Digital Demodulation of a Fractional Fringe Interferometer

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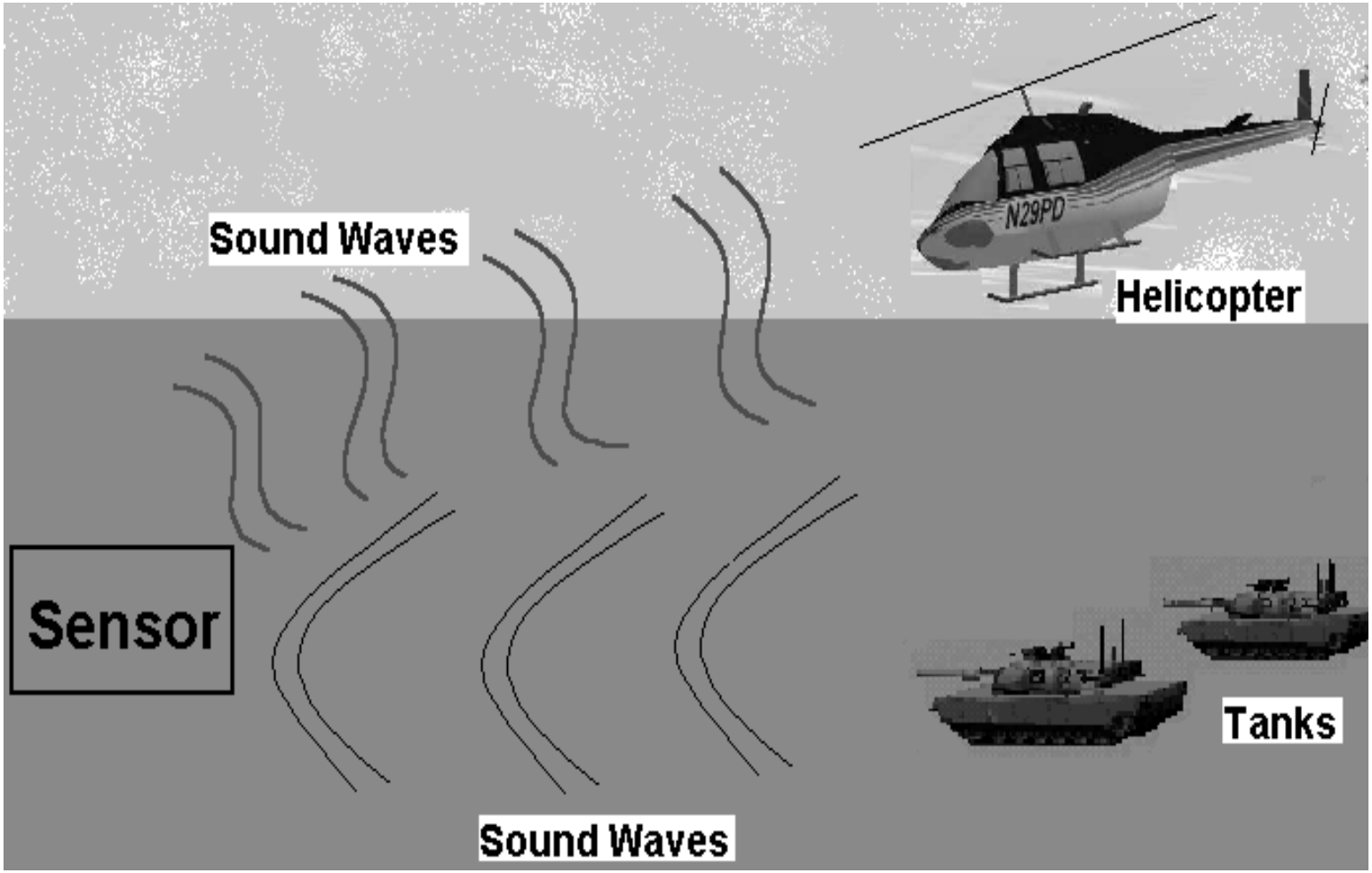
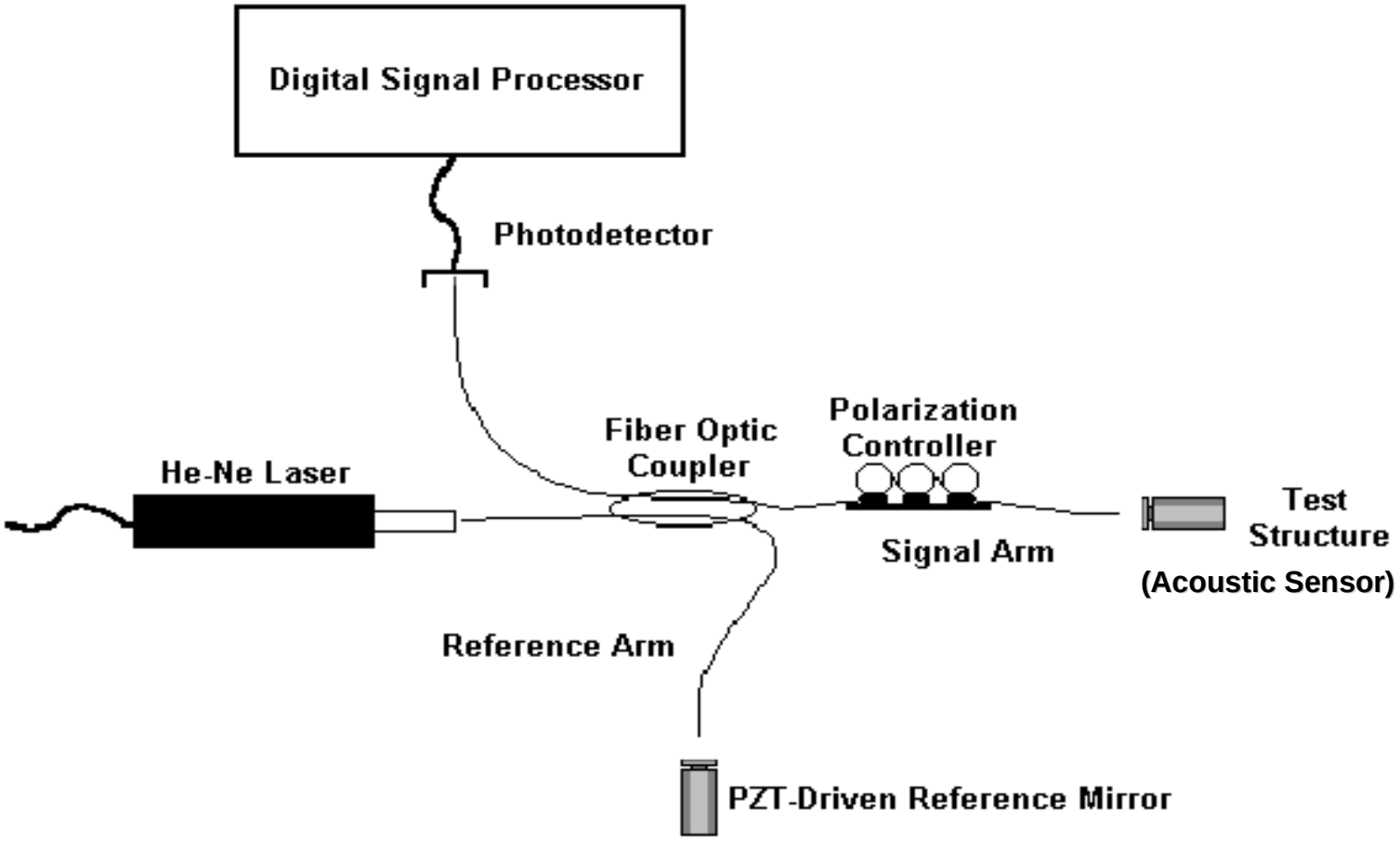
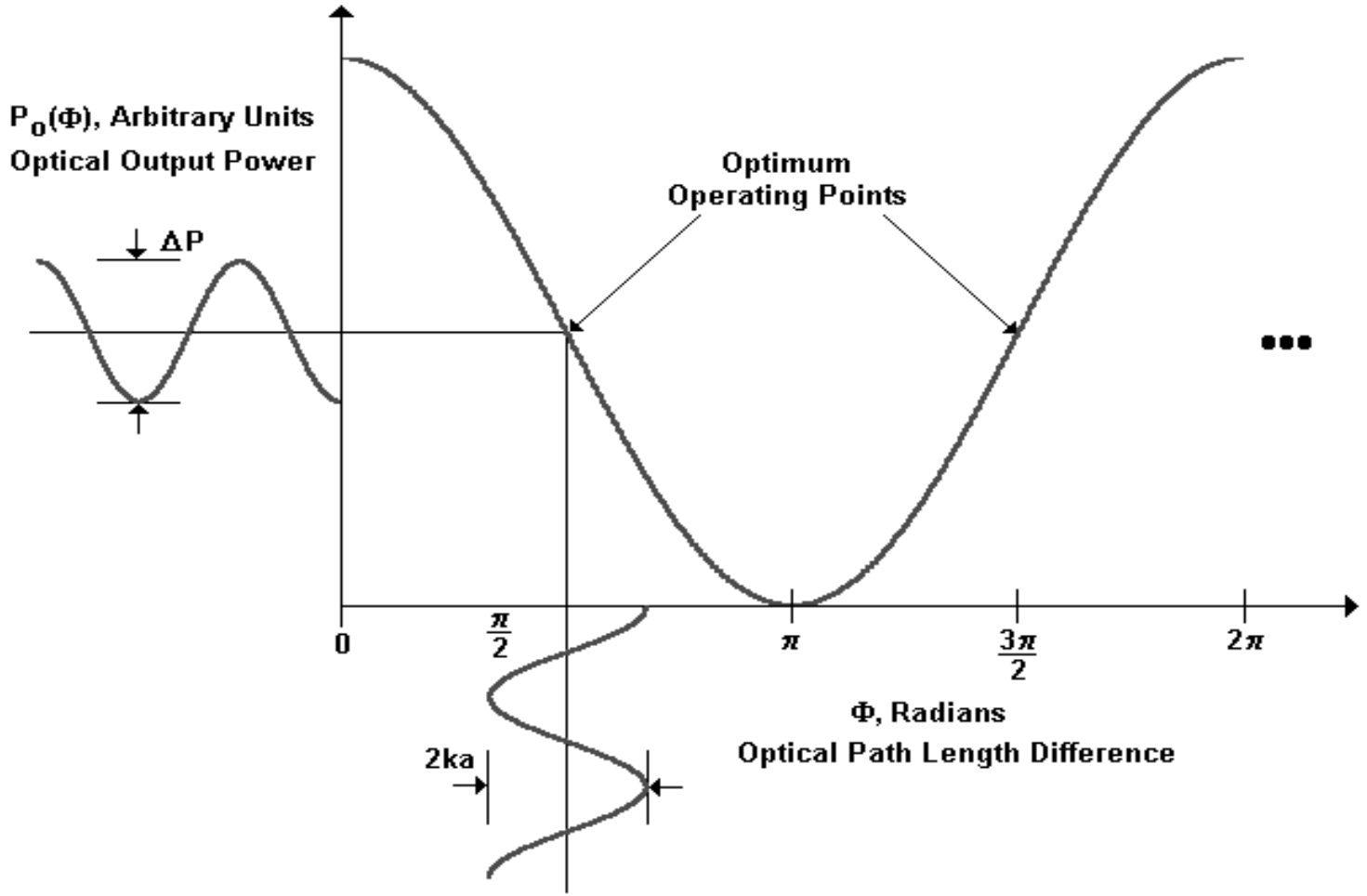
Acoustic Sensing Application



