1394B Startup Proposal

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1394B Startup Proposal

- Simple Tone Detector Modulation (STPM) - Permits AC Coupling
- Low Power < 2 milliwatts using existing XTAL oscillator
- Modulation - Morris Code Like (STPM)
- Formulation Based on Bounded Limits and Information Theory
- Existence Proofs - Tone Paging and PL (private line) etc.
- Heuristic Approach

Purpose of This Presentation

- Build a Technical Framework and Basis for Design and Evaluation of a Tone Startup
- Assumes AC Coupling and Simple Tone Position Modulation Coding (STPM)
- Very Low Power(standby current less than500uA)
- Existing Crystal Based Reference (precise timing)
- Reliable Detection in the Presence of Noise and Data.

Rules of Thumb for Tone detection Technology

- Optimal Sensitivity 0db SNR(Paging)
- Tone detectors have BP filter Q's of about 40 (tradeoff between response time and ringing)
- Based on tone frequency and Integration time Scaling (K factor = 25K) - Optimal Integration time is about 40U seconds for 1Mhz
- Ideal falsing Probability of Less Than 1 per 10 years based on continuous operation in presents of Gaussian Noise
- Tradeoff Between Noise and Sensitivity
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Tone Detection Technology

- Divide Down from 24.576Mhz Oscillator
- 1 Mhz Selected for analysis (1-12Mhz Feasible)
- Sensitivity Can Be Traded for Falsing Margin

Key Elements of Implementation

- 200uA Self Adjusting Crystal Oscillator
- Commutating Synchronous Sampling Filter
- Digital Integrator or Zero Crossing Detector
- Digital CMOS compatible

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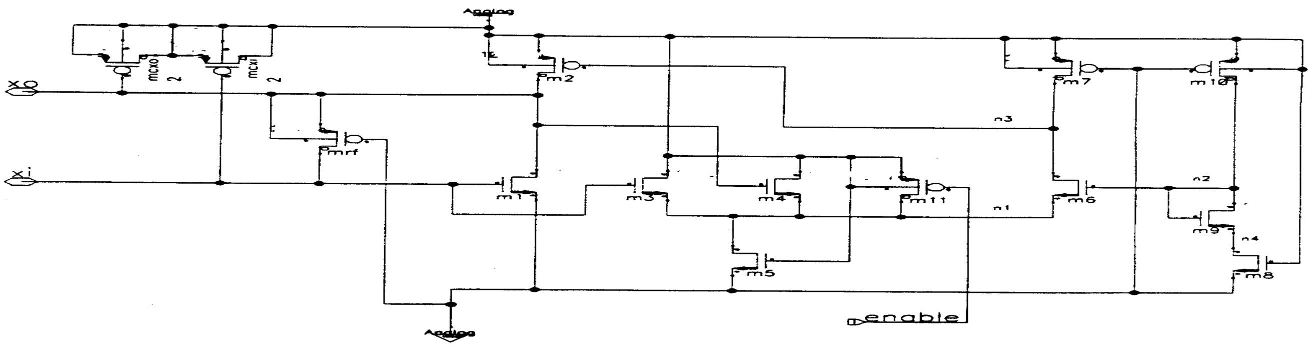

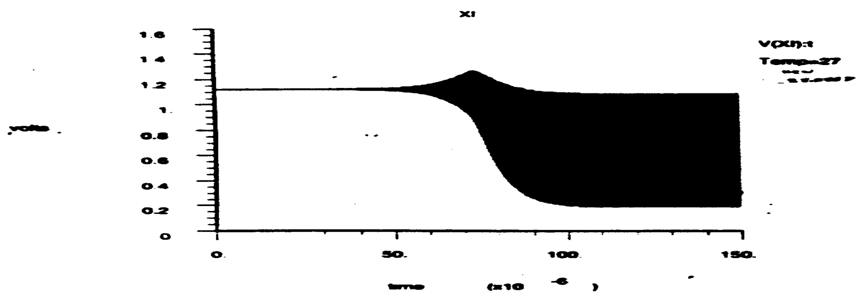

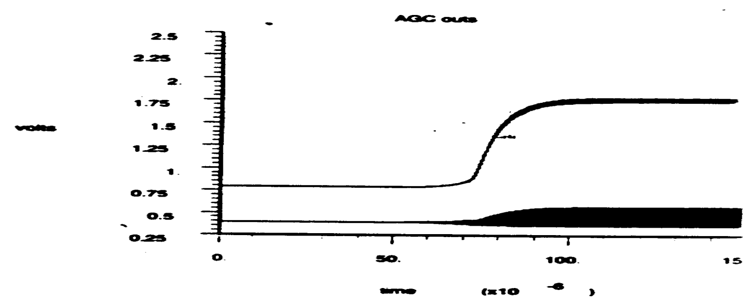

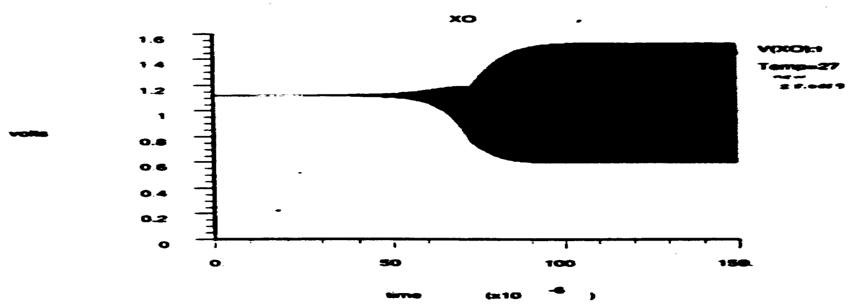

Methods of Tone Detection

- Integrate and Dump
  - Near Ideal for Low Signal to Noise results - approaches matched filter results
  - One disadvantage is Sin(x)/x response
  - Quantizations Issues with Digital Approach
- Correlator
  - Multiple Samples per Bit - relatively high complexity/power
  - Must sample at center of bit (PLL/DLL?)

