

Design IV

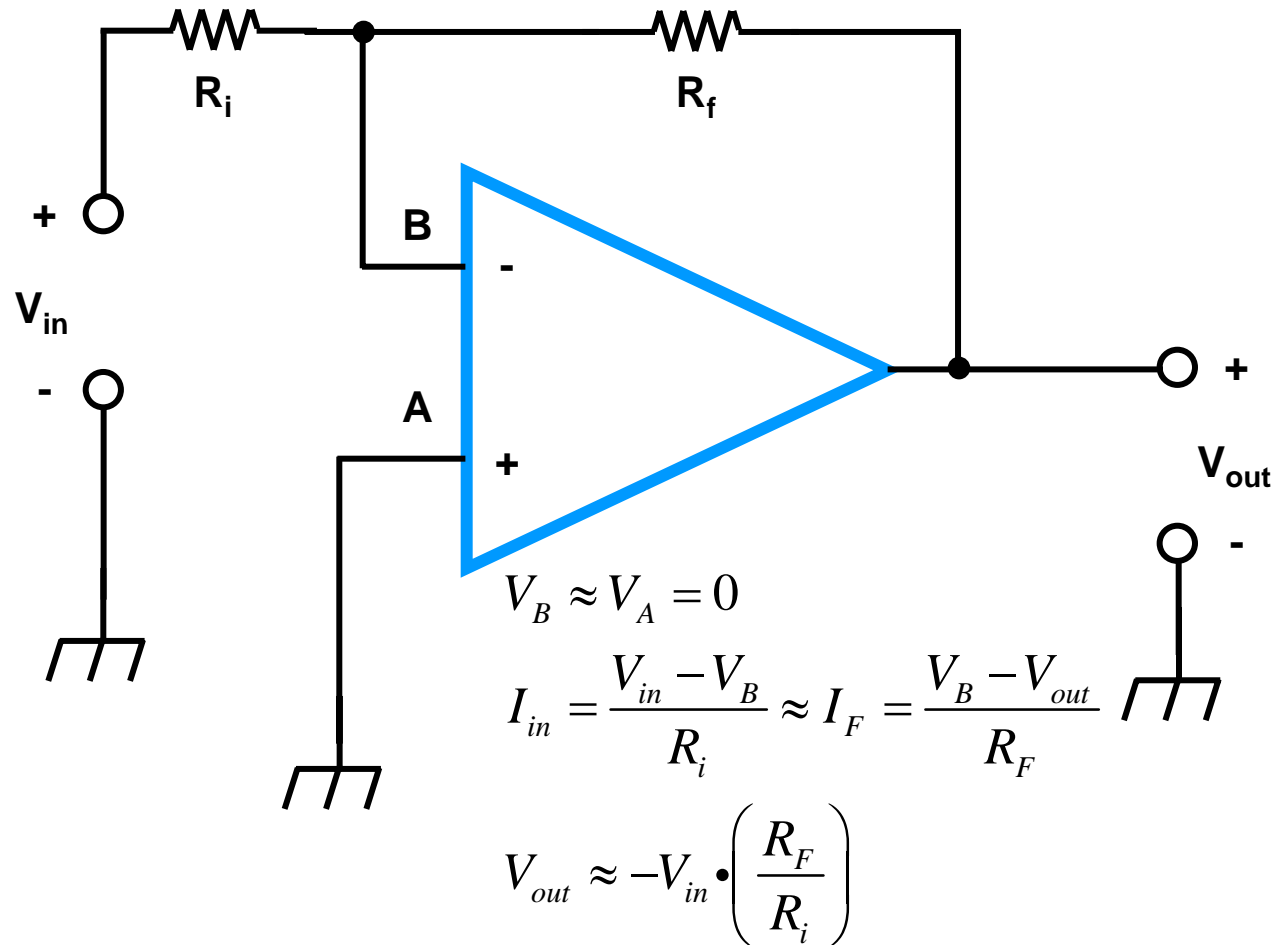
E232 Fall 07

Class 5

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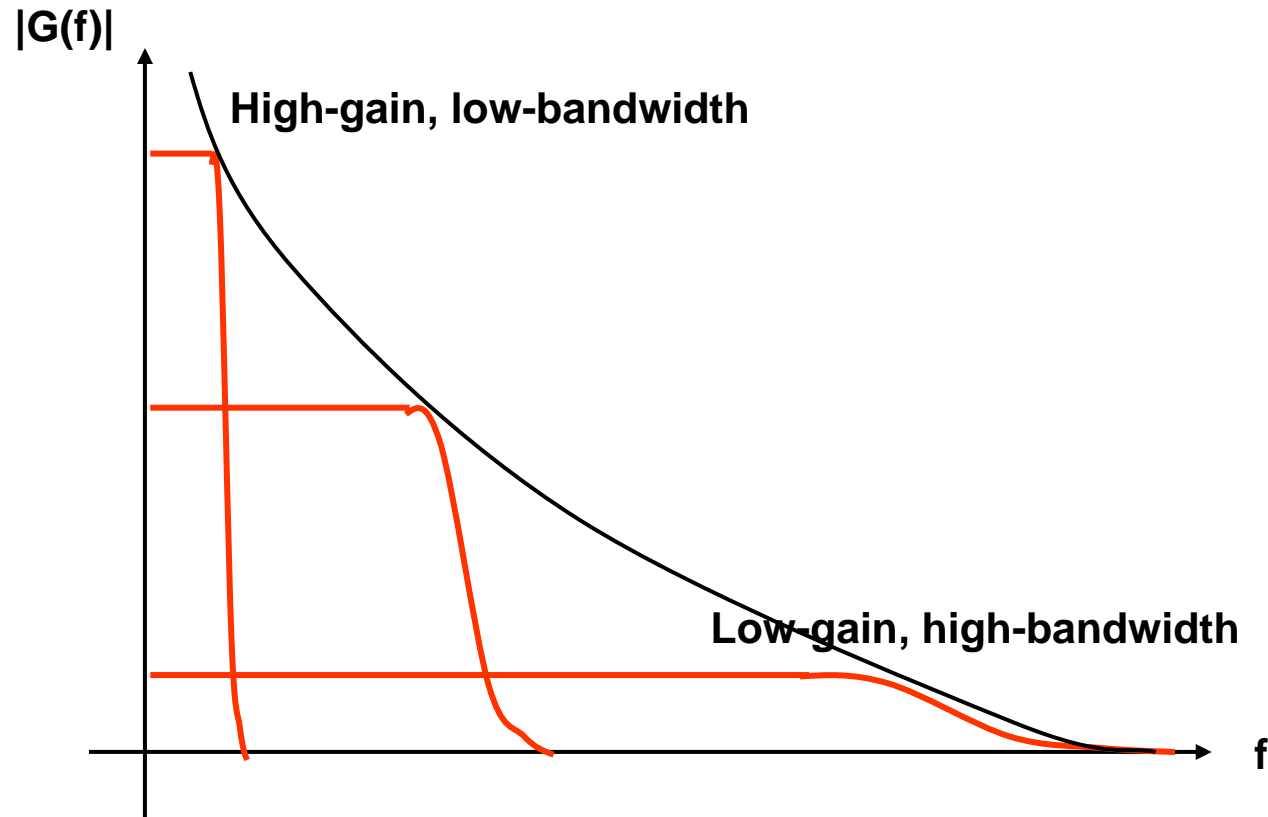
Signal Conditioning and Transmission