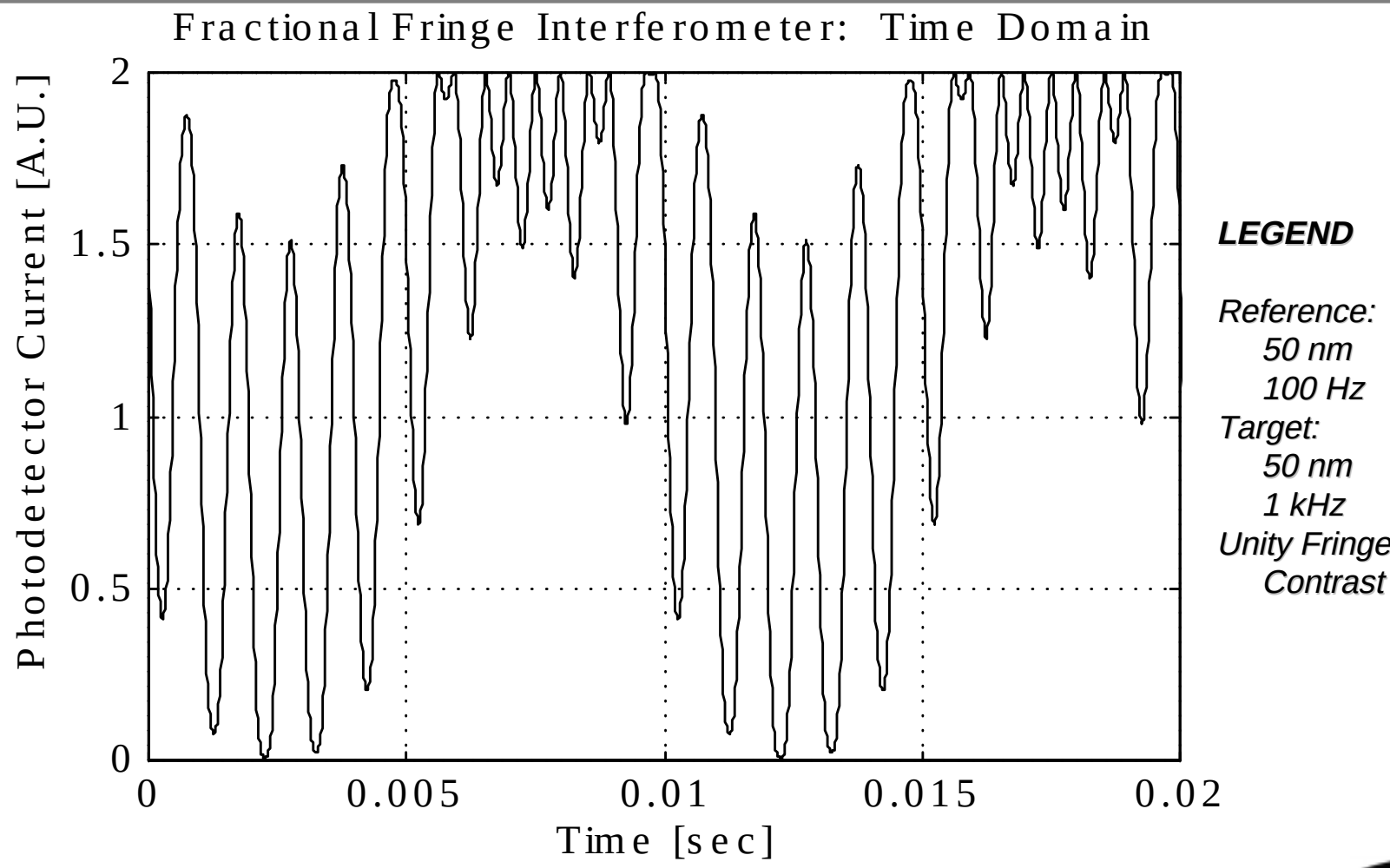
System Configuration



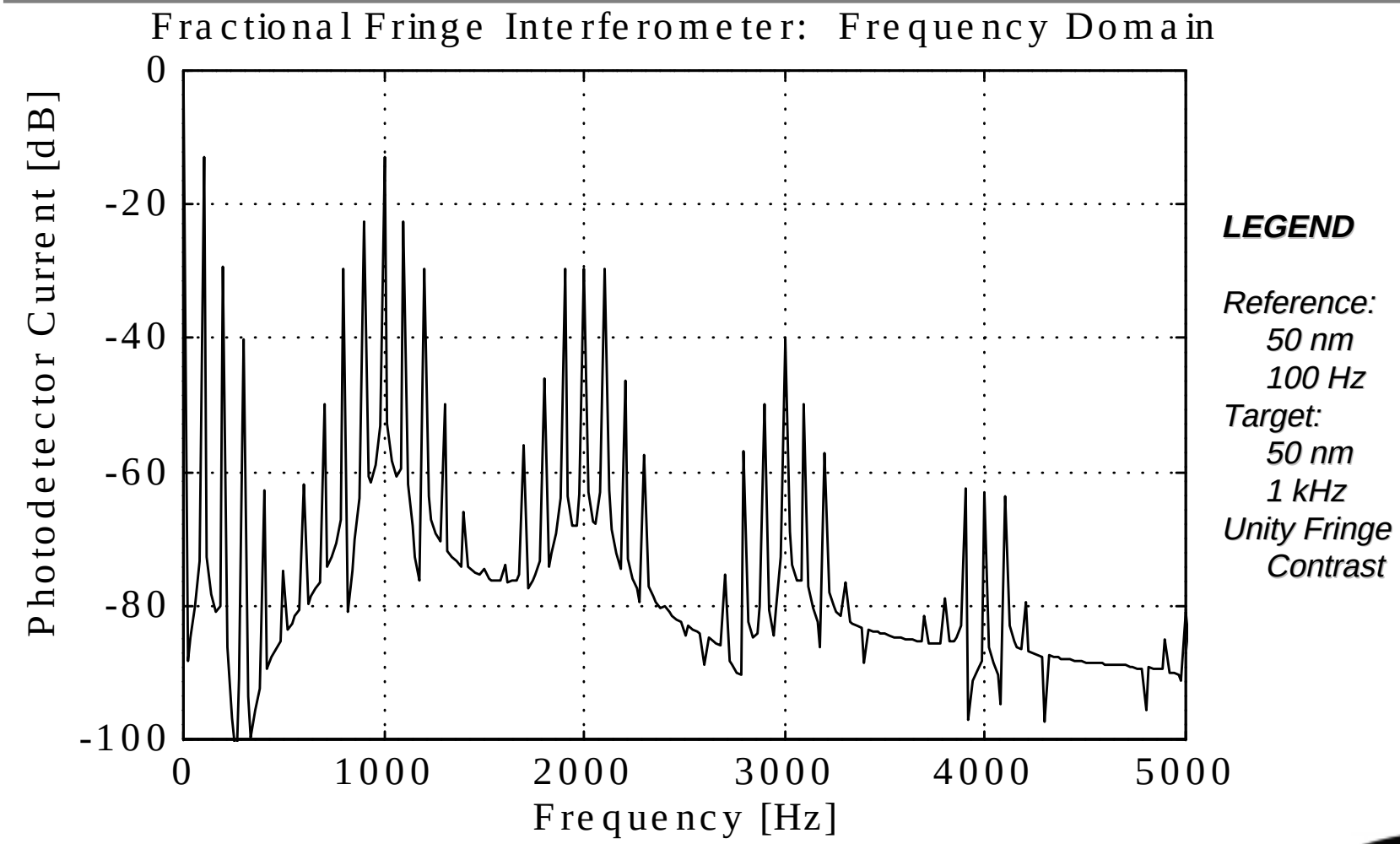
Quadrature Condition



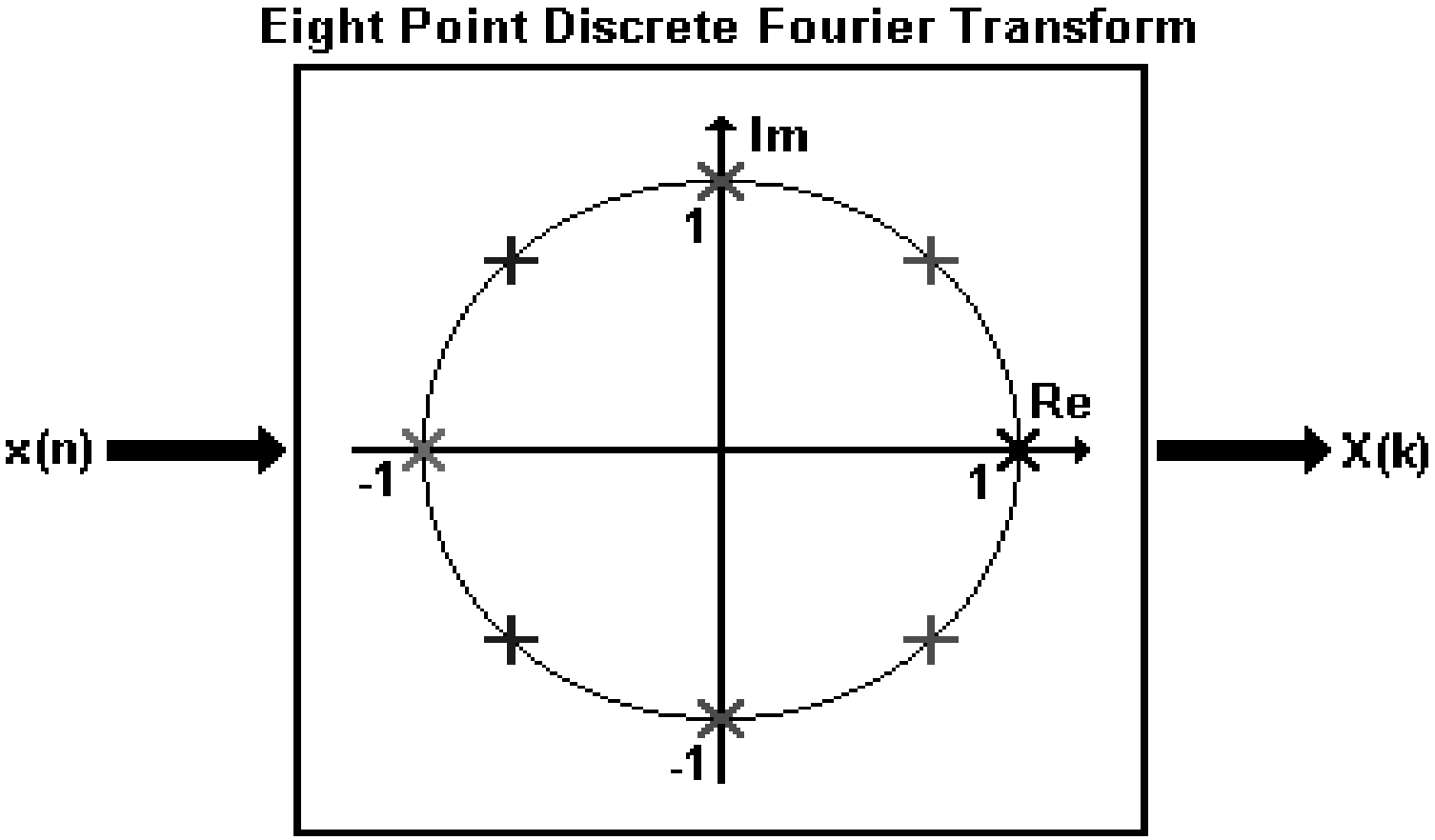
Theoretical Output Signal: Time Domain



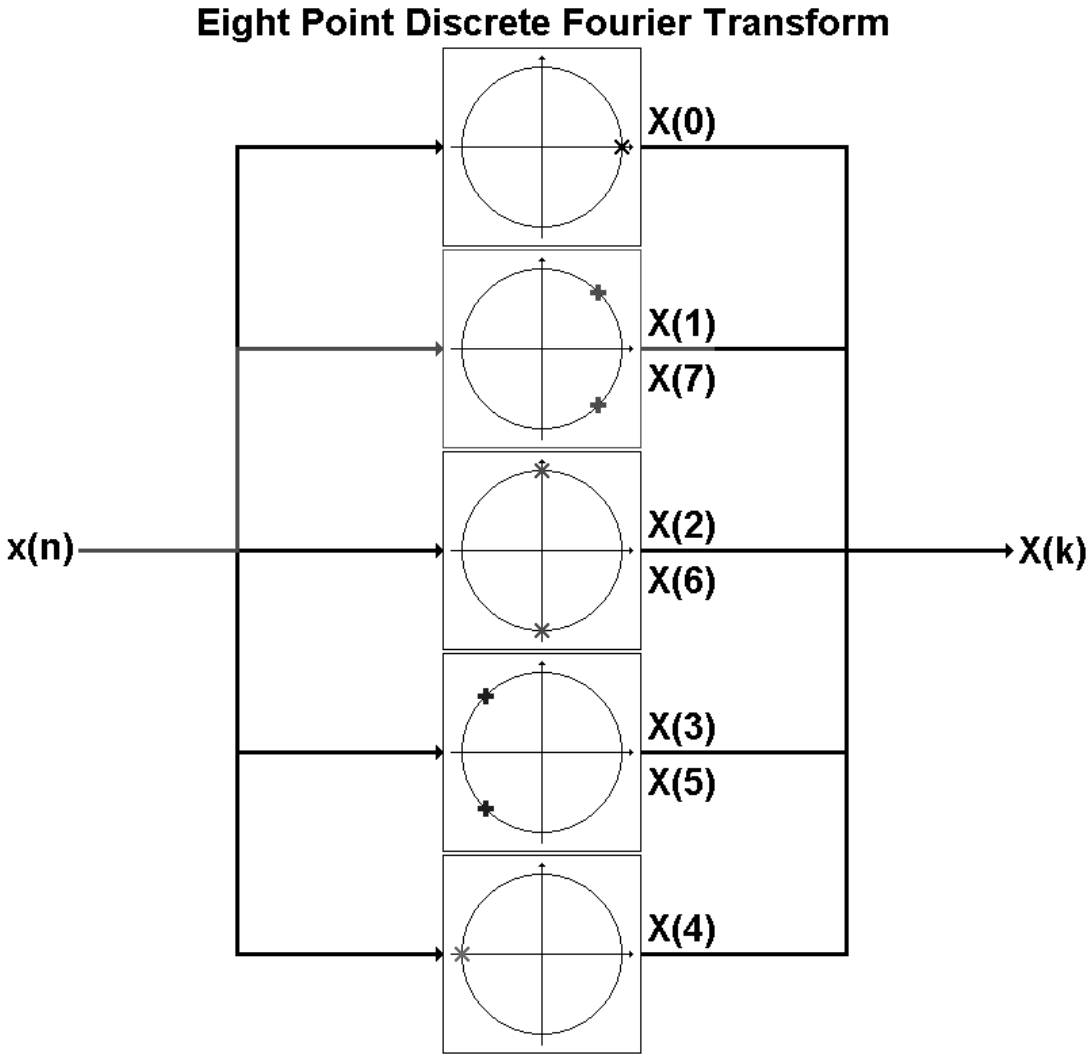
Theoretical Output Signal: Frequency Domain



Discrete Fourier Transform (DFT)



