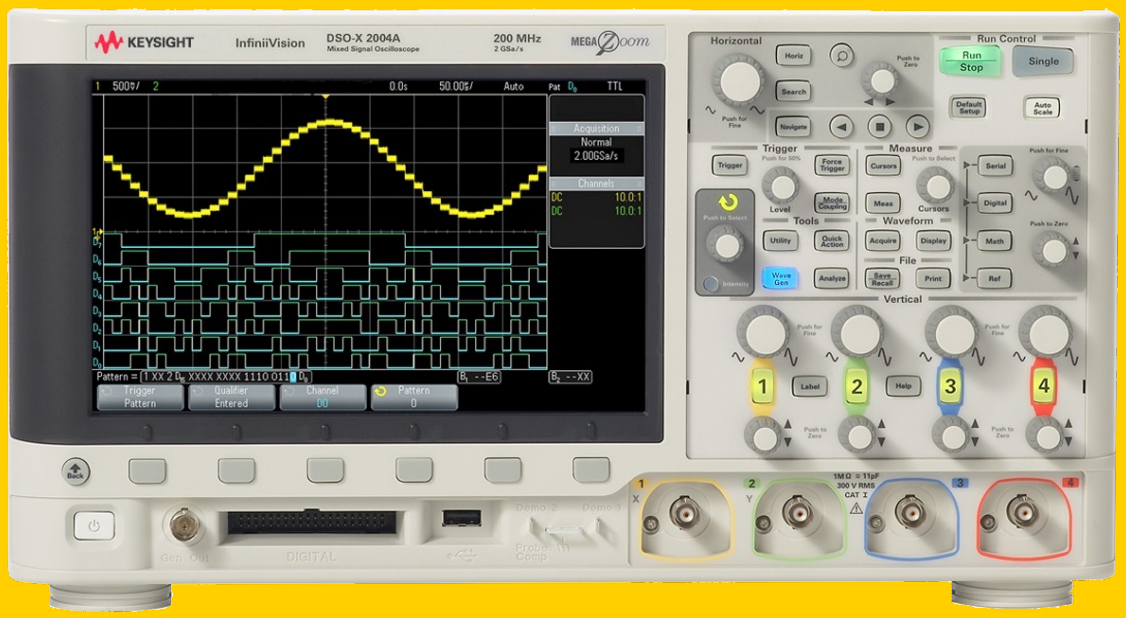
ETH STUDENT PROJECT HOUSE

OSCILLOSCOPE INTRODUCTION

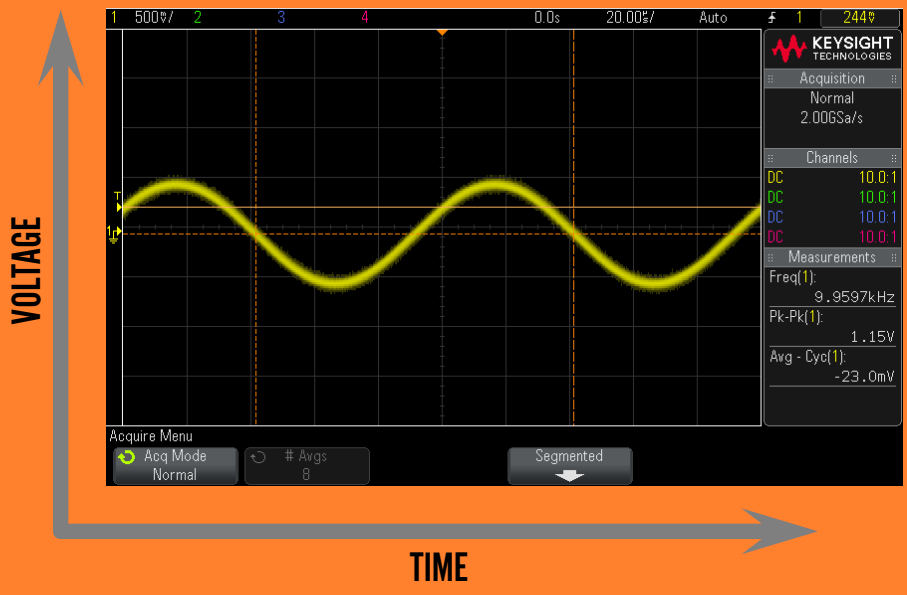
Keysight InfiniiVision DSOX2004A



BASIC PRINCIPLE

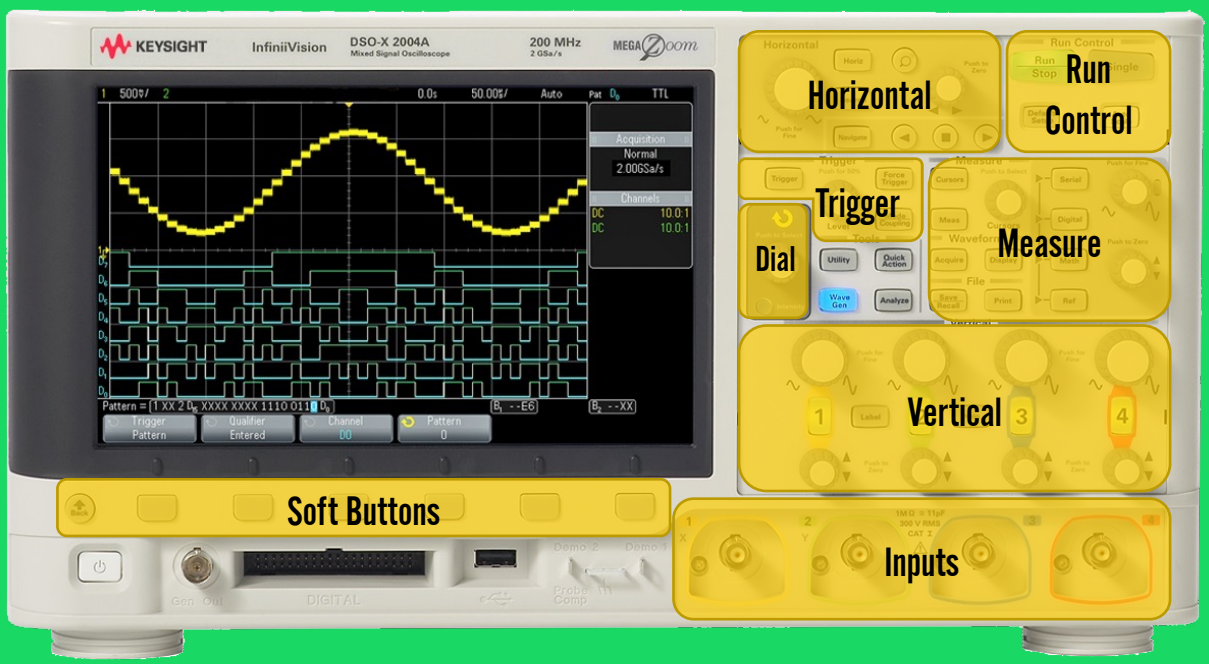
What is an oscilloscope used for?

The oscilloscope is a tool to visualize and measure electrical signals. It is like a stethoscope for the engineer. It allows you to see and troubleshoot electrical signals. The basic mode of operation makes a graph of Voltage vs Time. There are also more complicated modes which we won't get into.



CONTROLS

The scope has different areas for the corresponding controls



INPUTS Connect the probes to hook up to your circuit

VERTICAL Scale and move the signal vertically

HORIZONTAL Scale and move the signal horizontally

TRIGGER Set and configure triggers. Also select the coupling

MEASURE Perform measurements on your Signal. Store waveforms to USB

RUN CONTROL Here you can stop the signal at any time. Also used for single triggering

SOFT BUTTONS Many different functions depending on the context.

DIAL Used a lot to select from menus.

SETTING UP A MEASUREMENT

This manual will help you get from circuit to measurement step-by-step and is divided into 5 steps:

1. ***Connect*** ***Page 4***
We hook up our circuit and learn how and why to use oscilloscope probes.