- Operational Amplifier – inverting amplifier



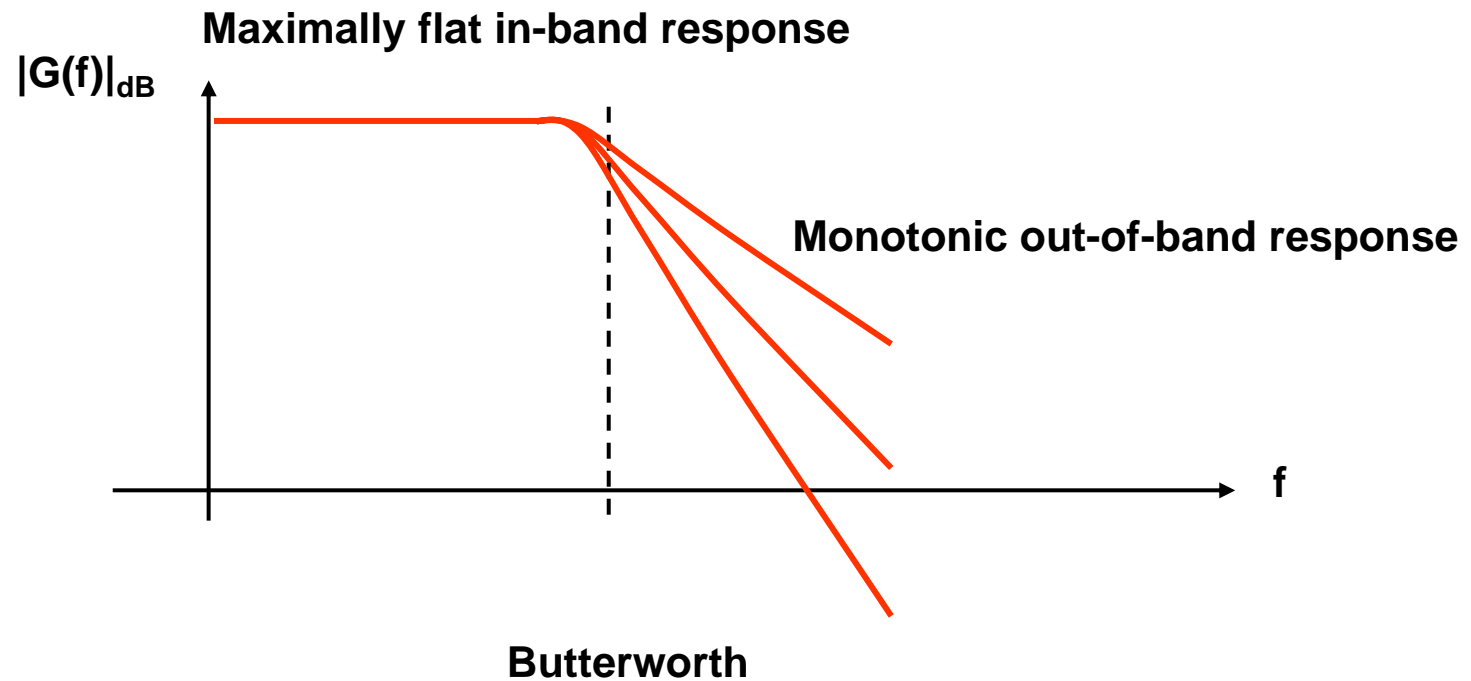
Signal Conditioning and Transmission

- Operational Amplifiers – Gain Bandwidth Product



Signal Conditioning and Transmission

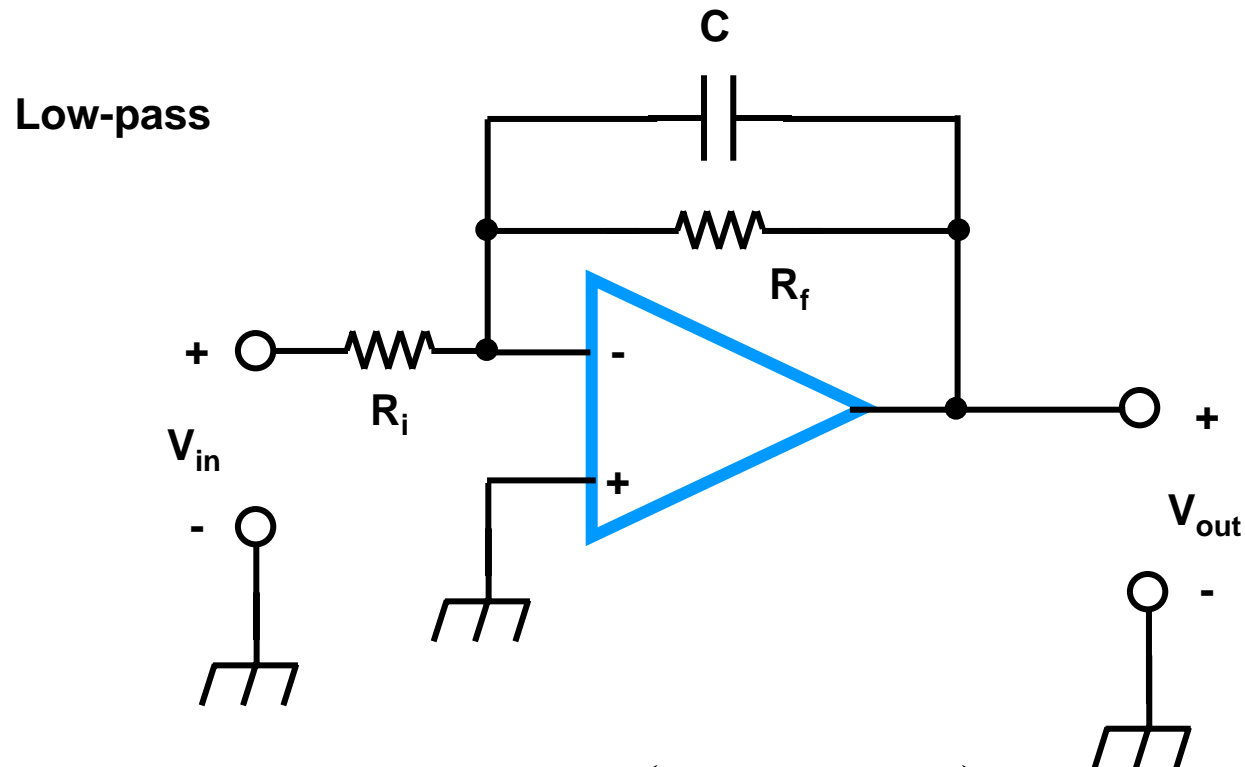
- Filter families



Good phase response
High filter order needed for high out-of-band attenuation

Signal Conditioning and Transmission

- Building filters with op-amps

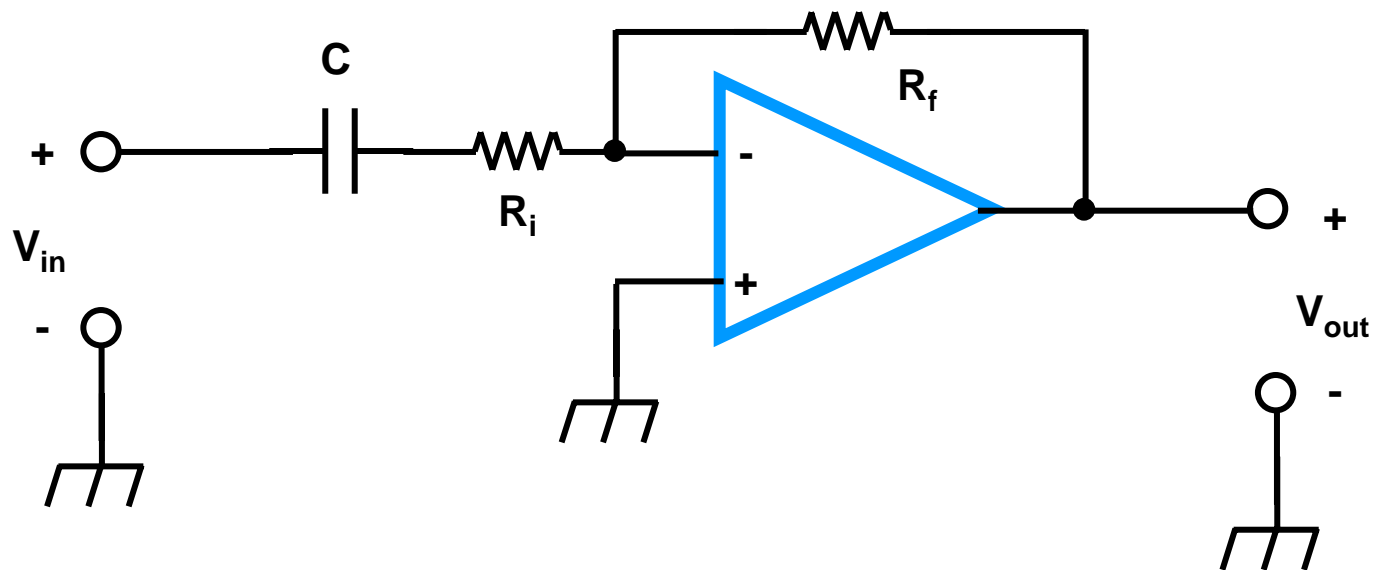


$$G(f) = -\left(\frac{R_f}{R_i}\right) \cdot \left(\frac{1}{1 + j2\pi fCR_f}\right)$$