Methods of Tone Detection (2)

- Zero Crossing/ Bandpass Filter(BP)
  - Good compromise between complexity and performance
- DSP Zero Crossing
  - Alternative to the above
  - Requires Simple A/D
  -

Bounded Information Theory

- Shannon's Law Information Theory Limits

C=Channel Capacity
SNR=Signal to Noise Ratio
NBW=Noise Bandwidth
BW=3db Bandwidth
T=Integration Time
Solve for Signal to Noise Ratio Given Channel Capacity

$BW := 100000$

$T := .00004$

$NBW := \pi \cdot BW$

$NBW = 3.142 \cdot 10^{5}$

$C := \frac{1}{T}$

$C = 2.5 \cdot 10^{4}$

$SNR := 10^{\frac{C}{NBW}} - 1$

$SNR = 0.201$

$SNRdb := 10 \cdot \log(SNR)$

$SNRdb = -6.966$

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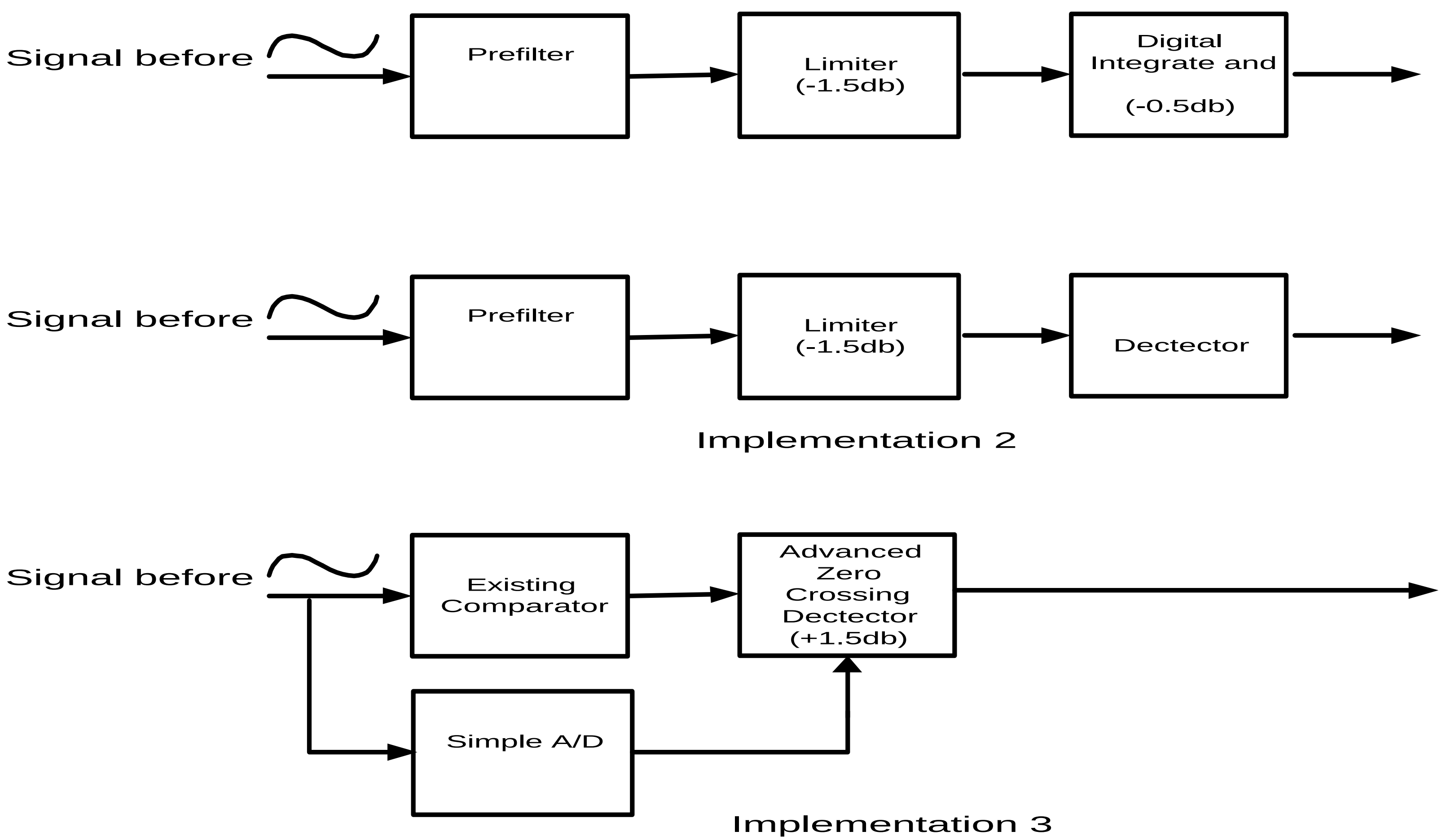

Considerations in Selection of Tone Detectors

- Power and Silicon Area
- Compatibility with Digital Submicron CMOS
- Impact to existing systems and drivers
- Robustness in Noise and Signals

Integrate and Dump Analysis

- Analog or Digital Implementation Possible
- System Analysis Started
- Slightly Better than Zero Crossing
- Zero Crossing an Acceptable Alternative

