EEG Probe Project

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EEG Probe Project

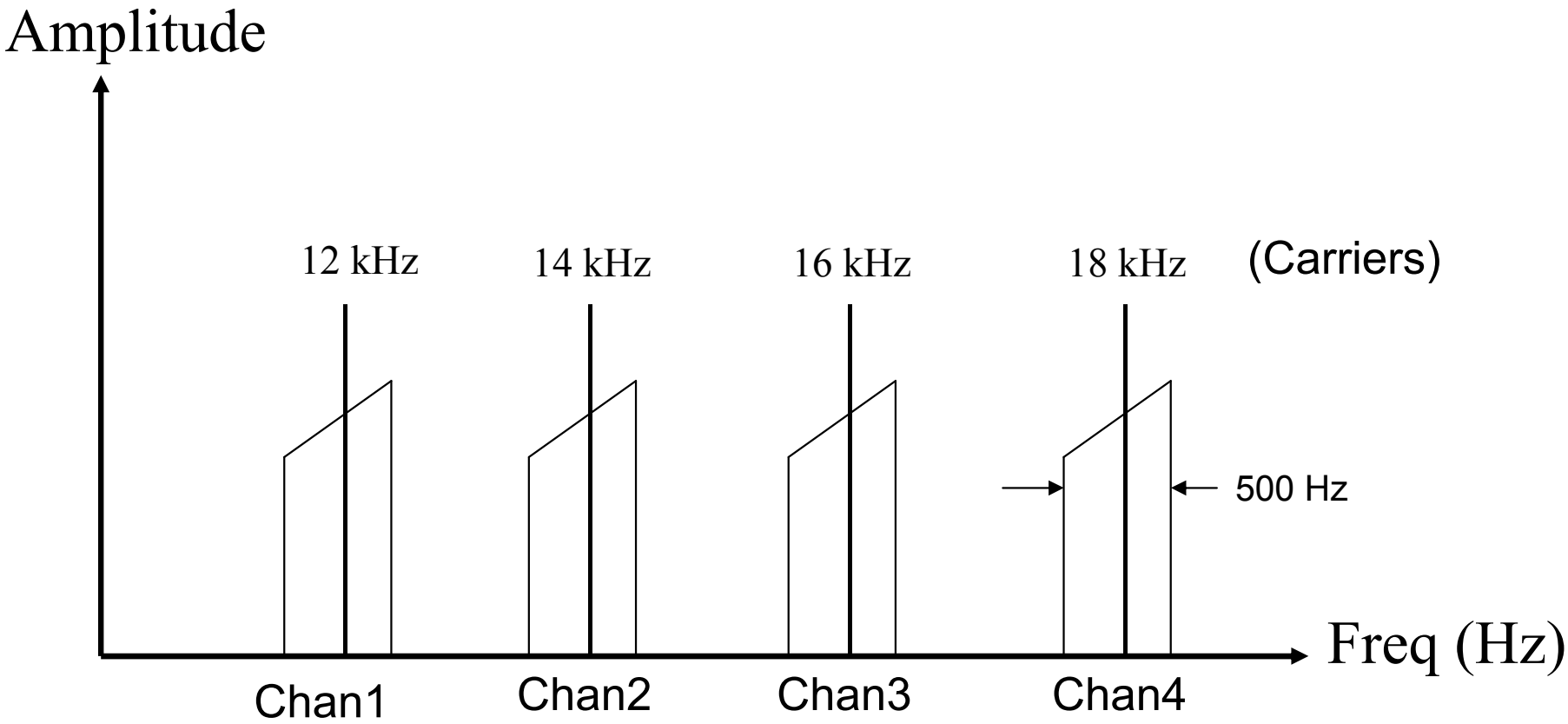
- Design Objectives
  - Investigate BCI for severely handicapped individuals
  - Use time, frequency, and phase displays
  - Use DSP techniques for near real time responses
  - Use only the mono input to the sound card of a PC for multiple channel displays (start with two channels)

EEG Probe Project

- Design requirements
  - Some compatibility with Modular EEG H/W
    - Can use analog section with modulator section, +/- 5V operation
  - Single input (mono to sound card)
  - Two channel prototype, expandable to 32 channels
    - Reference leg for both channels
  - Select either SSB, AM, or FM modulation technique
    - Selected AM for frequency stability, better spectrum management than FM
  - Displays
    - Stripline, Vertical FFT, Vertical Phase, Waterfall
    - Application screen size = 1024 by 768

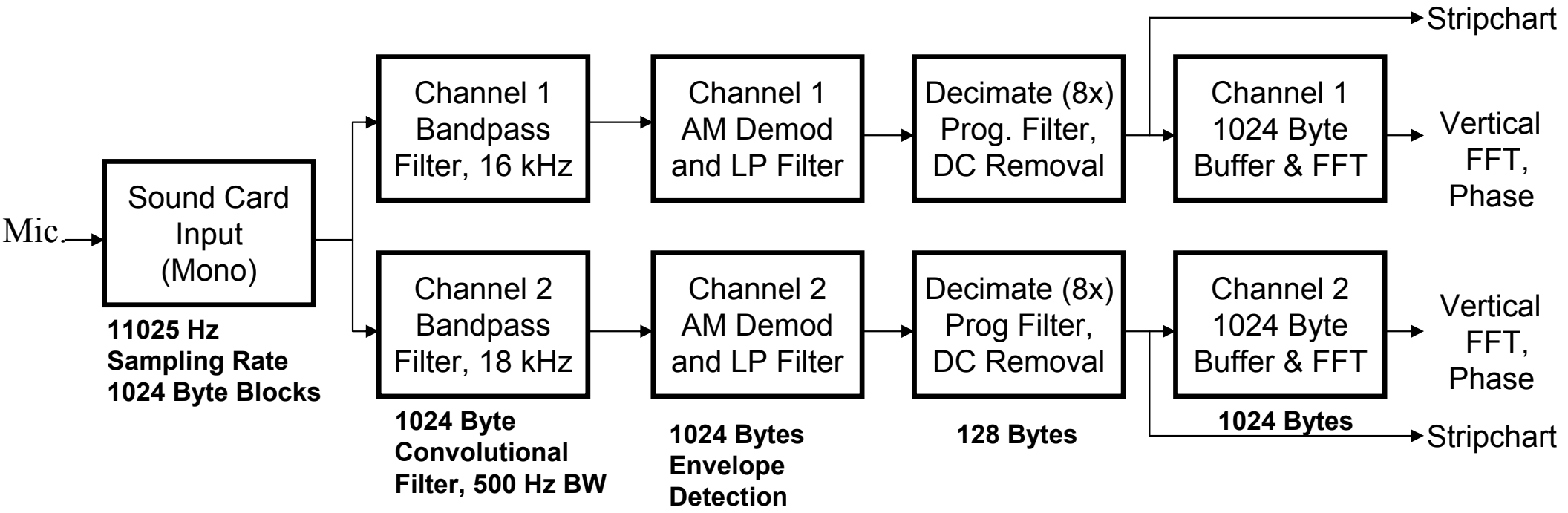
EEG Probe Project

- System Design (AM Modulation)