DFT: Parallel Form

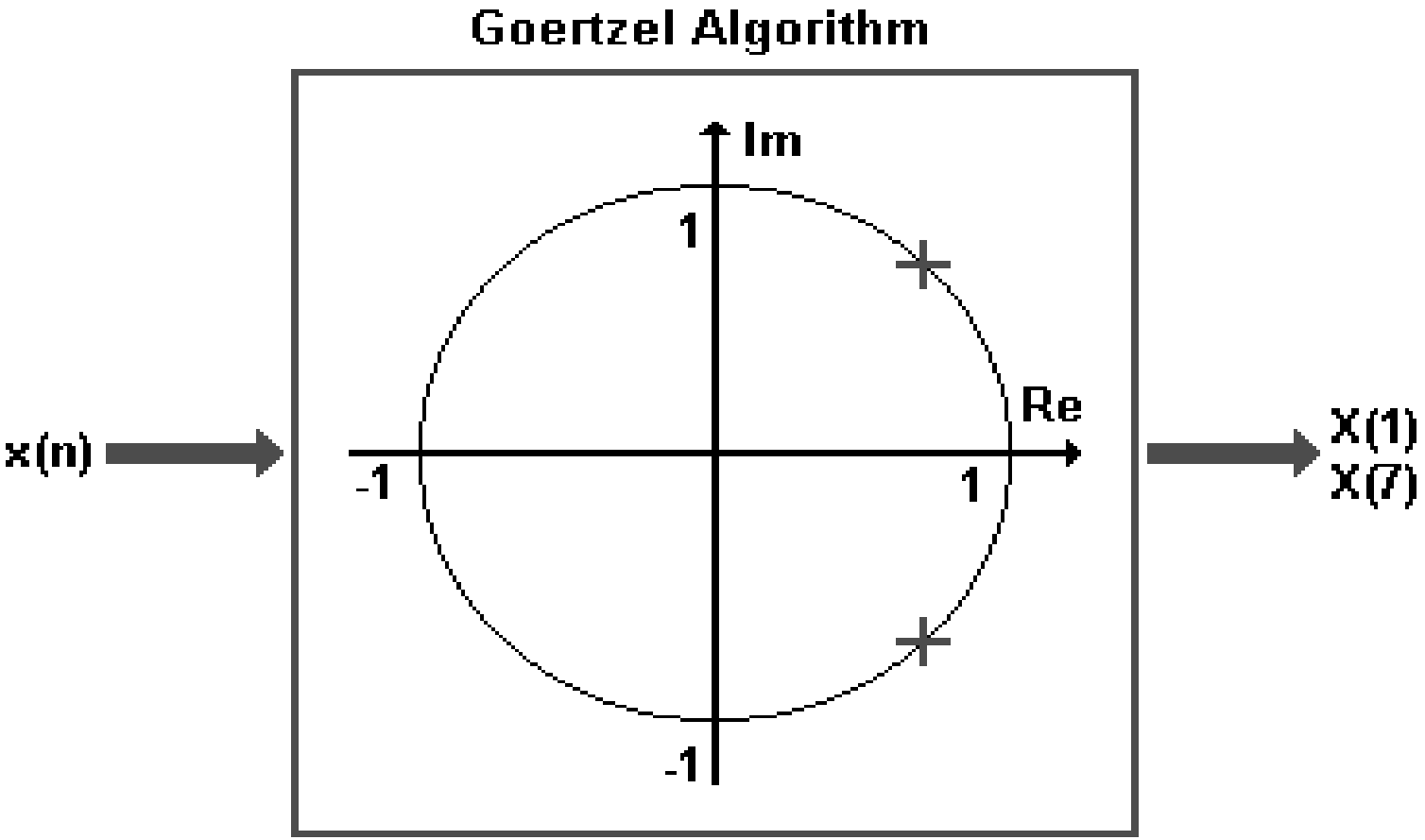


Computational Efficiency: Comparative Example

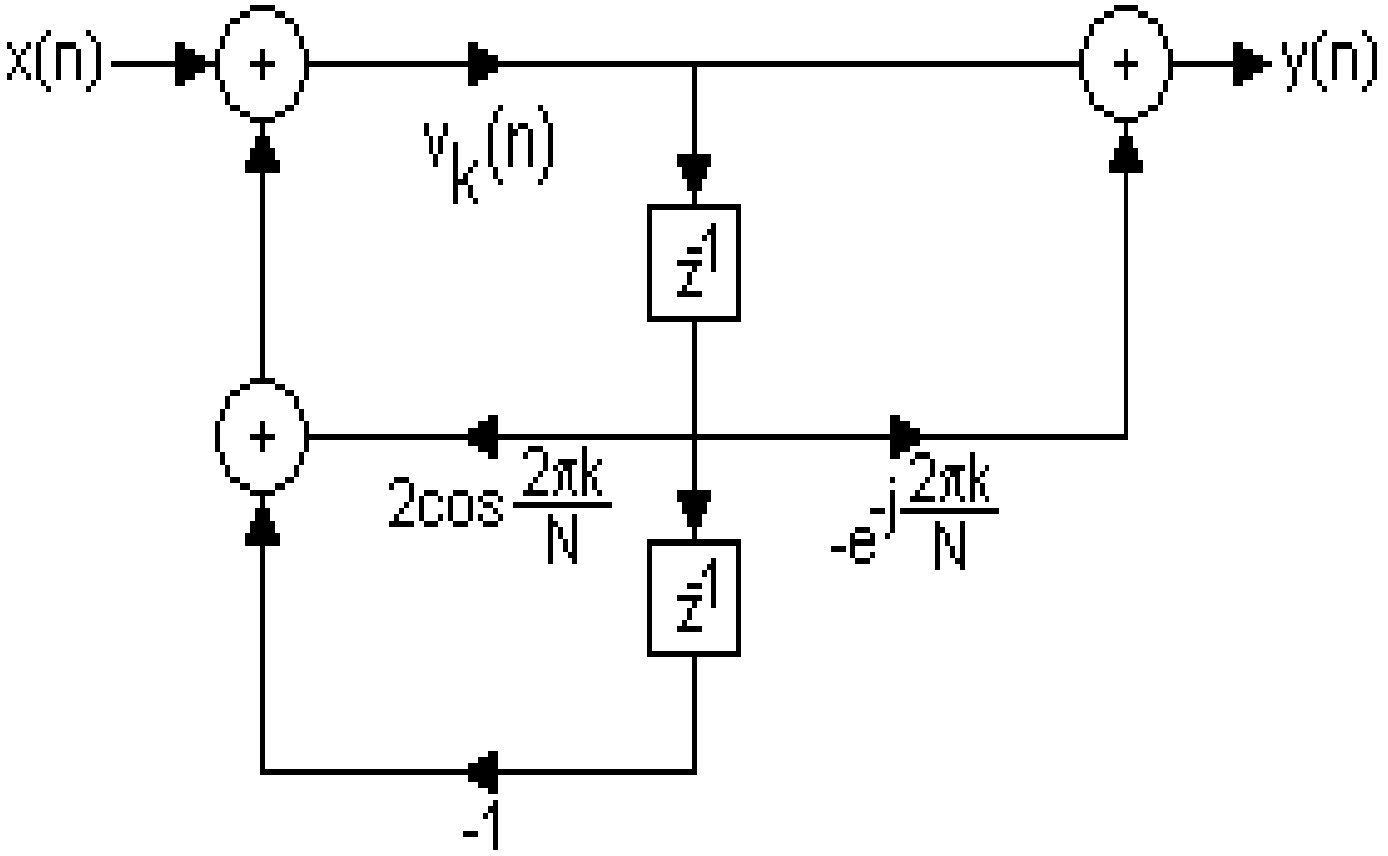
Mathematical Operations	Direct DFT	FFT Decimation		Goertzel Algorithm
		Time	Frequency	
Complex Multiplications	8	7	7	0
Complex Additions	7	7	3	0
Real Multiplications	0	0	0	11
Real Additions	0	0	4	19
Total Multiplications	32	28	28	11
Total Additions	30	28	24	19
TOTAL COMPUTATIONS	62	56	52	30