Implementation of Digital Integrate and Dump

- Full Wave Rectification of Signal and Noise
- 3 Integrate Regions
  - No Signal/Noise - action slow Integrate Down
  - Medium Signal Present - Slow Count Up
  - Fast Count Up Slow Count Down
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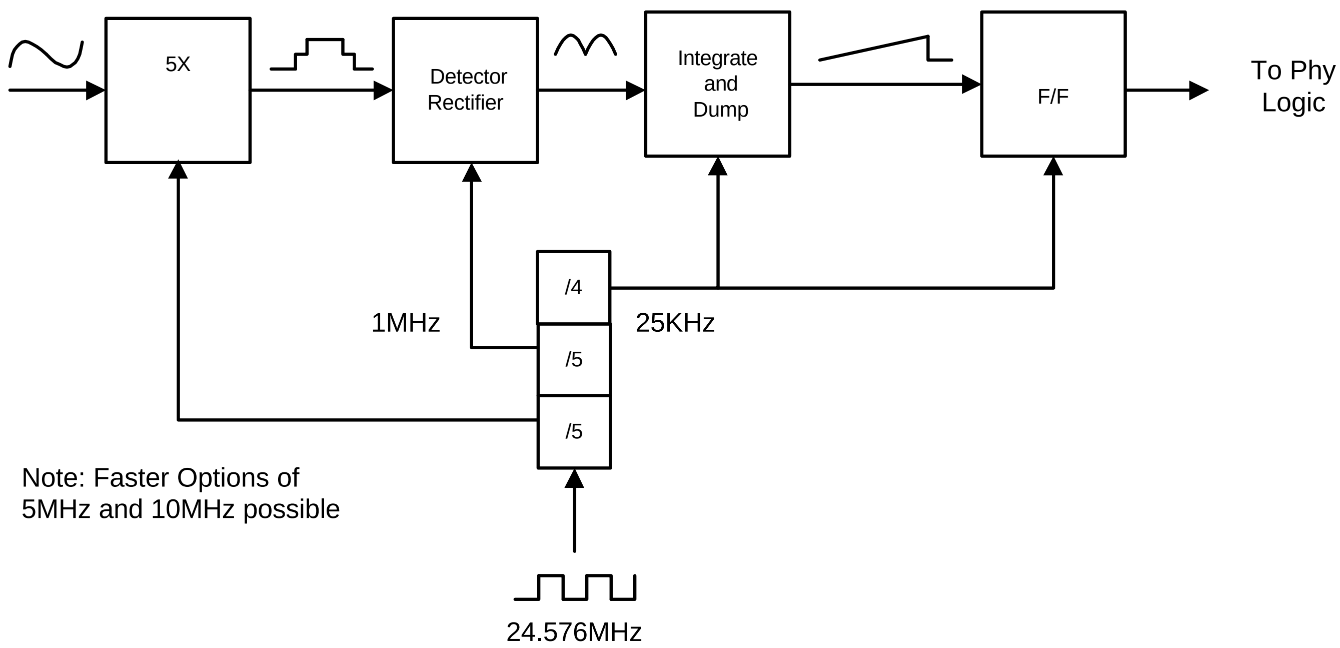

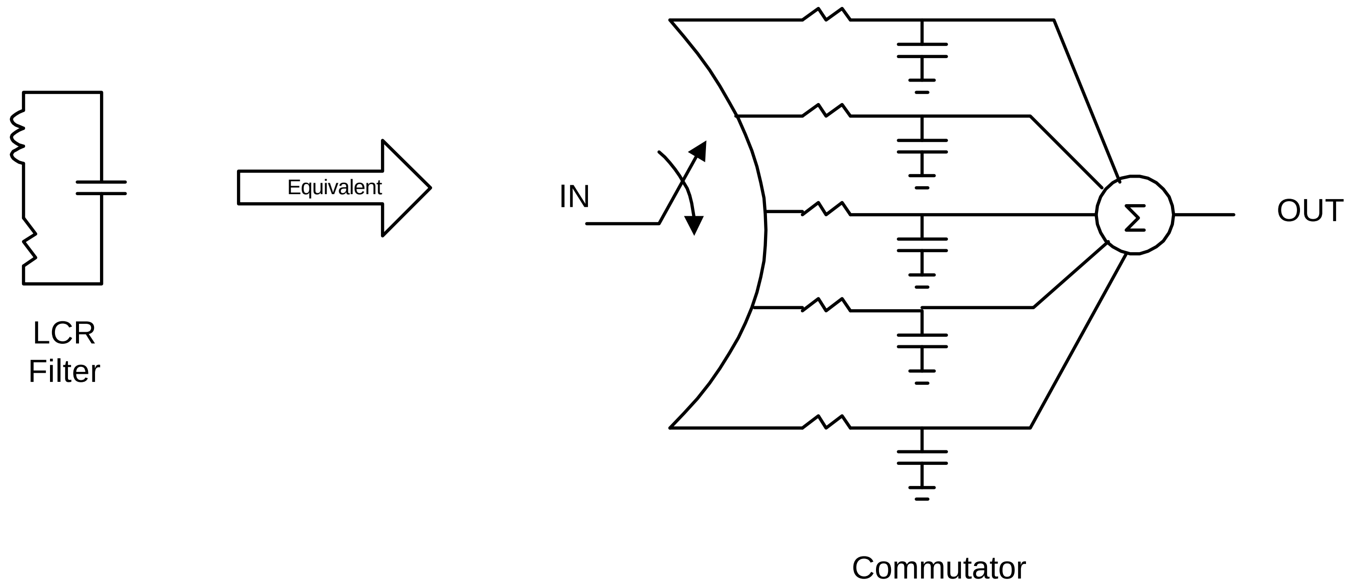
LCR
Filter
Equivalent
IN
OUT
Σ
Commutator

Simplified Calculations of Noise Bandwidth for Commutating Filter

Commutating Filter Build Up
t=Time
R-Resistance
C=Capacitance
T=Sampling Pulse Width
Q=Quality Factor (10)
F=Center Frequency (1Mhz)
BW=3db LP Bandwidth (50Khz)
L=Inductance (assume 1e-6 Henries)