Signal Conditioning and Transmission

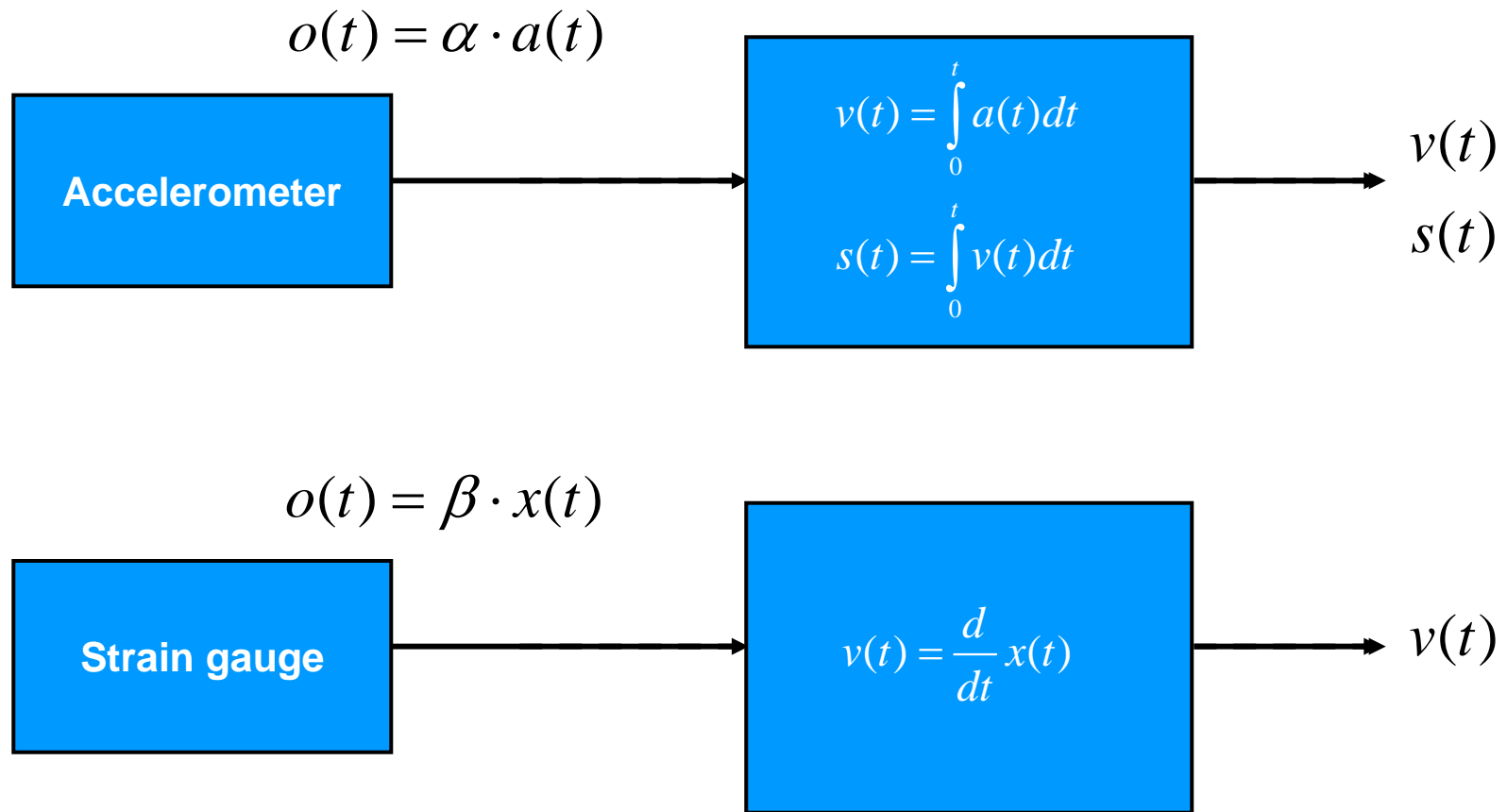
- Building filters with op-amps

High-pass



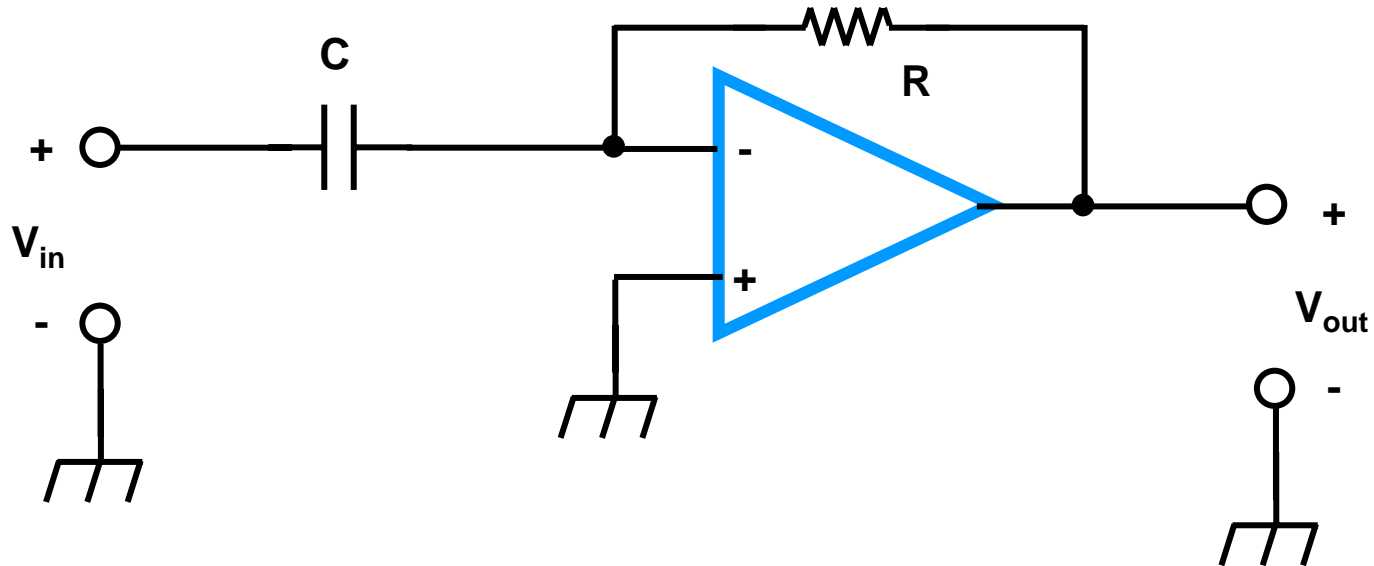
Signal Conditioning and Transmission

- Computing integral and derivative values



Signal Conditioning and Transmission

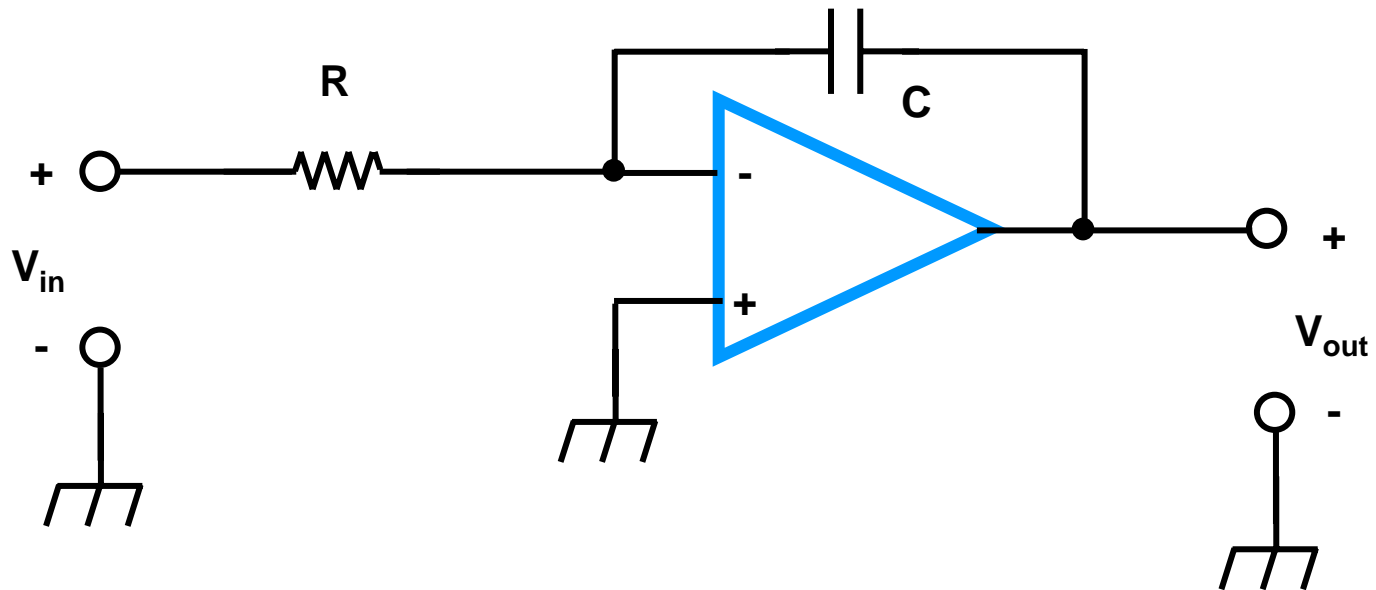
- Differentiator



$$V_{out}(t) = -RC \frac{d}{dt} V_{in}(t)$$

Signal Conditioning and Transmission

- Integrator



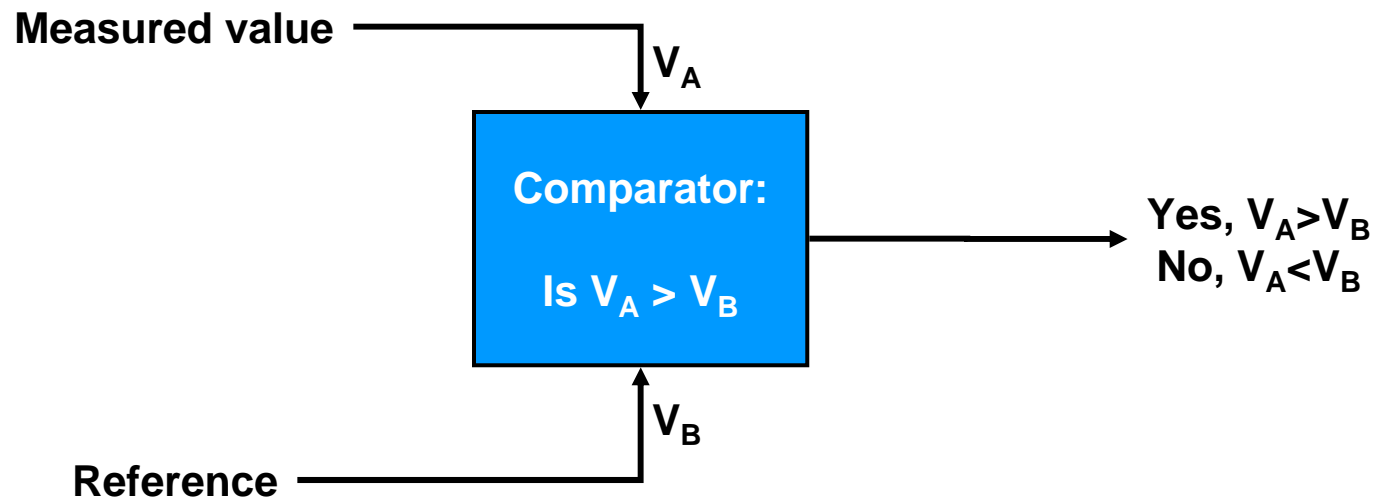
$$V_{out}(t) = V_{out}(0) - \frac{1}{RC} \int_0^t V_{in}(t) dt$$

Today's topics

- Signal conditioning, transformation
 - Comparators
- Indicators and recording devices
 - Voltage
 - Waveforms
 - Frequency
 - Spectrum

