

Digital Logic Design

Supplement slides

2014 Spring Semester

Digital Storage Oscilloscope

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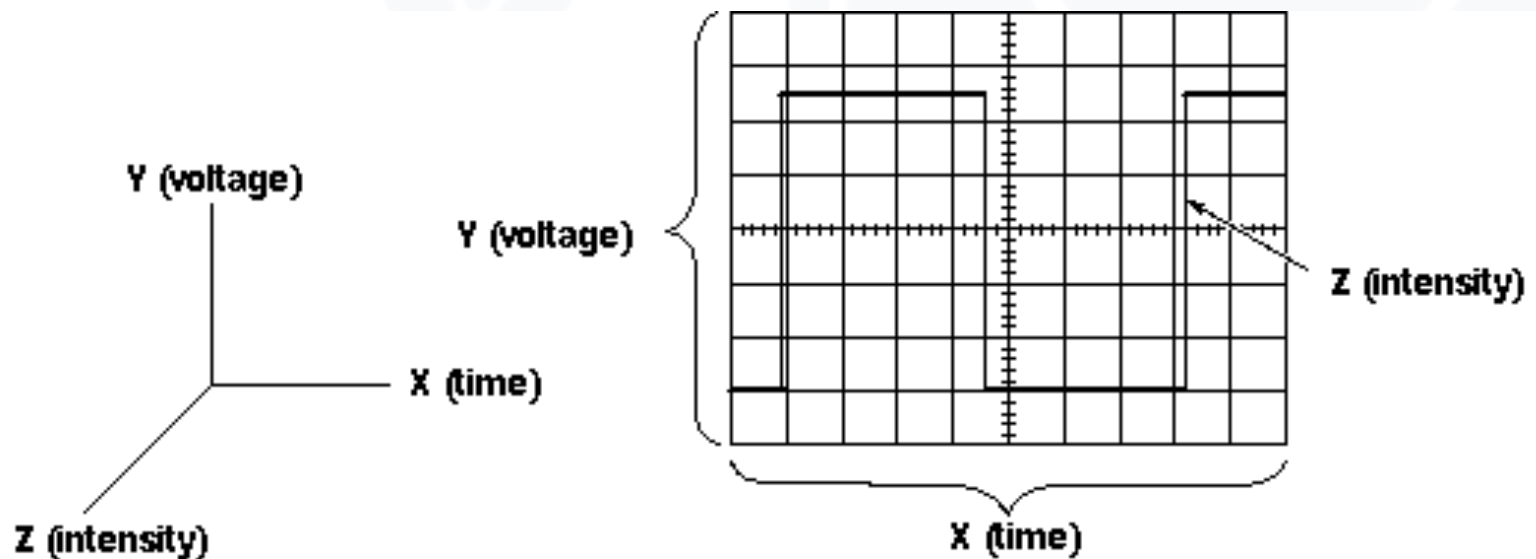
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Introduction

- A graph-displaying device of electrical signal
 - X axis: Time
 - Y axis: Voltage
 - Z axis: Intensity or brightness



Introduction (contd.)

- Information given by oscilloscopes
 - Time and voltage
 - Frequency and phase
 - DC and AC components
 - Spectral analysis
 - Rise and fall time
 - Mathematical analysis

What can you do with oscilloscopes?

- Designing and repairing electronic equipment
- With the proper transducer (Ex: microphone)
 - Electrical signal in response to physical stimuli, such as sound, mechanical stress, light, or heat.
 - Engine vibrations
 - Brain waves



