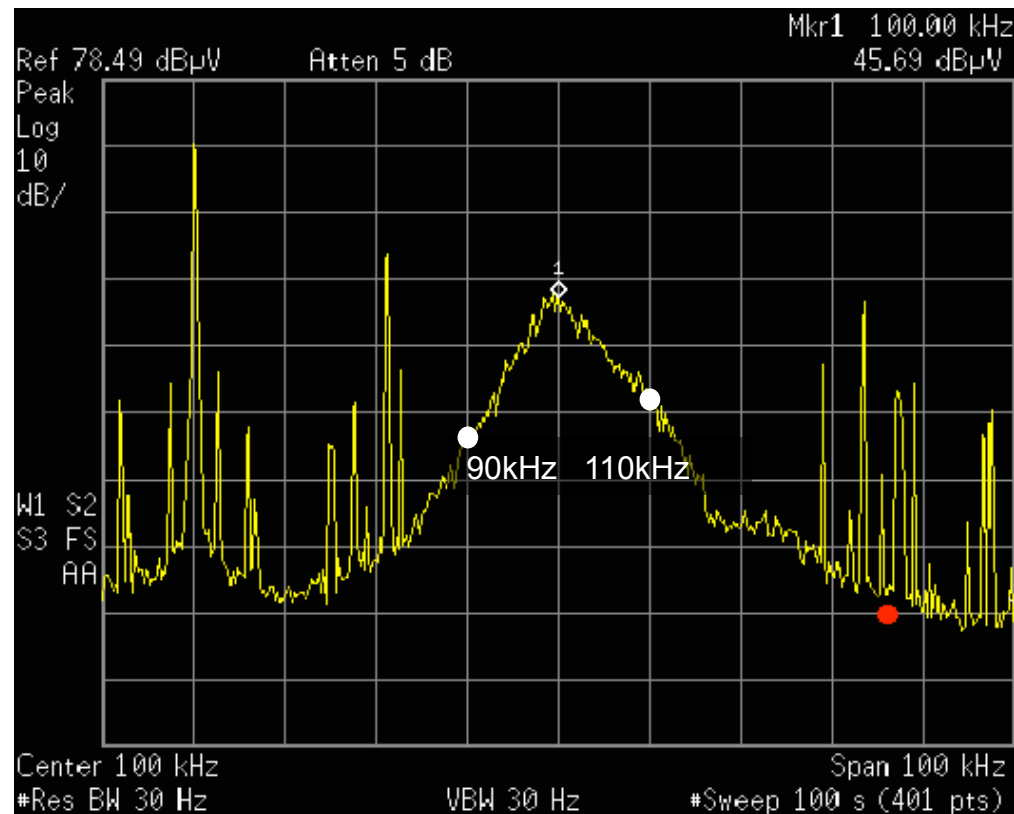
Carrier-wave interference with Loran

Spectrum from 50kHz -150kHz

FIGURE 1   (WRC-03)
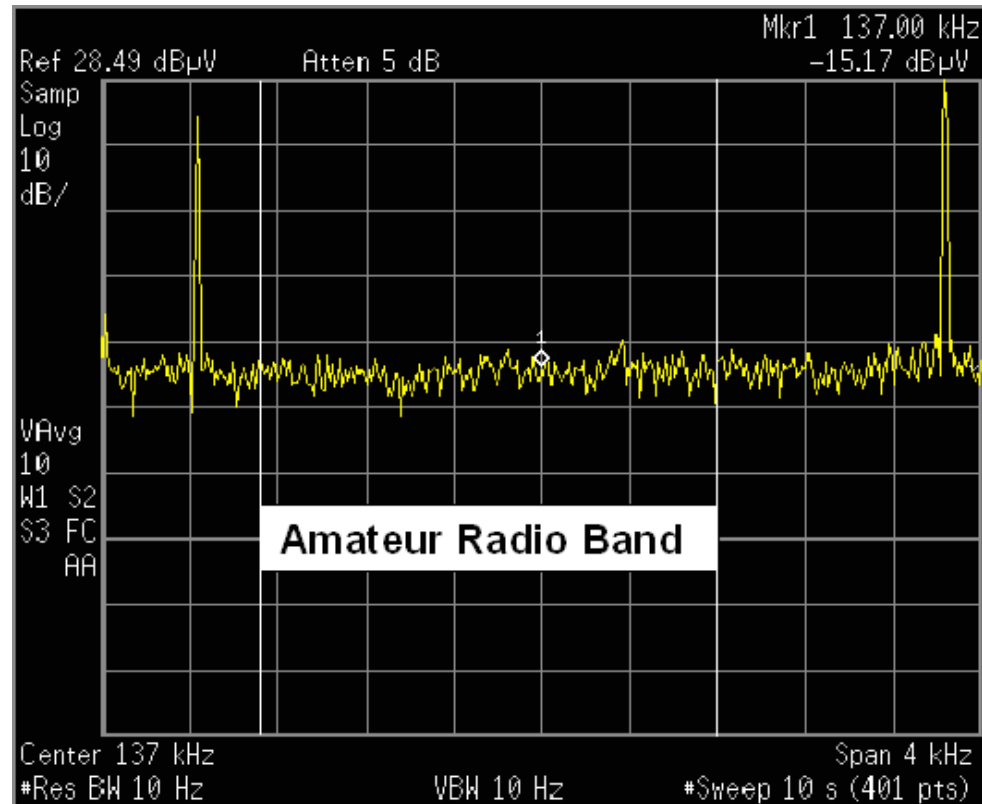
Out-of-band and spurious domains