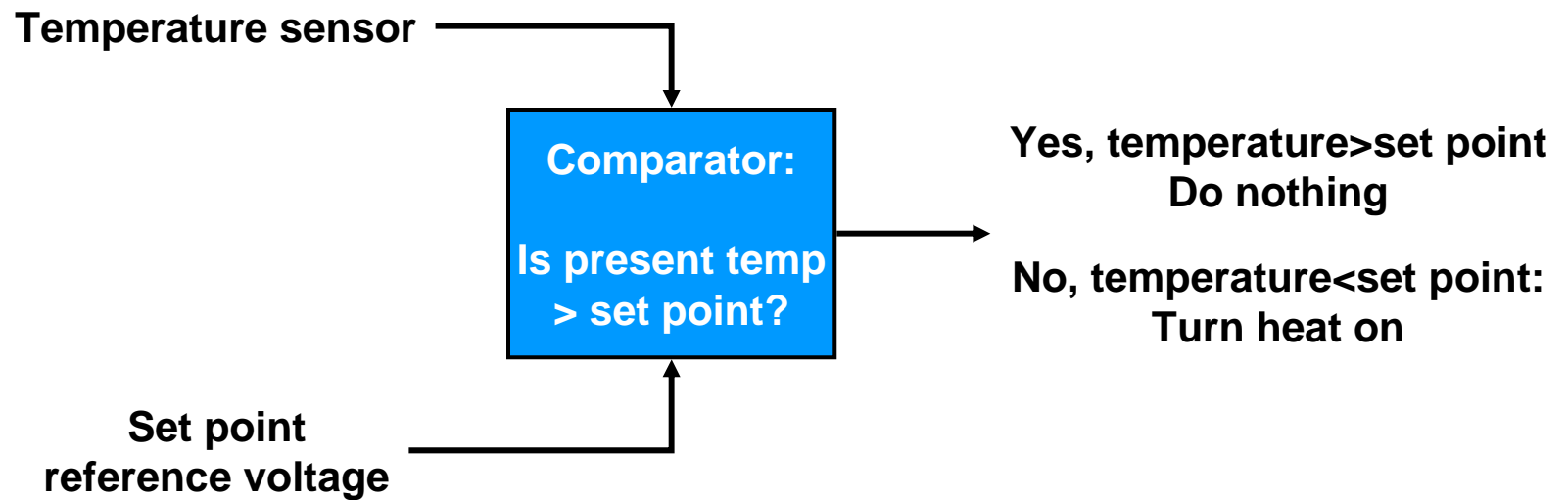
Signal Conditioning and Transmission

- Comparator



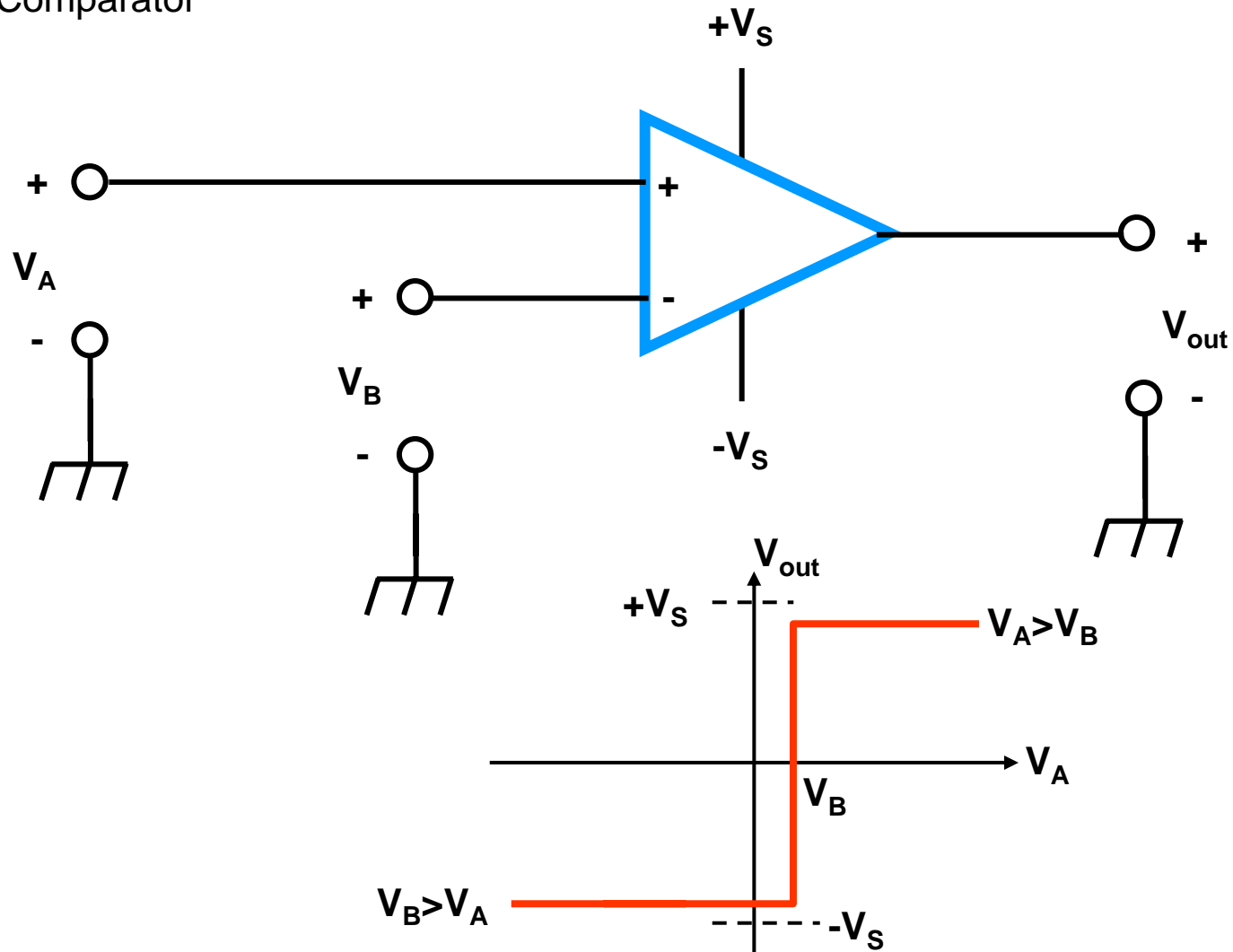
Signal Conditioning and Transmission

- Comparator

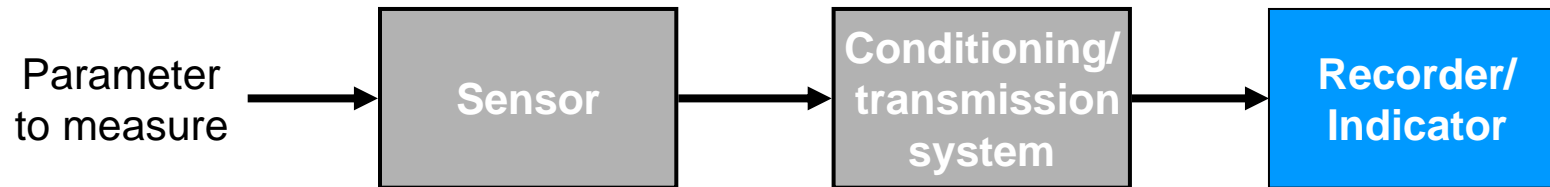


Signal Conditioning and Transmission

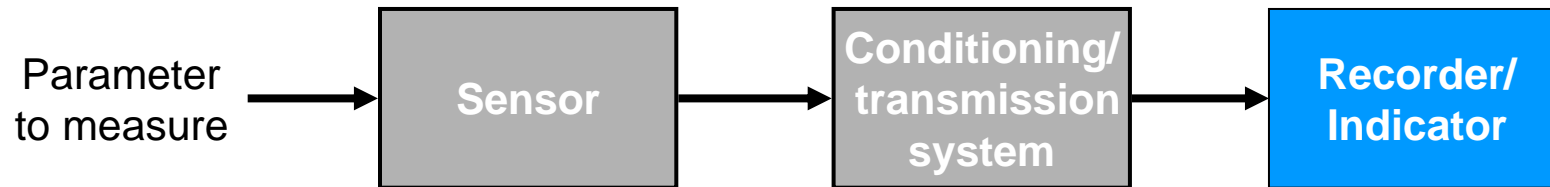
- Comparator



Recorders/Indicators



Recorders/Indicators



Static/slowly varying signals:

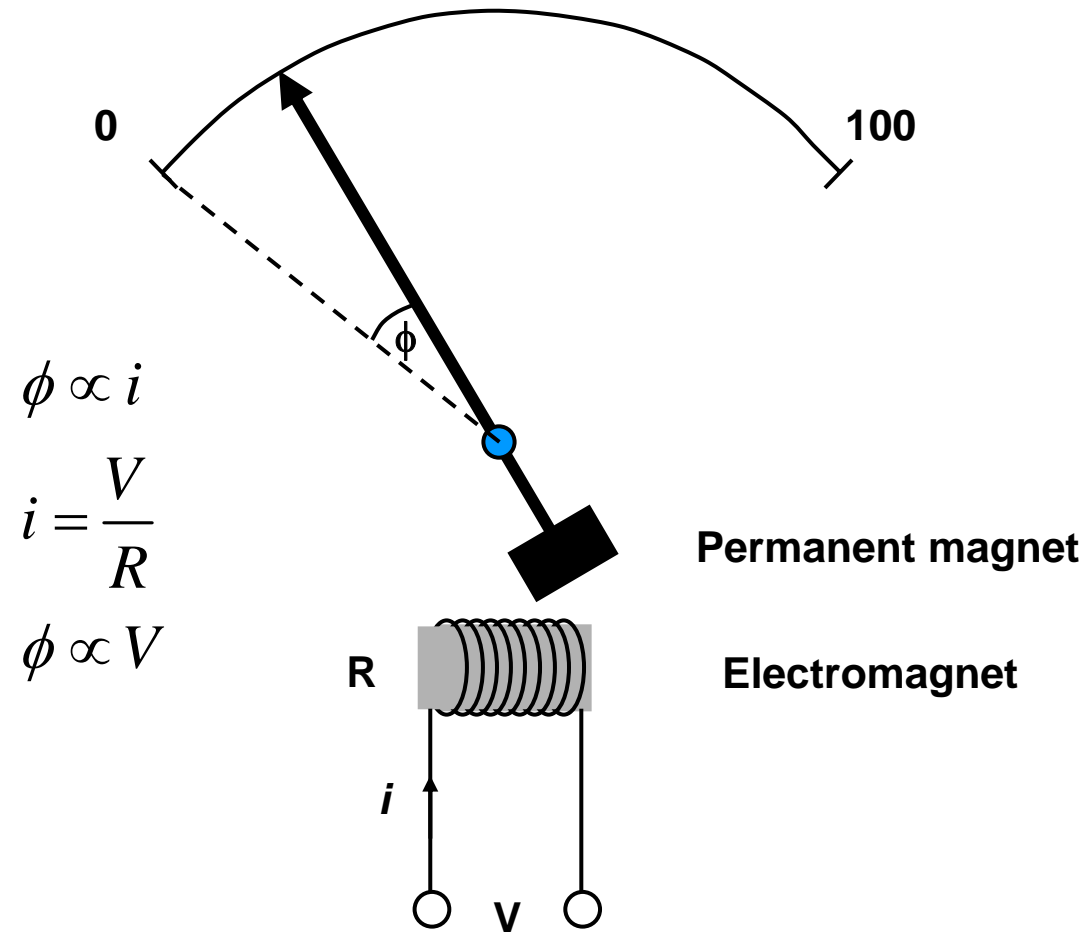
- Voltage
- Current
- Resistance

Dynamic signals:

- Time Domain (waveforms)
- Frequency domain (spectra)