2. ***Scaling and coupling*** ***Page 5,6***
We adjust the oscilloscope to the right amplification to properly display our signal

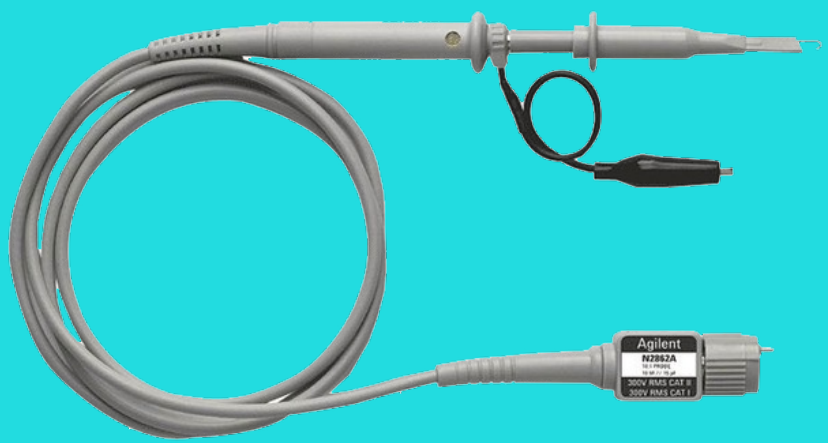
3. ***Trigger*** ***Page 7***
We set the triggers.

4. ***Measuring*** ***Page 8***
Perform measurements or do further math on your signal.
You can also do further analysis like FFT

5. ***Save/Export*** ***Page 9***
Save the measurement results for future reference

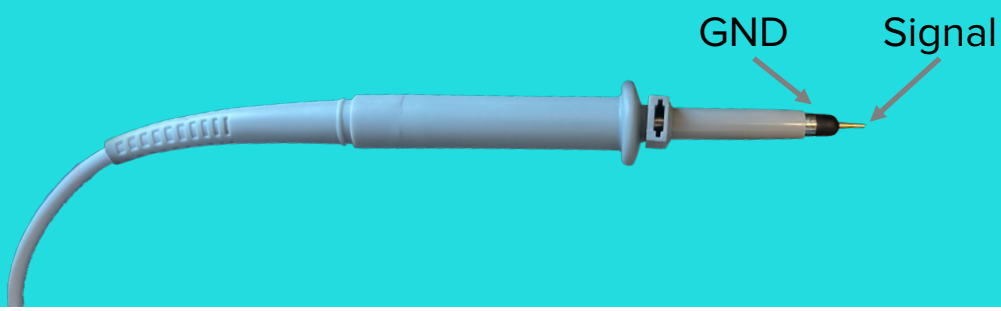
1. CONNECT

Always use the provided probes. They scale down the signal and prevent the oscilloscope from being damaged. They also increase the input impedance which lessens the load on your circuit. Probes need calibration. To see how to calibrate a probe go to page 10 of the manual. Connect the probe to the osci by attaching it to one of the inputs's and gently turning the grey ring.



Attention: The grounds (black leads) of the probes are internally connected. When performing measurements on multiple channels **only use one ground lead** to avoid shorting out your circuit.

For probing test points on PC Boards, the tip of the probe can be removed by gently pulling on it. **Don't solder directly to the probes!**

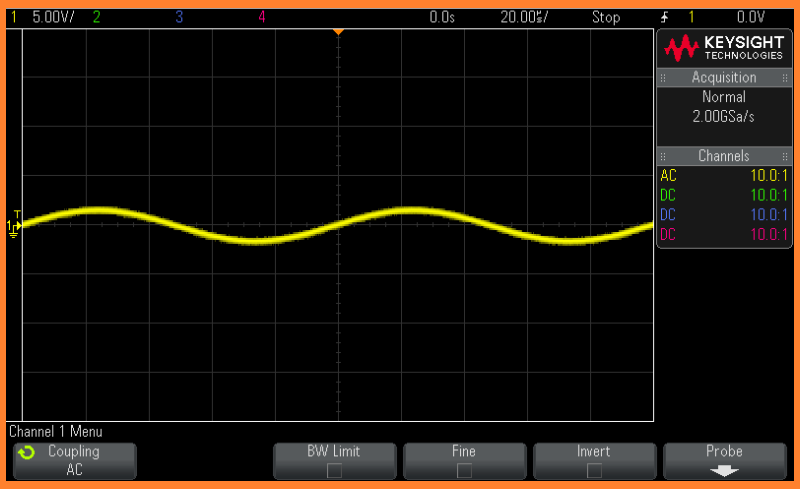


2. COUPLING

Coupling

The scope has different coupling options depending on the signal you're trying to measure. To set the Signal Coupling, press the channel button in the "Vertical" section. You can select between AC and DC. DC coupling shows you the signal as is while AC removes any DC-Component. You can also set certain Filters here.