ITU Radio Regulations, Volume 1, Chapter 1, 'Terminology and Technical Characteristics', 2004
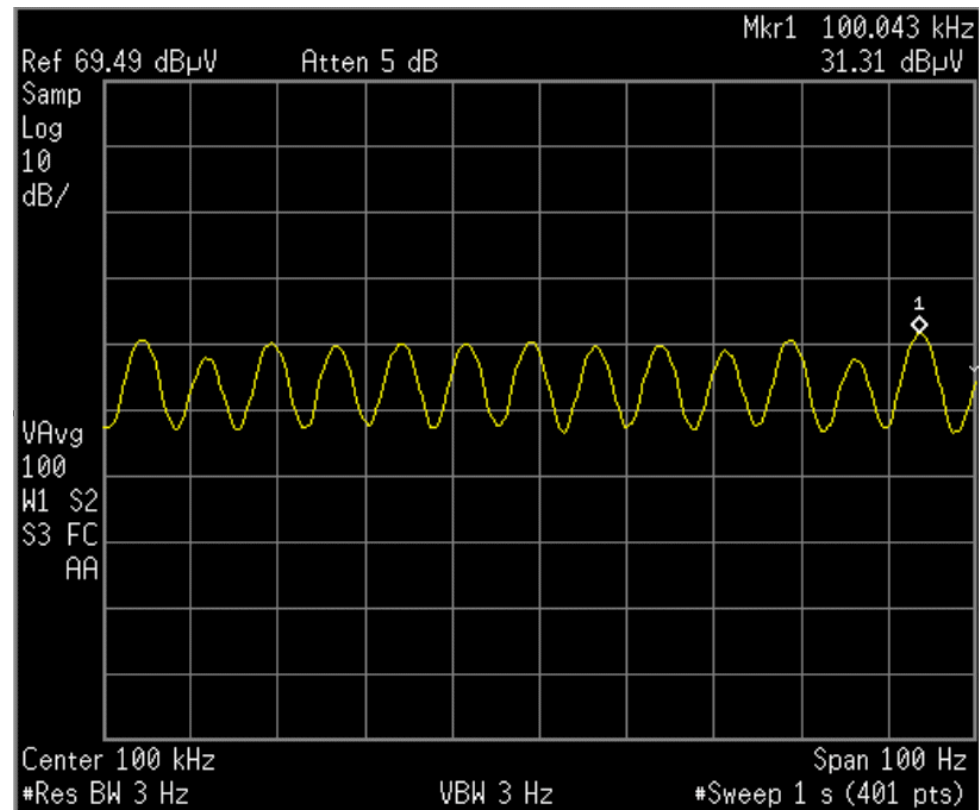