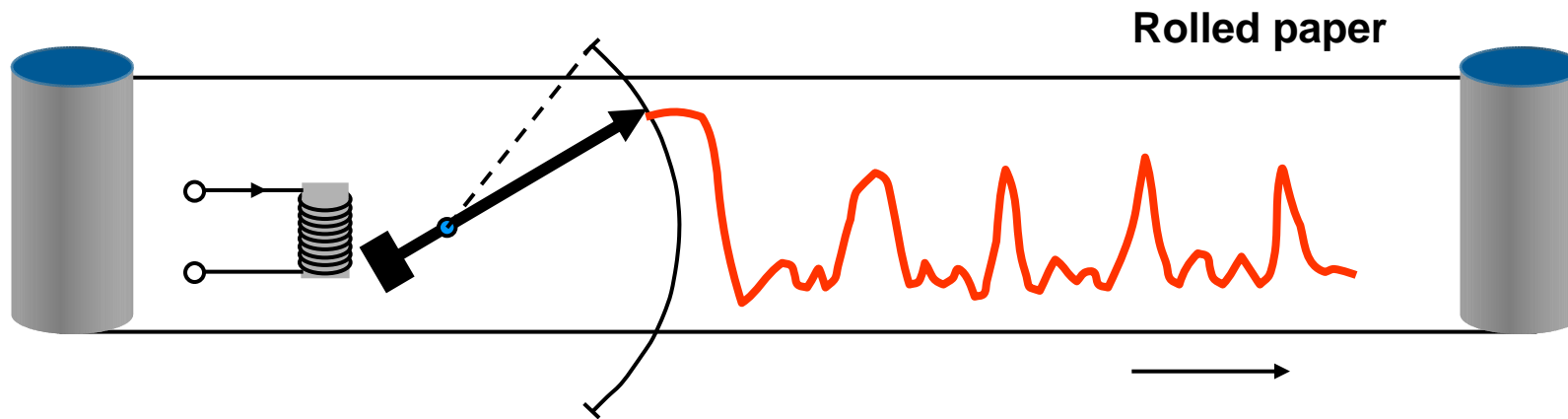
Recorders/Indicators

- Classical voltage (current) measurement



Recorders/Indicators

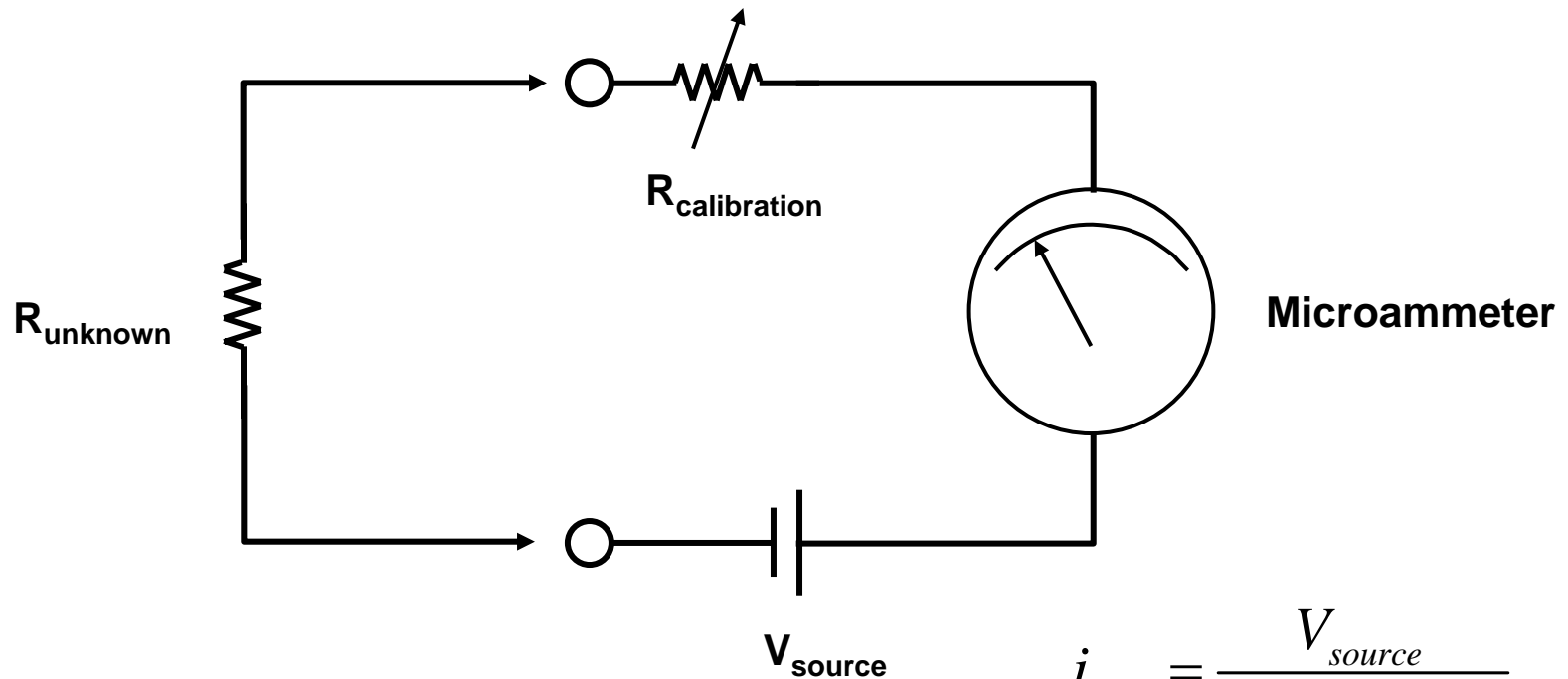
- Classical voltage (current) recorder



- **Seismic indicators**
- **EKG monitors**
- **Polygraph machines**

Recorders/Indicators

- Classical resistance measurement

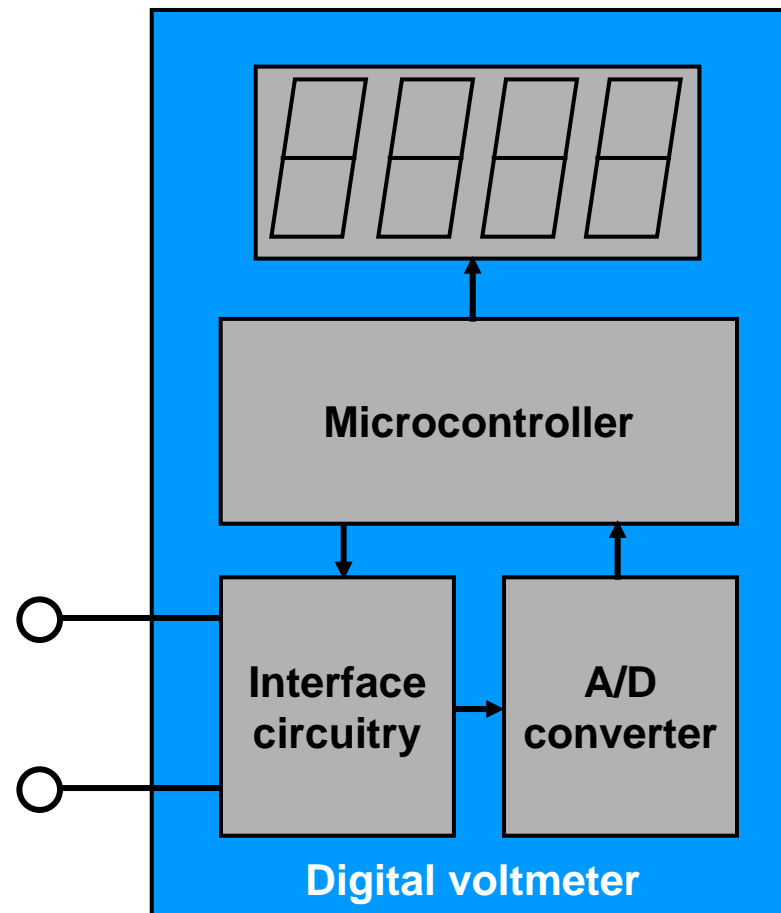


$$i_{max} = \frac{V_{source}}{R_{calibration} + 0}$$

$$i = \frac{V_{source}}{R_{calibration} + R_{unknown}}$$

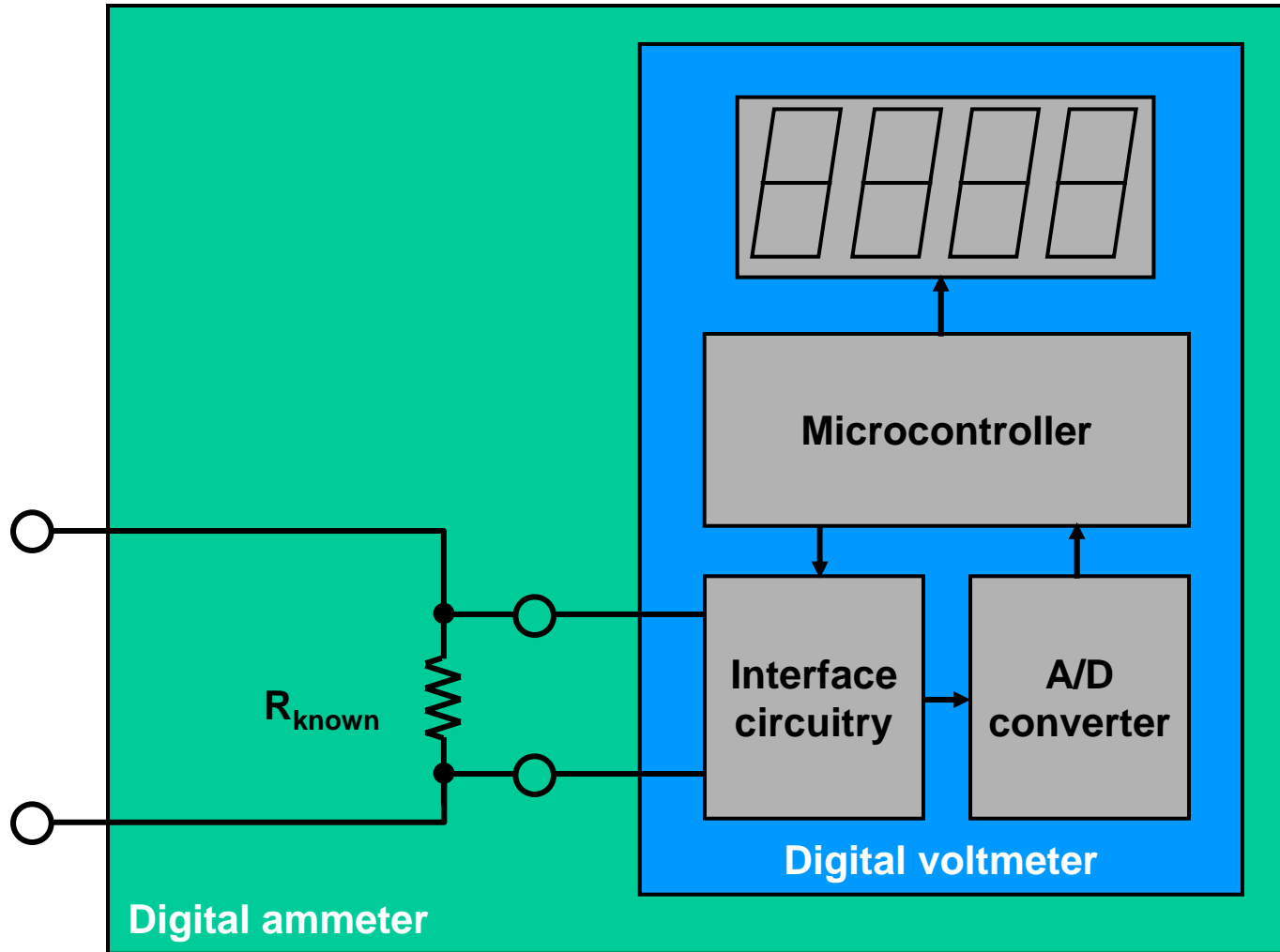
Recorders/Indicators

- Modern voltage, current measurements