Signal with DC-offset on DC coupling. The scope is not able to trigger.



Same Signal with AC coupling.

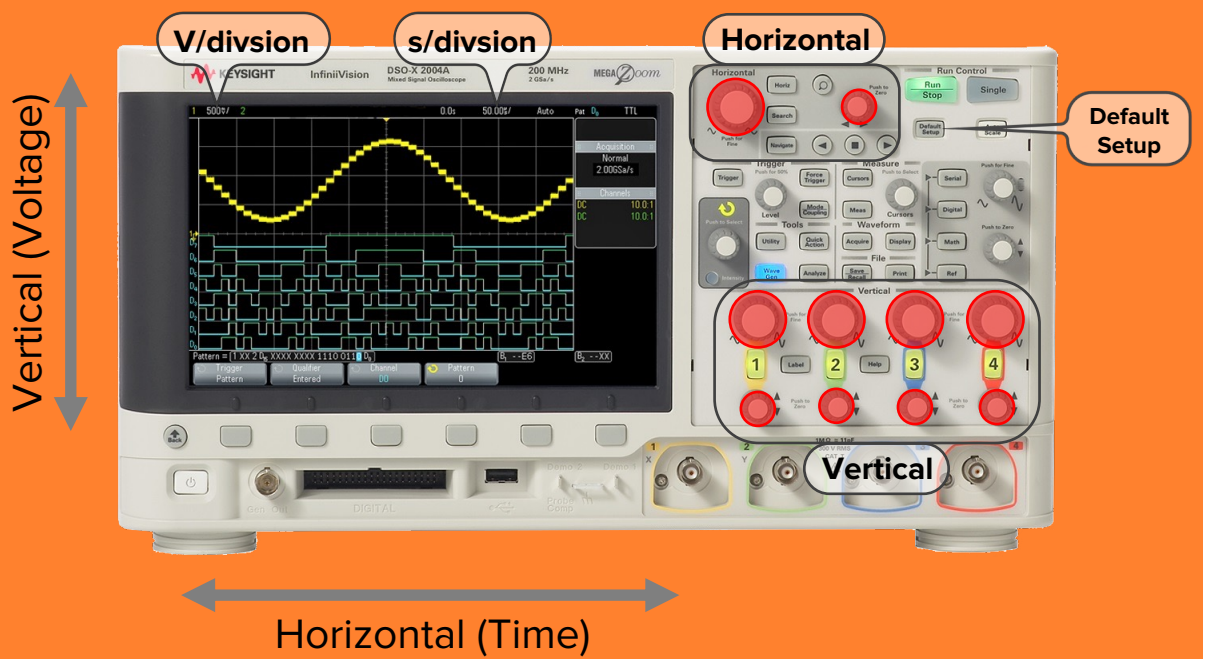
2. SCALING

Scaling

Once the right coupling is chosen, you can proceed by scaling the signal using the global horizontal control as well as the vertical controls, one per channel. This squeezes and stretches the signal on the display. The bigger knob controls scaling, the smaller one position.