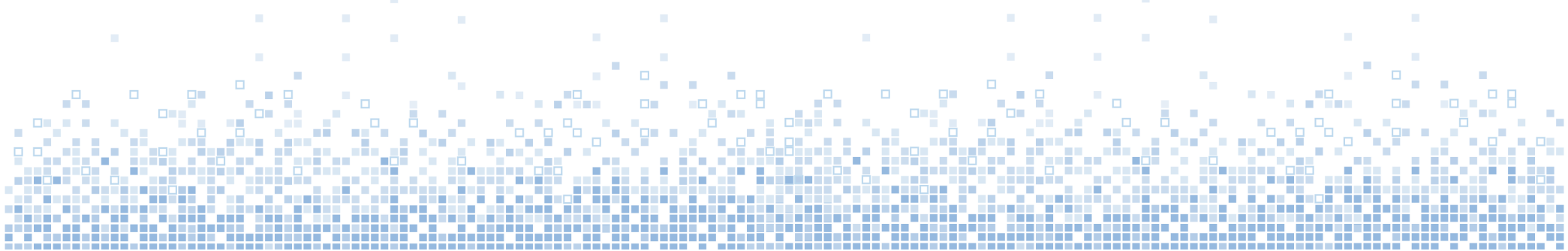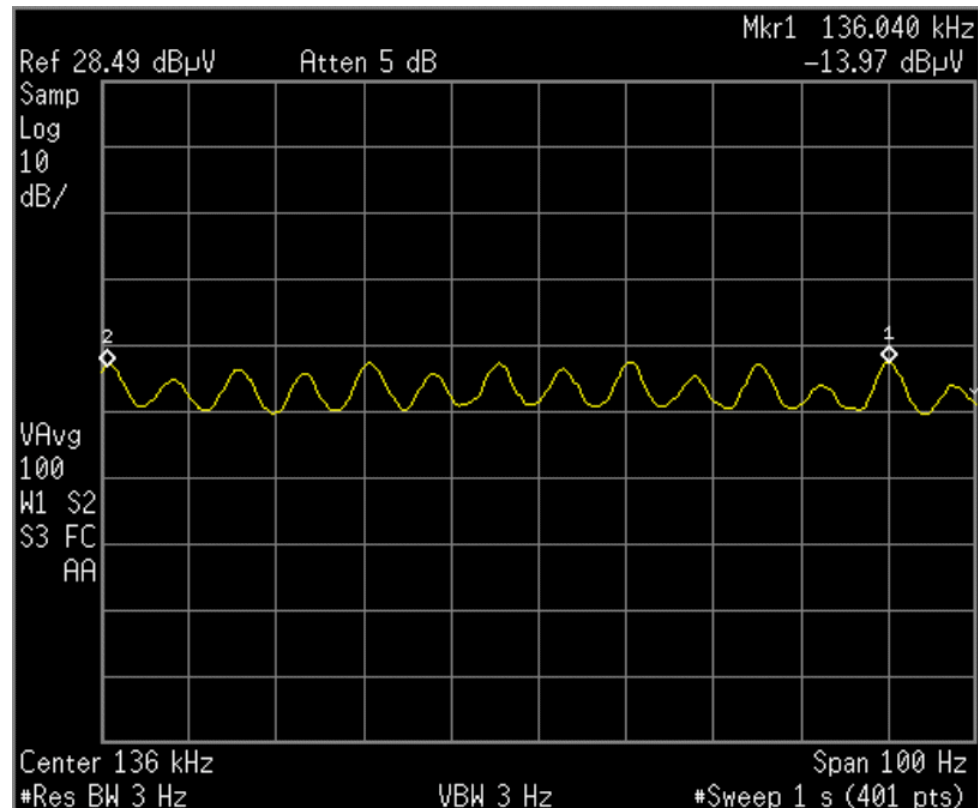Spectrum from 50kHz -150kHz near Anthorn

