



UNIVERSITÀ DEGLI STUDI DI PAVIA

**Dept. of Electrical, Computer and
Biomedical Engineering**

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Bench-top instrumentation for electronic measurements

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Instrumentation for electronic measurements

- Designed and built for measuring parameters in electronic components and study the response of electronic circuits: power supplies, multimeters, signal generators, oscilloscopes, semiconductor parameter analyzers, spectrum analyzers, impedance meters, logic state analyzers, pattern generators and many others
- We will focus on two instruments in particular
 - **signal generator**: is used to provide a stimulus to a circuit, in such a way that we can study its response to some kind of signals (e.g., sinusoidal signals, step signals) and extract some information on its characteristic (e.g., bandwidth, gain, sensitivity)
 - **oscilloscope**: is used to represent signals in the time domain, i.e., to show how a signal changes in time

We already tried something similar with ELVIS



KEYSIGHT 33500B Waveform Generator



- Can be used to generate periodic signals of the sinusoidal, square or triangular kind - amplitude and frequency of the generated signal can be controlled from the front panel

KEYSIGHT 33500B Waveform Generator



power on
button

Before switching the generator ON, be sure that the amplitude and the DC component of the signal are compatible with the circuit you are testing - **too large a signal may damage your device under test!**

output BNC
connector



BNC connectors and cables



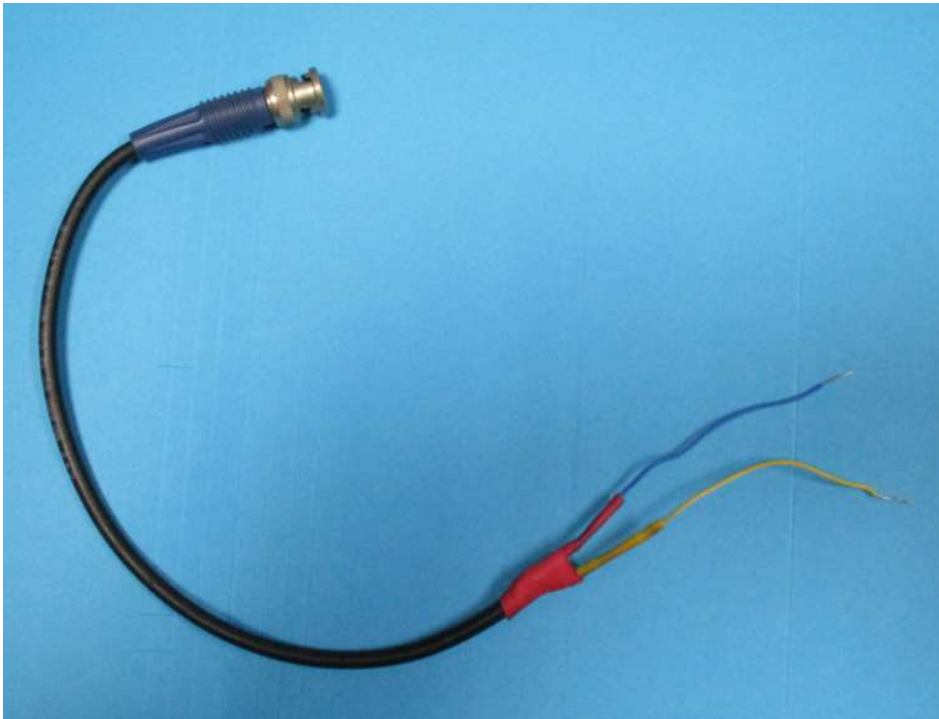
male BNC connector



female BNC connector



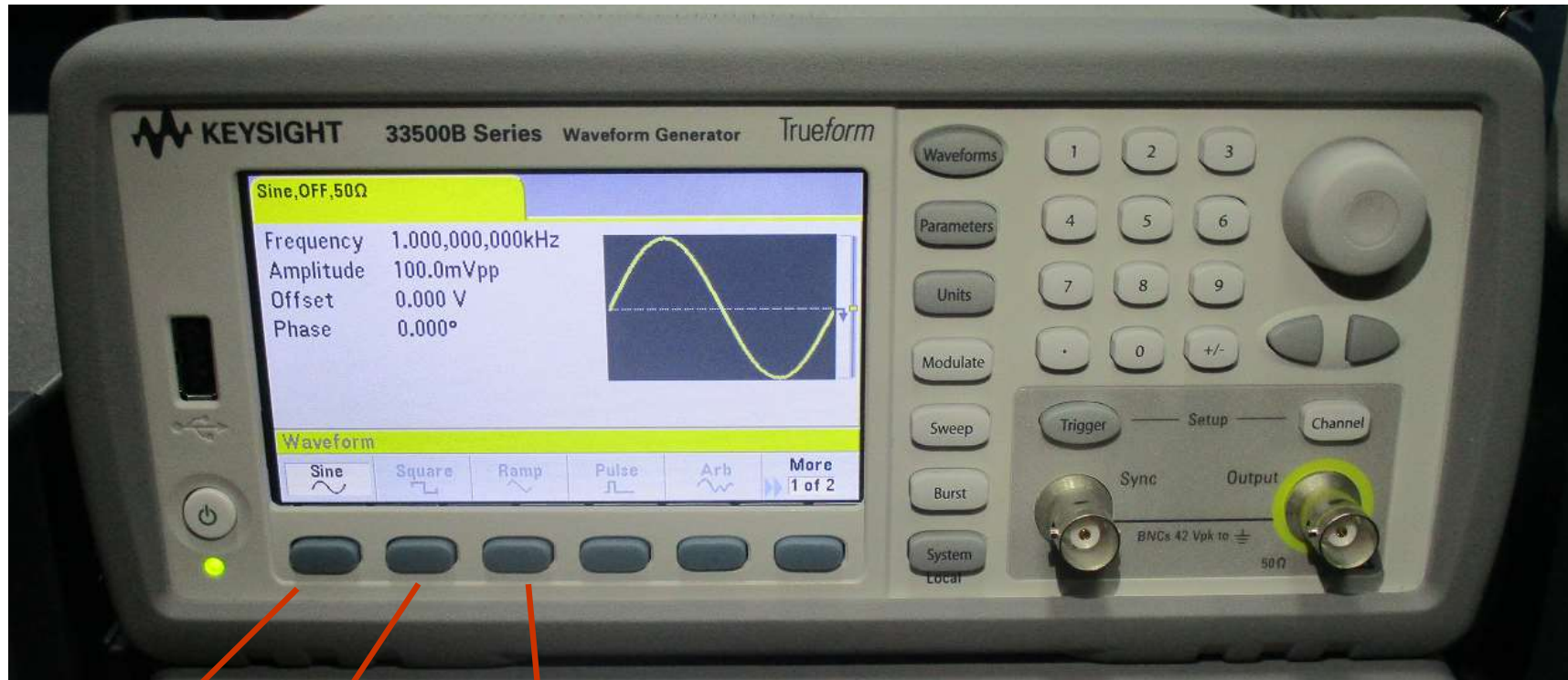
BNC/free wire cable



to be used with circuits built on the breadboard



Main controls: waveform shape

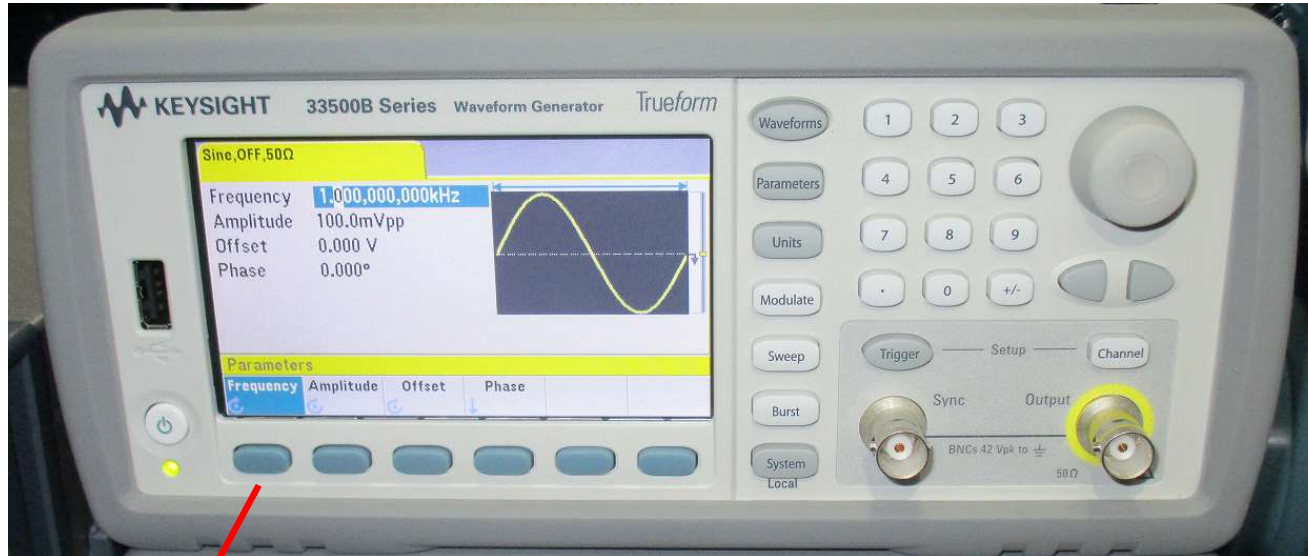


sine

square

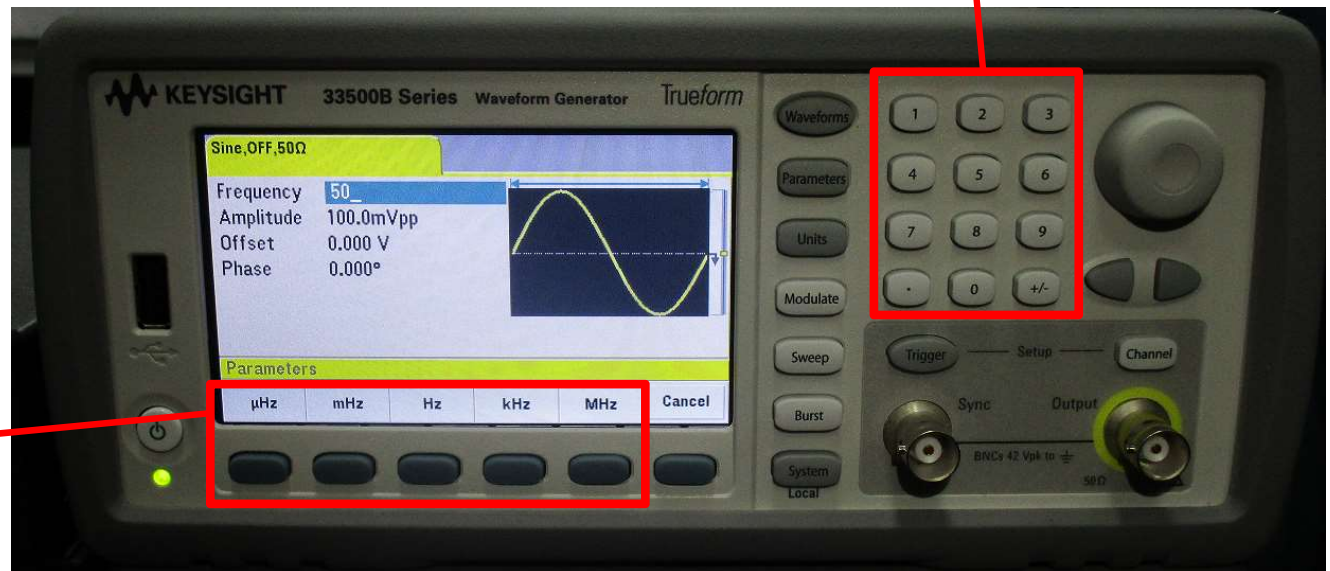
ramp

Main controls: frequency



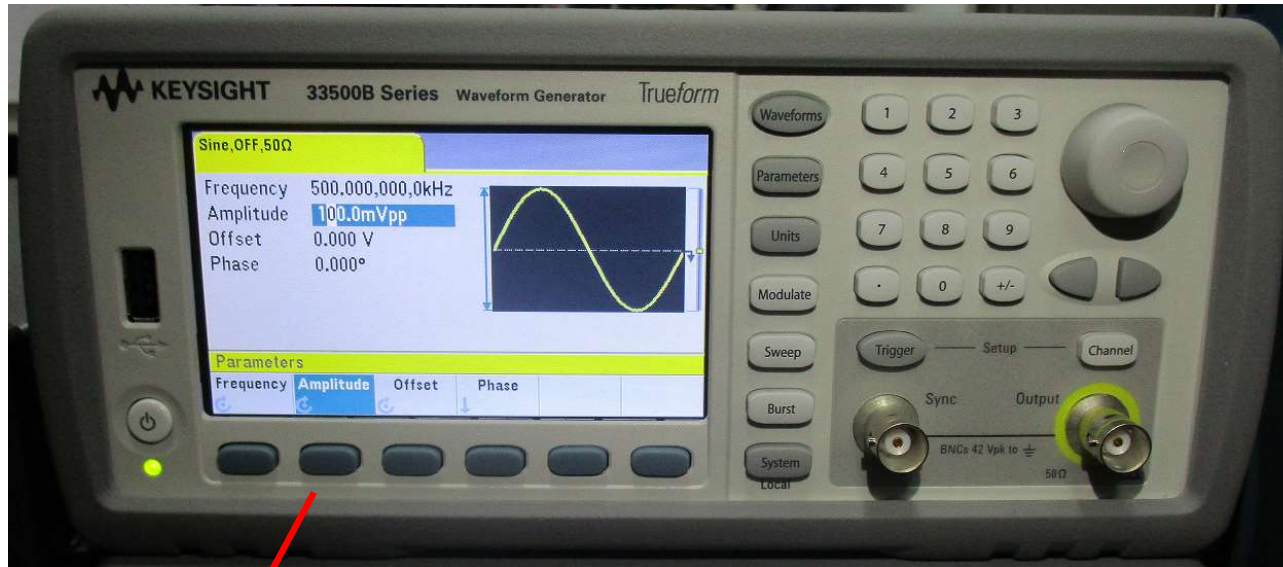
1) select 'Frequency'

2) choose value



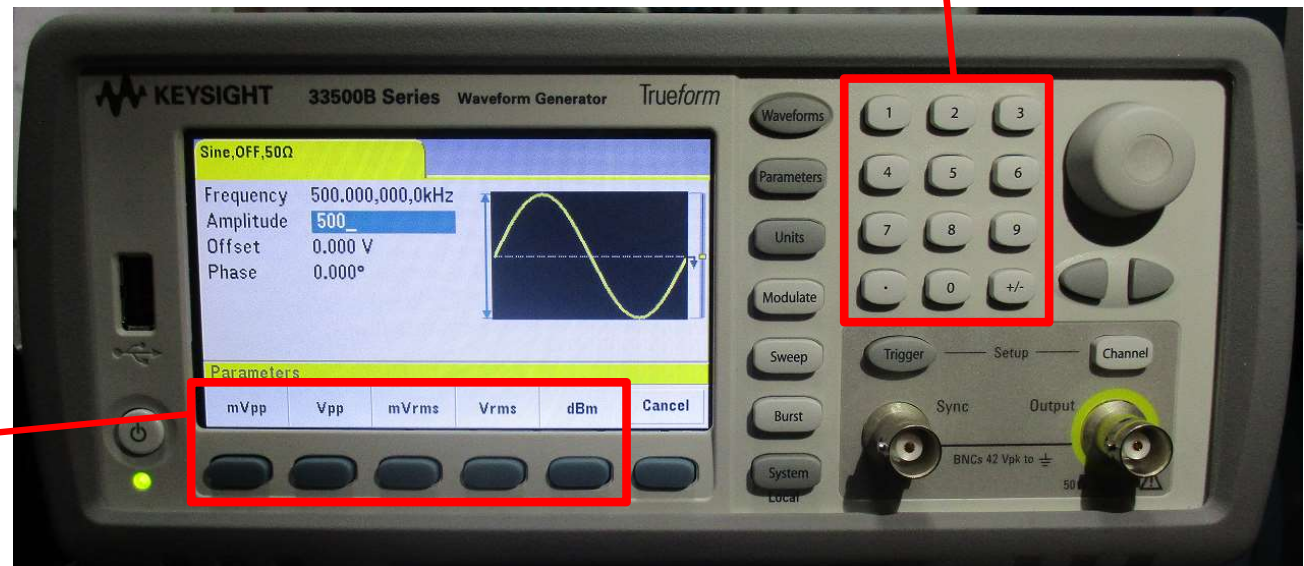
3) choose order of magnitude

Main controls: amplitude



1) select
'Amplitude'

