

Electronics Oscilloscopes

Terry Sturtevant

Wilfrid Laurier University

August 23, 2018

Oscilloscope

Oscilloscope

- a very fancy voltmeter *with one important difference*

Oscilloscope

- a very fancy voltmeter *with one important difference*
- allows you to see how a voltage *varies in time*

Typical oscilloscope

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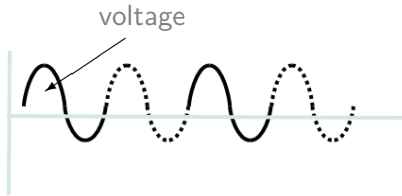
An oscilloscope uses the second approach.

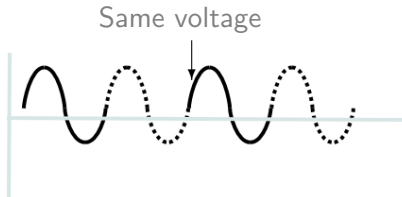
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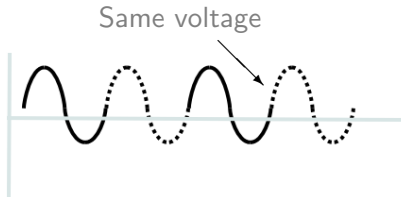
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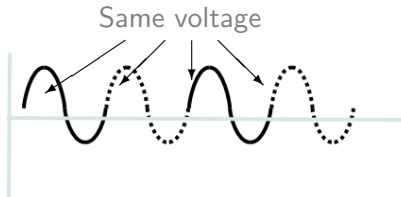
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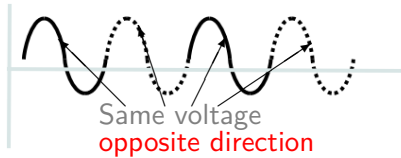
Actually a digital storage scope can use the first one as well.











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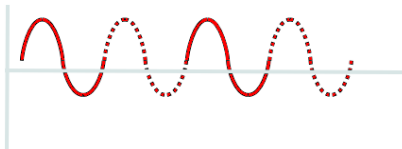
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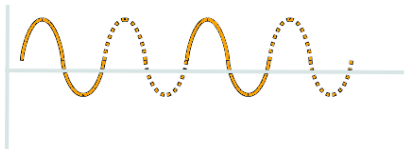
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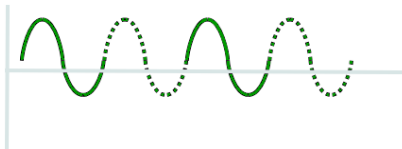
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- Consider a sine wave:
Except for the peak and the trough, every value within the waveform will be repeated twice in one cycle;
once on the way up,
and once on the way down.
- If we pick a value and a direction, (going up or down), we can specify any point in the cycle uniquely.



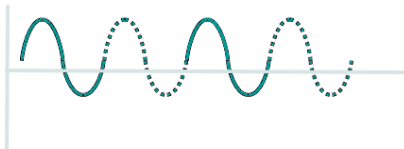
First pass



Second pass



Third pass



Fourth pass

- If we now start drawing the signal on a screen at that point, we will show some of the wave.

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- If we then look for the same point on the *next* cycle, and redraw it over the original, it should look exactly the same. This is how a scope works.

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- If we then look for the same point on the *next* cycle, and redraw it over the original, it should look exactly the same. This is how a scope works.
- Most scopes have at least two input channels, so that two signals can be compared.

Triggering

Triggering

- channel

Triggering

- channel
- level

Triggering

- channel
- level
- polarity

Leads and inputs

Leads and inputs

- single voltage and ground; *not differential voltage!*

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- 1x, 10x probes (must agree with channel setting)

Leads and inputs

- single voltage and ground; *not differential voltage!*
- 1x, 10x probes (must agree with channel setting)
- external trigger