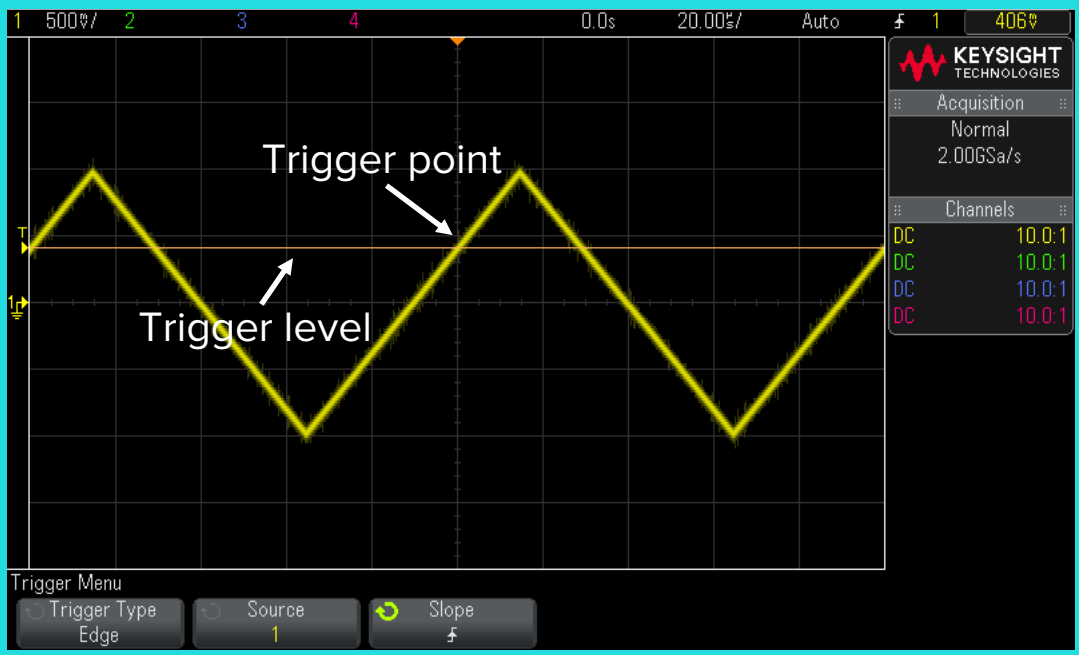
The oscilloscope screen has a grid overlayed. The distance from one line to another is called a division and the current settings are always displayed at the top of the screen.

There is also a ”Auto Scale” button in the Run Control section which often provides a good initial setting.



3. TRIGGERING

To make the waveform appear stationary on the screen, the oscilloscope needs some way to synchronize the “pictures” that it’s taking. This is done using triggers.



To set triggers press the ”Trigger” button. You can then select from different types of triggers but we mostly use edge triggering. Using the knob the trigger level can be adjusted. This level controls where on the signal the triggering is happening. A good place to start would be around 0V.

Besides continuous measurement, the scope can take “single” pictures of signals. Press the single button to arm the scope. The scope will take one “picture” once the trigger condition is fulfilled.

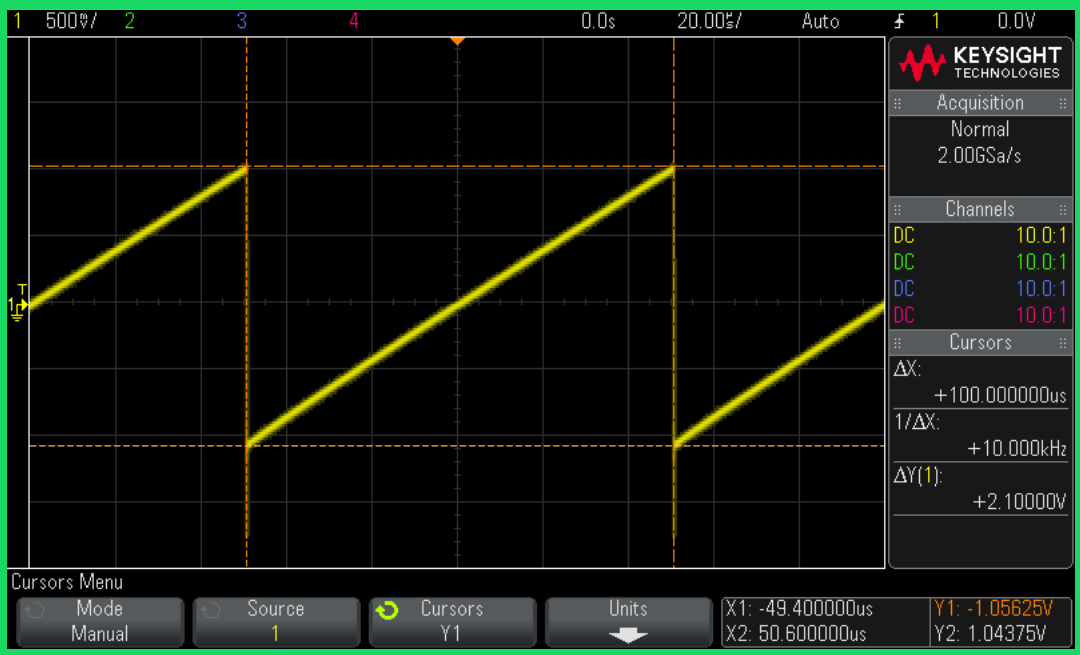
4. MEASUREMENTS

Sometimes we want a more precise way of measuring different parameters than just counting divisions. This is where the measuring menu comes in.