2) choose
value



3) choose
order of
magnitude



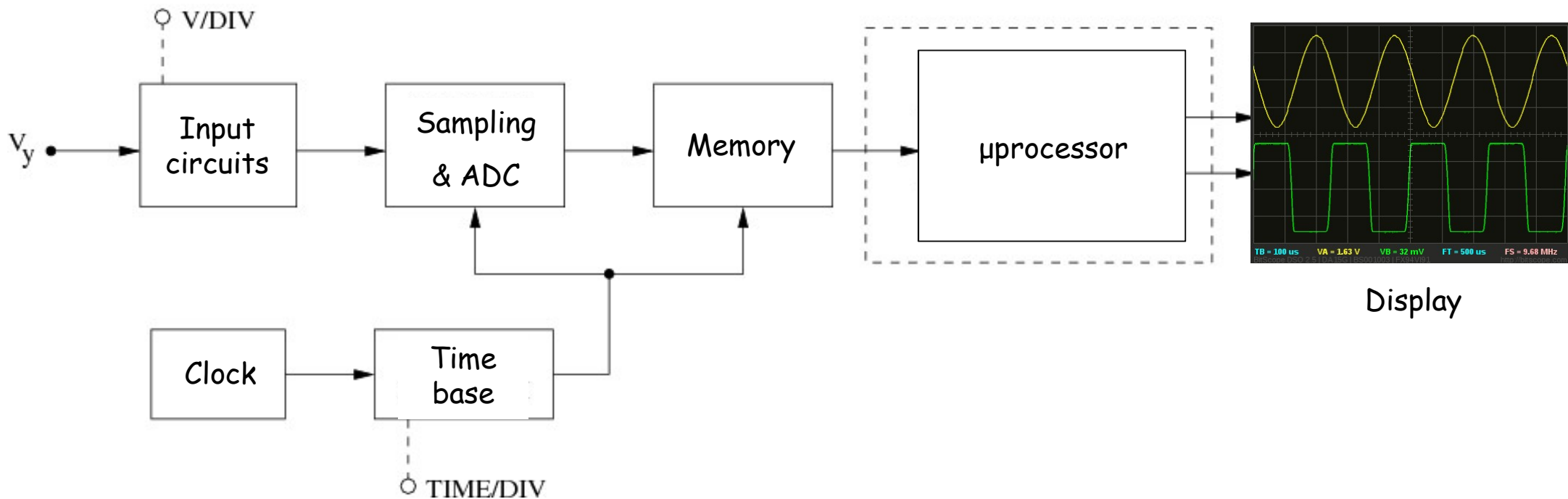
Oscilloscopes

- The main purpose of the oscilloscope is the representation of the time evolution of (mostly periodic) signals
- Oscilloscopes can be classified based on the technology used to build them, also affecting their operation
 - *analog scopes*
 - *sampling scopes*
 - *digital storage scopes*
- In an analog scope, the waveform is represented on the screen of a cathode ray tube (CRT), in modern, digital scopes, LCD displays are generally used

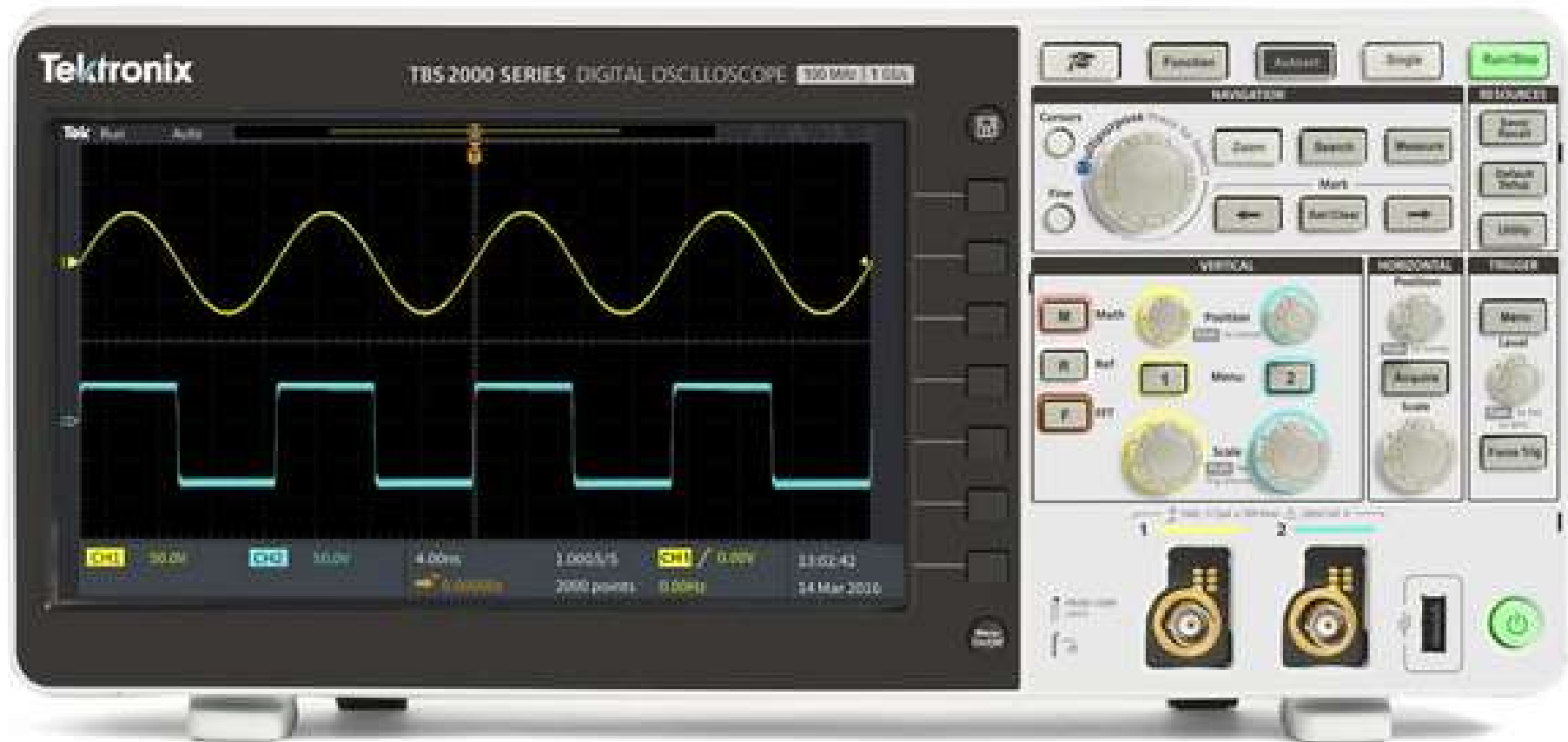


Digital storage oscilloscopes (DSO)

- Digital storage oscilloscopes sample and convert the signals by means of fast analog-to-digital (ADC) converters (**digitization process**)
- At regular time intervals (sampling period) the ADC stores the voltage sample, in a numeric form, on fast, dedicated memories
- Data need to be converted back to a waveform representation for them to be displayed on the scope screen (**reconstruction process**)