**Light
Source**

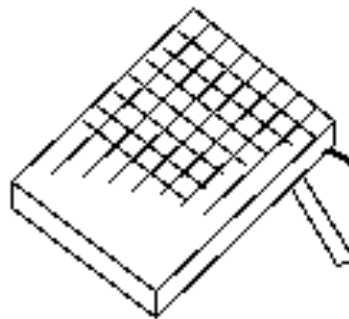
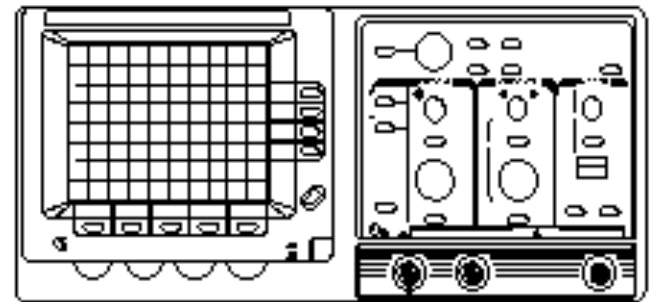
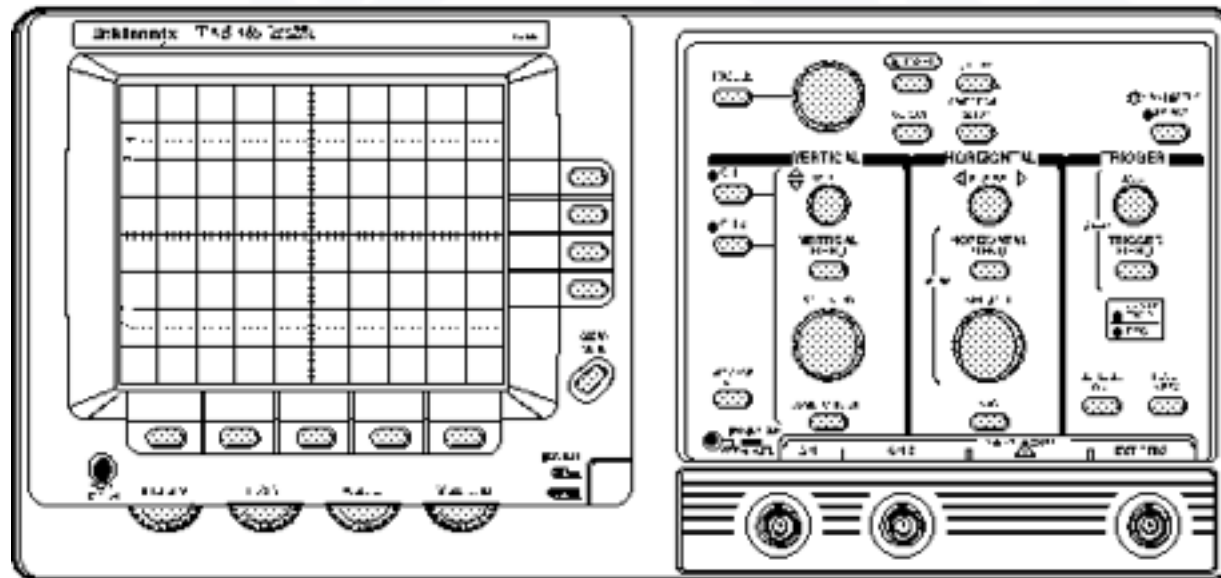


Photo Cell



Control panel of an oscilloscope

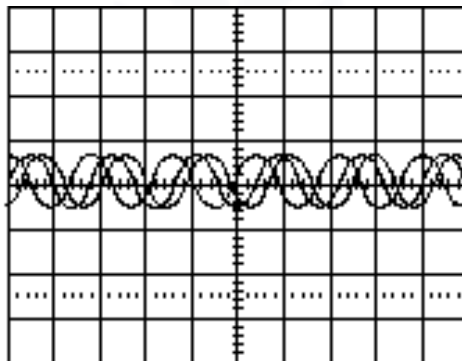
- Vertical Section
- Horizontal Section
- Trigger Section



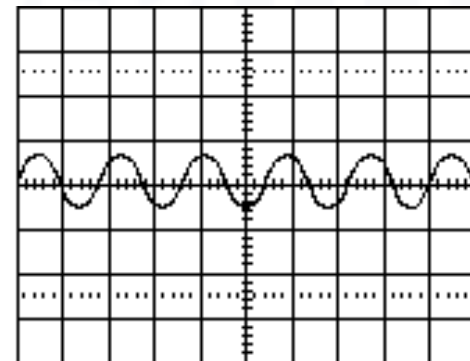
Basic setting

- Vertical system
 - attenuation or amplification of signal (volts/div)
- Horizontal system
 - The Time base (sec/div)
- Trigger system
 - To stabilize a repeating signal and to trigger on a single event