Assumptions: 8-point sequence
Calculation of 1 frequency pair

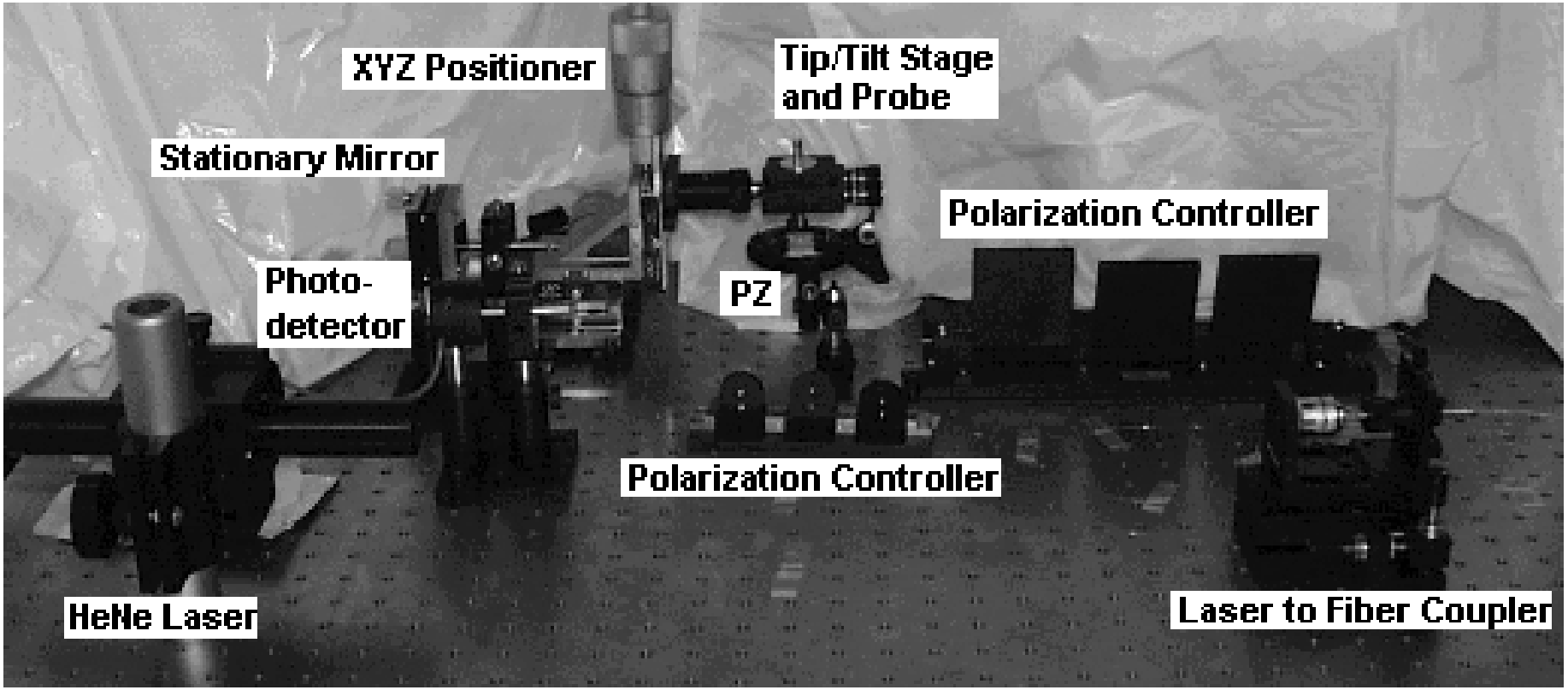
Goertzel Algorithm



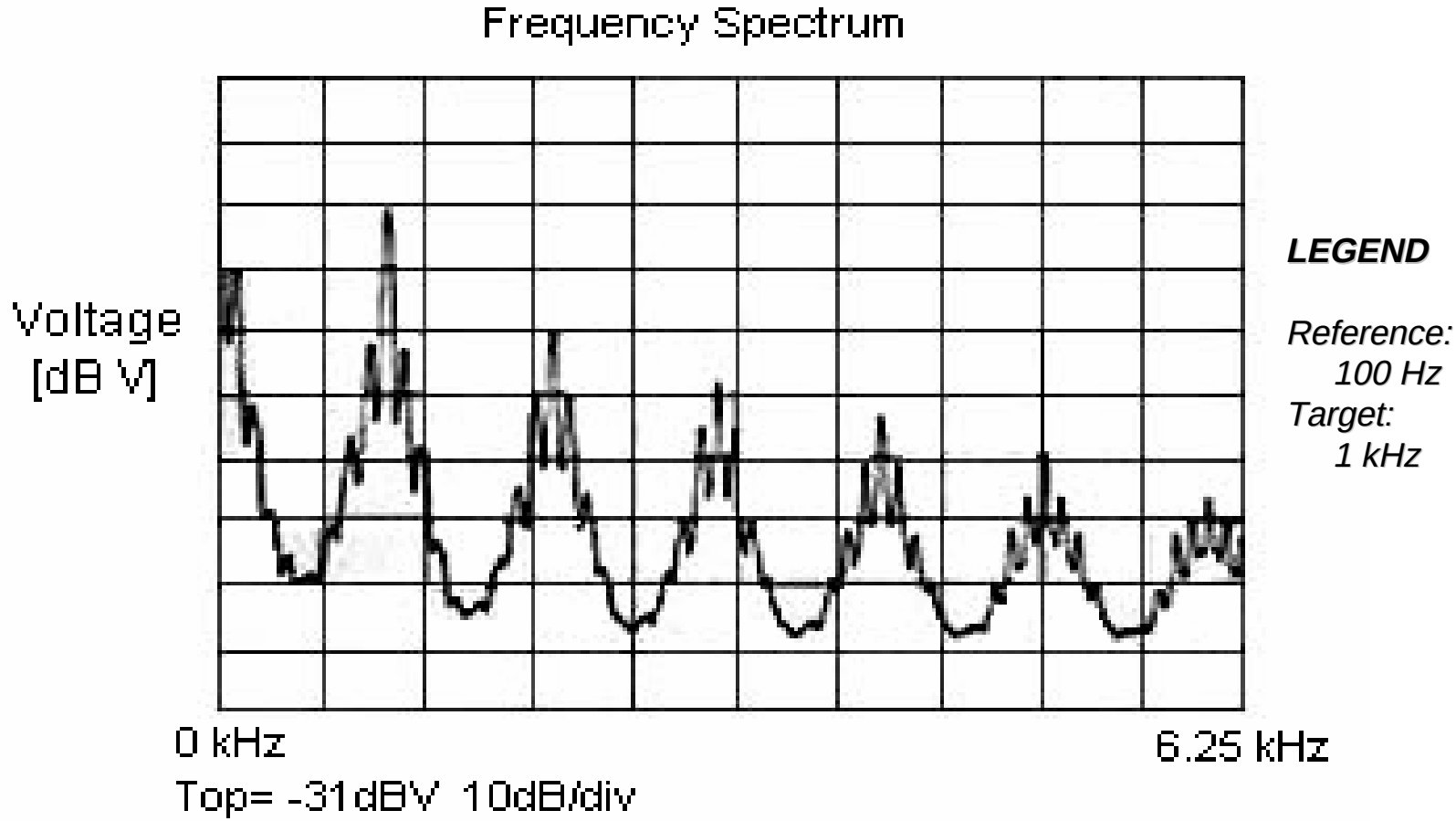
Goertzel Algorithm: Direct Form II



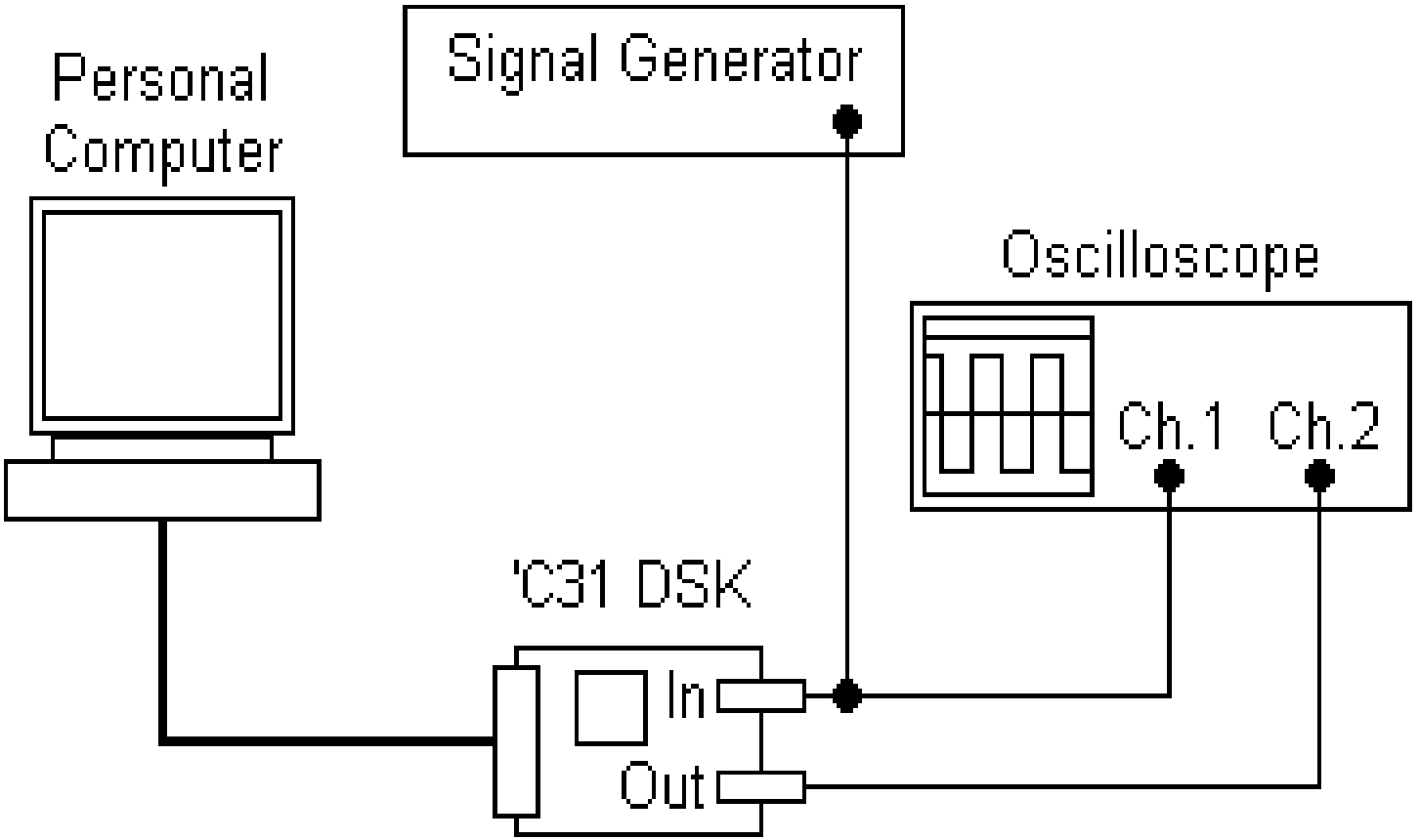
Experimental Interferometer Setup



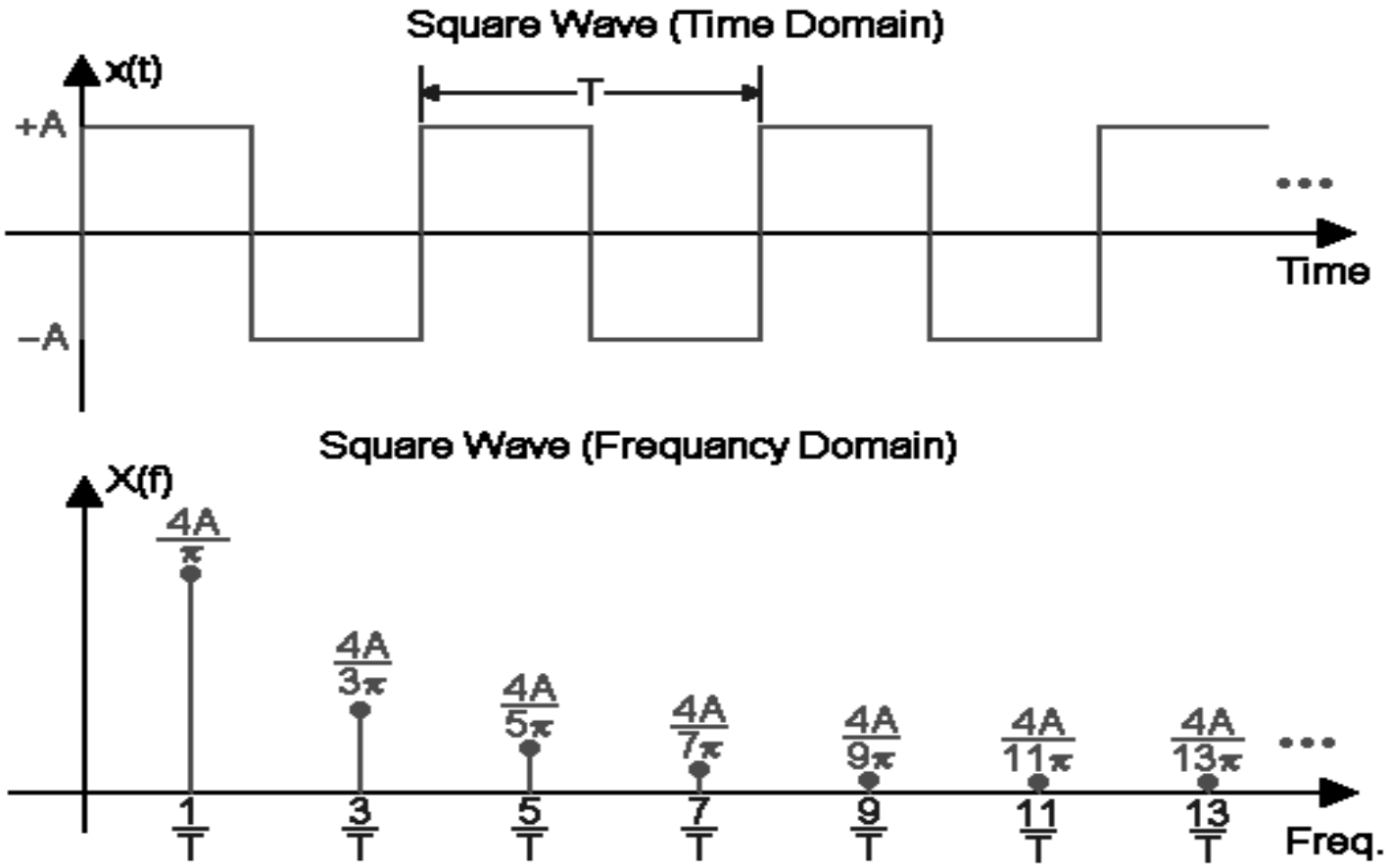
Experimental Output Signal: Frequency Domain