EEG Probe Project

- AM System Design, Processing Chain



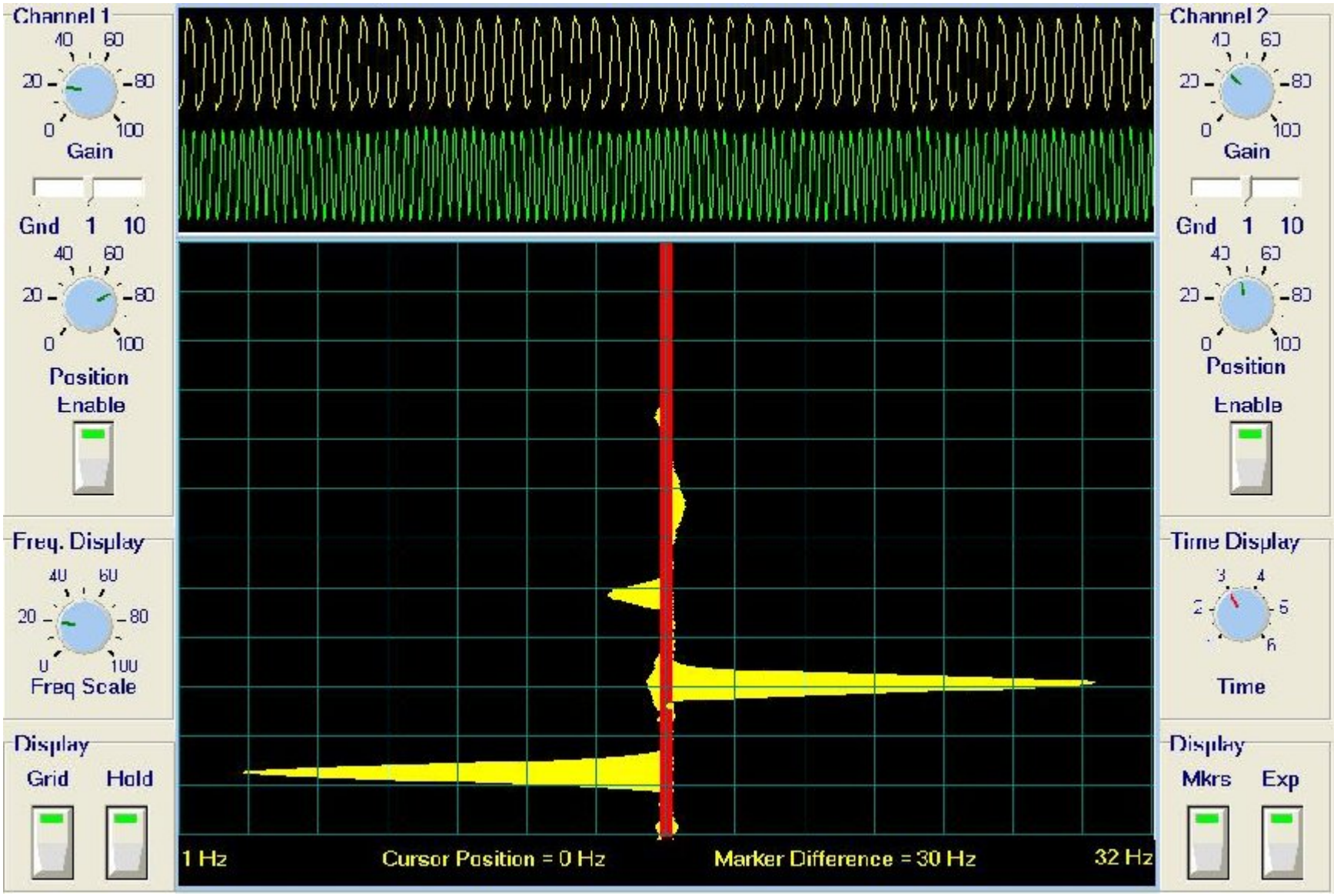
EEG Probe Project

- System Design: Displays
  - Vertical FFT
  - Vertical Phase
  - Strip Chart
  - Waterfall

EEG Probe Project

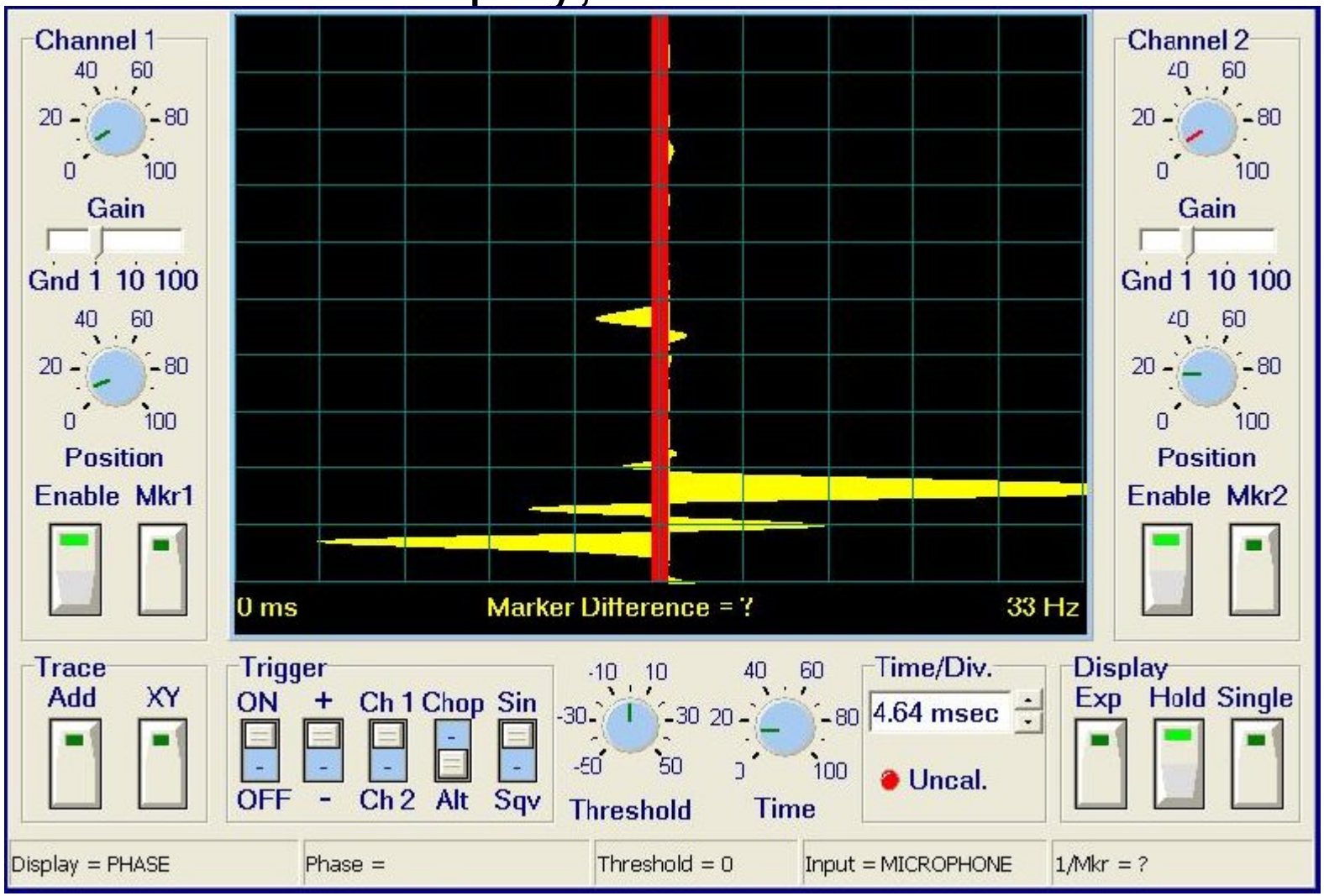
- Development Environment
  - Use C,C++ Builder IDE (from Borland)
  - Third party components (knobs, switches)
  - Low level sound card drivers
  - All software developed internally
    - Could use Intel DSP library for open source development