Spectrum from 135kHz -139kHz near Anthorn

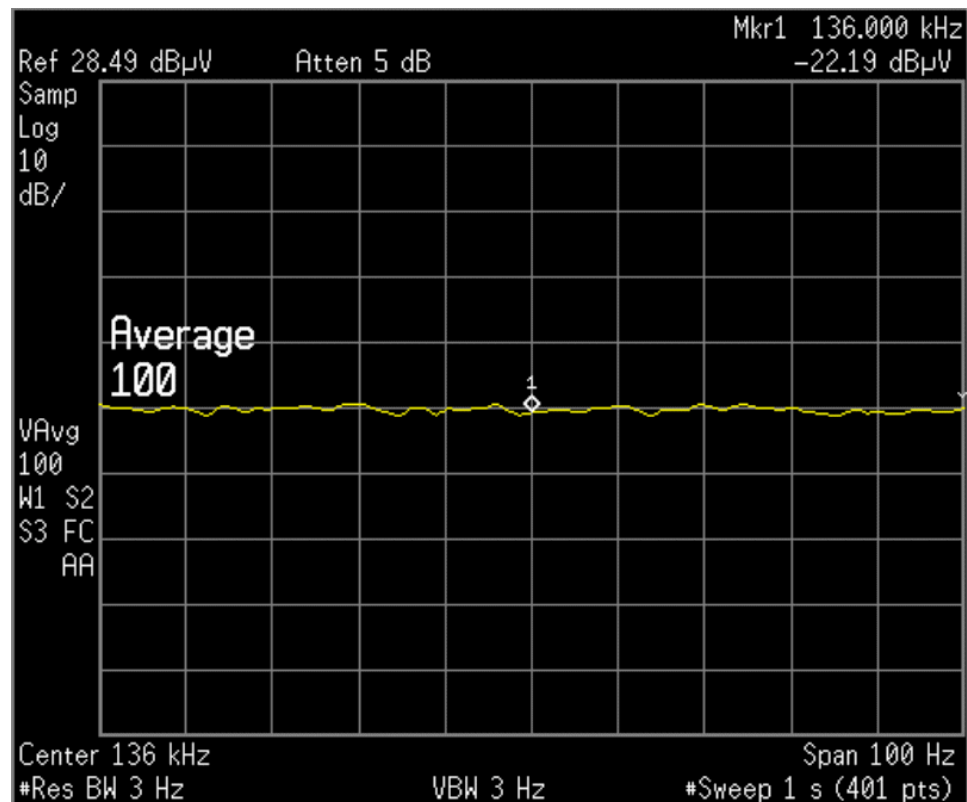100Hz-wide slice of spectrum at 100kHz near Anthorn
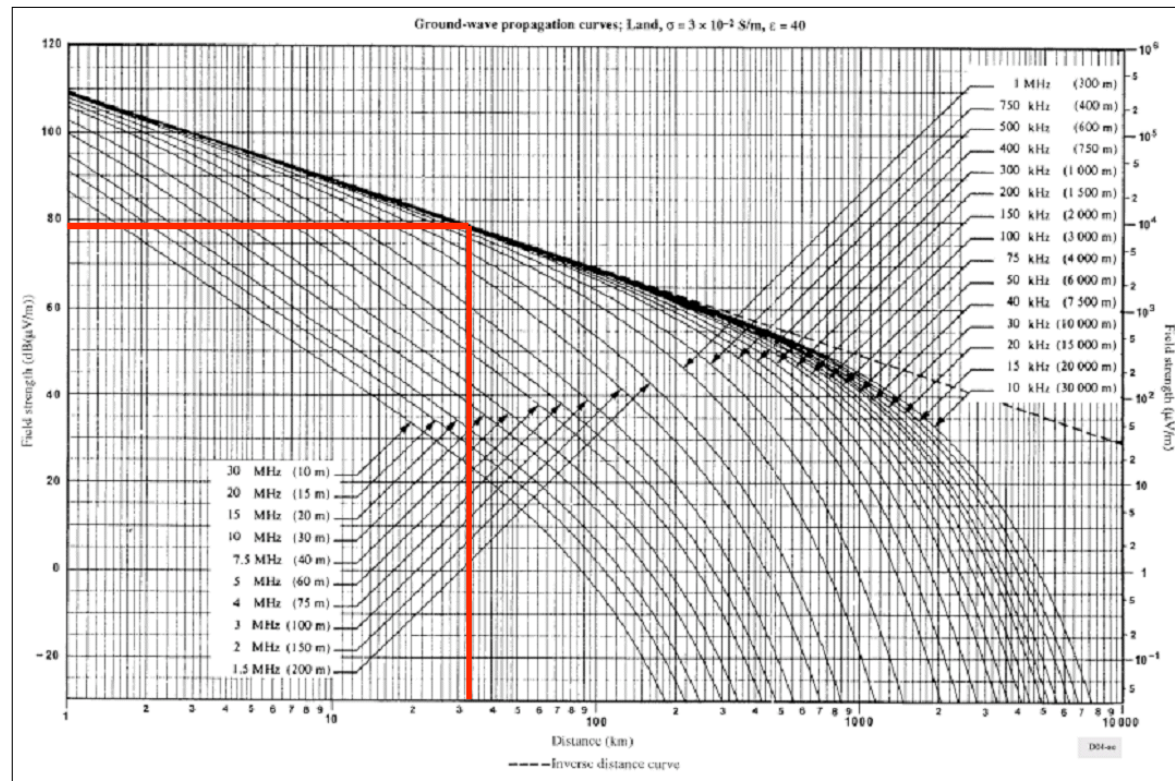
100Hz-wide slice of spectrum at 137kHz near Anthorn