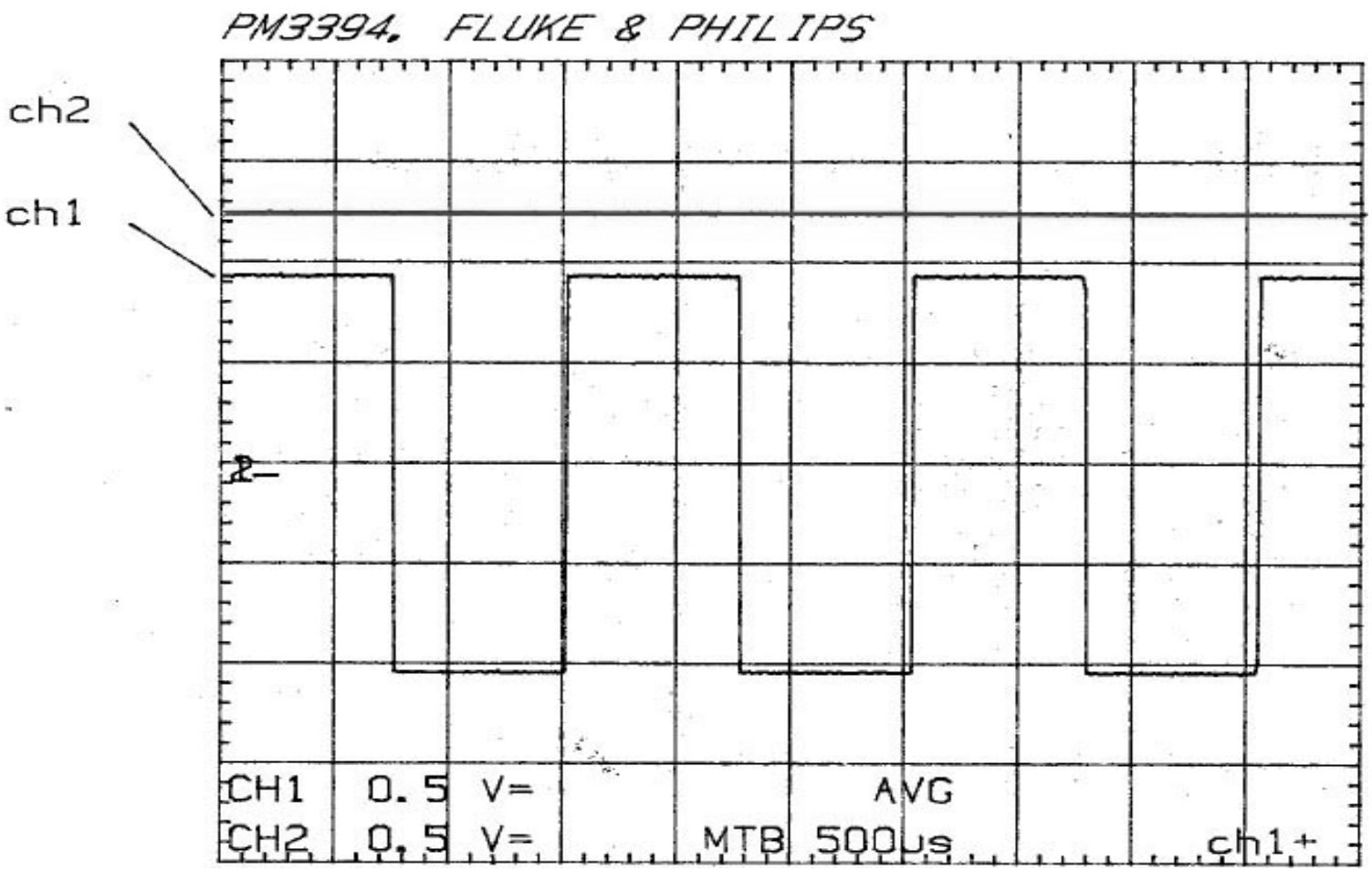
Goertzel Test Configuration



Square Wave: Time & Frequency Representation



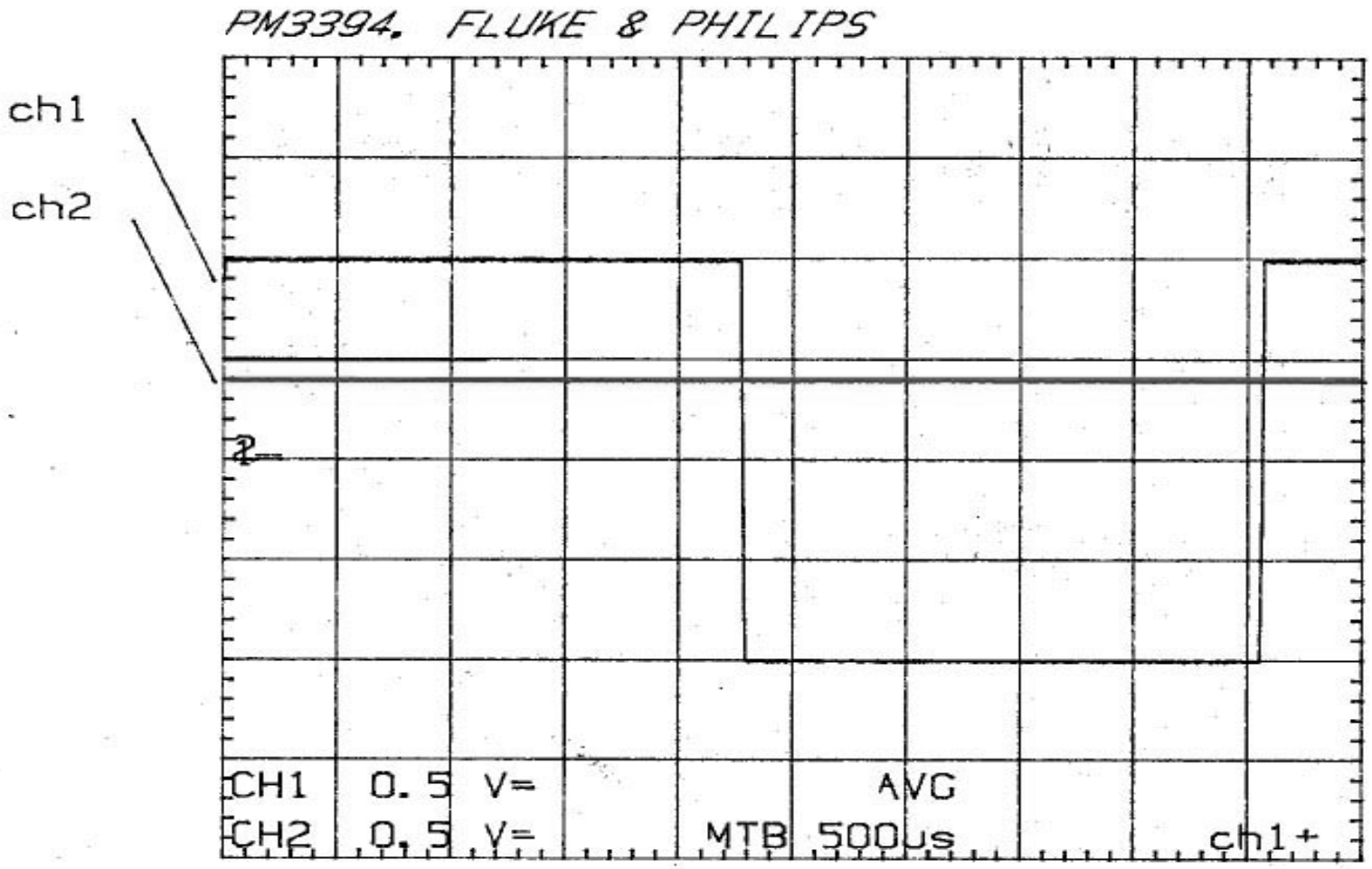
Goertzel Frequency Selectivity: 658 Hz Square Wave



