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Student sensor lab at home: safe repurposing of your gadgets

Outline

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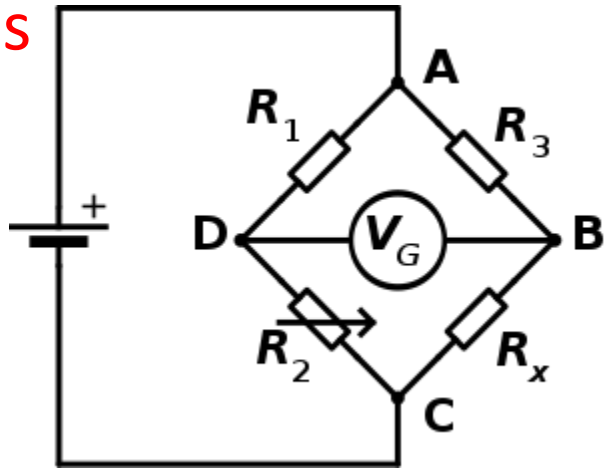
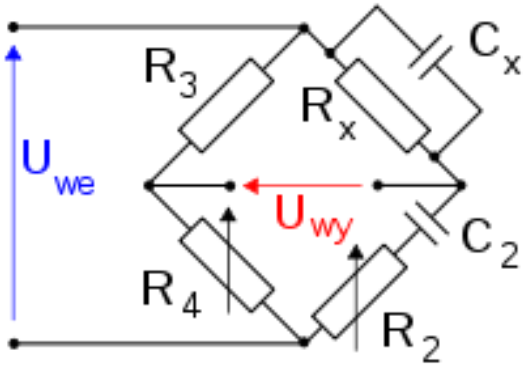
- Motivation: why repurposing home audio computing equipment
- Controlling the equipment
- Utilising ground loop isolators
- Connecting audio equipment to a custom circuit
- Using an external USB audio card
- Using Bluetooth audio
- Using Arduino
- Using custom hardware
- Conclusions

Why repurpose

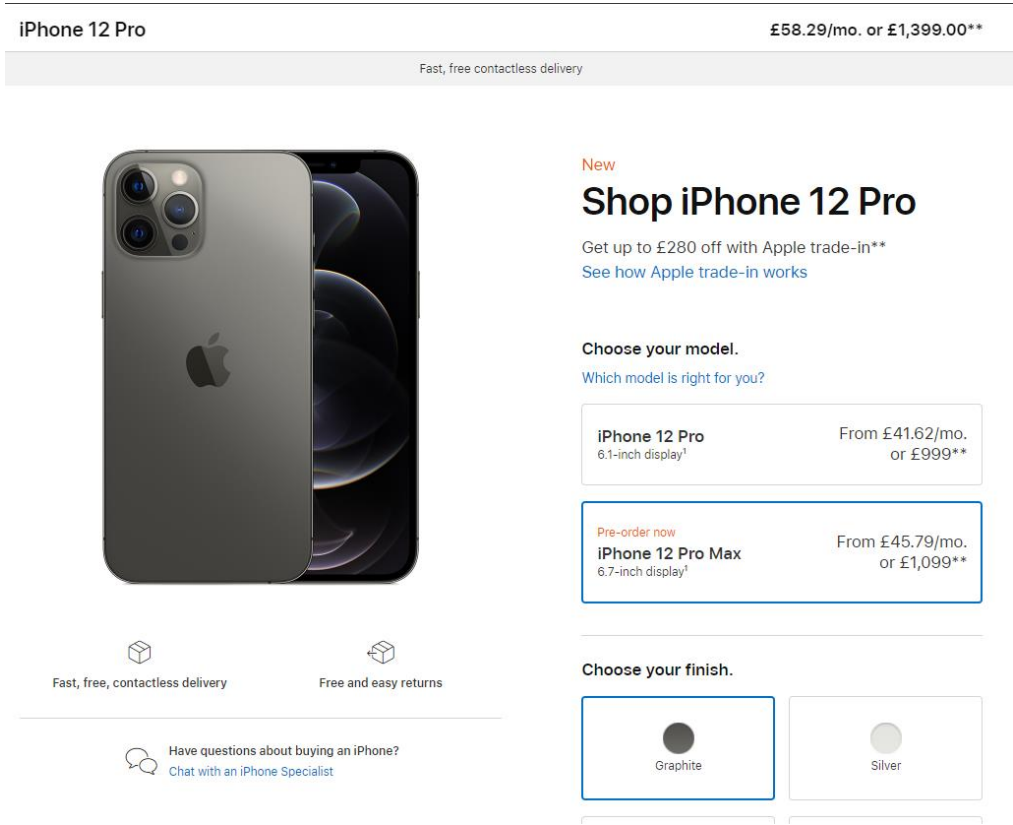
- COVID-19 severely restricted lab use on university campuses
- Hands on labs experience is essential for training electrical and electronic engineers
- There is no economical way of supplying, maintaining and supervising students at home with a professional measurement equipment
- Most of common gadgets that students possess (smartphones, tablets, laptops, PCs) are equipped with decent quality stereo audio
- Although audio range is limited to 20 … 20,000 Hz, these frequencies can be used for various sensor experiments, e.g. for Wheatstone and Wein bridges