You can use cursors to measure time & voltage. To activate cursors press the cursor button in the measure section and use the knob to move them.

Specific measurements

Press the “Meas” button in the measurement section. Set the channel and type of measurement, then add the measurement. There are many different types of measurements, the most common include: Peak-to-peak, Frequency, Period, etc.



The use of cursors to measure the amplitude and frequency of a sawtooth

5. SAVE

Sometimes we want to keep our measurements even after they are done. The scope can either export the waveform directly or save snapshots of the screen.

1. Insert your USB-Flashdrive into the USB Port

2. Press the button “Save/Recall” under the Measure section

3. Press the soft button “Save” and choose the desired file format. When you're ready to take the screenshot, press “Press to save”

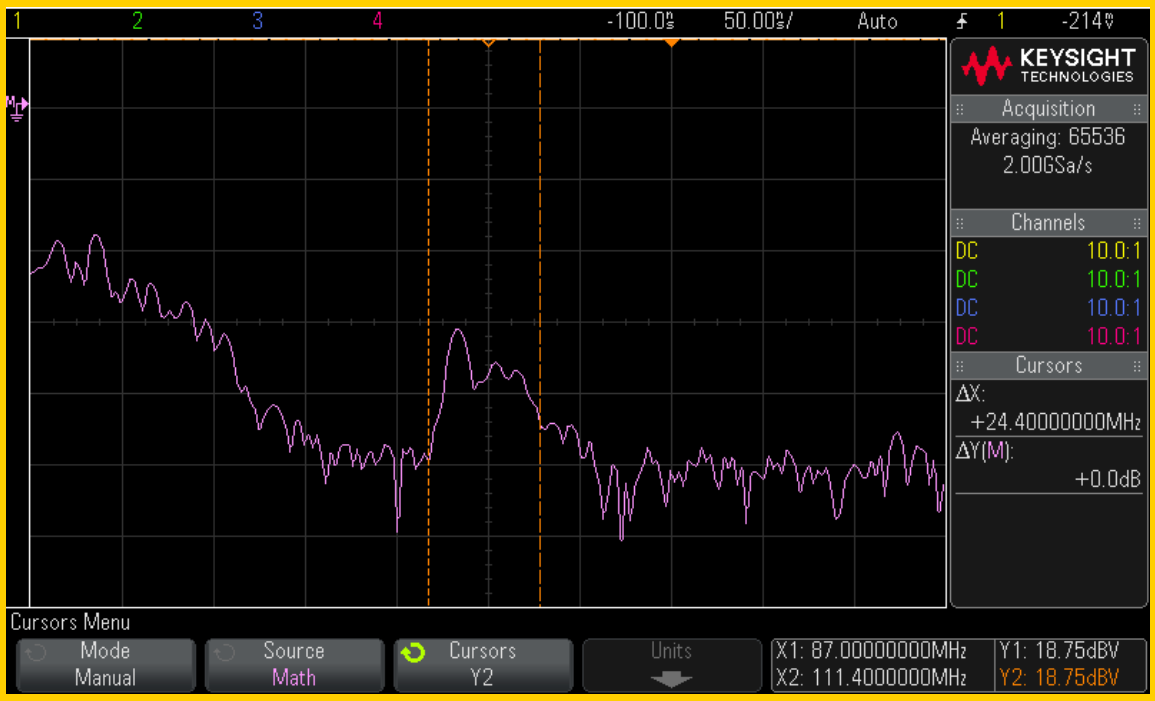
Example screenshot output

FFT & OTHER MATH

ADVANCED
★★★★★

What is FFT?