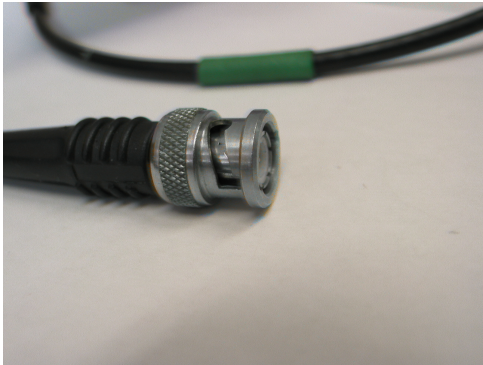




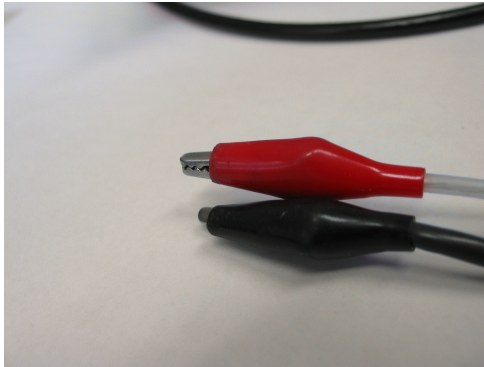
Input section



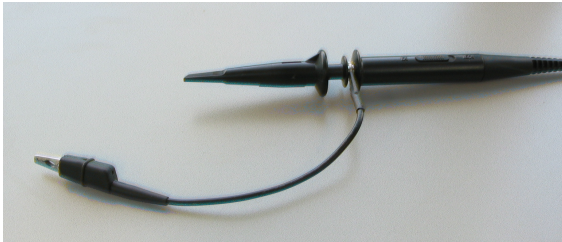
- BNC connector (end view)



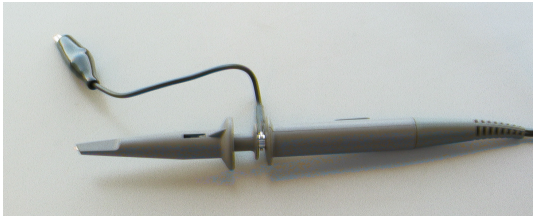
- BNC connector (side view)



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- Scope lead (black)



- Scope lead (grey)



- Scope lead probe switch

Channels

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- X, Y ; *Make sure to use ground clips!*

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Channels

- X, Y ; *Make sure to use ground clips!*
- 1x, 10x probe (must agree with lead)
- vertical resolution

Channels

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- 1x, 10x probe (must agree with lead)
- vertical resolution
- vertical position

Channels

- X, Y ; *Make sure to use ground clips!*
- 1x, 10x probe (must agree with lead)
- vertical resolution
- vertical position
- AC/DC coupling (like meter)

Other controls and features

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- horizontal position

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- XY mode (instead of timebase mode)

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- signal math; $X + Y$, $X - Y$

Other controls and features

- horizontal position
- XY mode (instead of timebase mode)
- signal math; $X + Y$, $X - Y$
last one allows differential measurement

Oscilloscope Oscilloscope Screens

Channel 1 screen
Display screen
Math screen
Measure screen
Trigger screen





Channel 1 section

- Channel 1 screen
- Display screen
- Math screen
- Measure screen
- Trigger screen



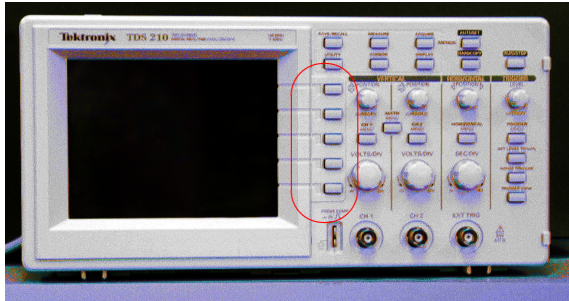


Channel 2 section

Oscilloscope Oscilloscope Screens

Channel 1 screen
Display screen
Math screen
Measure screen
Trigger screen





Menu controls

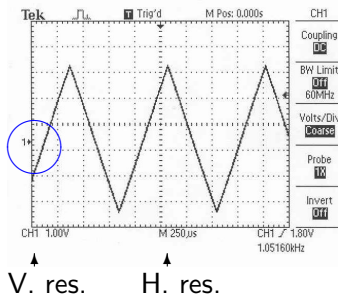
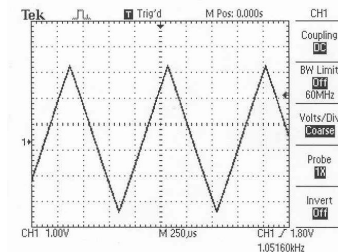


Figure: Channel 1 settings

- Indicates to which channel everything else applies
- Ground for this channel is at left