Untriggered Display



Triggered Display



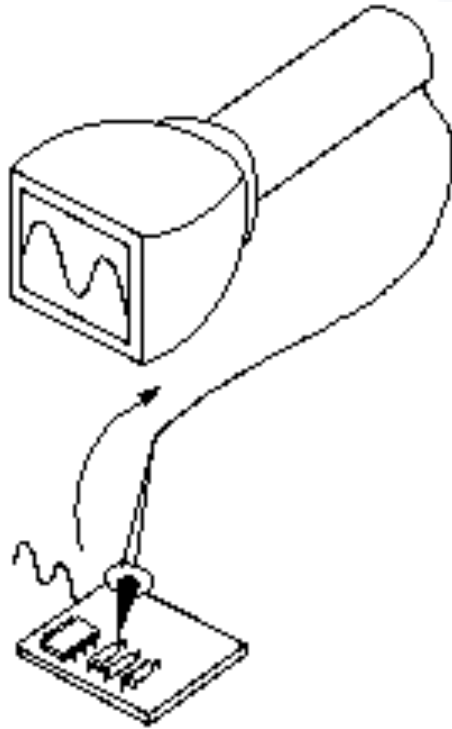
In digital circuits

- Measuring
 - Logic level
 - Timing
 - Logic strength
 - Rise and fall time
 - Frequency
 - Signal integrity
 - Waveform distortion
 - Noise level

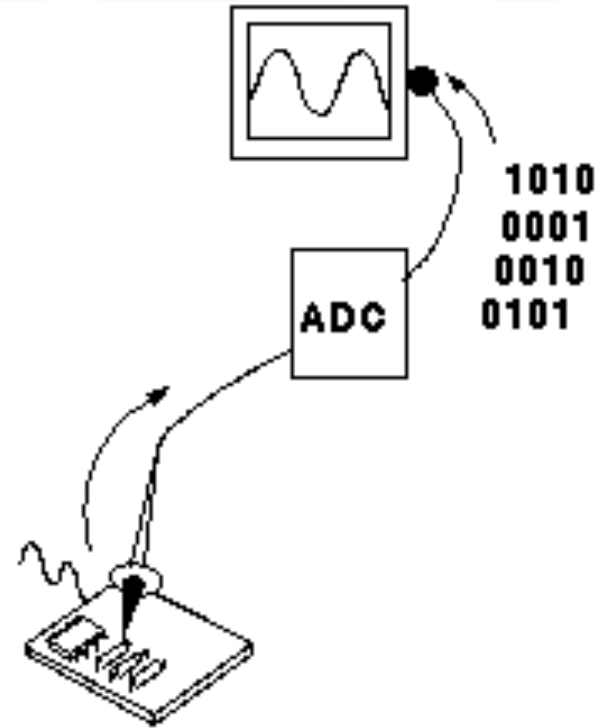
In digital circuits (contd.)

- Diagnosing
 - Timing fault
 - Proper fan-in and fan-out
 - Proper pull-up and/or termination
 - Collision
 - Signal integrity
 - Reflection
 - Noise, crosstalk and ground bounce
 - Open, short or stuck at 0 or 1

Analog and digital oscilloscope



**Analog Oscilloscopes
Trace Signals**

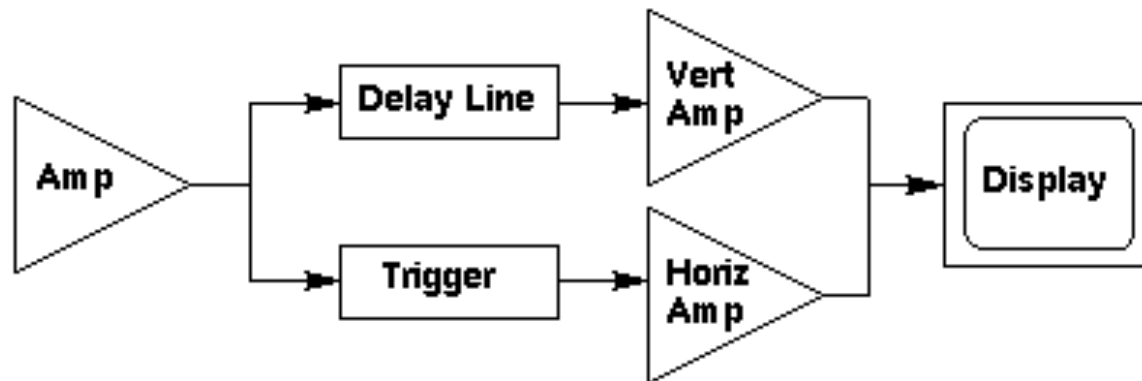


**Digital Oscilloscopes Sample Signals
and Construct Displays**

Analog oscilloscope

- Real-time display of signals
- Block diagram
 - Sweep generator and vertical amplifier
 - Earthquake recorder