LEGEND

Ch. 1:
Square Wave
658 Hz
2 V pk-pk
Ch. 2:
1.25 V DC

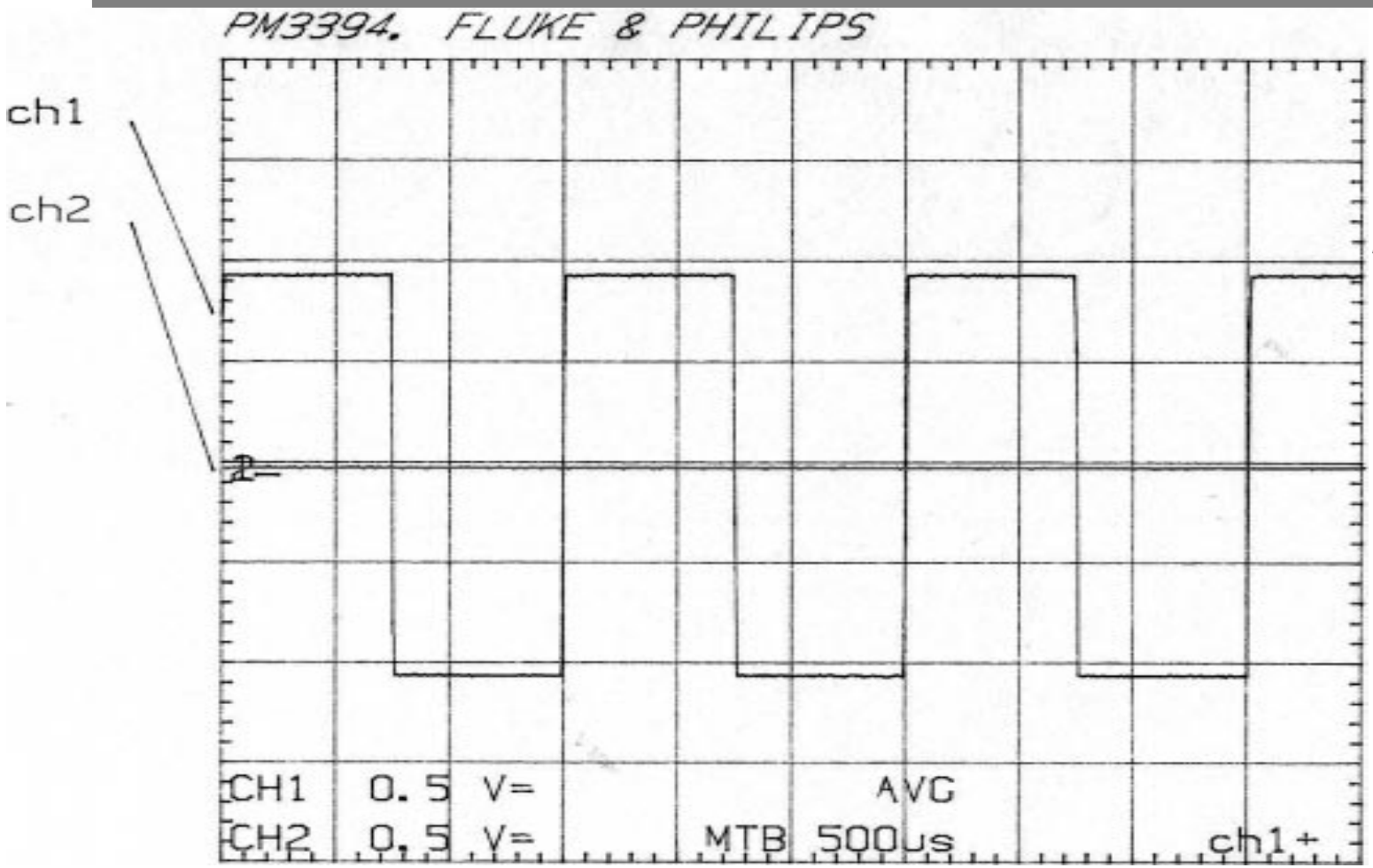
Goertzel Frequency Selectivity: 219 Hz Square Wave