V. res.

H. res.

← Channel 1

← Coupling

← BW Limit

← Volts/Div

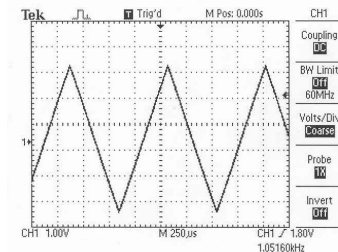
← Probe

← Invert

← Other

Figure: Channel 1 settings

- AC, DC or GROUND
- Get rid of DC offset (or not), or show ground



V. res.

H. res.

← Channel 1

← Coupling

← BW Limit

← Volts/Div

← Probe

← Invert

← Other

Figure: Channel 1 settings

- Bandwidth limit

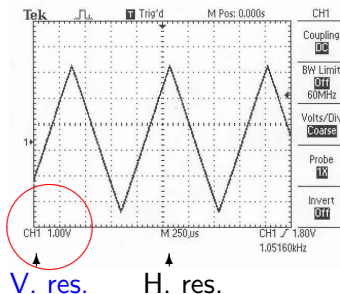
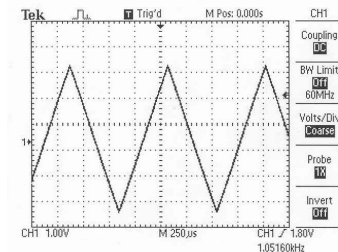


Figure: Channel 1 settings

- Vertical resolution
- Setting is shown at lower left



V. res.

H. res.

← Channel 1

← Coupling

← BW Limit

← Volts/Div

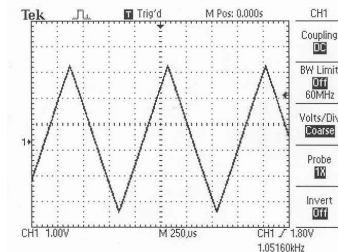
← Probe

← Invert

← Other

Figure: Channel 1 settings

- The PROBE setting must match the setting on the cable switch, or be '1X' if there's no cable switch.



← Channel 1

← Coupling

← BW Limit

← Volts/Div

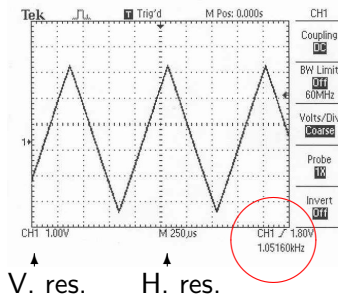
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← Invert

← Other

Figure: Channel 1 settings

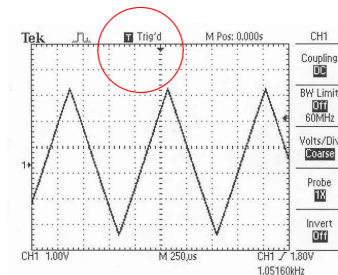
- Invert the voltage or not



- ← Channel 1
- ← Coupling
- ← BW Limit
- ← Volts/Div
- ← Probe
- ← Invert
- ← Other

Figure: Channel 1 settings

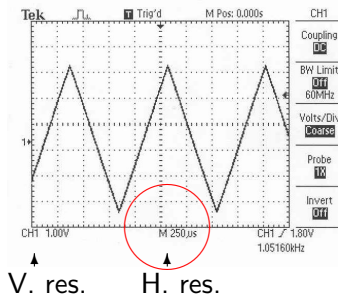
- Trigger settings are displayed



- ← Channel 1
- ← Coupling
- ← BW Limit
- ← Volts/Div
- ← Probe
- ← Invert
- ← Other

Figure: Channel 1 settings

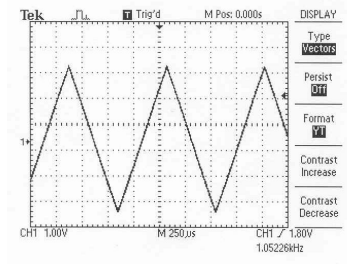
- Trigger status is displayed



- ← Channel 1
- ← Coupling
- ← BW Limit
- ← Volts/Div
- ← Probe
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- ← Other

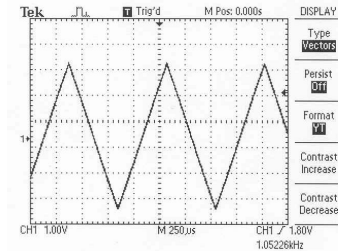
Figure: Channel 1 settings

- Horizontal resolution is displayed



- ← Display
- ← Type
- ← Persist
- ← XY or YT
- ← Contrast +
- ← Contrast -

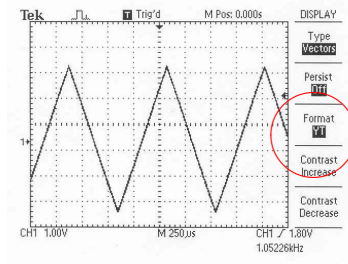
Figure: Display settings



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Figure: Display settings

- Allows you to choose *timebase* mode or *XY* mode



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Figure: Display settings

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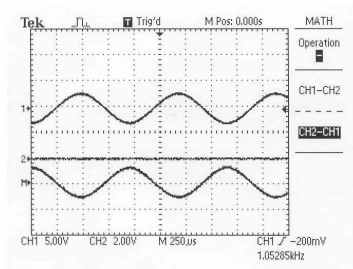
Oscilloscope
Oscilloscope Screens