$F := 1000000$

$L := .000001$

$$C := \frac{1}{(2 \cdot 3.14159 \cdot F)^2 \cdot L}$$

$C = 2.533 \cdot 10^{-8}$

$$R := \frac{2 \cdot 3.14159 \cdot .000001}{10} \cdot 1000000$$

$R = 0.628$

50 Khz Bandwidth Commutating and IC Scaling

$C := 2.5 \cdot 10^{-9}$

$$R := \frac{2 \cdot 3.14159 \cdot 50000 \cdot .000001}{10}$$

$R = 0.031$

$$R := \frac{1}{(2 \cdot 3.14159 \cdot C \cdot 50000)}$$

$R = 1.273 \cdot 10^{3}$

127K with a 25pf Capacitor Scaled

5X vs 7x Synchronous Oversampled Filter

- Prime Number Sampling
- A Property is the Integral Relatively Unaffected by Phase
- 7X Shows a 3db SNR Quantization Improvement over 5X
- 5X should be adequate for this Application.
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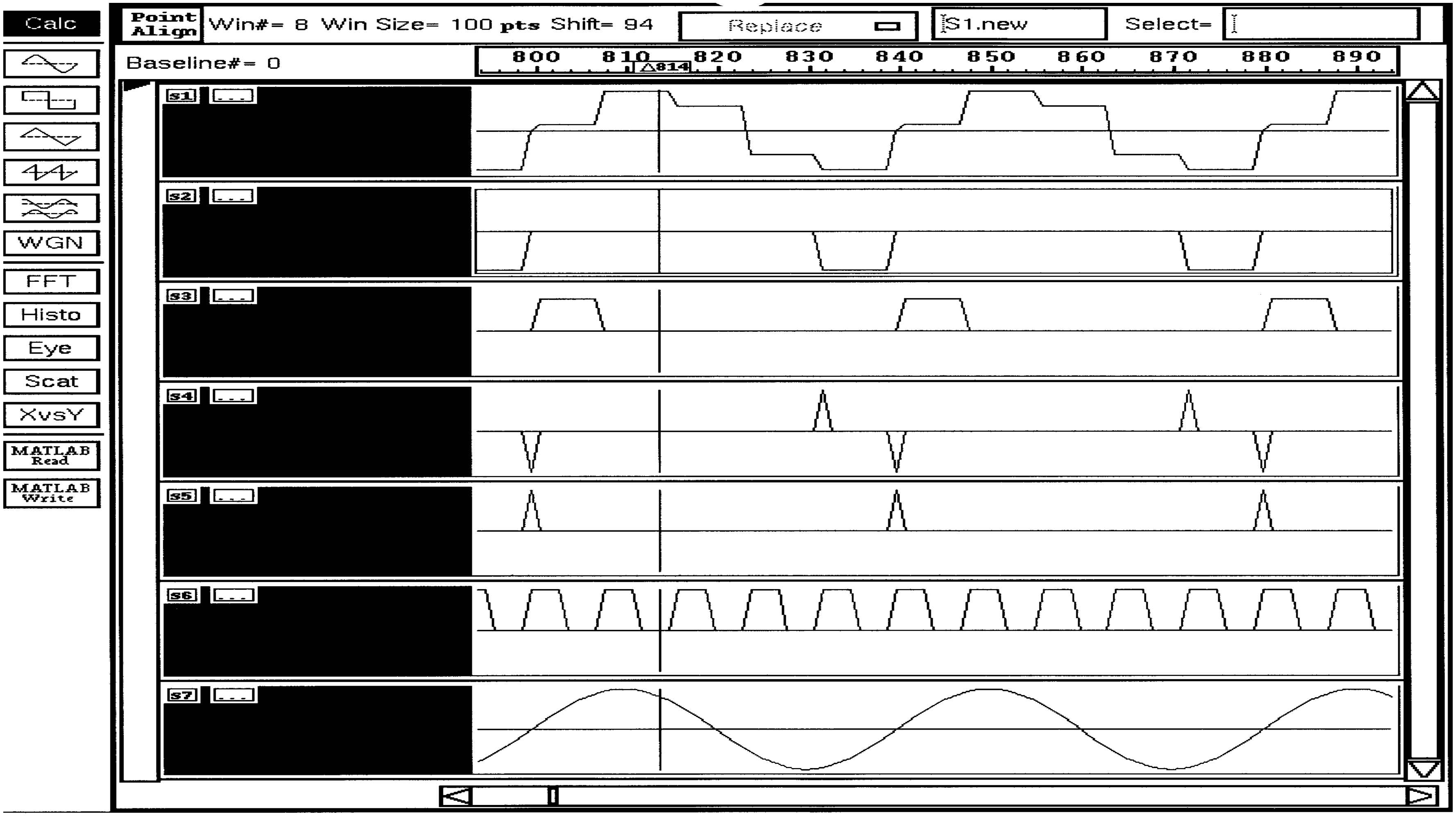