Loop antenna rotated through 90 degrees

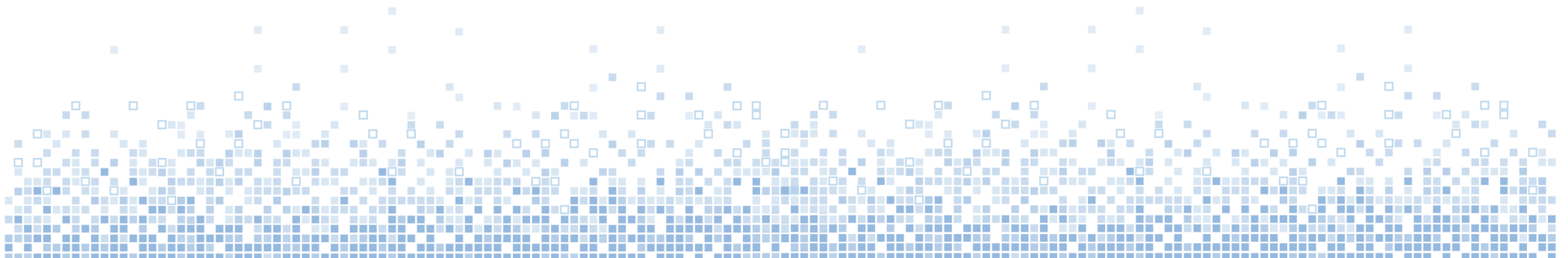Groundwave propagation curves (from ITU 368-7)

	Field strength	Radiated power
Single spectral line	6dBμV/m	50μWatt
Whole amateur band (284 spectral lines)		14mWatt

Radiated power from Anthorn in Radio Amateur Band
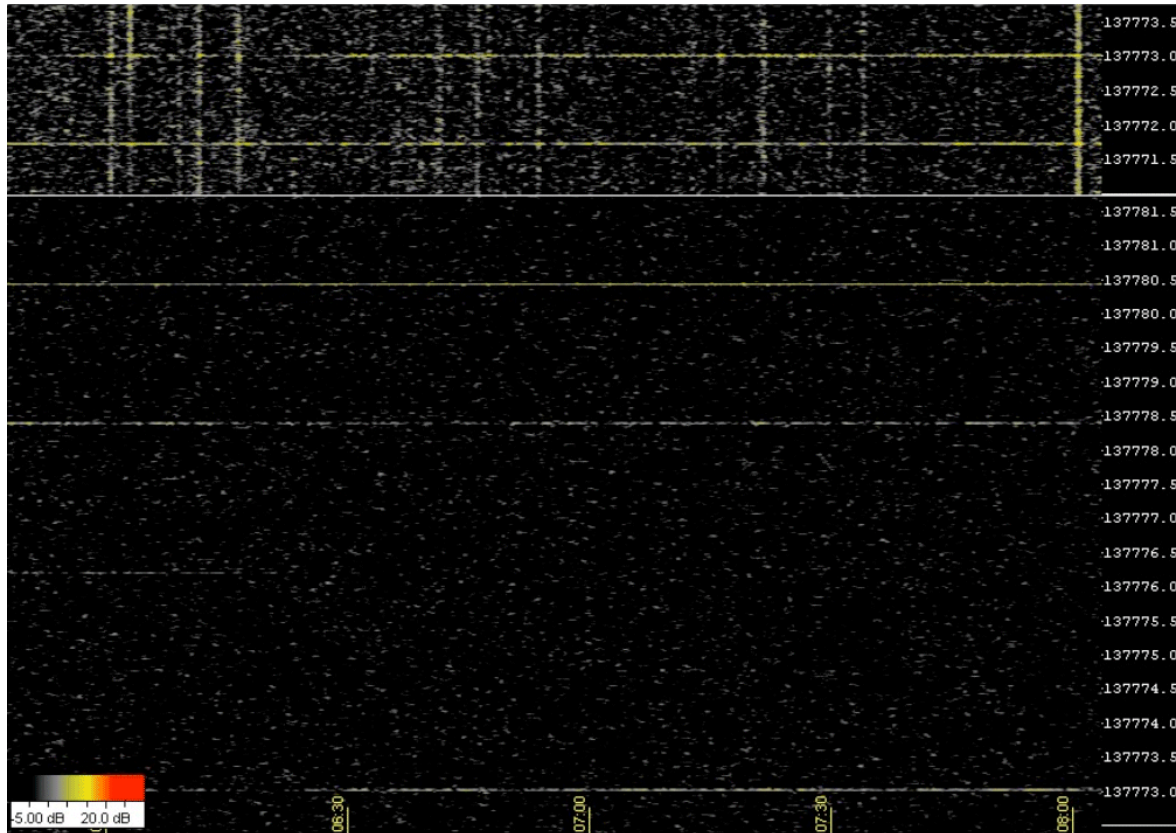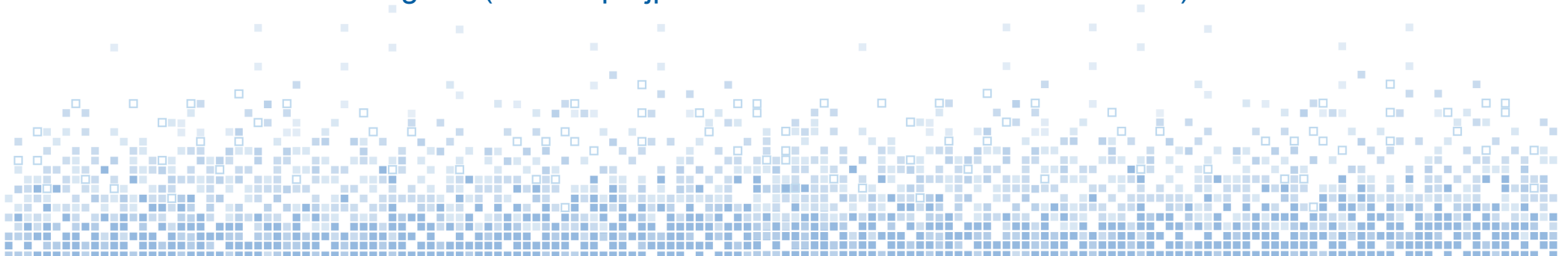
- **Entire band only 2.1kHz wide**