Analog Display



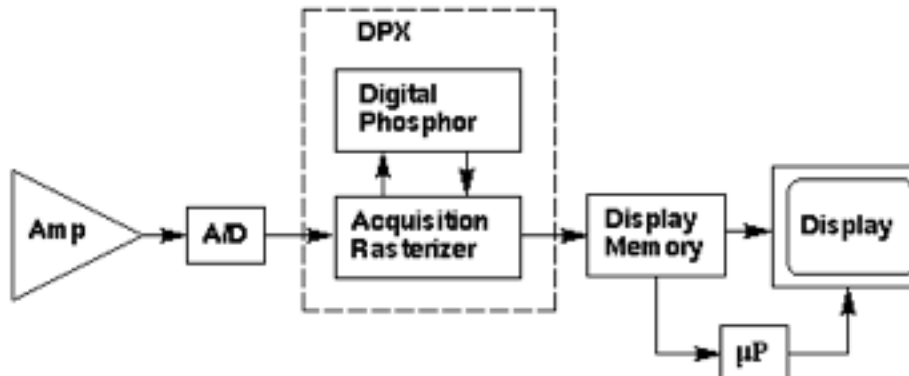
Digital oscilloscope

- Capture and view events
 - Digital storage oscilloscope (DSO)

Serial Processing

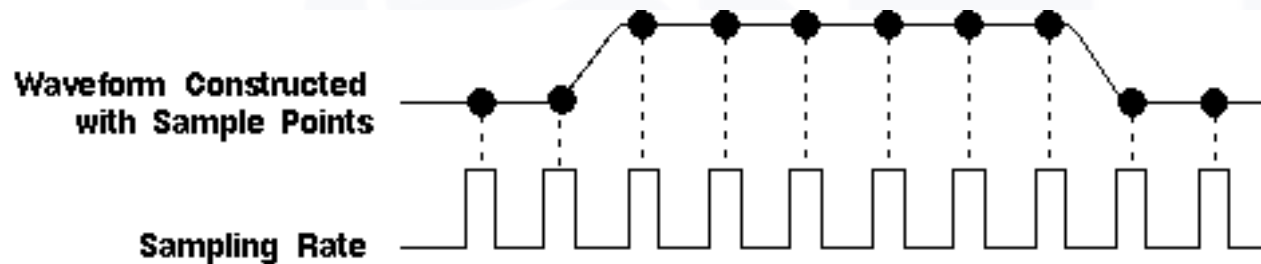


Parallel Processing

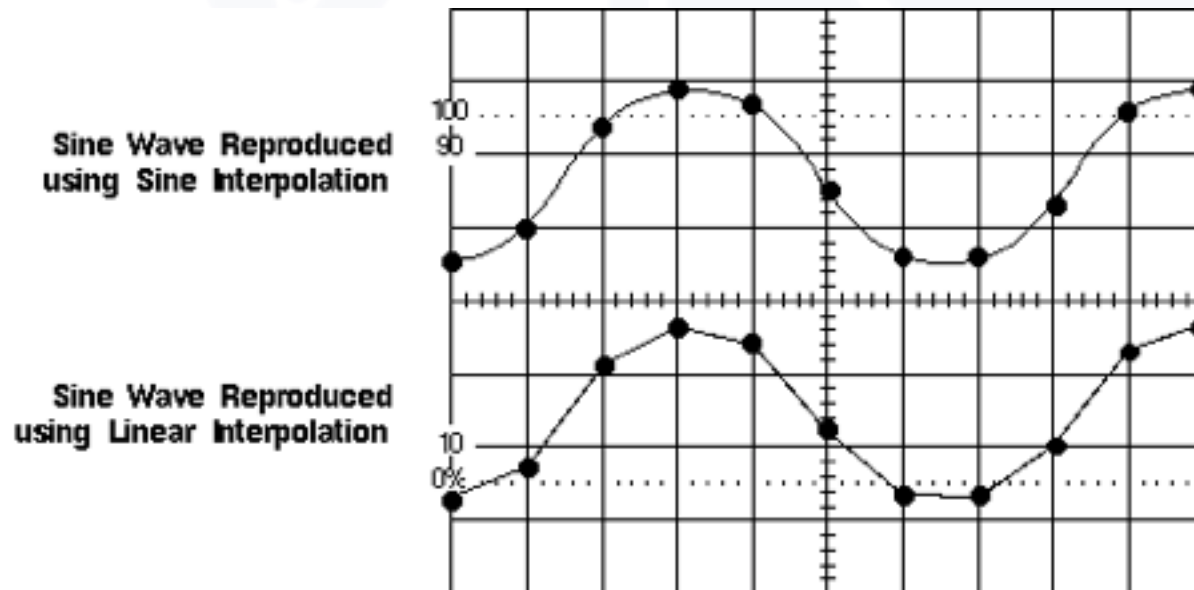


Digital oscilloscope (contd.)