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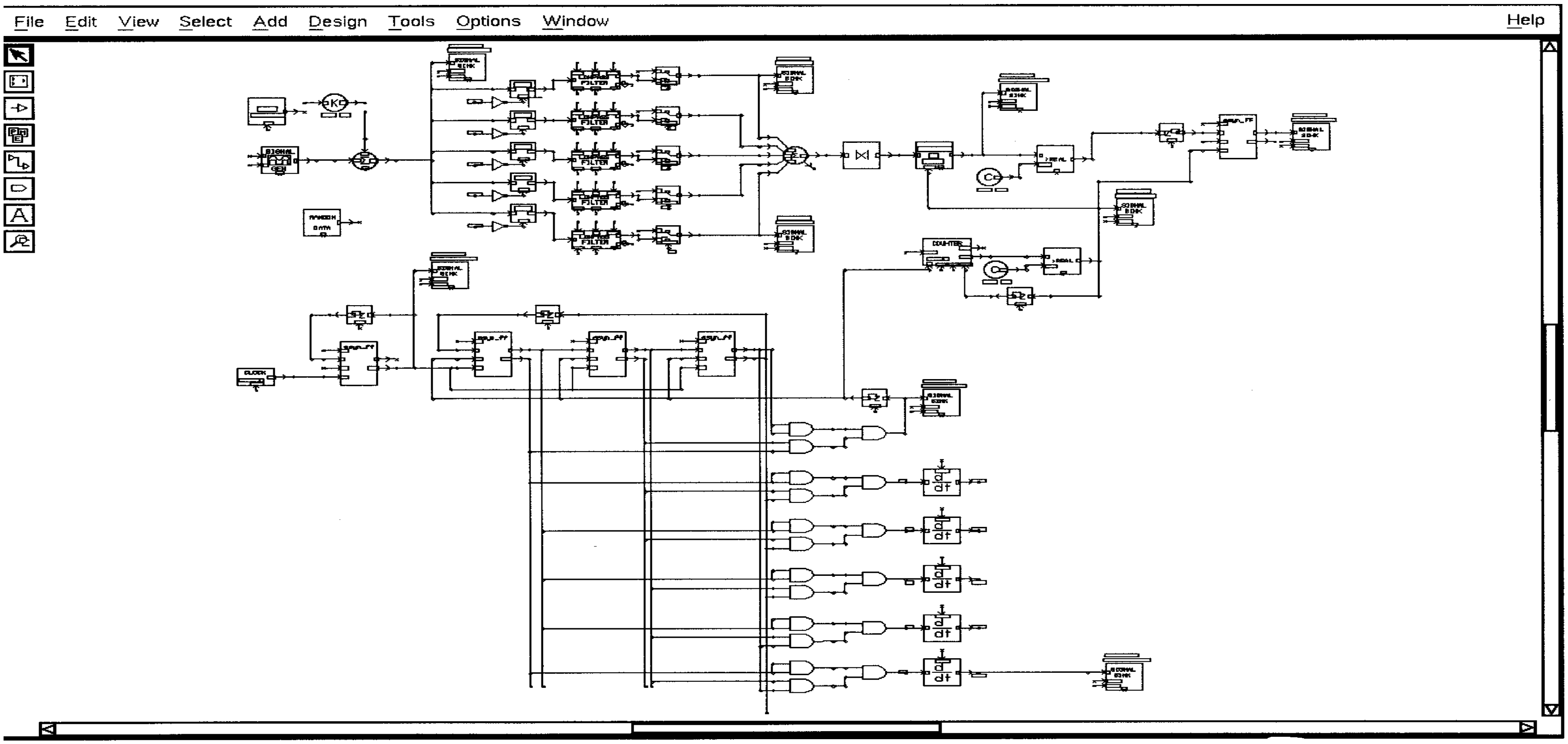

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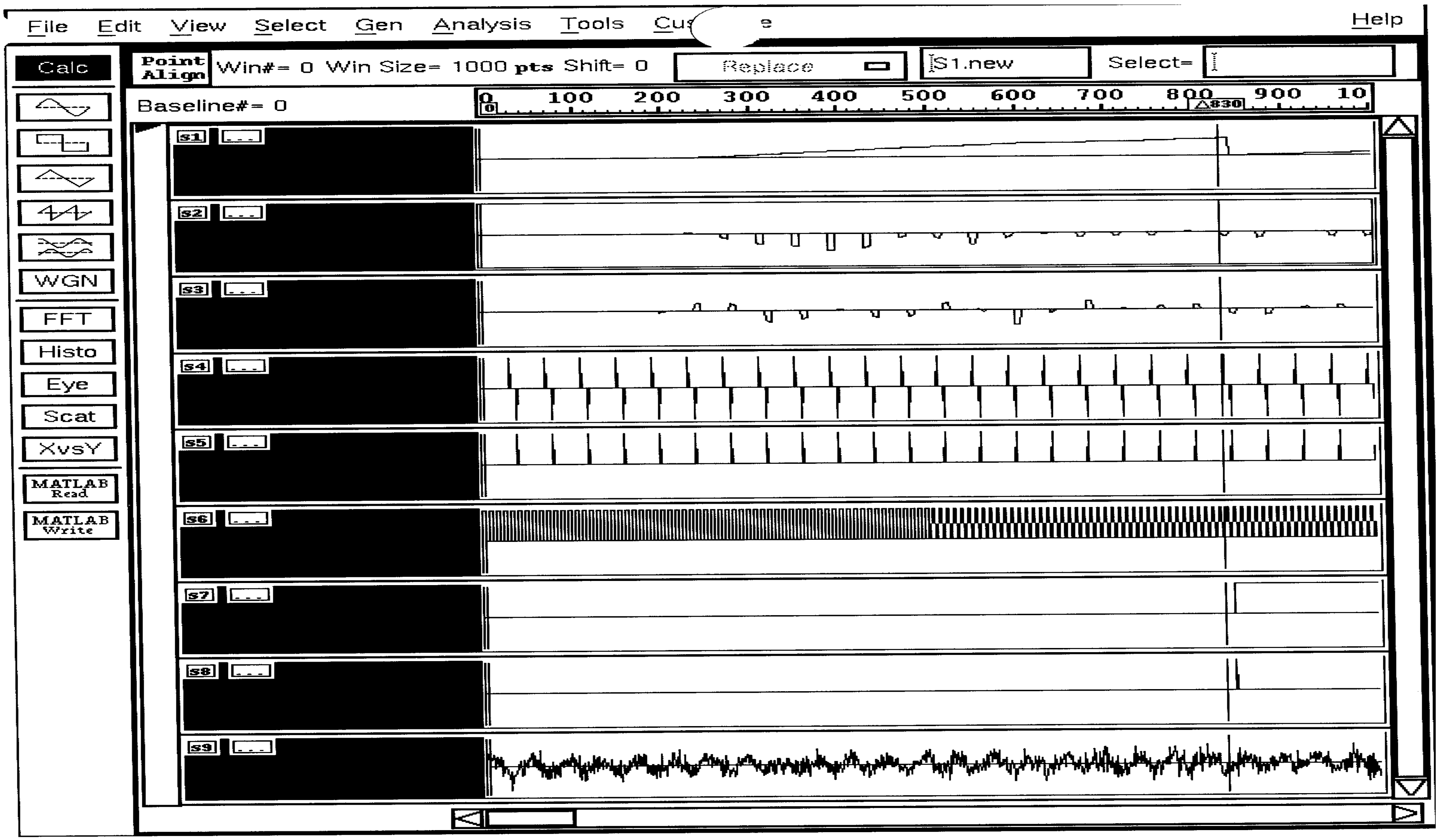