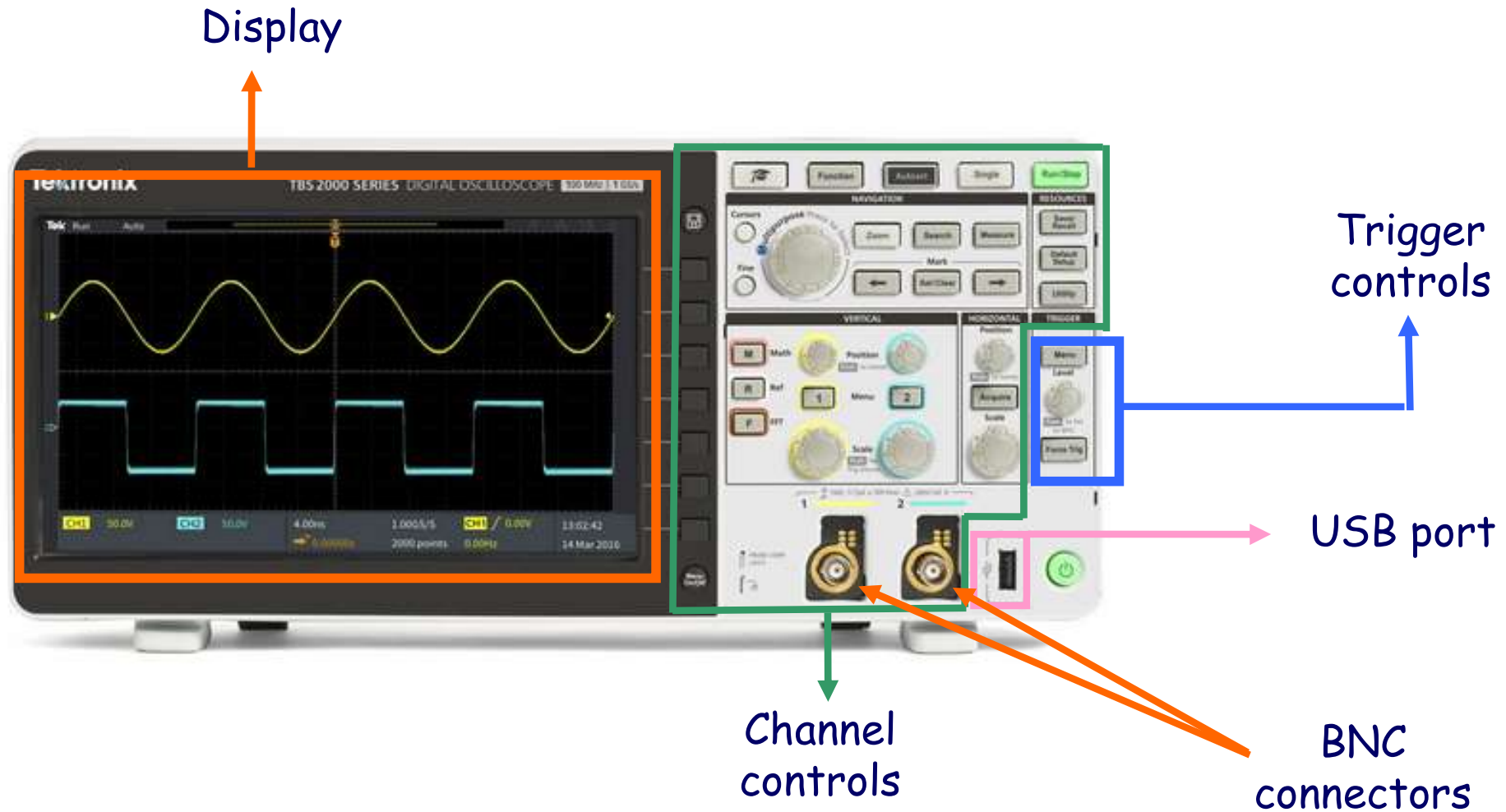


Tektronix TBS 2102 Digital Storage Oscilloscope





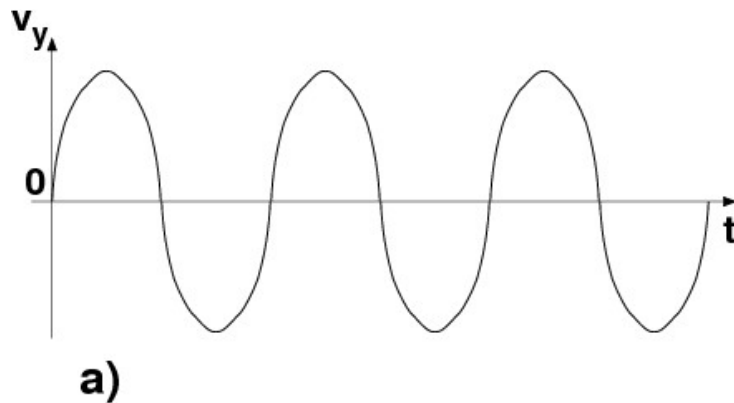
Front panel



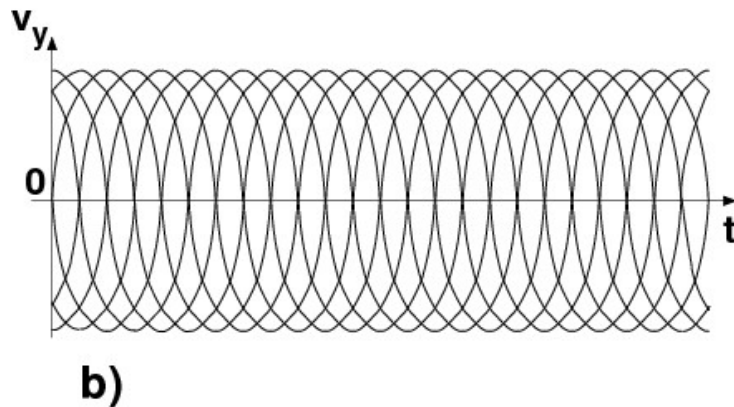


Trigger

- Trigger circuits are used to synchronize the scope operation with the (periodic) signal under measurement



- trigger circuits are **correctly** set - the signal on the screen appears as a **still waveform**