Sampling



Interpolation



Why DSO?

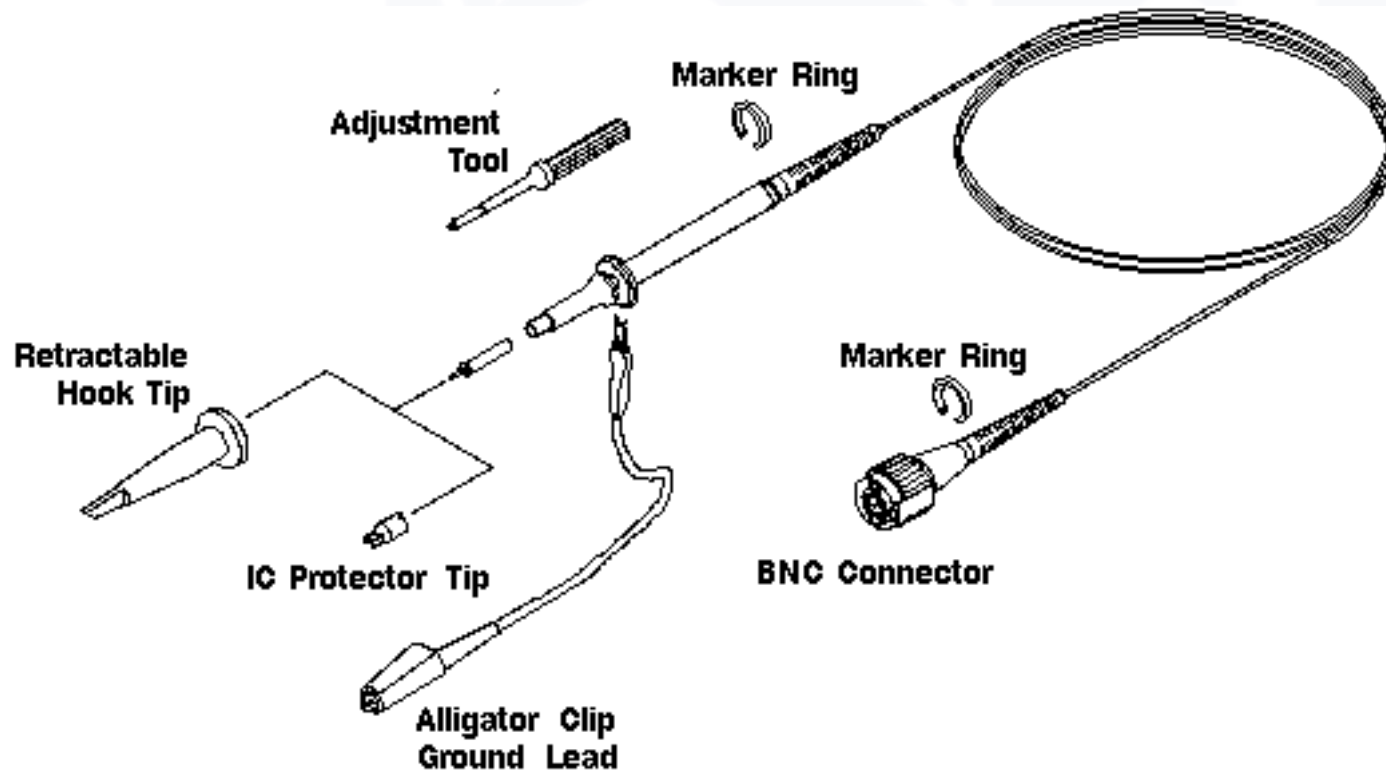
- Trend
- Easy of use
- One-shot measurement
- Non-periodic waveform
- Recoding
- Lengthy waveform analysis
- Triggering
- Complex trigger condition
- Data reuse
- Connectivity

Probe

- High quality connector
 - No discontinuity
- High impedance ($10M\Omega$)
 - Invisible observer (no circuit loading)
- 50Ω for high frequency measurement
- Passive probe and active probe

Probe (contd.)

