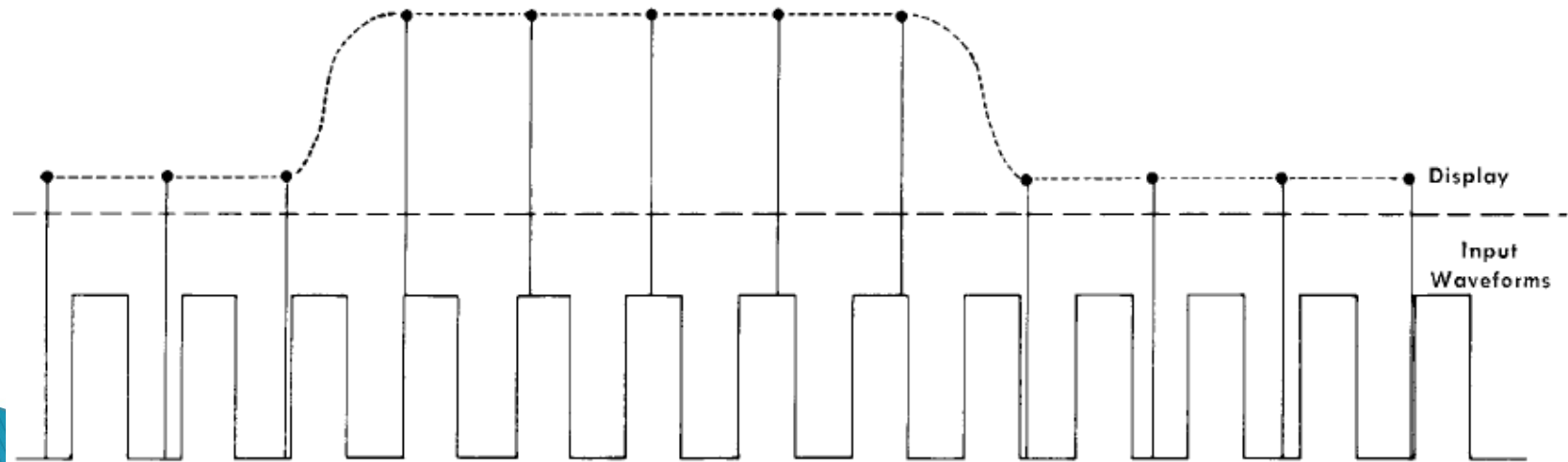


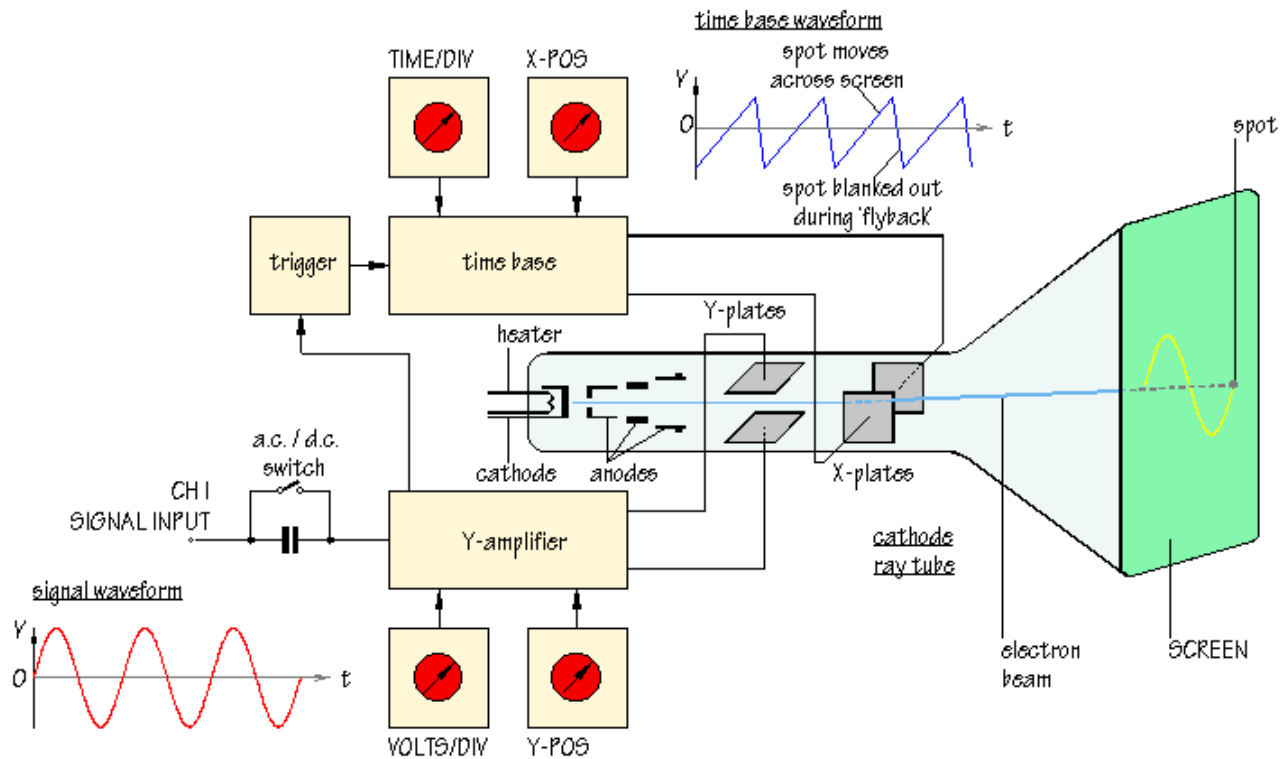
Equipments

▶ Oscilloscopes

- Digital vs analog
 - Sampling oscilloscopes
 - Bandwidth vs Sampling frequency



Oscilloscope



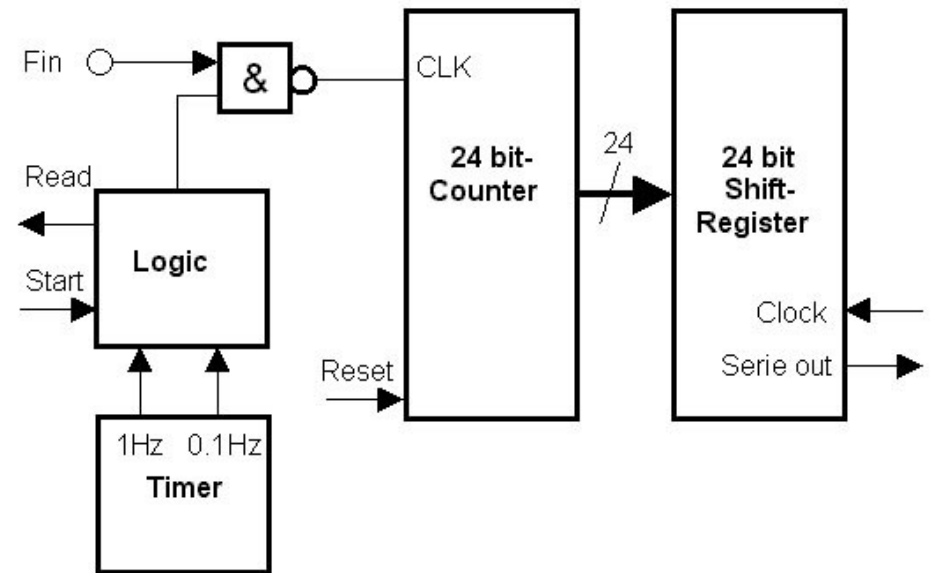
Signal generators

Arbitrary waveforms

- ▶ Oscillators (sinusoidal waveforms)
- ▶ Signal generators (RF)
- ▶ Function generators
- ▶ Arbitrary waveforms generators
 - Analog
 - Digital (DAC based)
- ▶ Synthesizers (base frequencies)

Frequency counters

- ▶ Frequency
- ▶ Period
- ▶ Event counter
- ▶ Frequency rates
- ▶ Time intervals