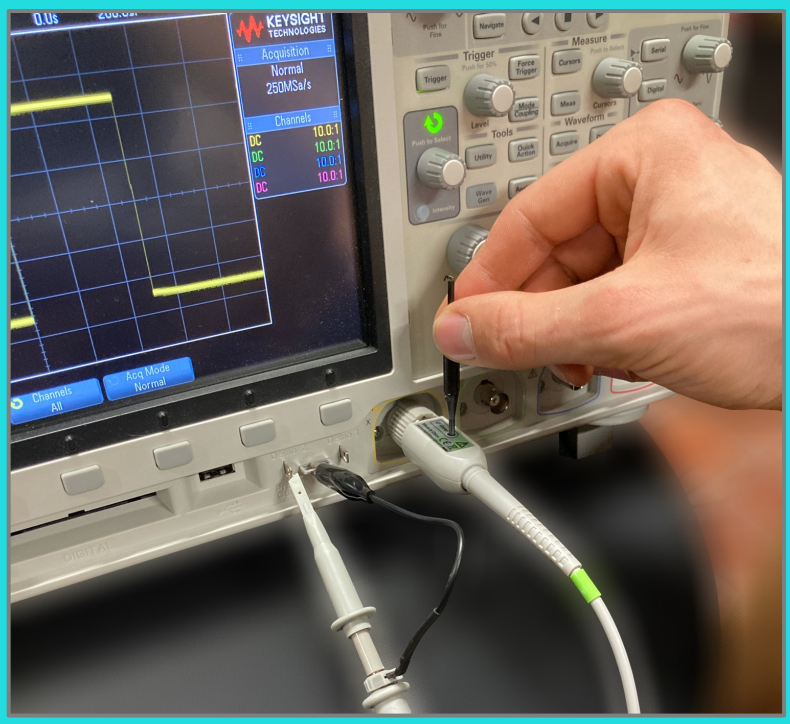
FFT (Fast Fourier Transform) is a mathematical Function that transforms our signal from the time domain to the frequency domain. To enable FFT first scale your signal, then press the math button in the measure section and choose FFT as the operator. Set the source, center frequency and span. You can now disable the yellow trace by pressing the soft button on the channel in the vertical section. There are also other many other mathematical functions that can be applied in the same way.



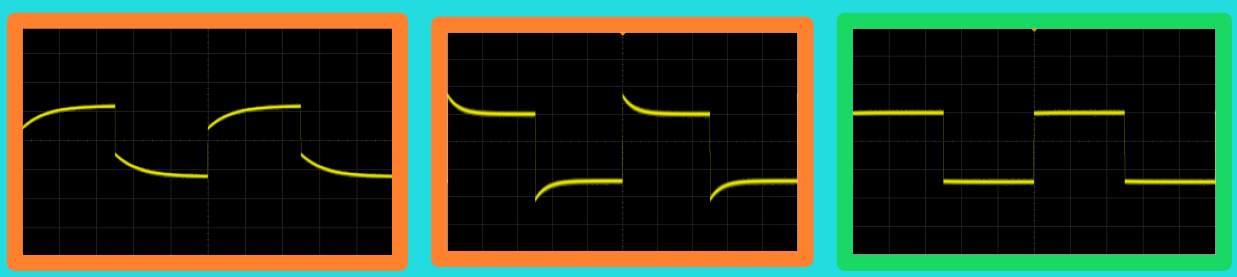
FFT on the signal from an antenna. The swiss FM radioband is clearly visible from 87 to 110 MHz

PROBE CALIBRATION

To calibrate a probe connect it to an input and hook the probe onto the Probe Compensation post on the bottom of the instrument. Also connect the probe ground.

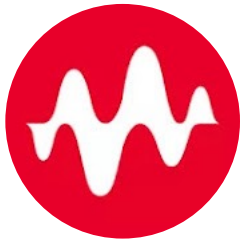


Press the Autoscale button on the top right.
You should now see a Squarewave displayed on the screen.
Use the provided tiny screwdriver and adjust the screw on the base of the probe until the Squarewave looks nice.



BAD GOOD

SPECS



- Digital signal oscilloscope
- Bandwidth: 200 MHz
- Sampling rate: 2GSa/s
- 4 analog Channels
- 8.5 inch display (not touch)
- integrated digital voltmeter

FURTHER RESOURCES

If you want further resources on how to use an oscilloscope we highly recommend this Keysight video course (ca. 1 hour):

Oscilloscopes 101 for Engineering Students
from Keysight Hands-On

https://youtube.com/playlist?list=PL2XuMA5AwNUznkBE46tcZAF3p5Edxgm-z