- **Data transmissions or V-E-R-Y S-L-O-W Morse code**

- **Each dot 3-30 seconds, each dash 9-90 seconds**

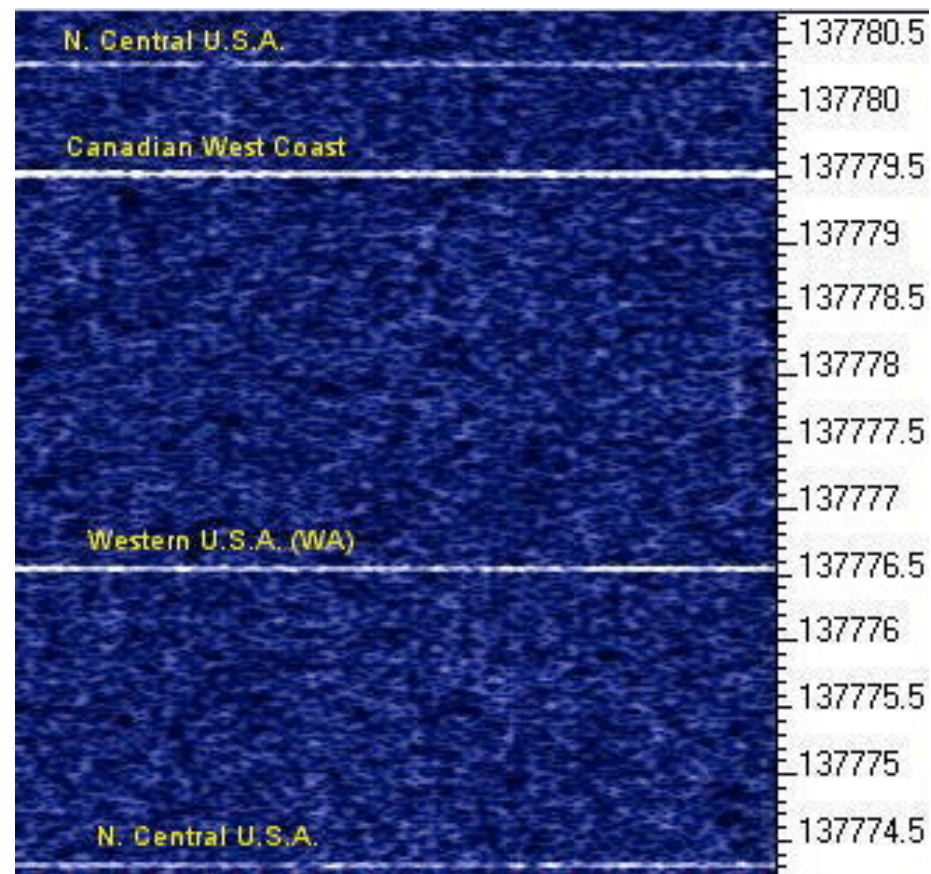- **Bandwidth less than 1Hz**

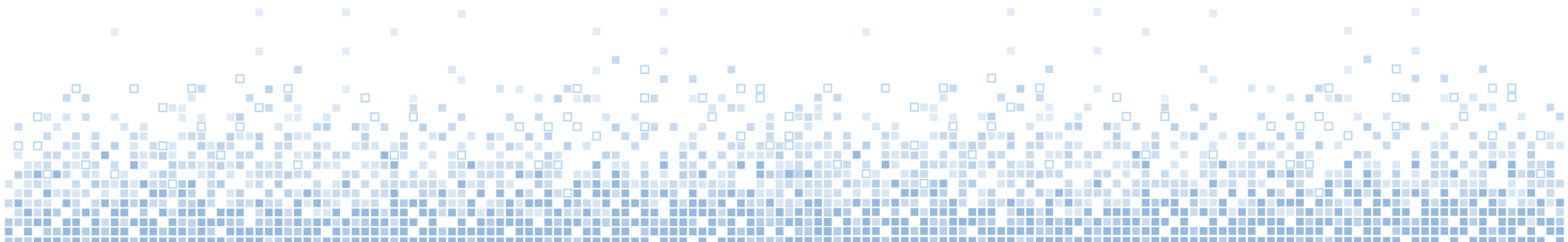- **Visual reception**

Amateur Radio techniques at 136kHz
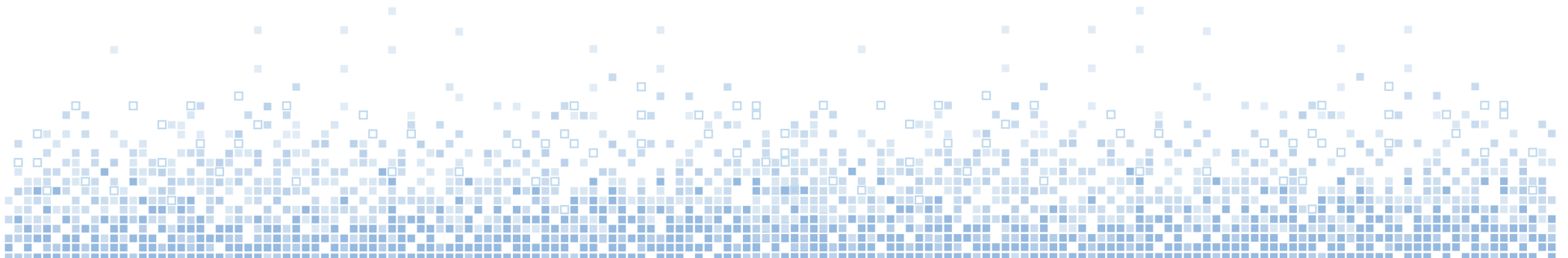