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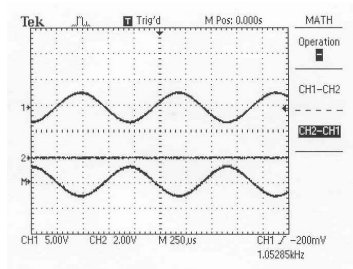


Math mode control



- ← Math
- ← Operation
- ← 1-2
- ← 2-1

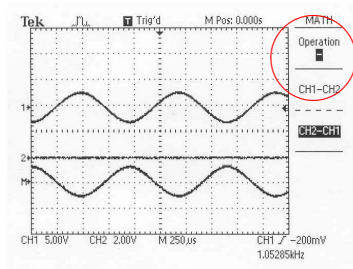
Figure: Math settings



- ← Math
- ← Operation
- ← 1-2
- ← 2-1

Figure: Math settings

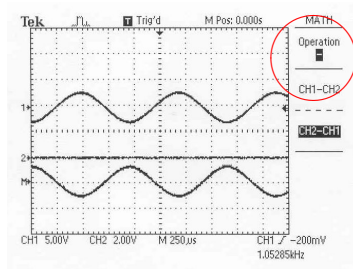
- Allows you to add or subtract channels



- ← Math
- ← Operation
- ← 1-2
- ← 2-1

Figure: Math settings

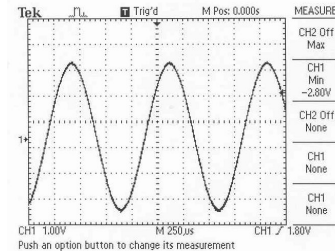
- Allows you to add or subtract channels



- ← Math
- ← **Operation**
- ← 1-2
- ← 2-1

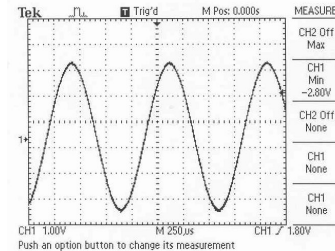
Figure: Math settings

- Allows you to add or subtract channels
- **Be sure to have same vertical setting on both channels!**



← Measure

Figure: Measure settings



← Measure

Figure: Measure settings

- Allows automatic measurement of certain signal properties

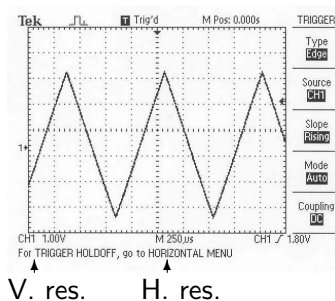
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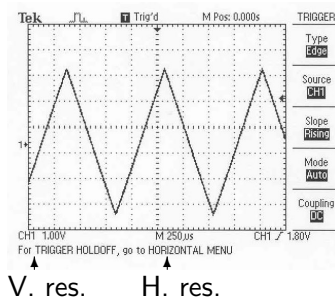


Trigger section



- ← Trigger
 - ← Type
 - ← Source
 - ← Slope
 - ← Mode
 - ← Coupling
- ← Trigger

Figure: Trigger settings



← Trigger
← Type
← Source
← Slope
← Mode
← Coupling
← Trigger

Figure: Trigger settings

- Various trigger settings can be adjusted

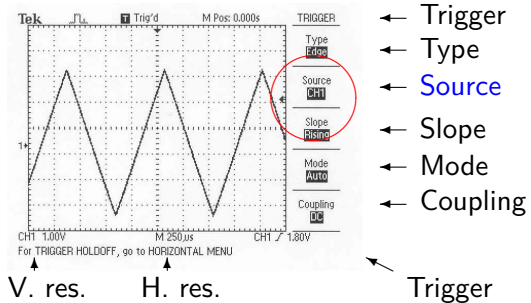


Figure: Trigger settings

- Various trigger settings can be adjusted