Vertical FFT Display, 6 Hz and 12 Hz inputs

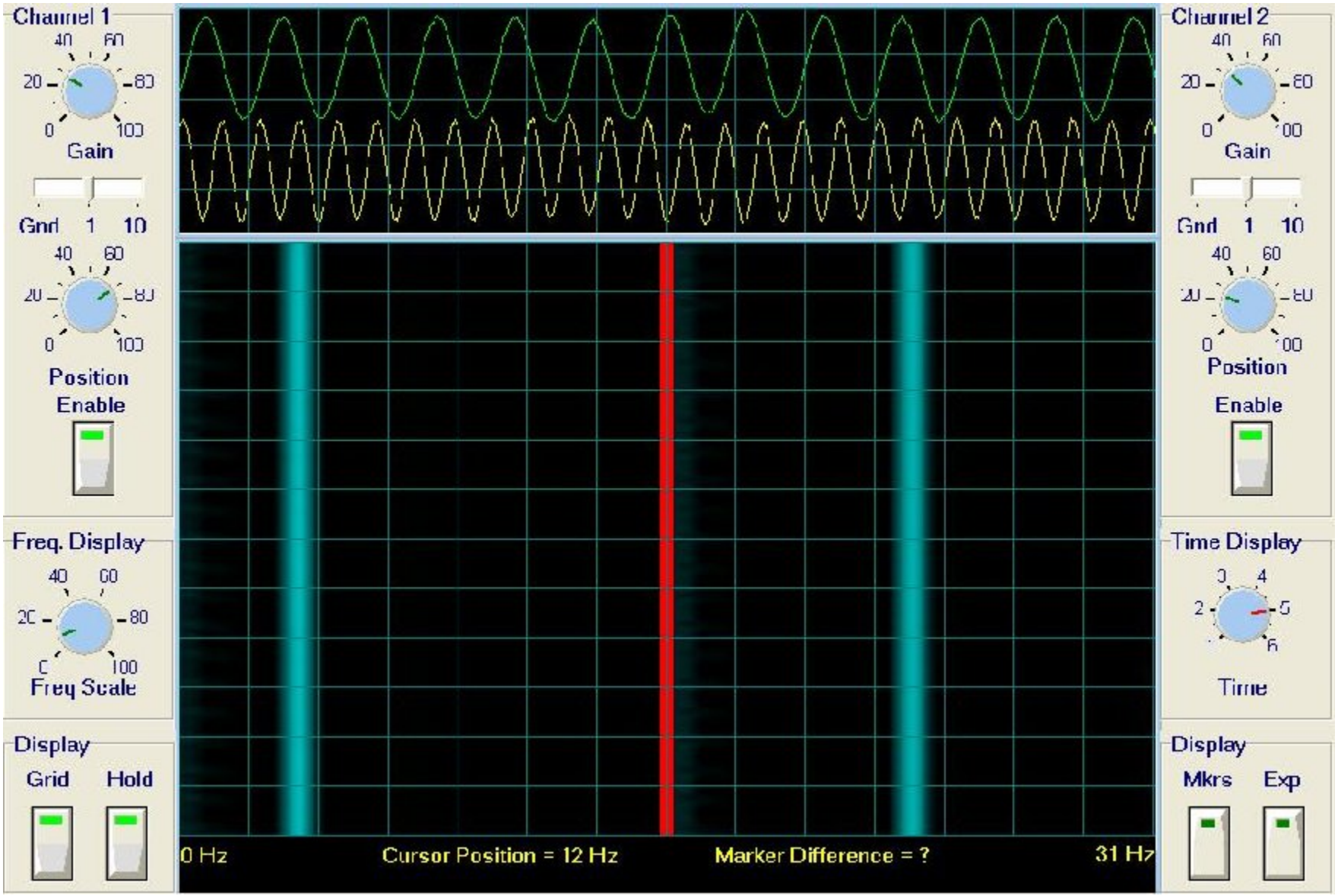


EEG Probe Project

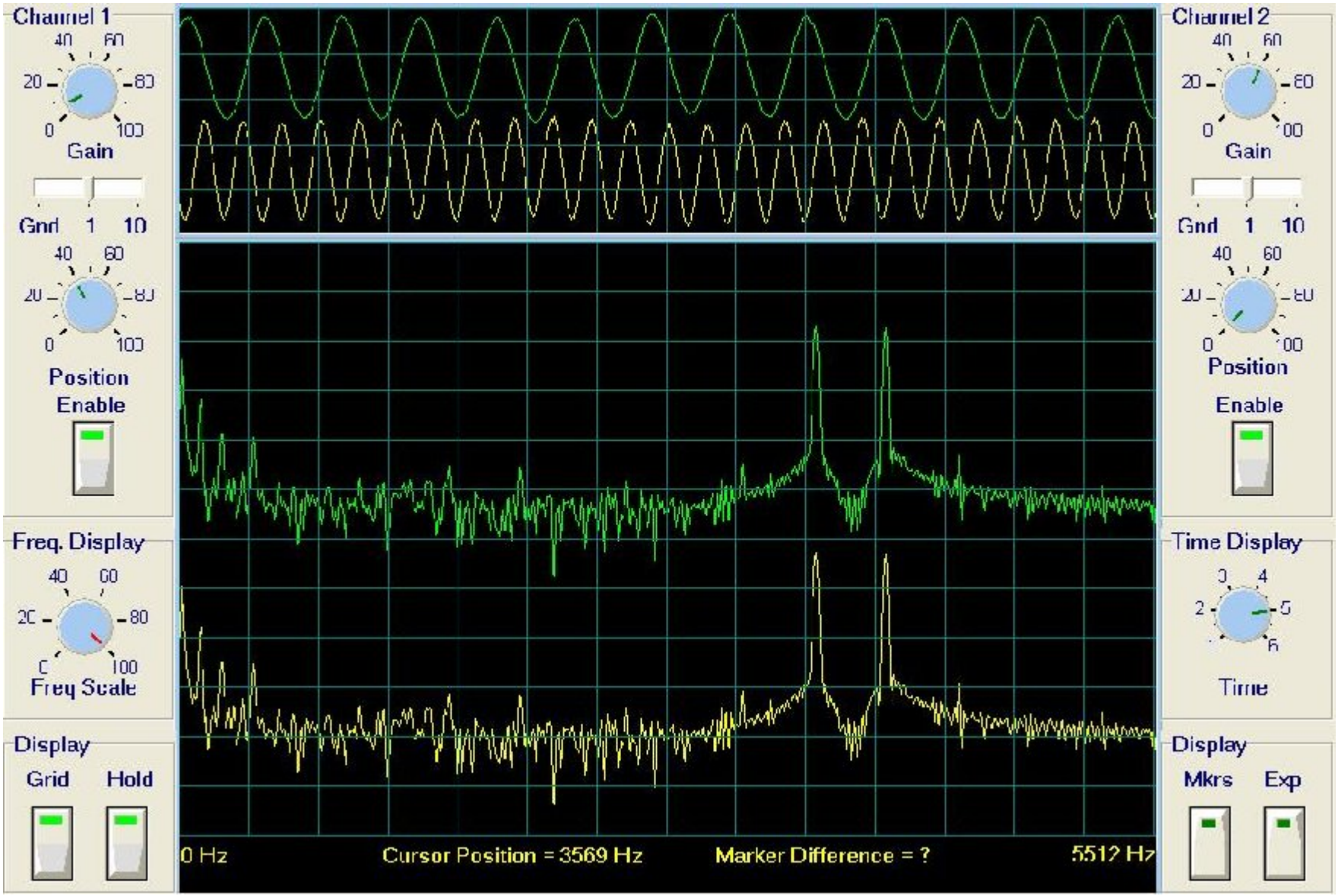
- Vertical Phase Display, 2 Hz and 5 Hz



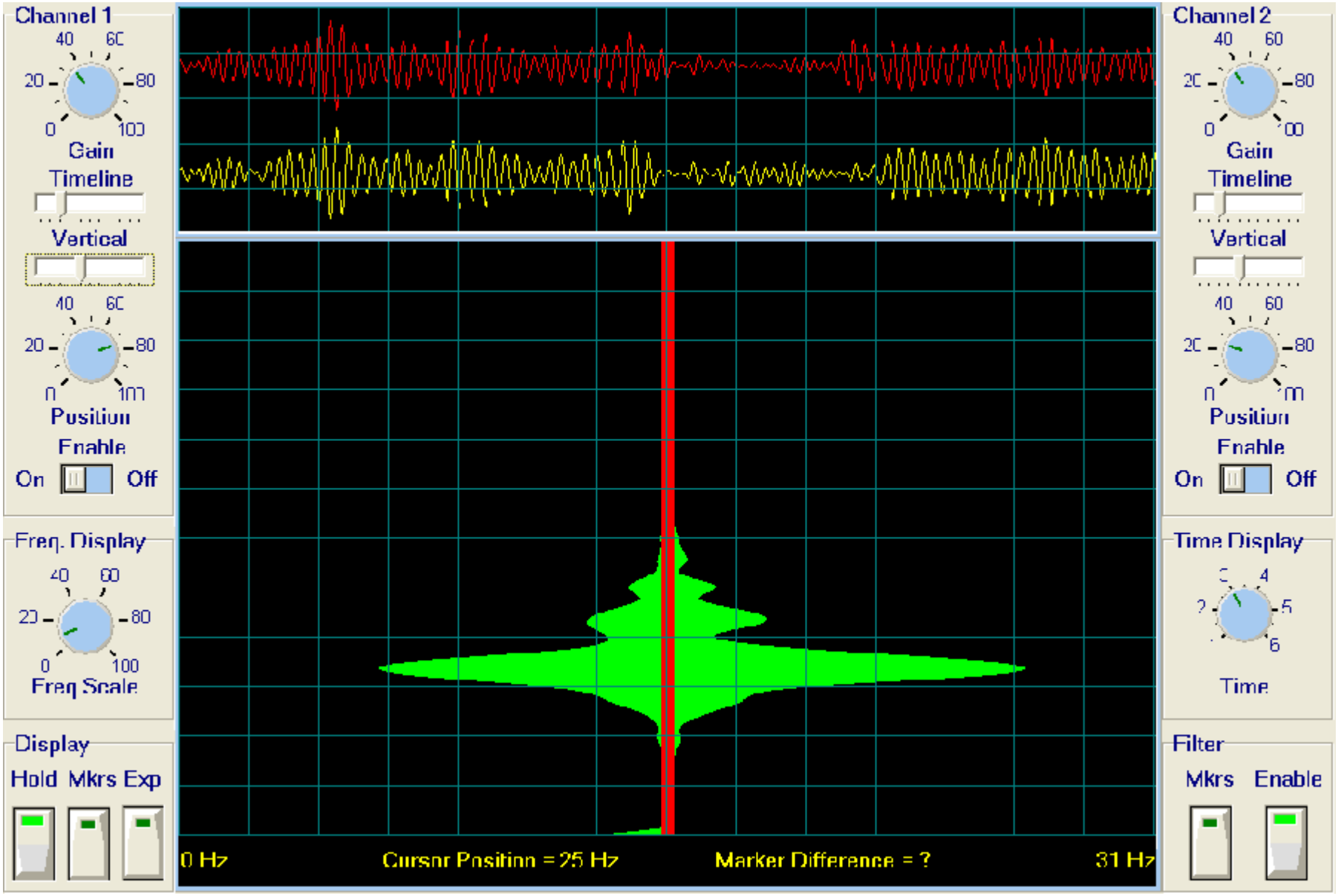
Waterfall Display, 6 Hz and 12 Hz inputs



RAW FFT Spectrum 3.5 kHz and 4.0 kHz carriers



Alpha Bursts, 9 Hz

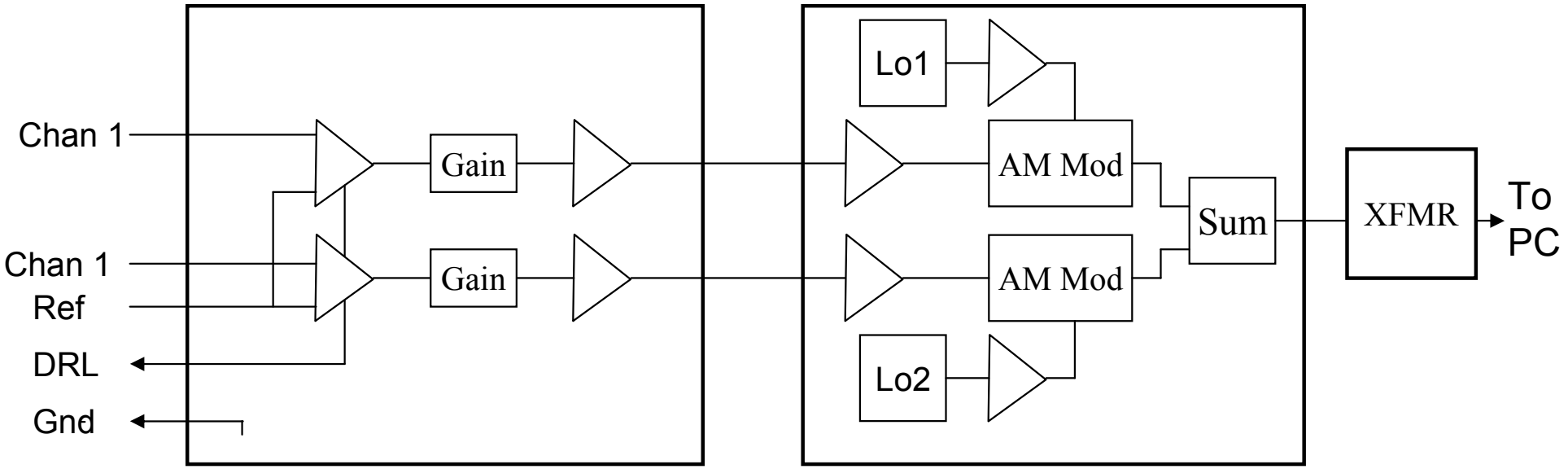


EEG Probe Project

- First Hardware Protype
  - Two PC boards
    - Dual channel analog design similar to Modular EEG
    - Dual channel modulator board using low cost ICs , output transformer coupled for isolation from the PC
    - Single supply input (+12 volt) from isolation transformer, converted to +/- 5 volts.
  - Front panel gain control for each channel
  - Power supply LEDs