Waterfall diagram (from http://jpmere.online.fr/Grabber/Grabber.htm)

US Loran spectral lines (from http://www.imagenisp.ca/jsm/136.html)
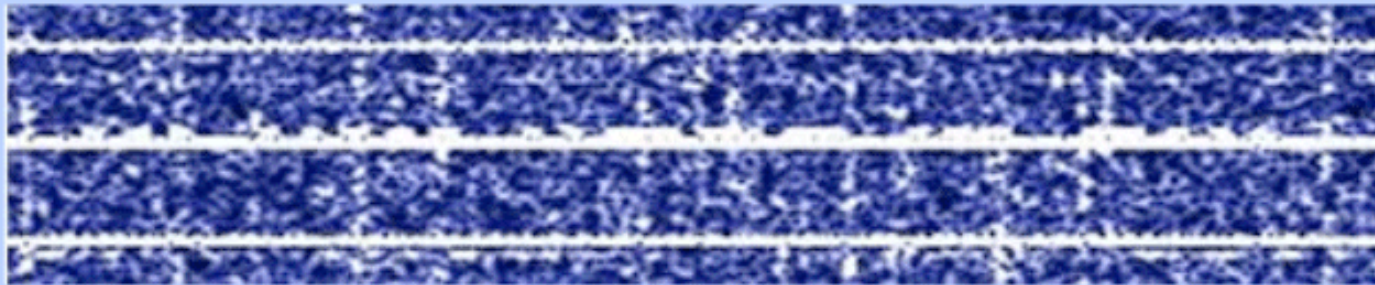
S52AB's callsign - his QRSS3 transmission was less than 1 Hz from a Rugby Loran line, but I was still able to give him a reprt of 'O' (perfectly readable).