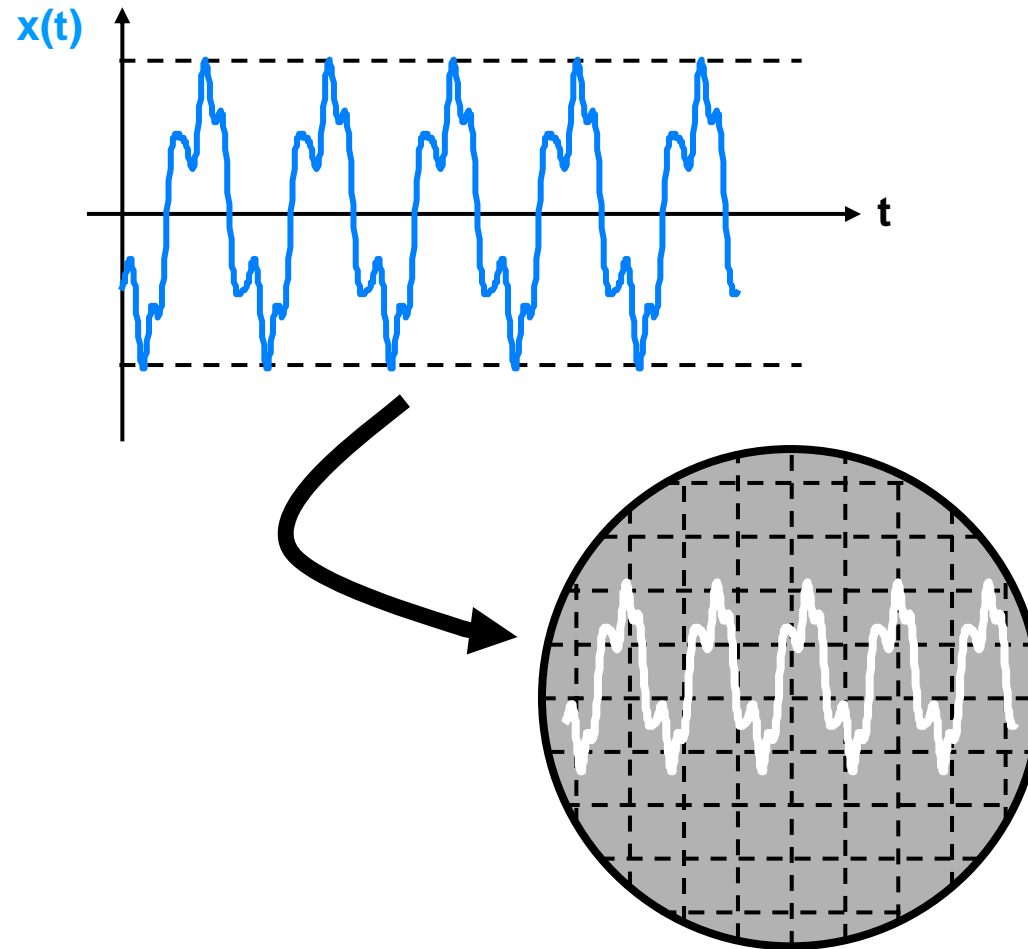
Recorders/Indicators

- Modern voltage, current measurements



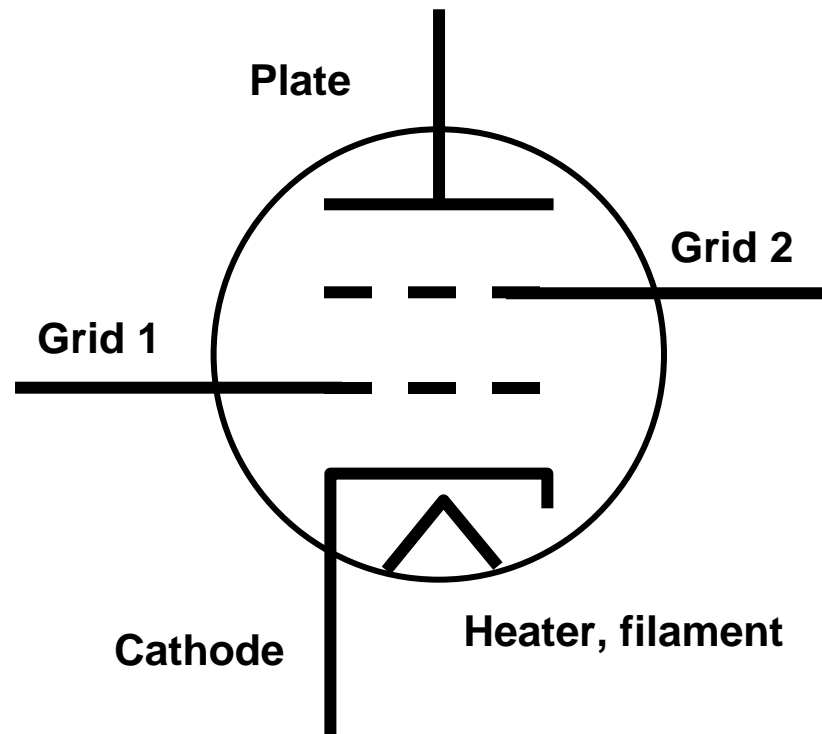
Recorders/Indicators

- Dynamic signal measurements – waveform displays



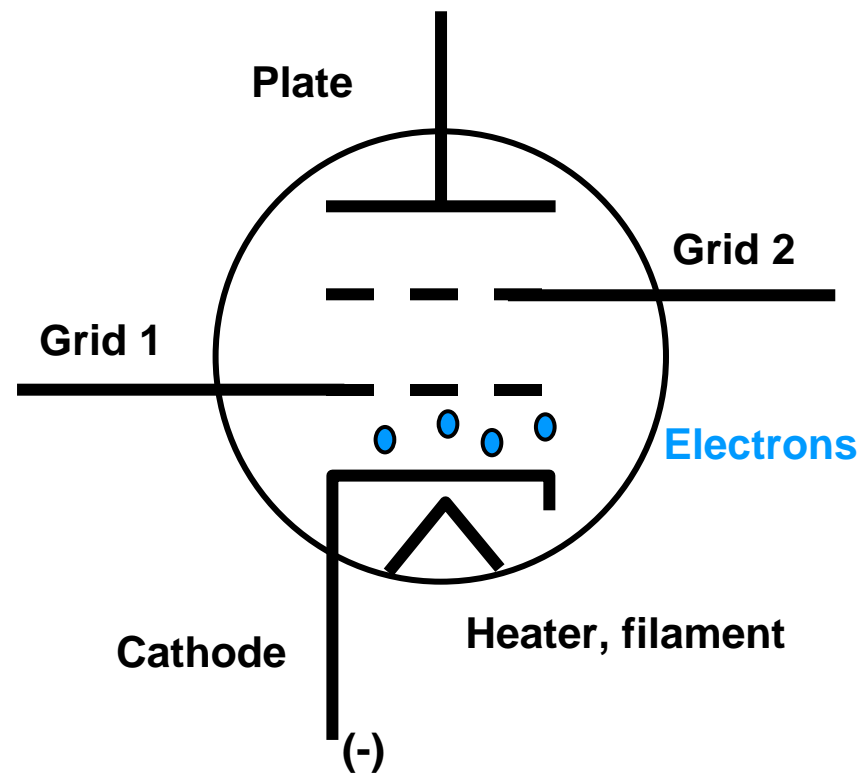
Recorders/Indicators

- Dynamic signal measurements – waveform displays



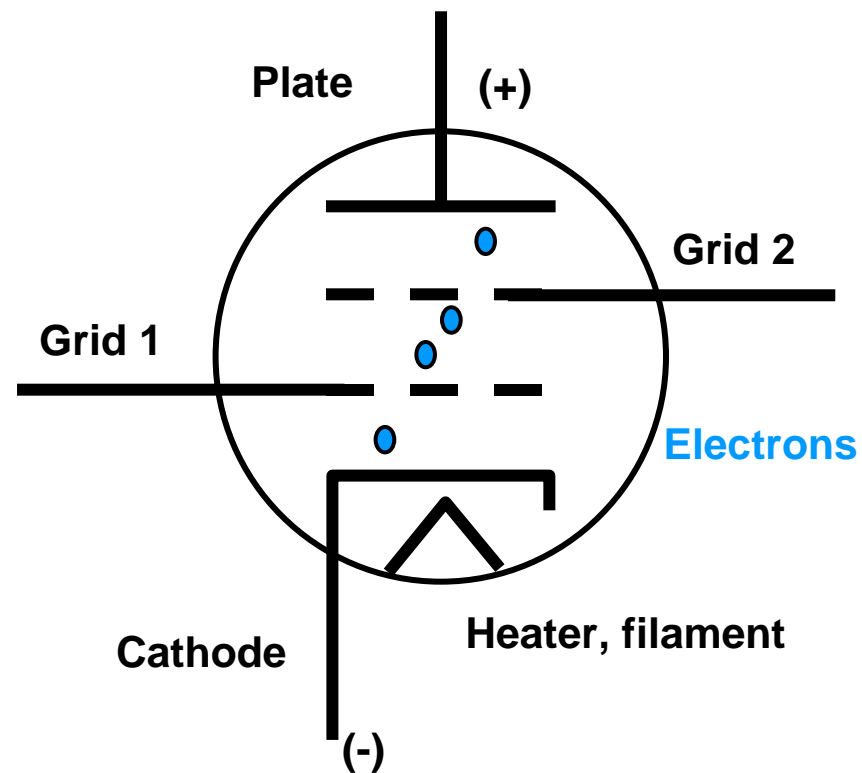
Recorders/Indicators

- Dynamic signal measurements – waveform displays



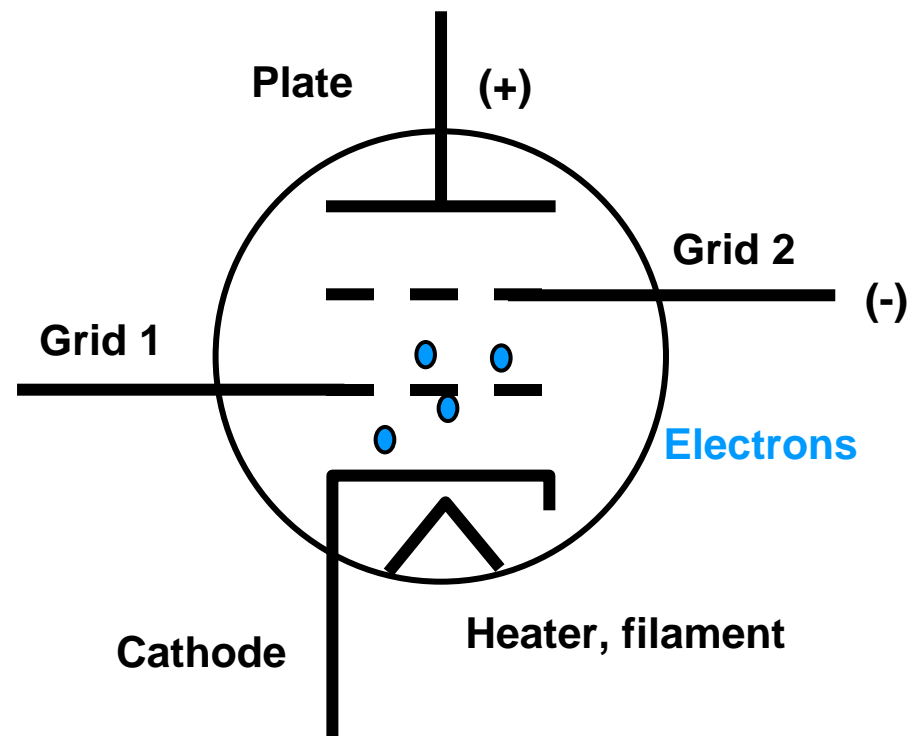
Recorders/Indicators

- Dynamic signal measurements – waveform displays