EEG Probe Project

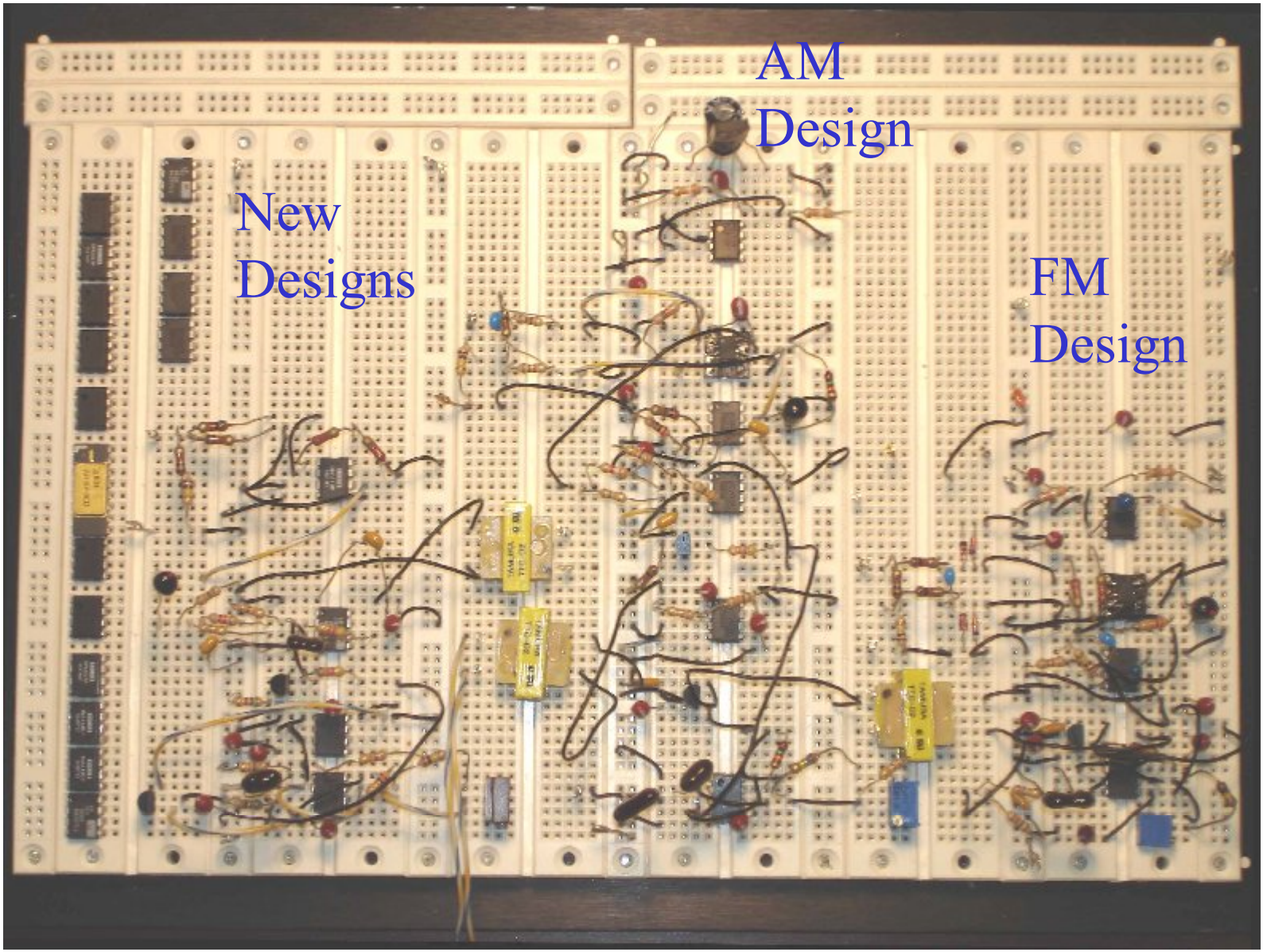
- Hardware Block Diagram



Dual Channel
Low Noise Amplifier
Board

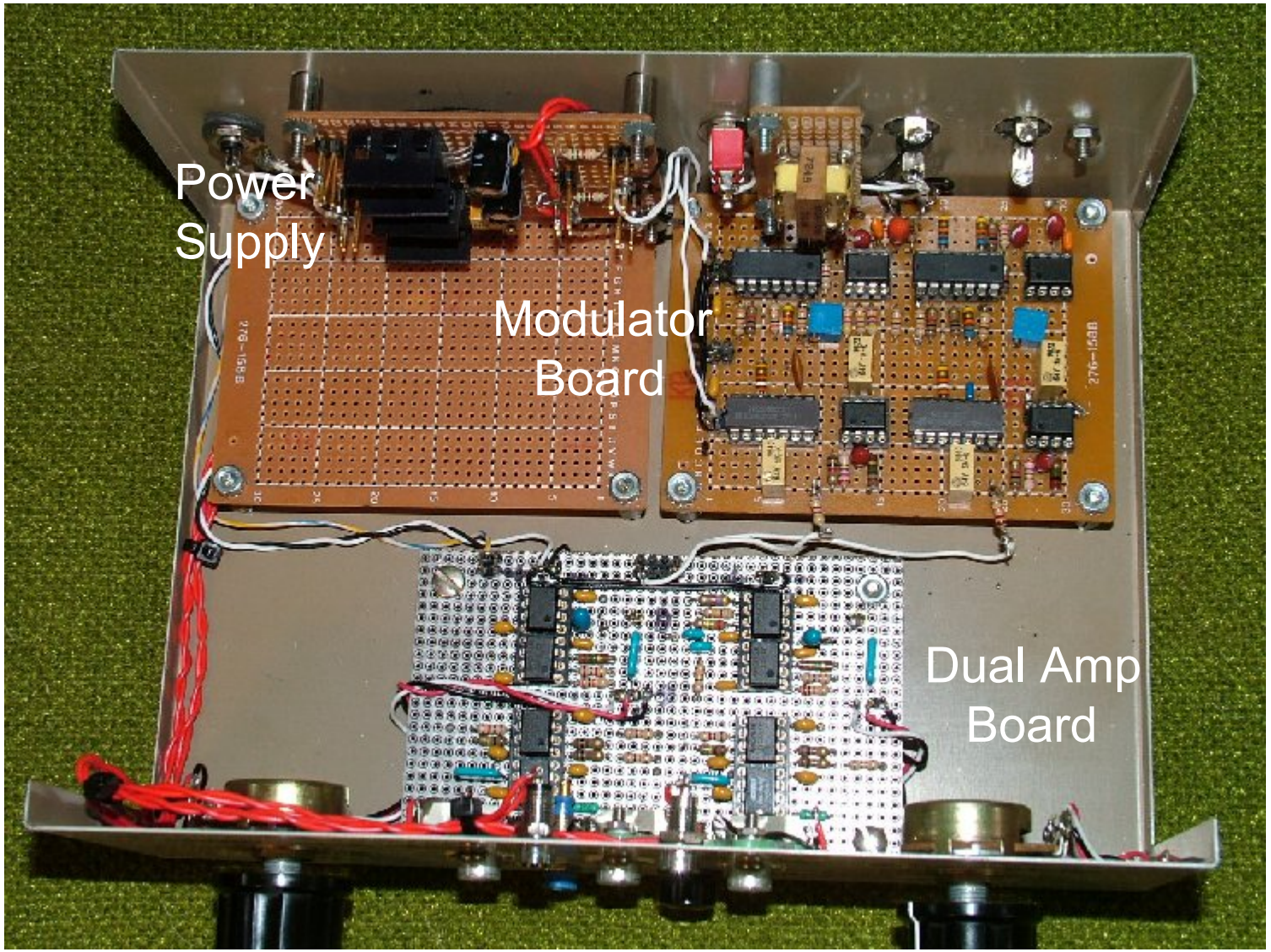
Dual Channel
AM Modulator
Board

Breadboard Designs



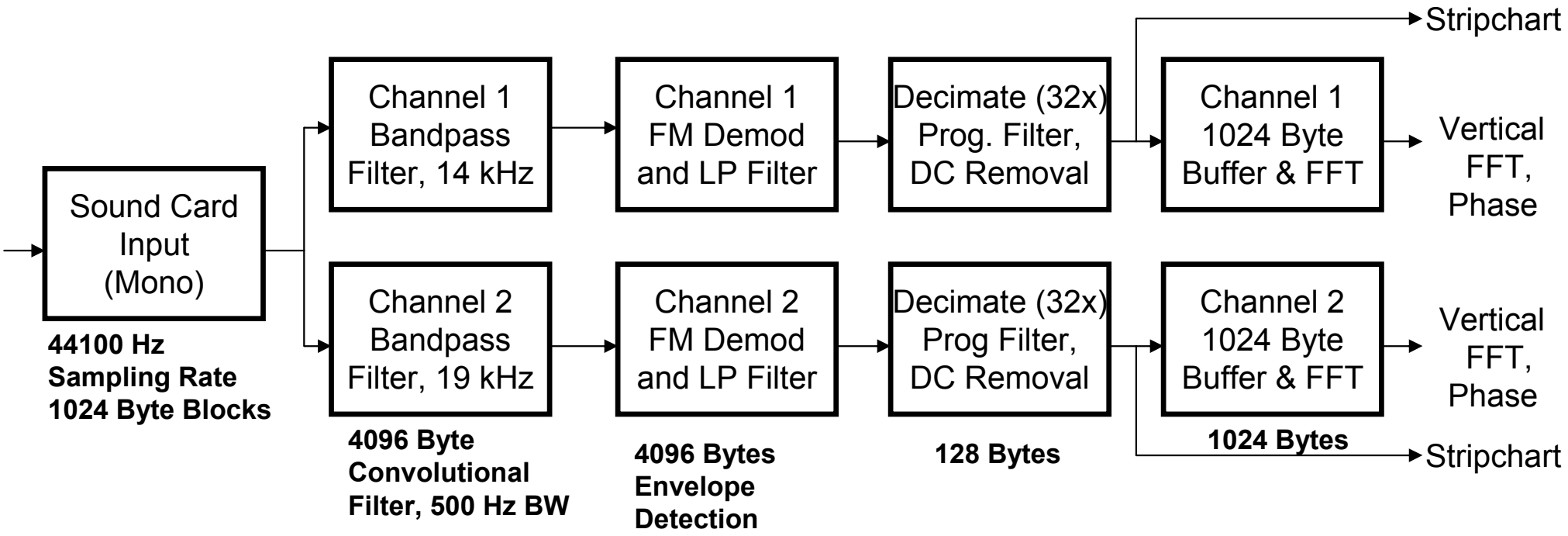
Prototype Unit

Chassis Layout

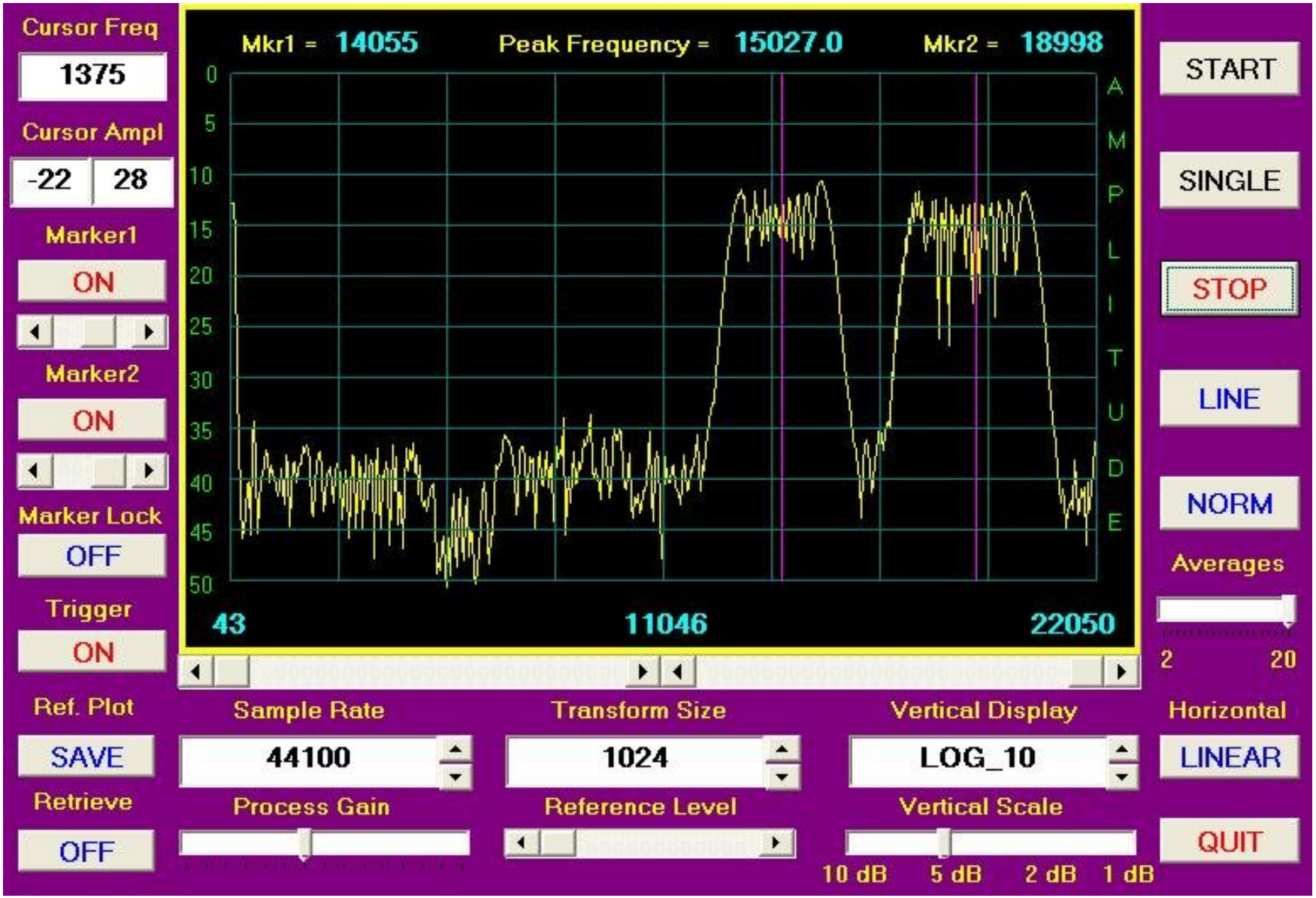


EEG Probe Project