LEGEND

Ch. 1:
Square Wave
219 Hz
2 V pk-pk
Ch. 2:
0.4 V DC

Goertzel Frequency Selectivity: 665 Hz Square Wave

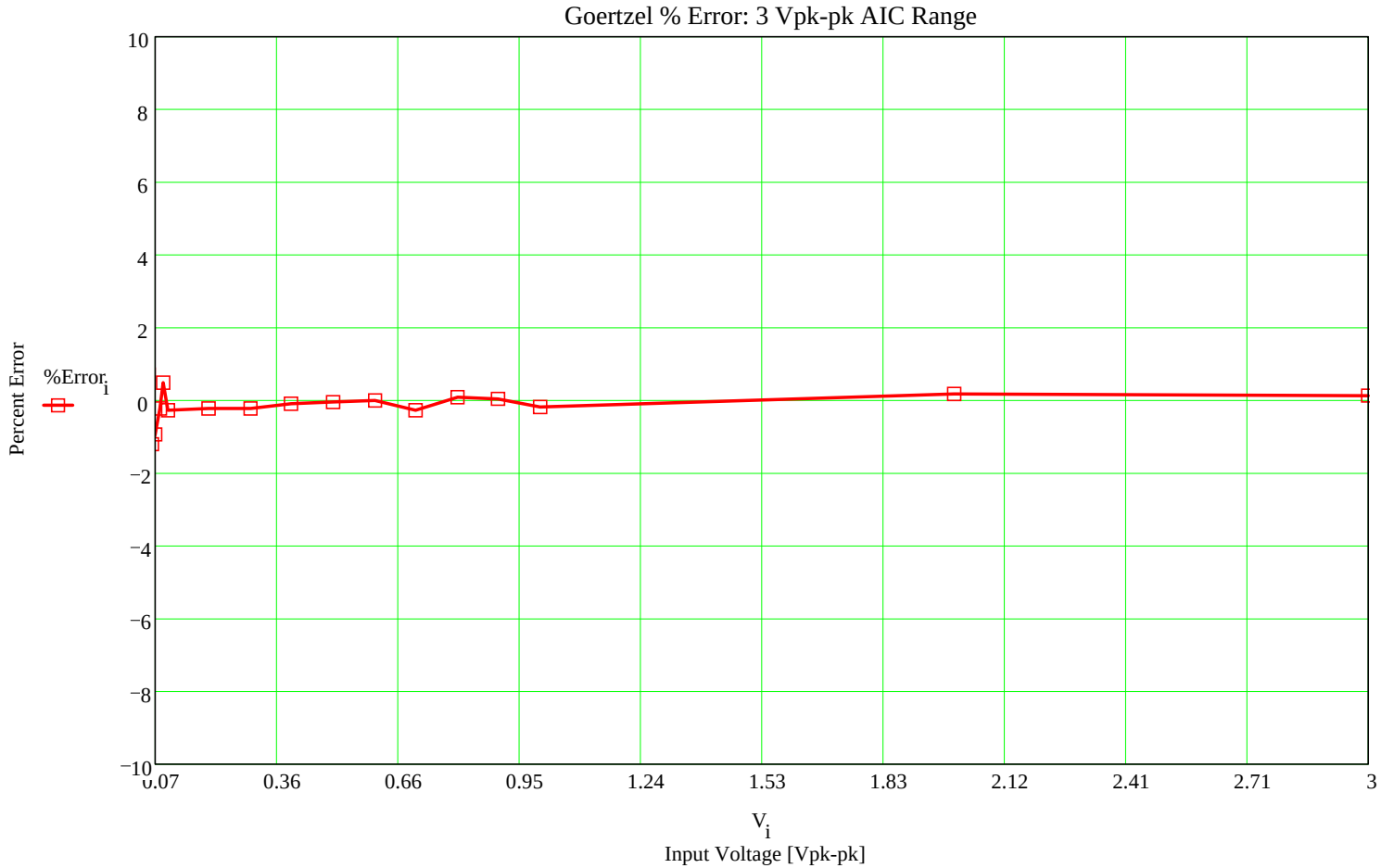


LEGEND

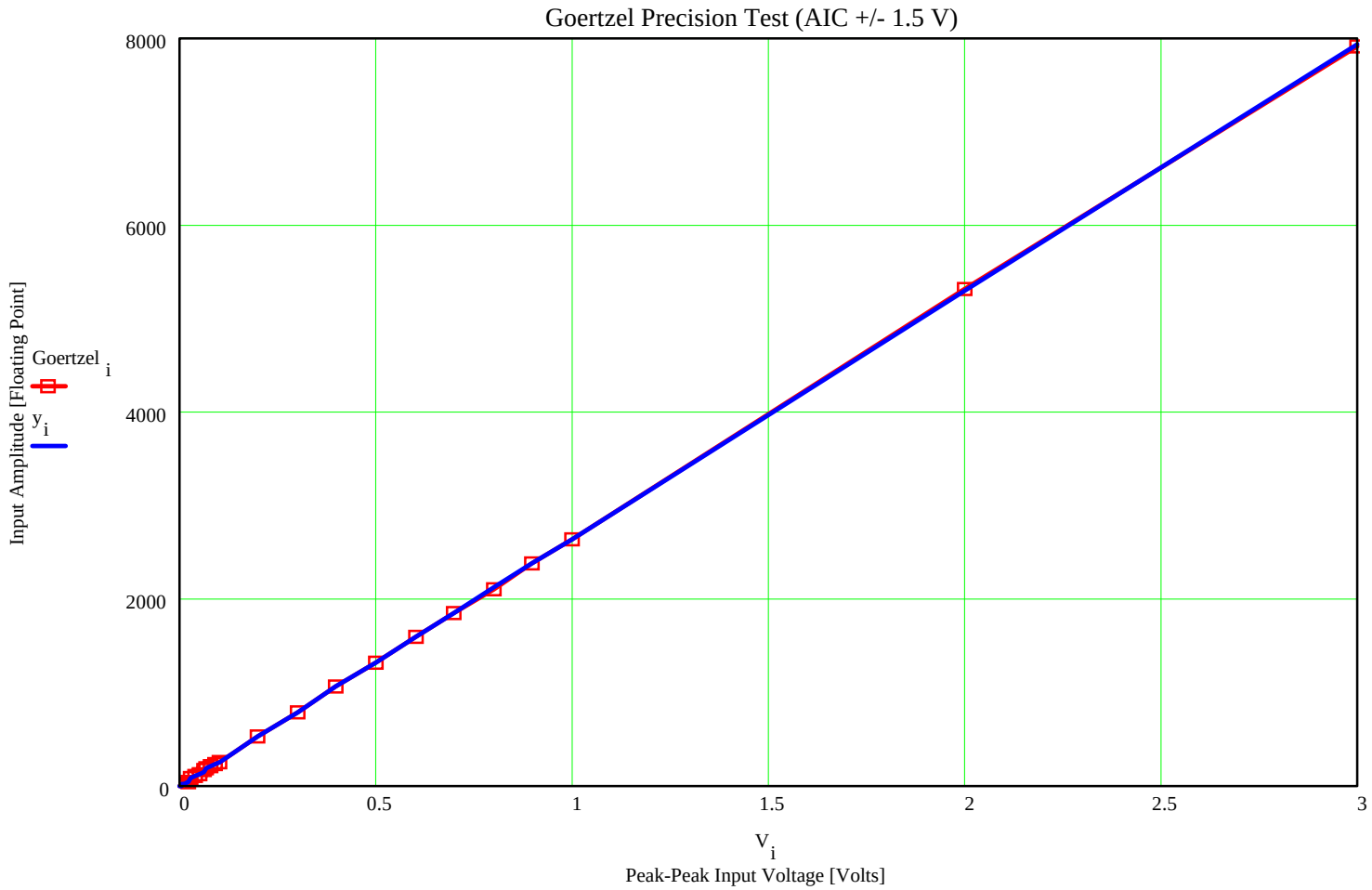
Ch. 1:
Square Wave
665 Hz
2 V pk-pk

Ch. 2:
0 V DC

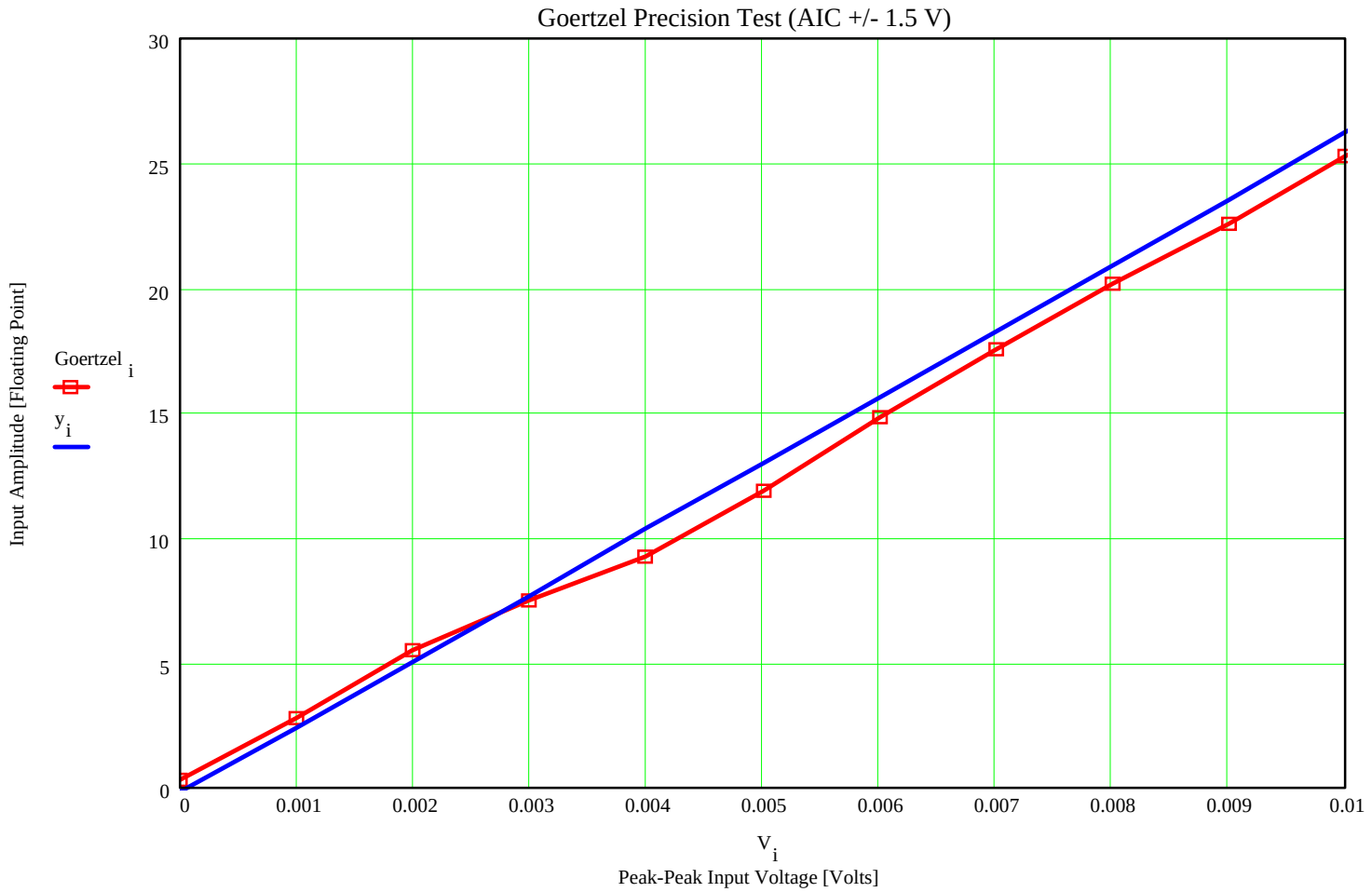
Goertzel Accuracy: 659 Hz Sinusoid



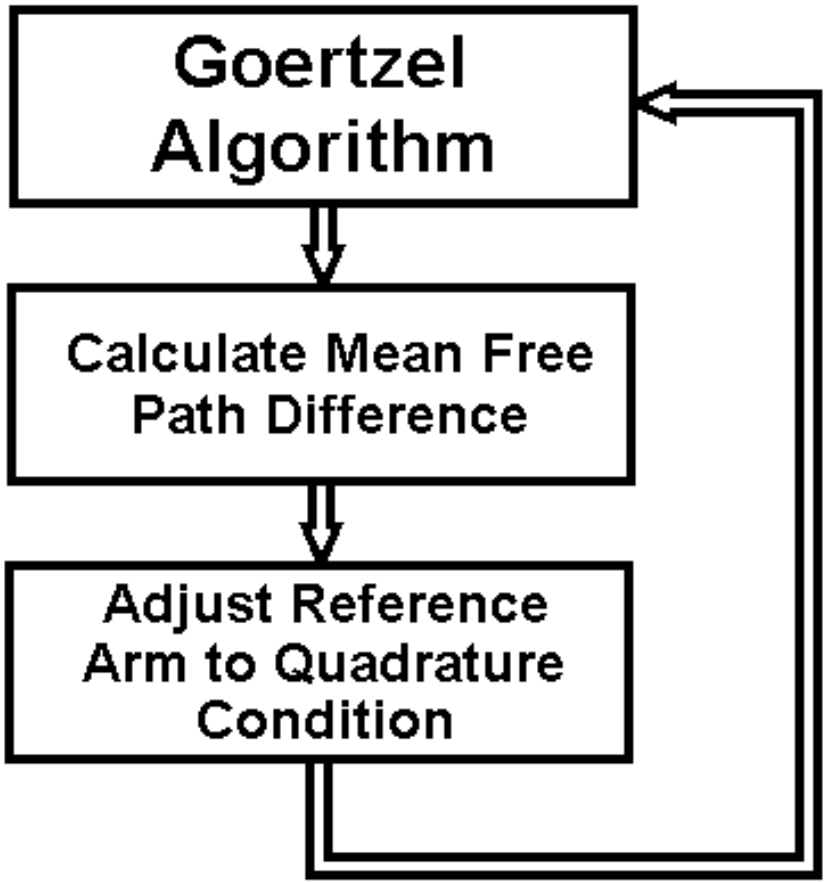
Goertzel Linearity: 659 Hz Sinusoid



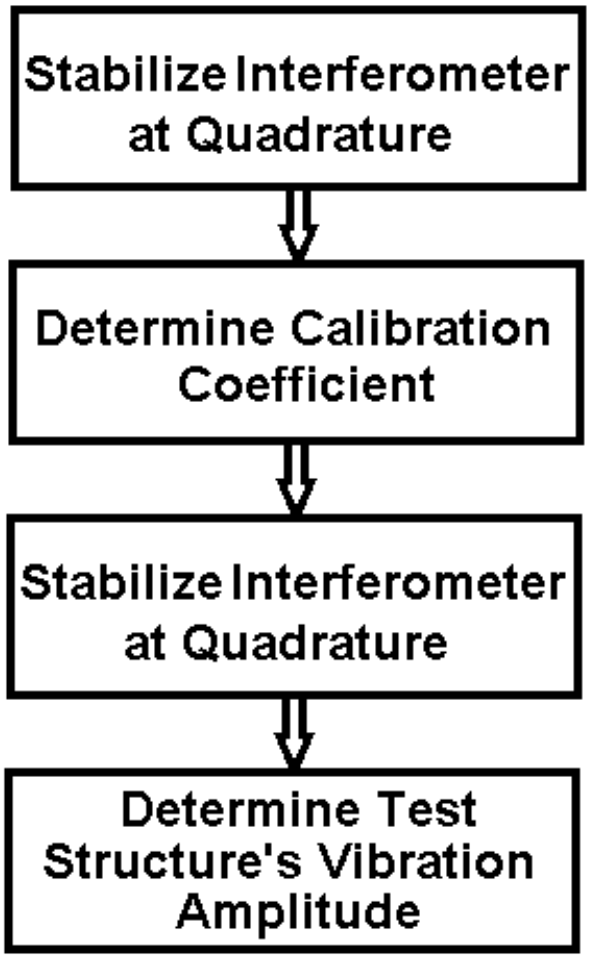
Goertzel Linearity: 659 Hz Sinusoid (Low Voltage)



Stabilization Scheme



Demodulation Scheme



Summary

- Constructed a **fractional fringe interferometer** for the characterization of microelectromechanical system (MEMS) structures.
- Developed **stabilization and demodulation** architectures based on **DSP**.
- Implemented the **Goertzel algorithm** on the TMS320C31 DSK to extract the requisite spectral components for stabilization and demodulation.