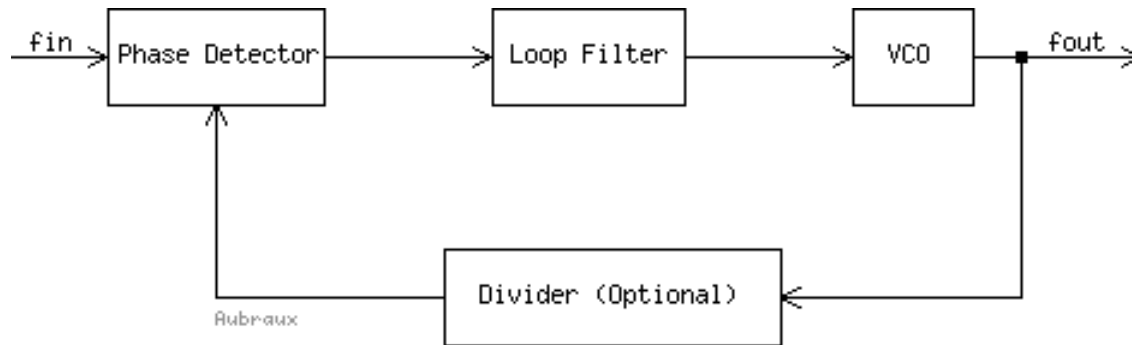


Frequency counters

- ▶ Very high frequency
 - Prescaler
 - Transfer oscillator (VFO based)
 - Two harmonics with zero beat
 - Ex: 2 471 429 e 2 544 118
 - $N=f_1/|f_1-f_2|$, $f_x=N*f_1$
 - Harmonic heterodyne converter
 - Transfer oscillator w/local heterodyne converter

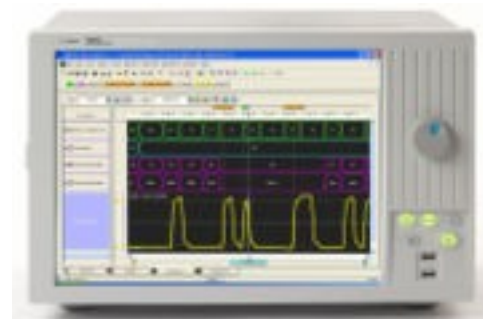
PLL

- ▶ Phase locked loops
 - Free-running/capture mode
 - Phase-locked
 - Lock range



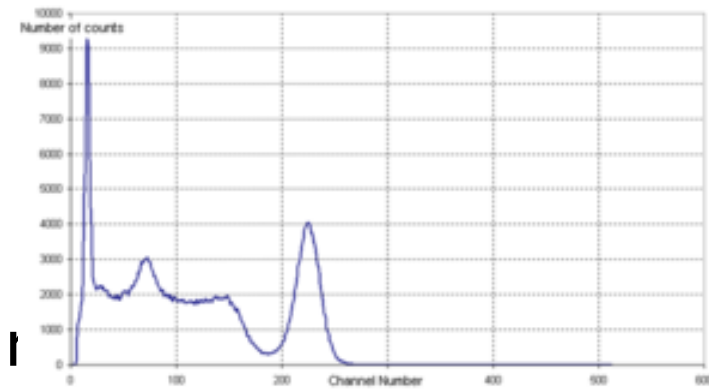
Logic analyzer

- ▶ Modes
 - Time
 - State
- ▶ Clock source
- ▶ Trigger condition



Multichannel analyzer

- ▶ Gaussian pulse shaping
- ▶ Fast ADC vs Bin's windows
 - Channel counters (9bits – 512 bins)
- ▶ Many events are needed to become statistical relevant
 - Low resolution time windows
 - Scintillator and photomultiplier efficiency



TDC

- ▶ Time to digital converter
 - Inter-pulse measurements
 - Time of flight applications
 - Neutron energy measurements
 - Ion beam energy
 - Particles decay time
 - Precise timing (capture time)