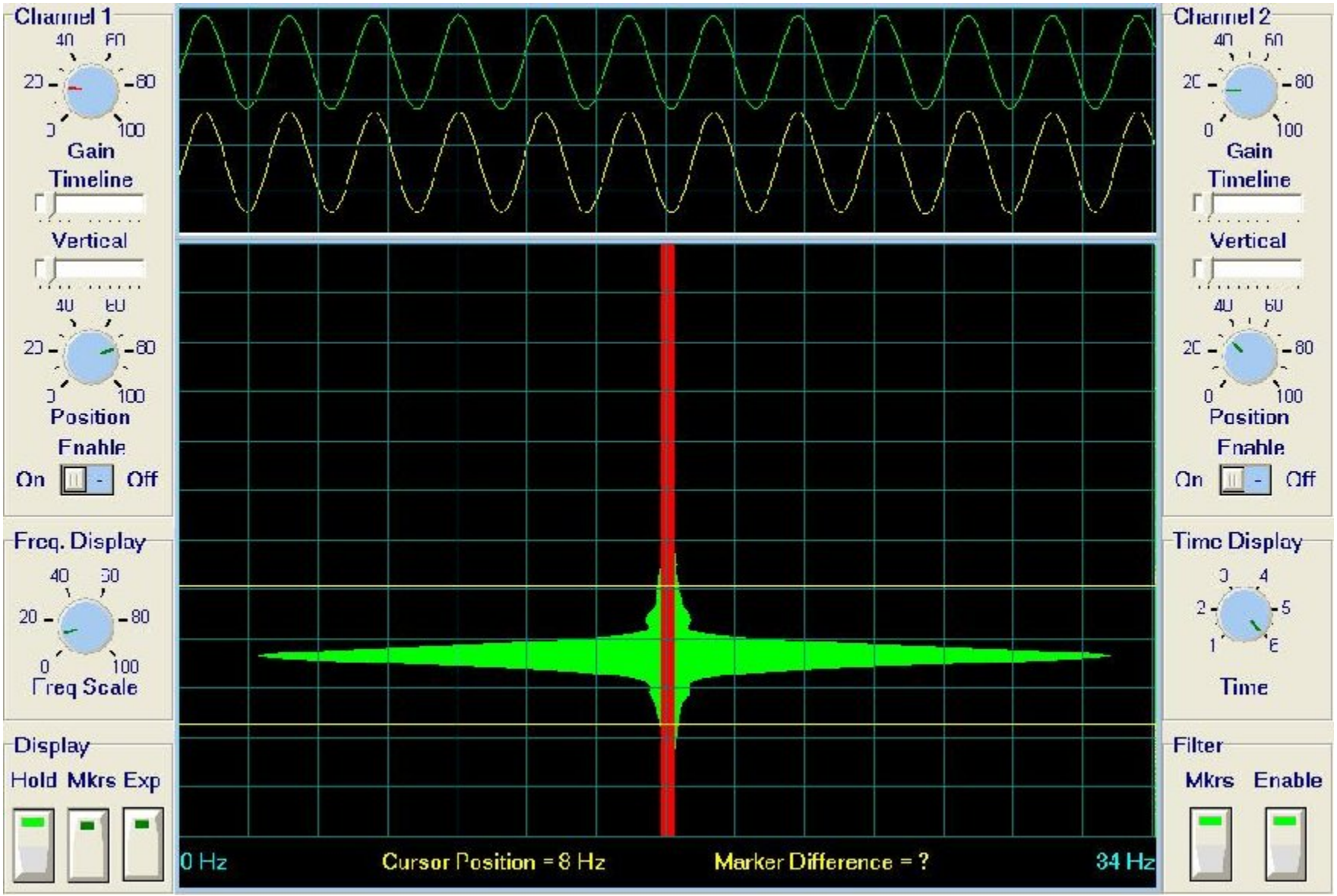
- FM System Design, Processing Chain



Dual Channel FM Spectrum



Dual Channel FM Waveforms



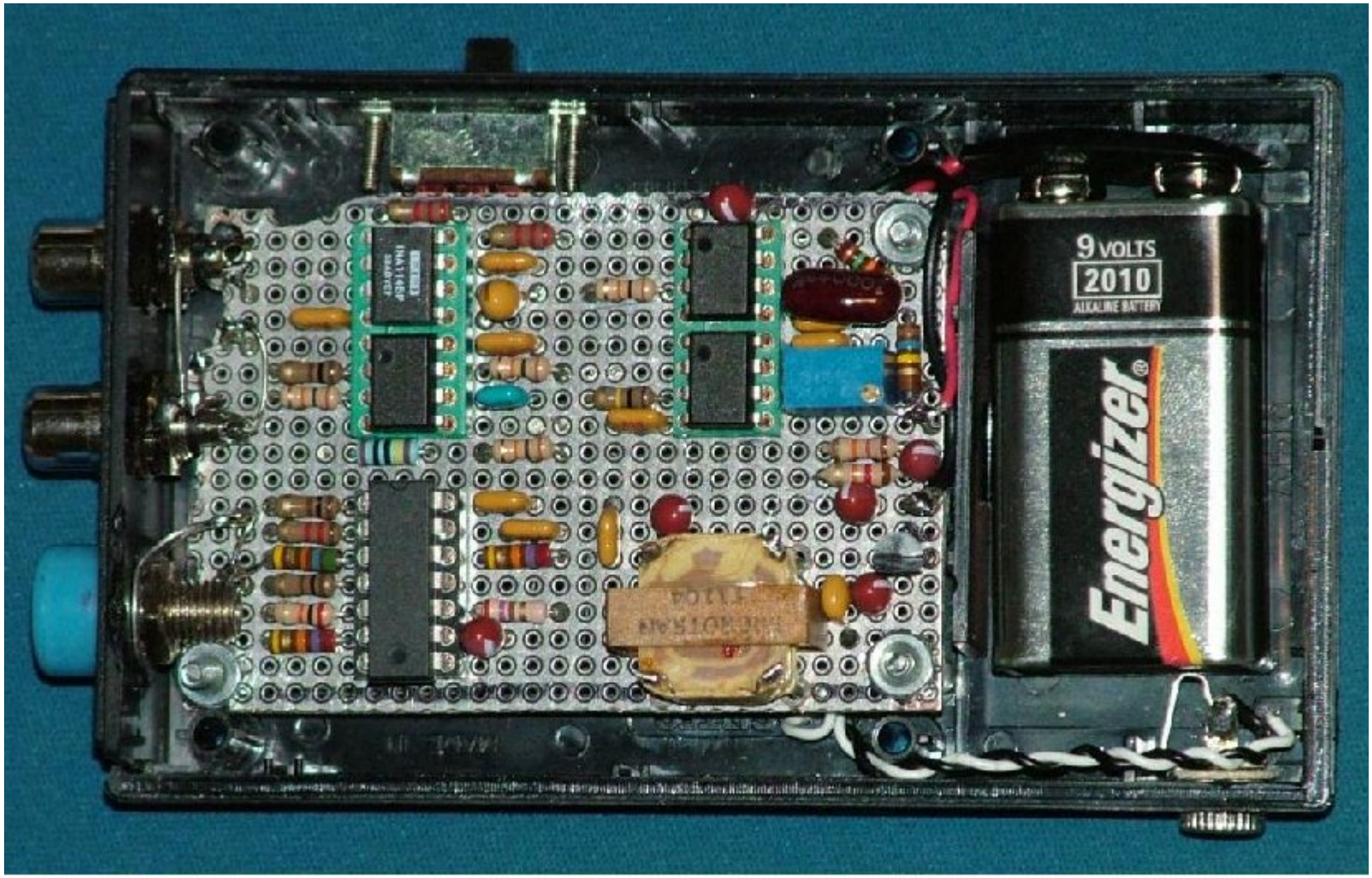
Modulation Scheme Comparison

- AM Modulation
  - Good spectrum management (1500 Hz per channel)
  - 80 dB dynamic range (2.0 mv to 0.20 uv)
  - Requires only 3 IC's plus a transistor per channel (most recent design)
  - Gain calibration procedure with sound card required
  - 60 dB cross-talk isolation between channels
- FM Modulation
  - Limited spectrum management (4 kHz per channel)
  - 80 dB dynamic range (1.5 mv to 0.15 uv)
  - Requires only 3 IC's per channel
  - Gain calibration built-in via H/W and S/W design
  - 60 dB cross-talk isolation between channels