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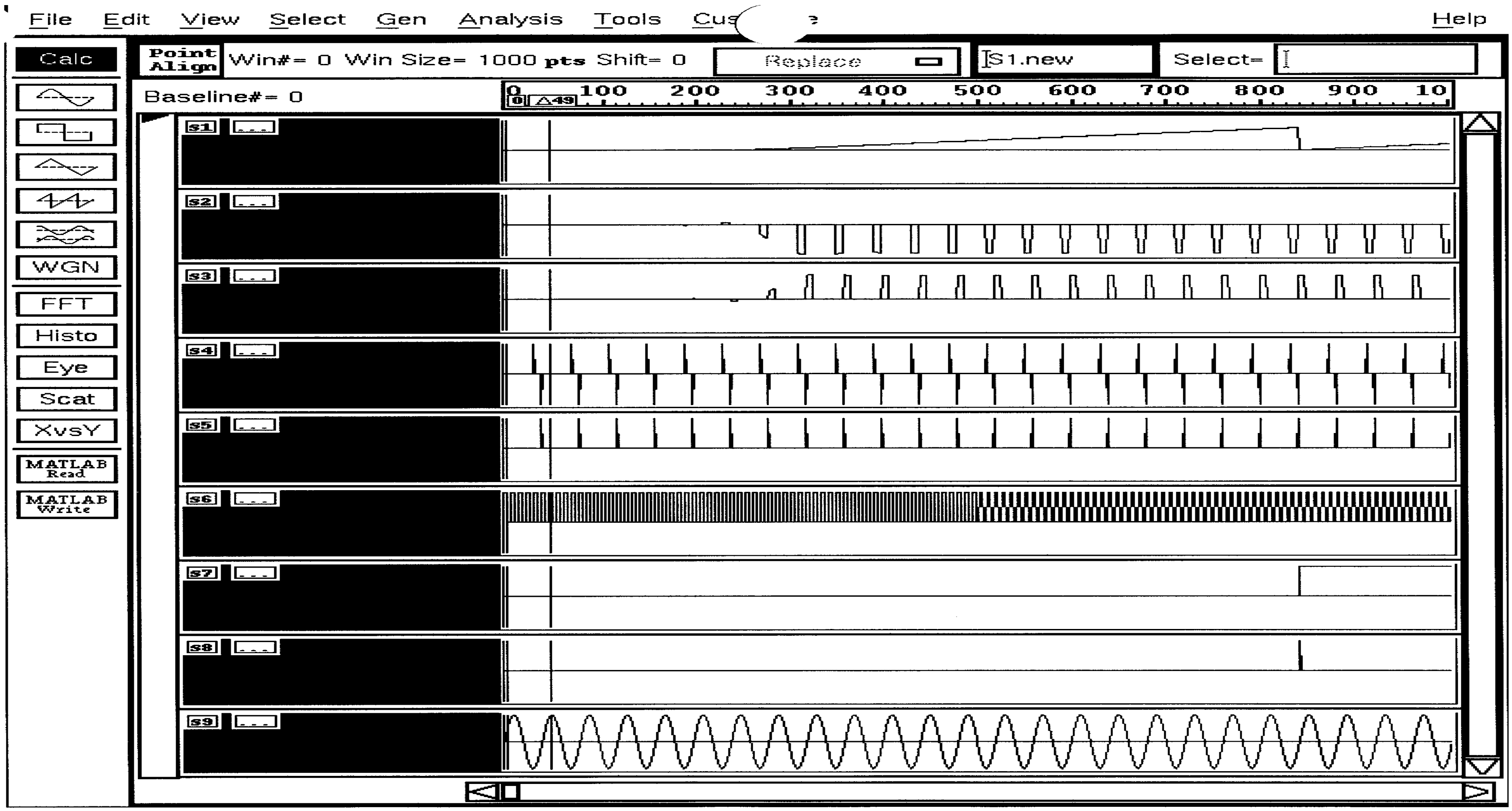