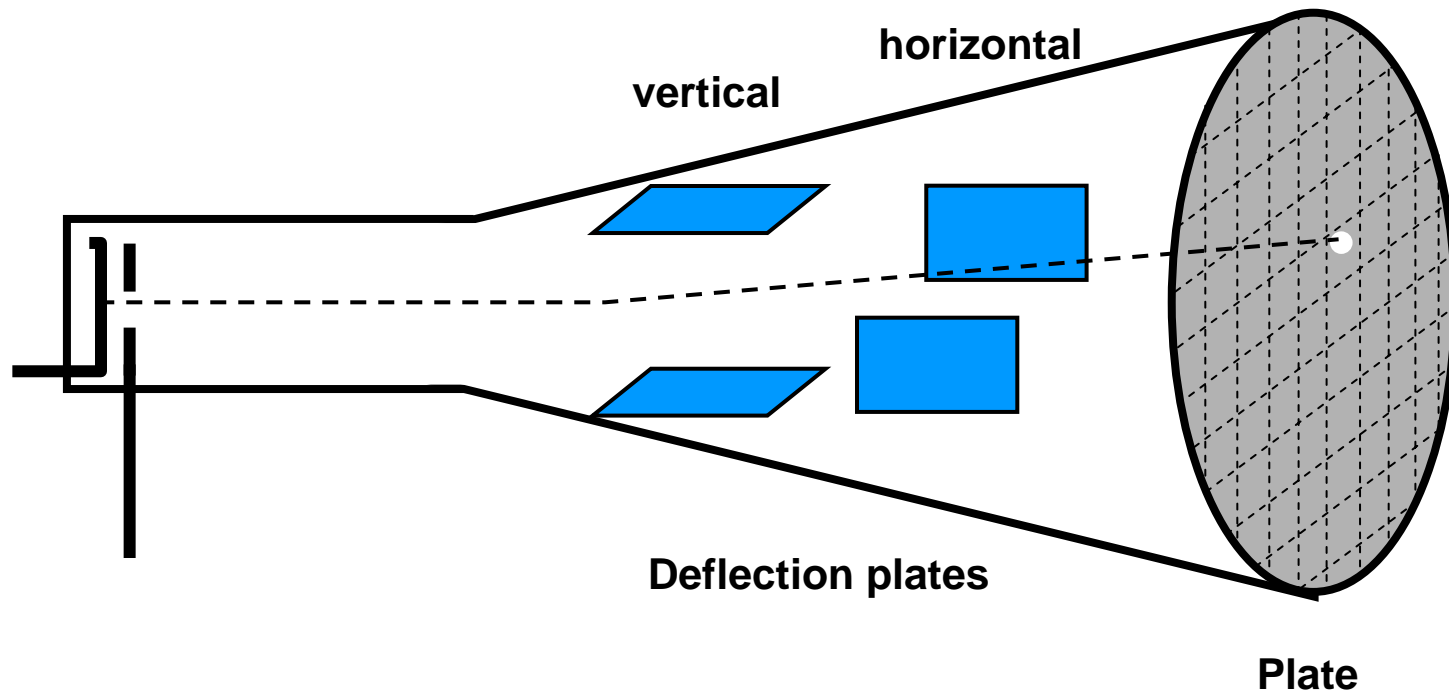
Recorders/Indicators

- Dynamic signal measurements – waveform displays



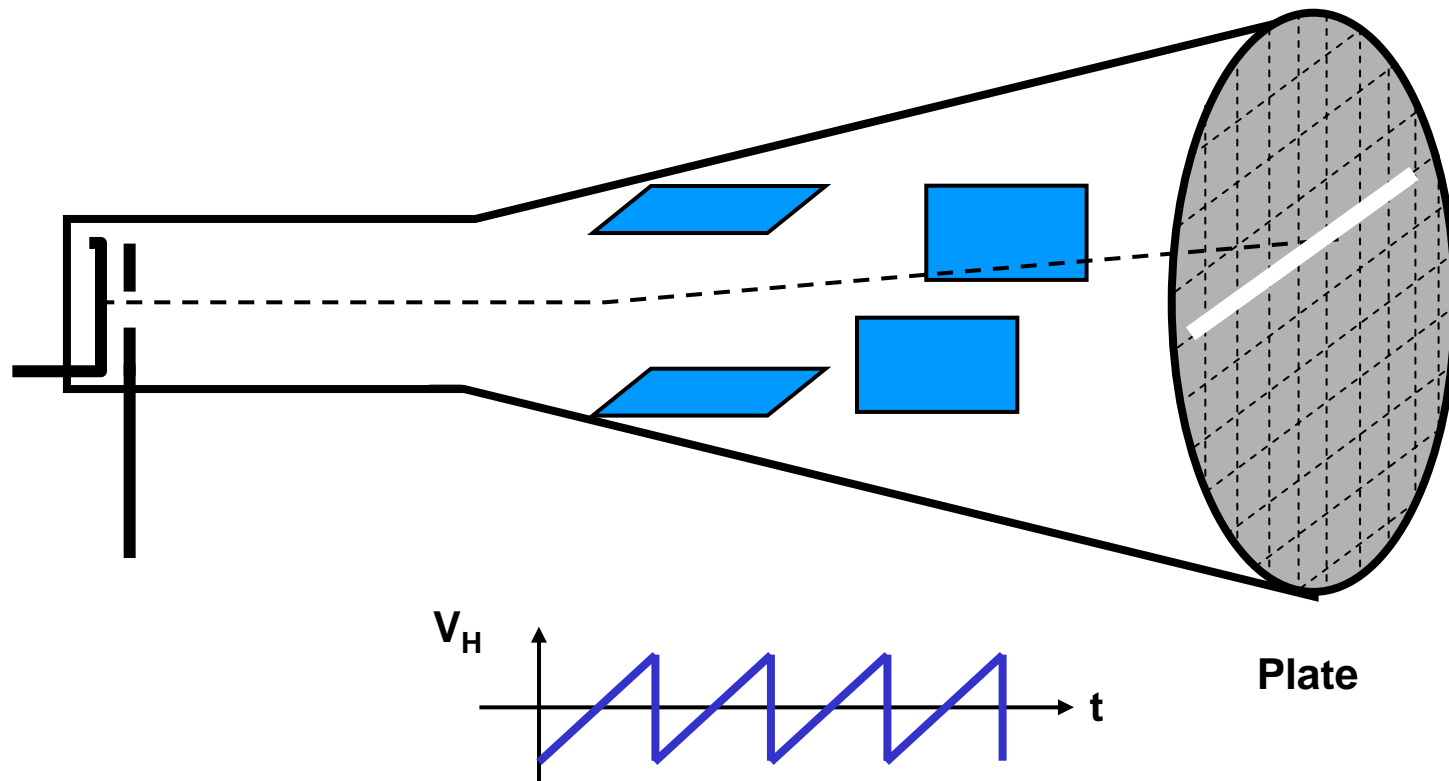
Recorders/Indicators

- Dynamic signal measurements – waveform displays: oscilloscope



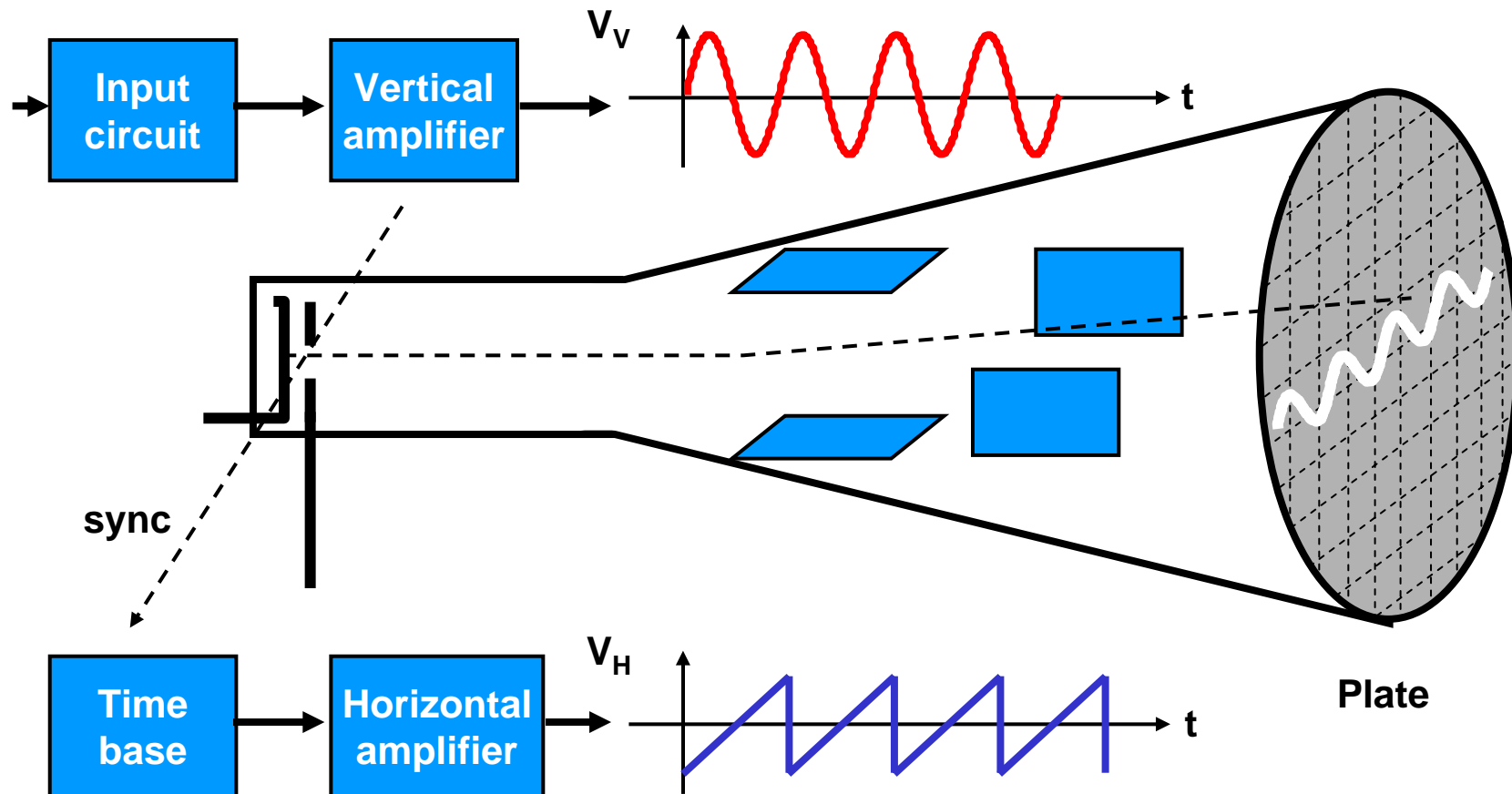
Recorders/Indicators

- Dynamic signal measurements – waveform displays: oscilloscope



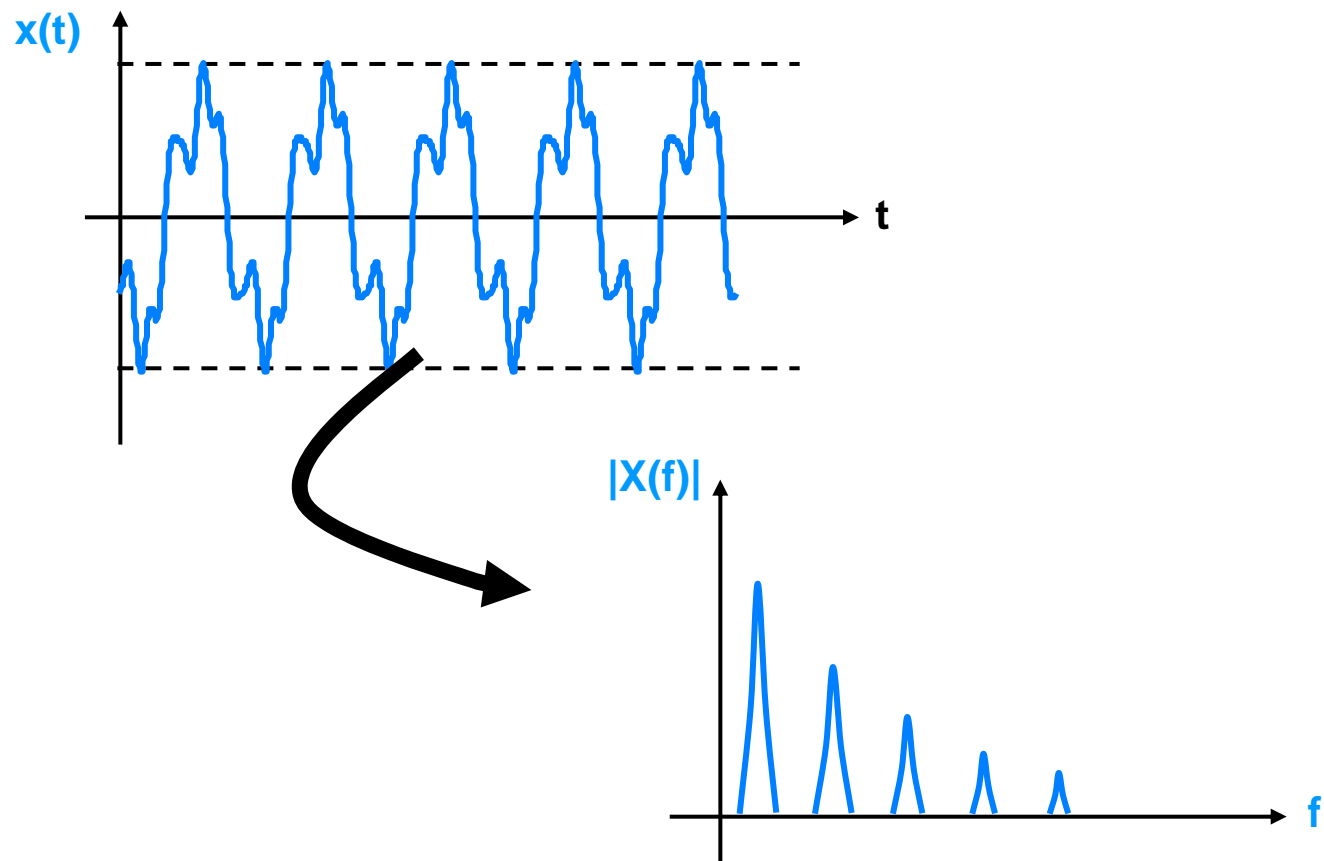
Recorders/Indicators

- Dynamic signal measurements – waveform displays: oscilloscope



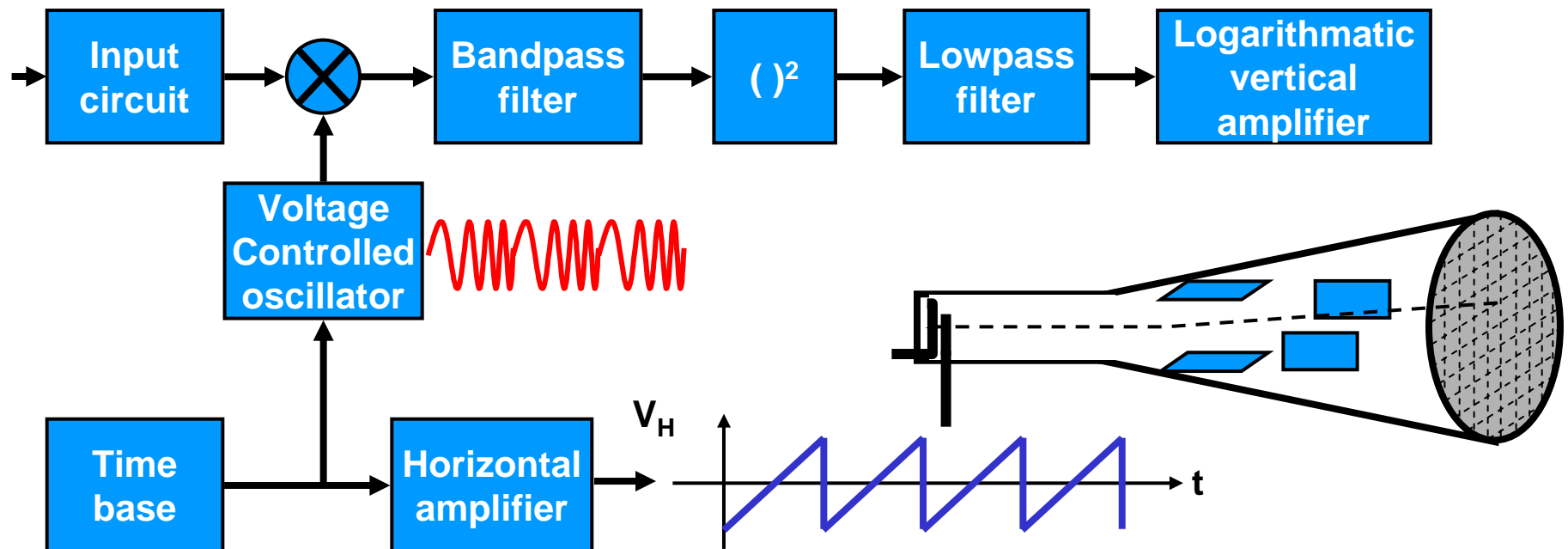
Recorders/Indicators