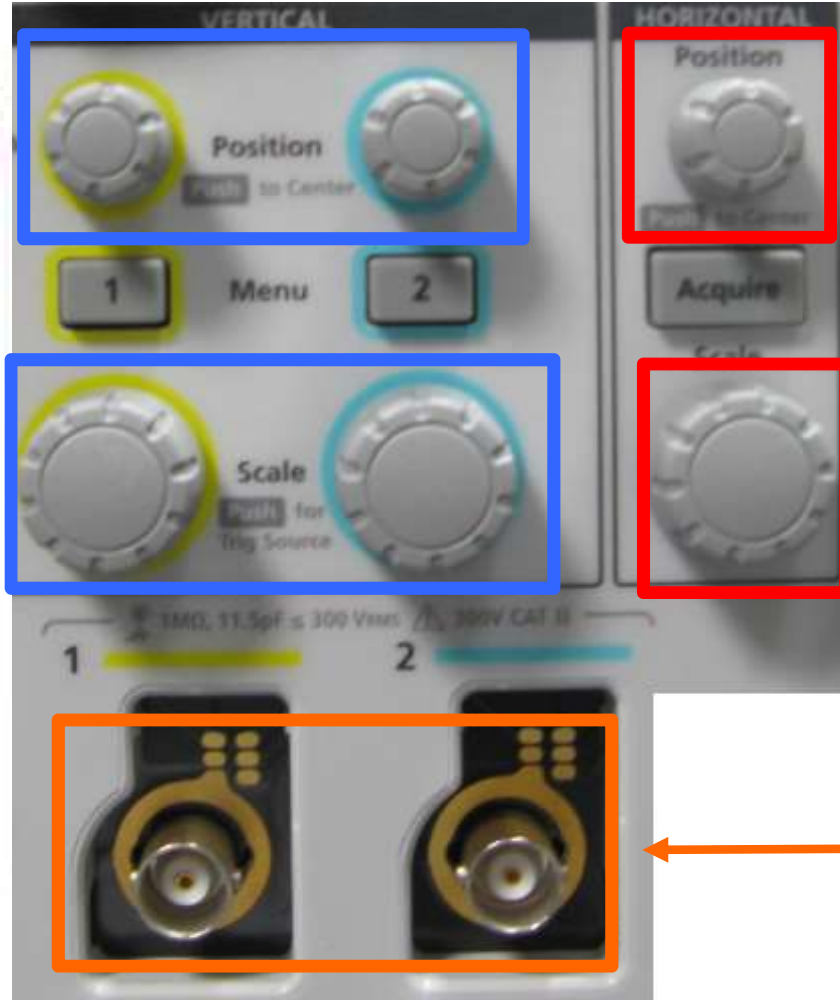
- trigger circuits are **not correctly** set - the signal on the screen may appear as a **running waveform**





Input channels

Vertical positioning (DC level) of traces



Horizontal positioning of traces



Vertical scale control



Horizontal scale control



BNC connectors



CH1
yellow trace

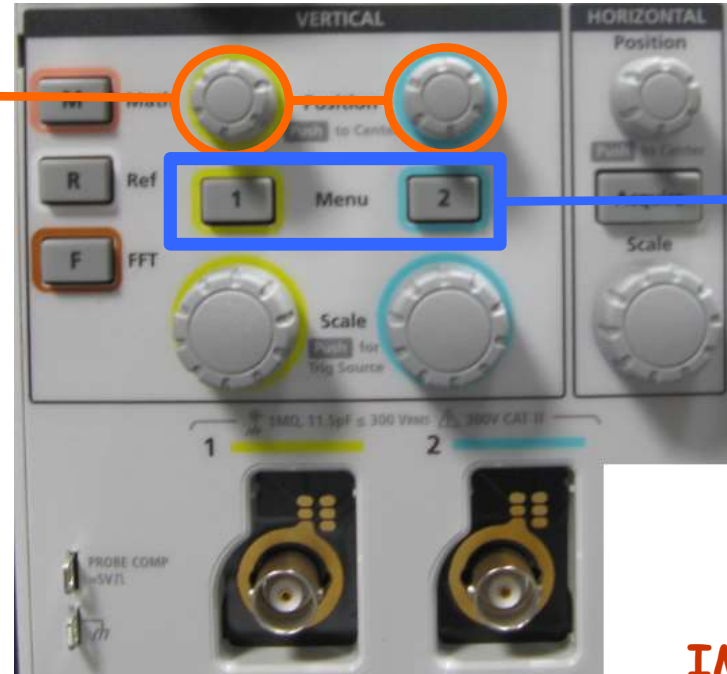
CH2
blue trace





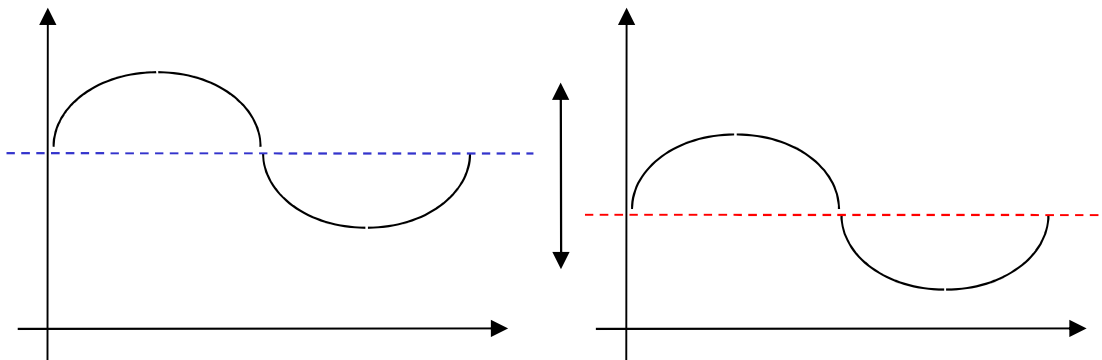
DC level control

DC level control



ON/OFF switches for CH1 and CH2

DC level



IMPORTANT: when we shift the DC level on the oscilloscope we are not changing the DC level (average value) of the actual signal, but just of its representation on the scope screen

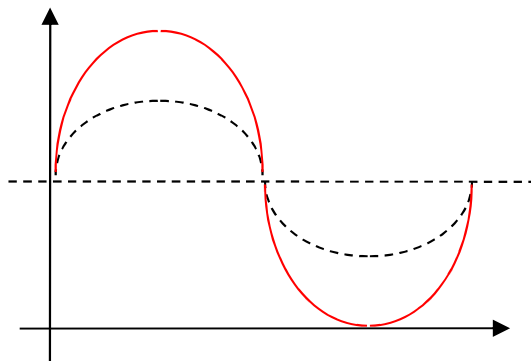


Horizontal and vertical scale control

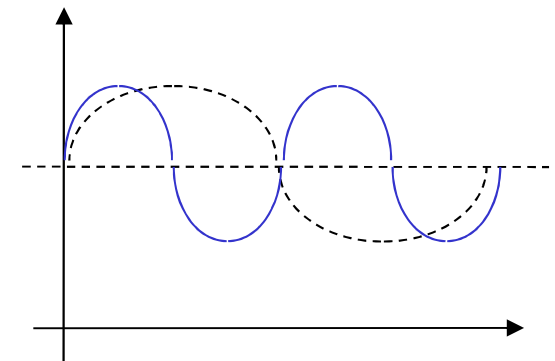
vertical scale control (V/div), one for CH1, one for CH2