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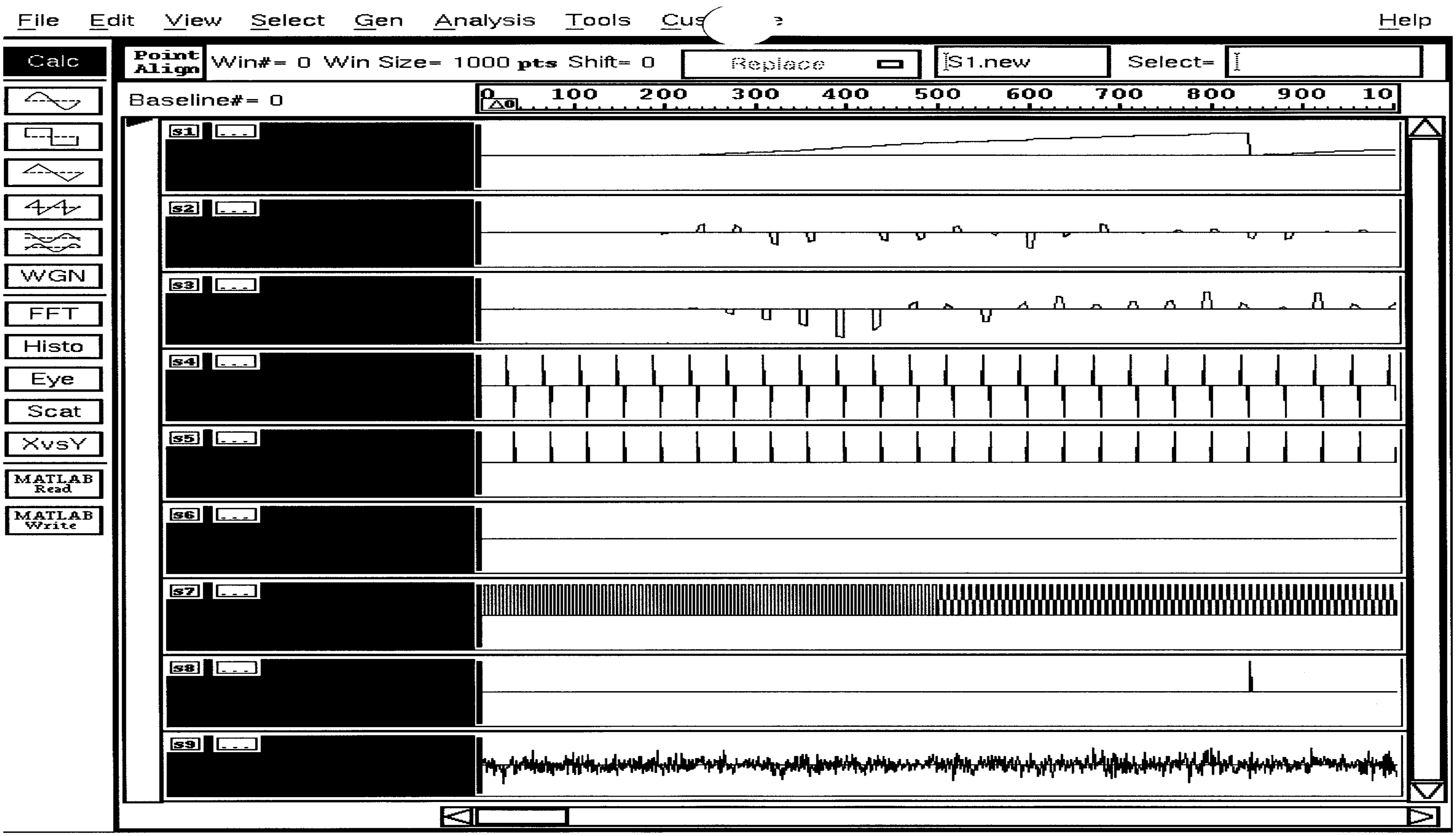

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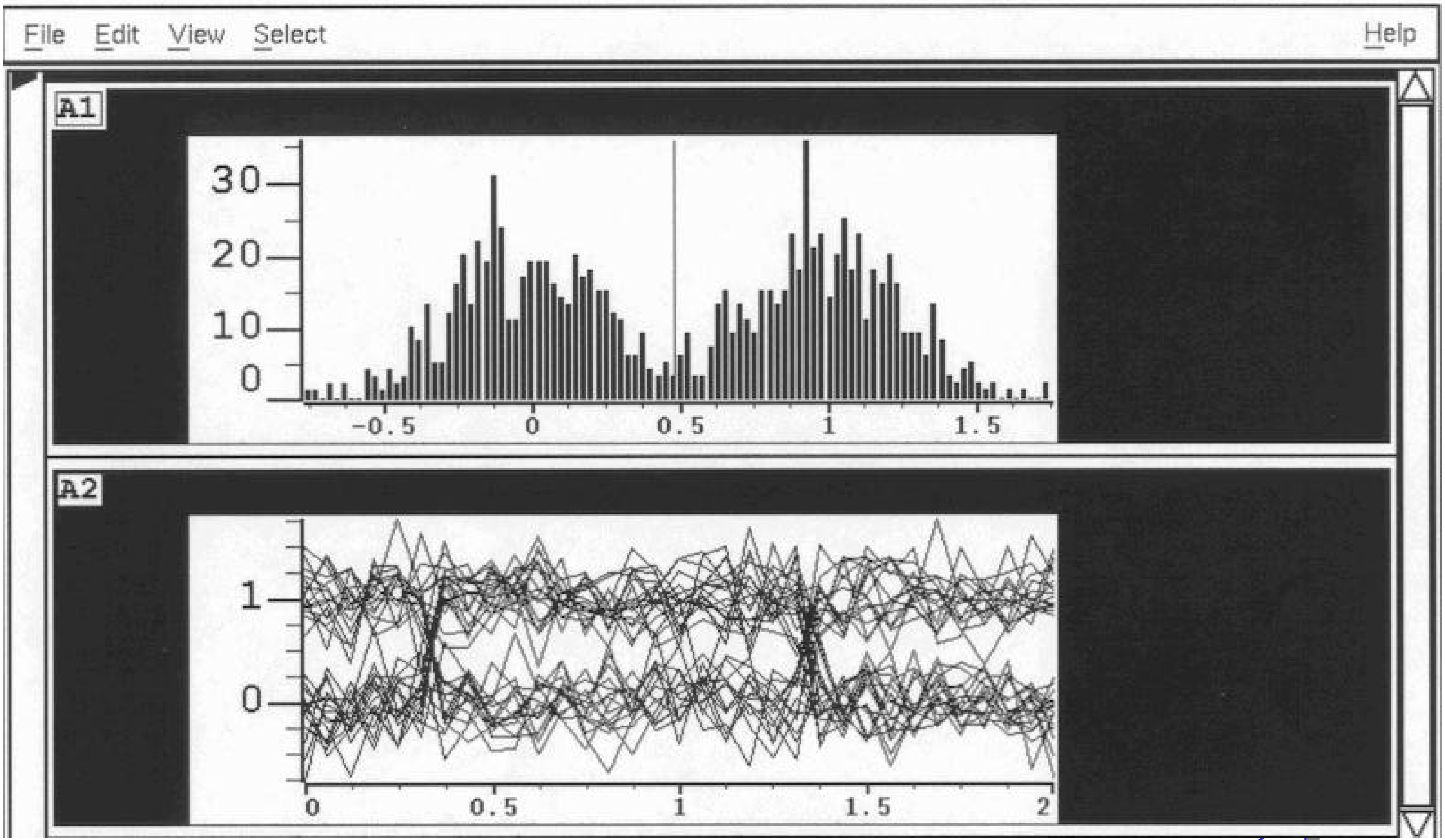