● Components

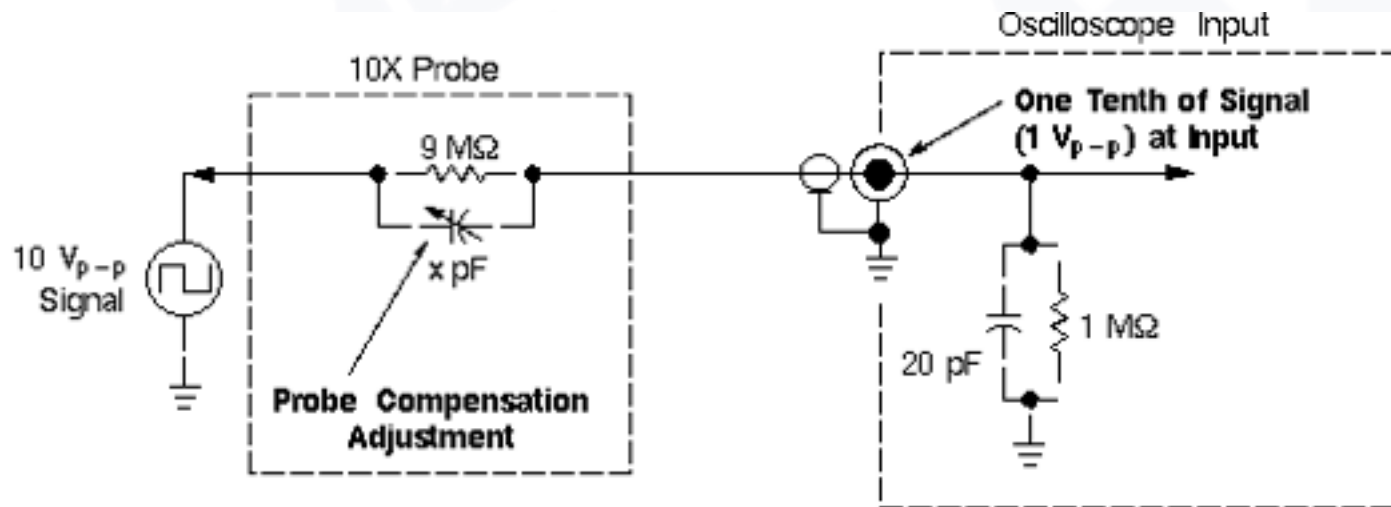


Passive probe

- 10× attenuation
 - Good for low circuit loading
 - Suitable to high frequency signal
 - Difficult to measure less than 10mV signals
- 1× attenuation
 - Good for small signals
 - Introducing more interference
- 20x attenuation
 - Newly announced
 - Low-capacitance passive probe
 - Tektronix P6158, 3GHz 20x

Passive probe (contd.)

- Bandwidth and capacitance
 - 10MHz(100pF) and 500MHz(10pF)
 - < 20K Won and < 500K Won
 - 20:1 high-speed passive probe



Active probe

- Signal conditioning \Rightarrow oscilloscope
- 1GHz (1.5pF) < 5M Won
- Require power source
- Good for high speed digital signals over 100MHz clock frequency (up to 500ps fall time)

Point to remember in probes

- Probe characteristics are described assuming that there is zero length of ground lead loop.
- More expensive, high performance (mostly low capacitance) probe is more severely affected by the ground lead loop.
- Don't even think about ground lead extension!
Do not waste money.
- No ground lead...Can you imagine?

High-performance DSO

- Why high speed?
 - High-fidelity measurement of digital signals
- Who degrade the fidelity of measurement?
 - Probe
 - Front-end analog amplifier
 - Sampling and interpolation
- How fast DSO do we need?
 - Bandwidth of the digital signals
 - Clock frequency, rise time and fall time

DSO performance measure

- Bandwidth (3dB or RMS)
 - Measurable frequency range
- Sampling rate
- Rise time
 - Adding rise time to the original signal
- Vertical sensitivity
 - Measurable weak signal (mV/div)
- Gain accuracy

DSO performance metrics

- Time base or horizontal accuracy
- Other metrics
 - ADC resolution (vertical resolution)
 - Record length