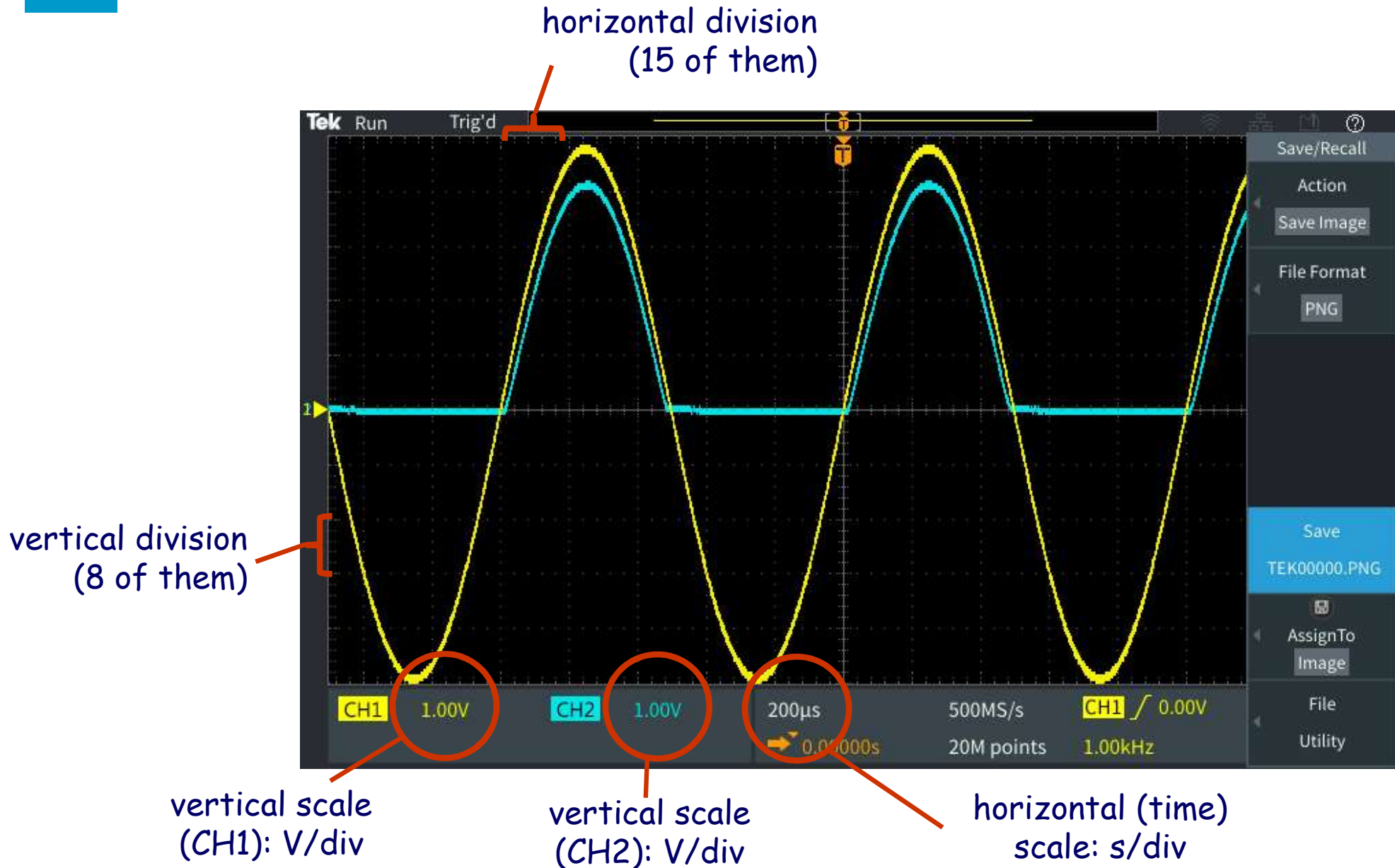
horizontal scale (s/div), one for both channels



IMPORTANT: when we change the scale of the signal we are not changing the amplitude or altering the time scale of the actual signal, but just of its representation on the scope screen