This is my signal as received in Slovenia. S52AB gave me an 'M' report (readable with difficulty). Note that he does not have QRM from Loran.

Reception less than 1Hz from a Rugby Loran spectral line
(from ttp://homepage.ntlworld.com/mike.dennison/index/lf/gallery/s52ab.htm)
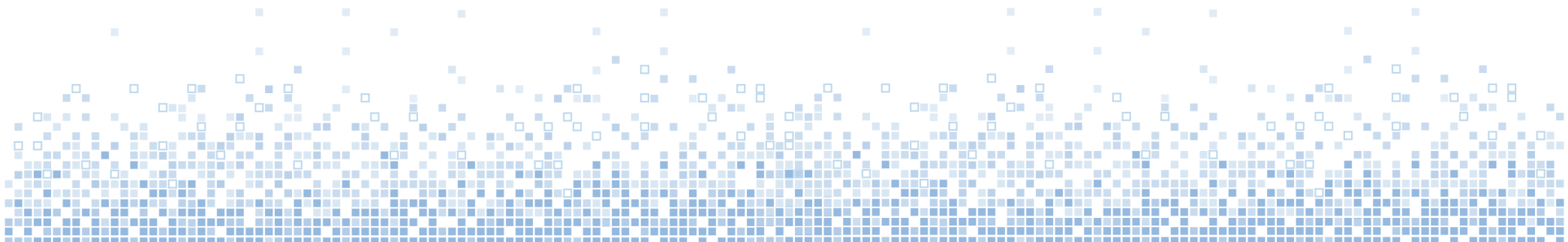
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ANC-4
Antenna Noise Canceller & Diversity Combiner

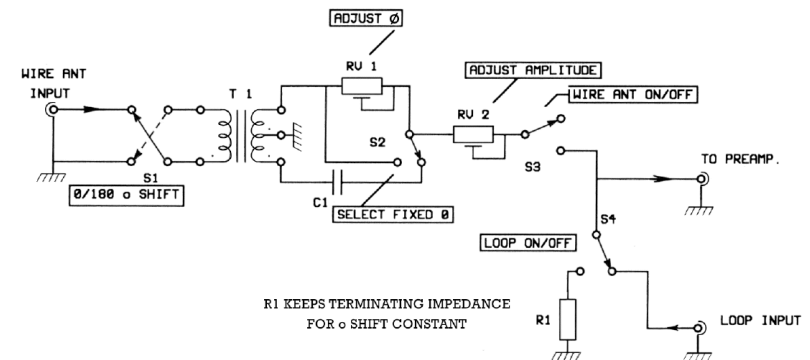**The Perfect Complement to Timewave's DSP-599zx!**

Features

- *Cancels S-9 line noise*
- *Reduces BPL noise*
- *Nulls strong interfering signals*
- *Works with any transceiver/receiver*
- *Makes 2 antennas into phased array*
- *Wipes out noise before it hits your receiver*
- *Up to 40 dB Reduction of interference generated by powerlines, electric motors, TVs and home electronics*
- *Works for voice, data & CW*
- *250 Watt rating*

TIMEWAVE ANC-4
POWER PHASE RANGE NOISE PHASE FREQ RANGE NOISE GAIN

A Simple Signal Canceller For 136Khz To Combat Loran or Other Noise Sources
by Derek Atter G3GRO

FIGURE 1
BASIC CANCELLER

R1 KEEPS TERMINATING IMPEDANCE
FOR ∅ SHIFT CONSTANT

Techniques for combating Loran!

(from http://www.timewave.com/support/ANC-4/anc4.html & http://www.carc.org.uk/assets/Downloads/vlffilter.pdf)

- Anthorn's Loran signal is correct

- No spurious transmissions in the amateur band

- Just 50µWatt per spectral line

- Lessay, Ejde and Sylt pre-date Anthorn

- Effective techniques to combat Loran

- But still …