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Modernisation of the Narod fluxgate electronics at Budkov Geomagnetic Observatory

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From the signal point of view, fluxgate unit is a low-frequency parametric up-convertor where the output signal is picked up in bands near second harmonic of the pump frequency fp (sometimes called idler for historic reasons) and purity of idler is augmented by orthogonal construction of the pump and pick-up coil.

In our concept, the pump source uses Heegner quartz oscillator near 8 MHz, synchronous divider to 16 kHz (fp) and switched current booster. Rectangular pulse is used for feeding the original ferroresonant pump source with neutralizing transformer in the case of symmetric shielded cabling.

Input transformer has split primary winding for using symmetrical shielded input cabling and secondary winding tuned by polystyrol capacitor and loaded by inverting integrator bridged by capacitor. This structure behaves like resistor cooled to low temperature. Next stage is bandpass filter (derivator) with a gain tuned to 2 fp with leaky FDNRs followed by current booster.

Another part of the system is low-noise peak elimination and bias circuit. Heart of the system is a 120-V precision source which uses 3.3-V Zener diode chain - thermistor bridge in the feedback. Peak elimination circuit logics consists of the envelope detector, comparators, asynchronous counter in hardwired logics, set of weighted resistor chains and discrete MOS switches in current-mode. All HV components use airy montage to prevent the ground-leak.

After 200 m long coaxial line, the signal is galvanically separated by transformer and fed into A/D converter, which is ordinary HD audio (96 kHz) soundcard. Real sample rate is constructed by a-posteriori data processing when statistic properties of the incoming sample are known. The sampled signal is band-pass filtered with a 200-Hz filter centered at 2 fp. The signal is then fed through a first-order allpass centered at 2 fp. The result approximates Hilbert transform sufficiently good for detecting the envelope via square sum-root rule. The signal is further decimated via IIR filters to sample-rate 187.5 Hz. Raw instrument data files are saved hourly in floating-point binary files and are marked by time stamps obtained from NTP server.

A-posteriory processing of (plesiochronous) instrument data consists of downsampling by IIRs to 12 Hz, irrational (time-mark driven) upsampling to 13 Hz and then using the INTERMAGNET standard FIR filter (5 sec to 1 min) to obtain 1-min data. Because the range of the signal processing system is about 60 nT (range of the peak elimination circuit is 3.8 uT), the resulting magnetograms look like the La Cour ones.