- Dynamic signal measurements – spectral displays



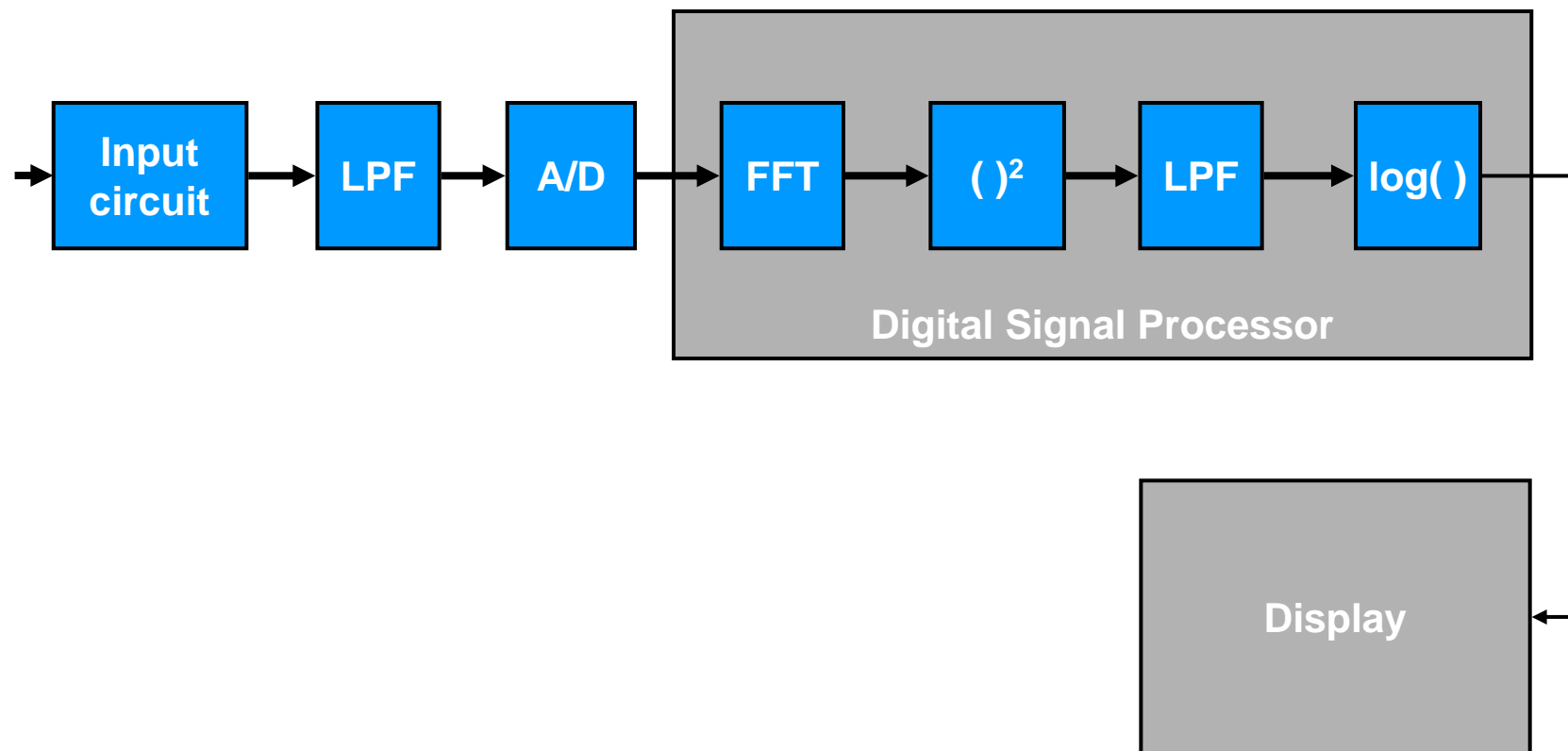
Recorders/Indicators

- Dynamic signal measurements – spectral displays: spectrum analyzer



Recorders/Indicators

- Dynamic signal measurements – spectral displays: FFT spectrum analyzer



Next topics

- Transmission
 - Signal level considerations
 - Interference sources
 - Ground loops
 - Rationale for digital signal transmission
- Computerized Data Acquisition
 - Signal representation
 - Components
 - A/D conversion
 - Sampling
 - Quantization effects
 - Fourier Transform and frequency domain analysis