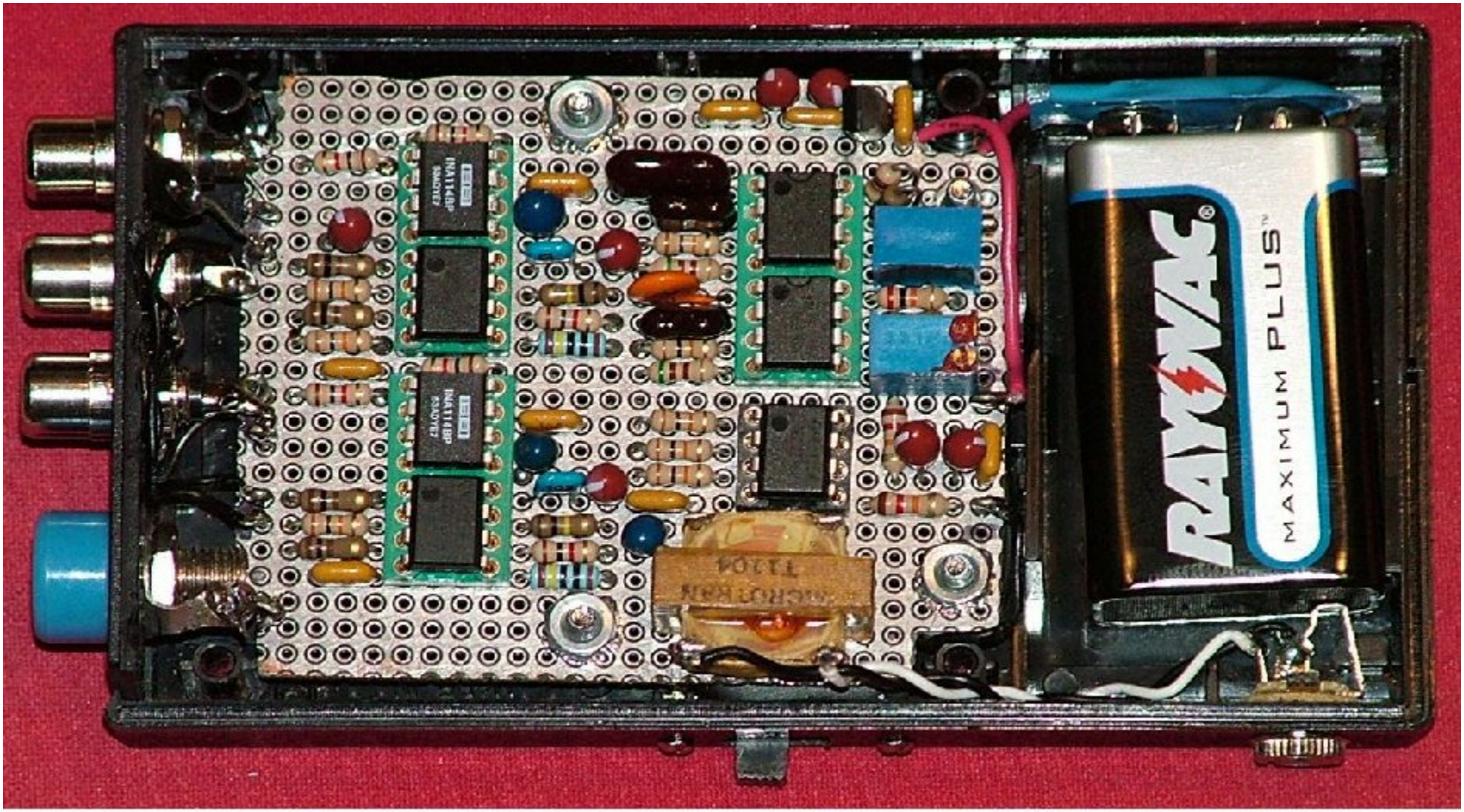
EEG Probe Project

- Prototyped single channel AM modulation unit
  - Current drain approximately 6.5 ma. @ 9 volts
- Prototype dual channel FM modulation unit
  - Current drain approximately 5.75 ma. @ 9 volts
  - Switched to CMOS version of NE555 IC
- Prototype dual channel AM modulation unit
  - Current drain approximately 7.0 ma. @ 9 volts
  - Switched to simpler AM modulator with better noise performance
  - Used CMOS version of NE555 IC (ICM7555)
- All prototypes completed and operational

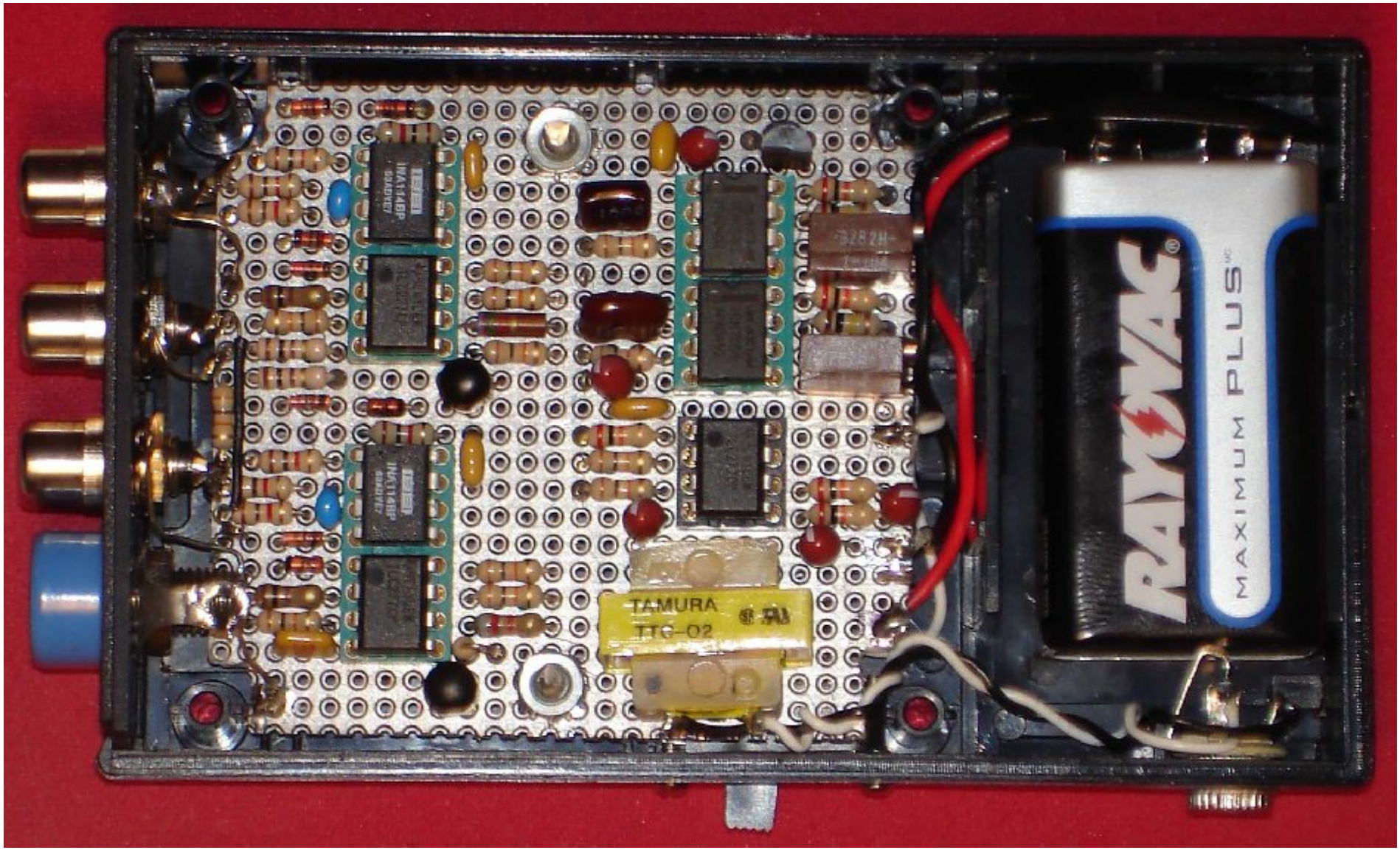
Single Channel AM Unit



Dual Channel FM Unit



Dual Channel AM Unit



EEG Probe Project

- Current Status
  - Completing final S/W application
    - AM demodulation design complete
    - FM demodulation design complete
    - Added adjustable LP and BP filters (S/W)
  - Switched to digital LO (for a two channel system only), used cheaper ICs to generate the local oscillator
  - Dual channel AM and FM designs completed and prototypes built

Software Update

- EEG Probe software
  - Added record and playback capability
  - Near real-time response with IIR digital filters
- Sound Card Interface to NeuroServer
  - Converts sound card data to EDF format and interfaces to the NeuroServer
  - Also converts sound card data to ModEEG format for RS-232 interfaces, requires Eltima virtual RS-232 driver
- Both software packages available at the SourceForge web site:
  - http://openeeg.sourceforge.net/doc/hw/sceeg/