Zero Crossing Algorithm

- Detection Based on 3 Criterion
  - Moving Average
  - Percentage of good versus bad periods
  - Total number of crossings in an interval

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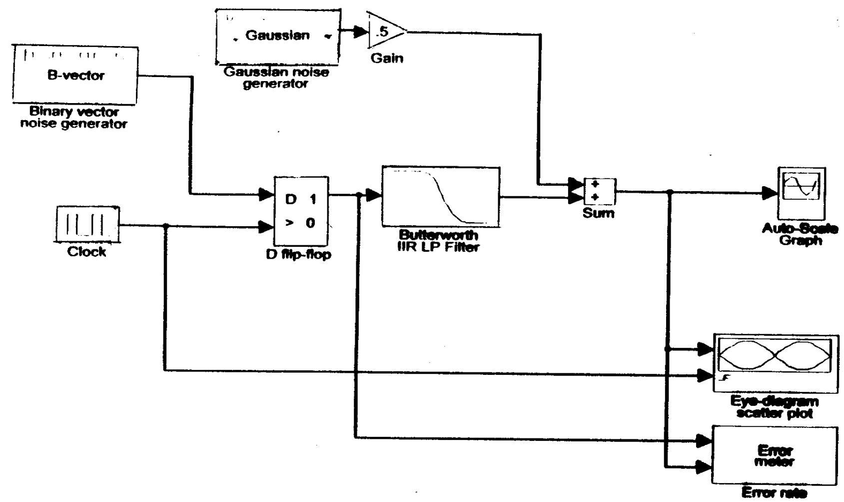

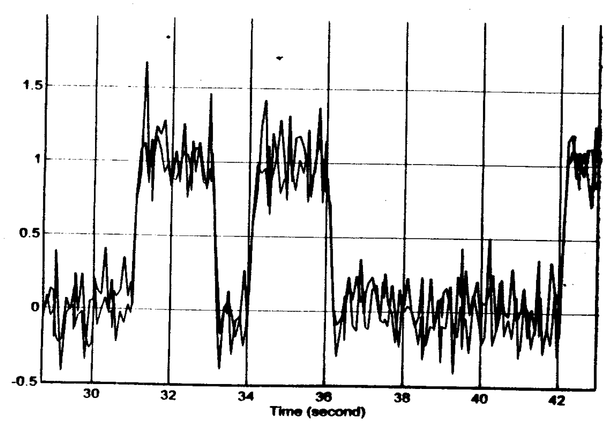

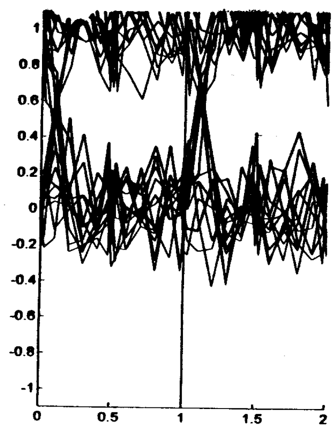

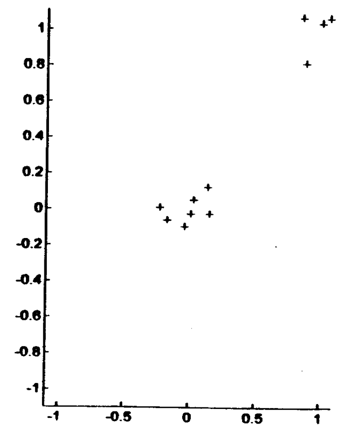

Falsing Probability Discussion

- Simple Continuous Sampling Suggests MTBF ~2 Years In Noise
- Assumptions 40 samples with a .5 probability in a row
- Increasing the run length to 50 samples increases it to 2000 years
- Setting Threshold at 10% Uncertainty Increases MTBF to 2 months (Conditional Probability).
- Signal and Noise Analysis (Blackman and Rice)

Concerns and Additional Work

- Bandwidth of Optical Network and Impact to Tone Frequency and Power
- Driver Compatibility (Bilingual)
- Compatibility with Suspend/ Resume?
- STPM state machine
- More Detailed System analysis/State Machine
- Debounce/ Connect state machine

Simulation and Analysis Tools Used

- Alta Group - SPW
- Matlab Simulink
- Spice

Conclusions

- Framework for Analysis Presented
- Simple Tone Scheme Feasible for Startup
- An Implementation Based on a Bandpass followed by an Integrate and Dump
- Crystal Based Detector Scheme Feasible