Vertical and horizontal scale

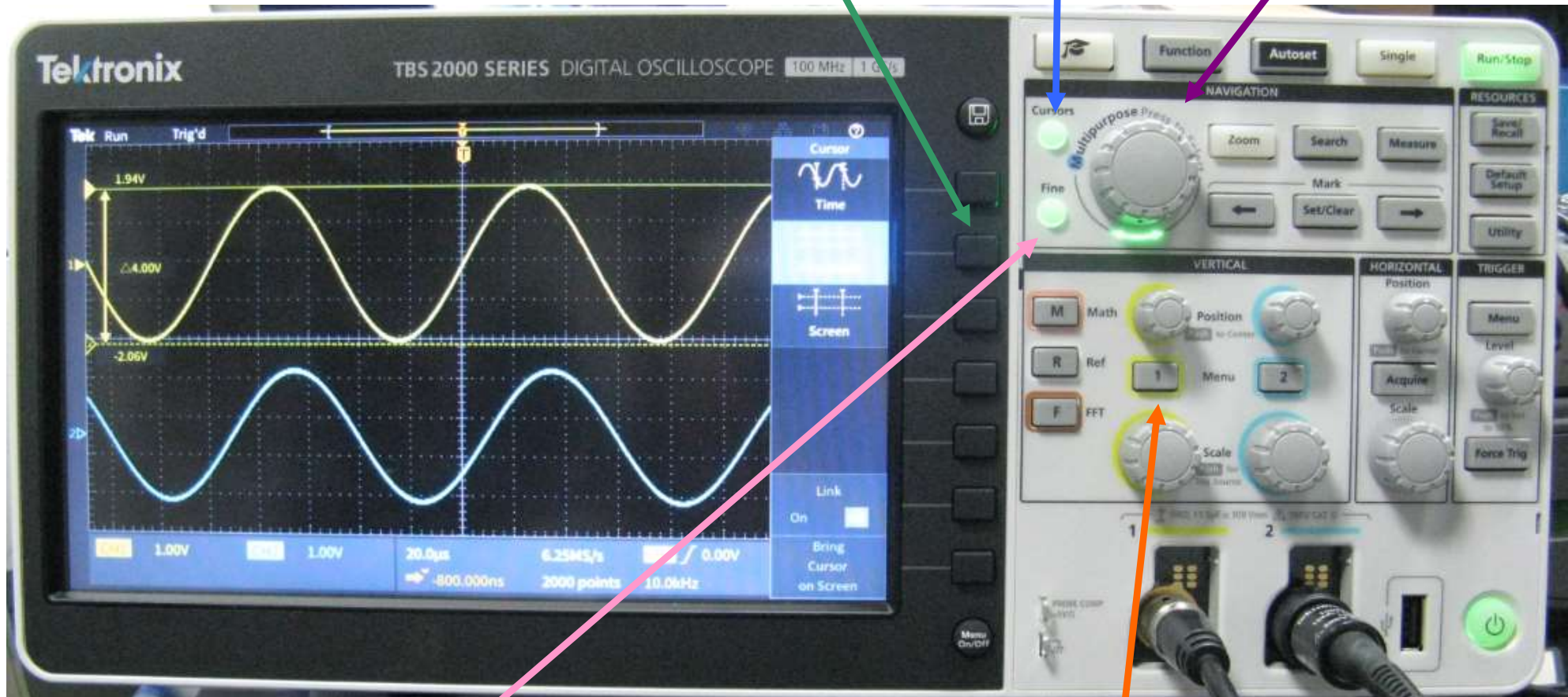


Amplitude measurement

3) Press to select the horizontal cursors

2) Press to bring the cursors on

4) Turn to move the cursors and press to select one or the other cursor



5) Press for fine adjustment of cursors

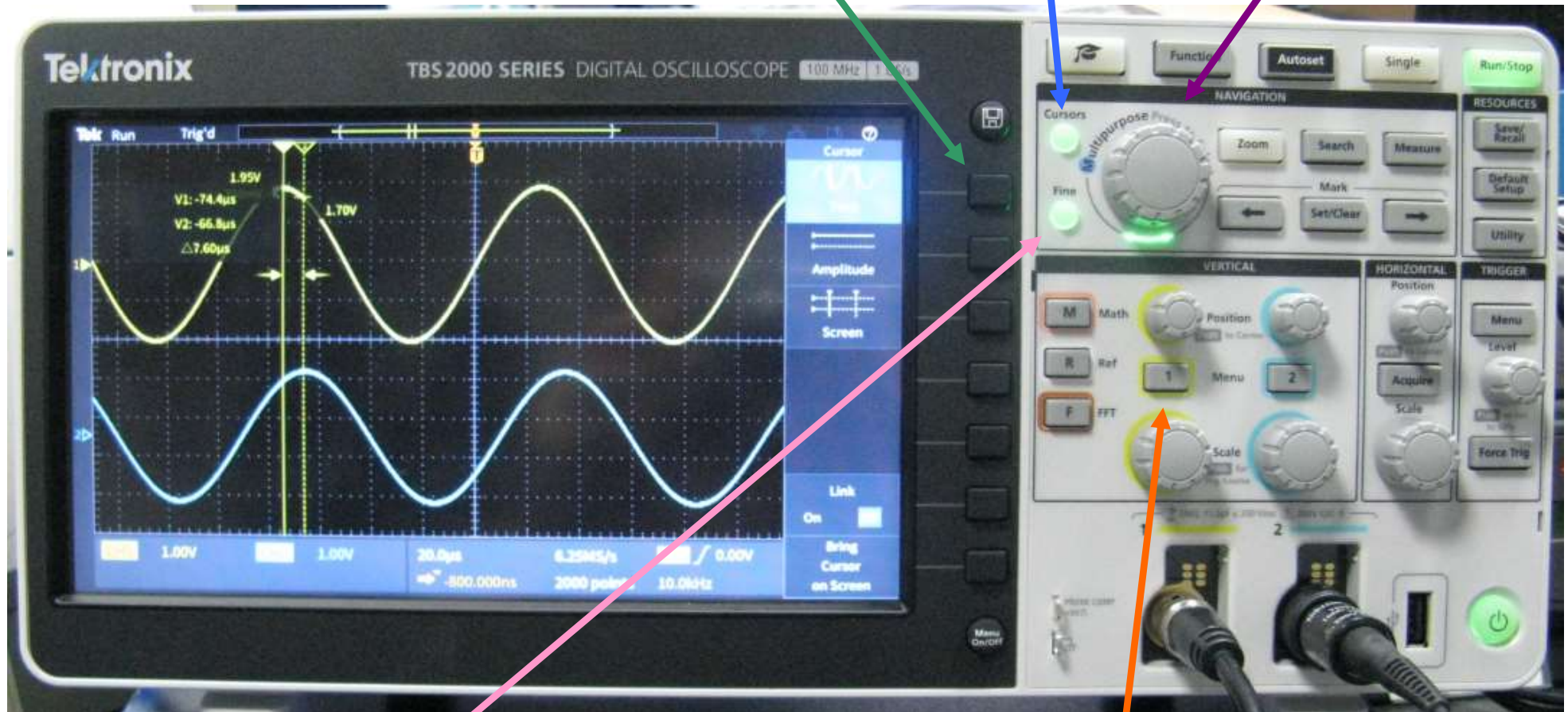
1) Press to select the channel

Time interval measurement

3) Press to select the vertical cursors

2) Press to bring the cursors on

4) Turn to move the cursors and press to select one or the other cursor



5) Press for fine adjustment of cursors

1) Press to select the channel



Probe



probe tip or
hook (under the
retractable
cap)

BNC
connector

alligator clip
(ground lead)