Is it straightforward

- Unfortunately not because of the following main reasons
- - safety of the learner (students can be very imaginative when using hardware; no university would want to get legally challenged because of H&S issues when operating laboratory instructions at home)
- - protection of the expensive gadgets



Apps that can be used for measurements (1)

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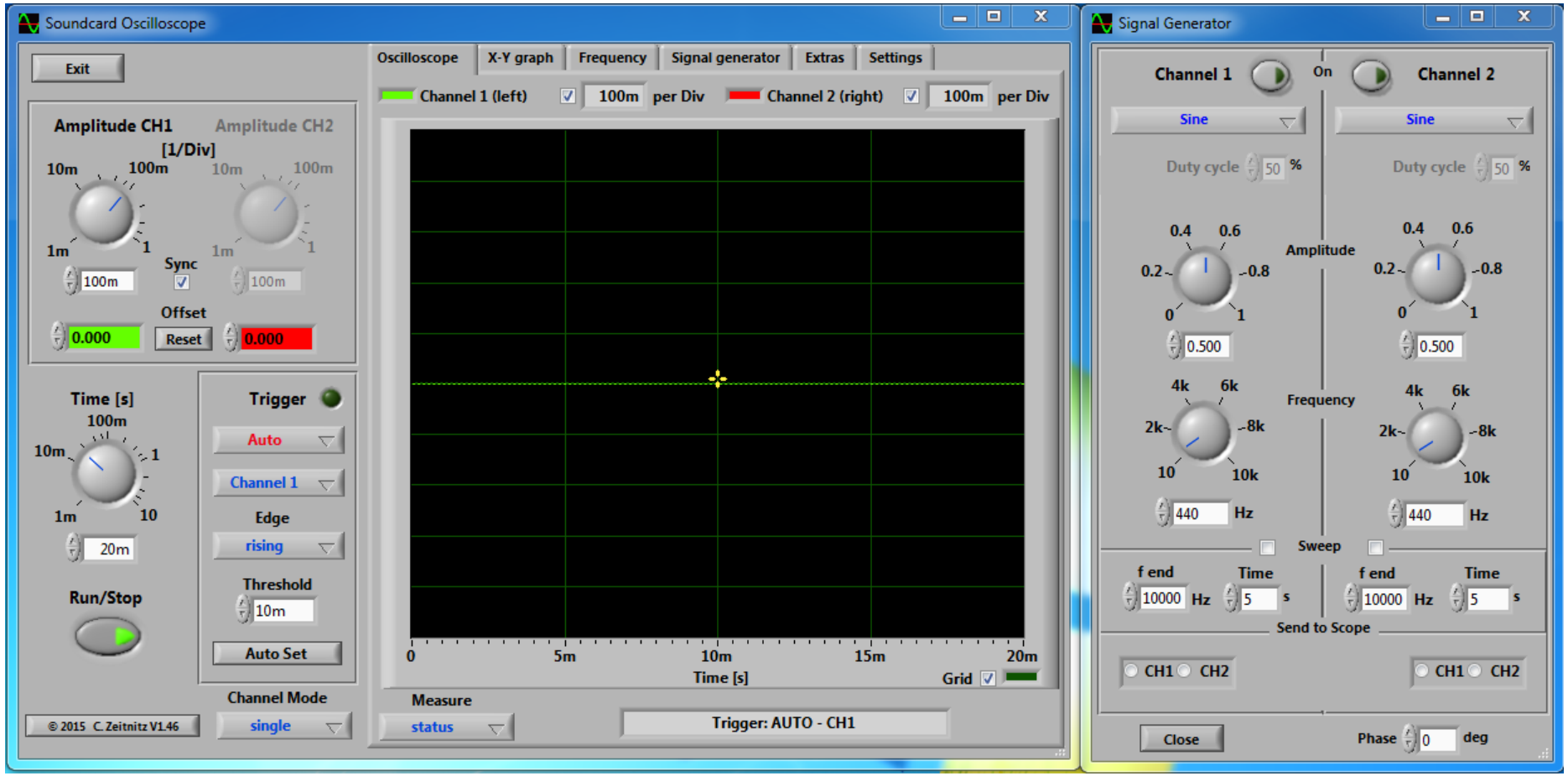
Christian Zeitnitz. Soundcard PC oscllloscope. https://www.zeitnitz.eu/scope_en



Apps that can be used for measurements (2)

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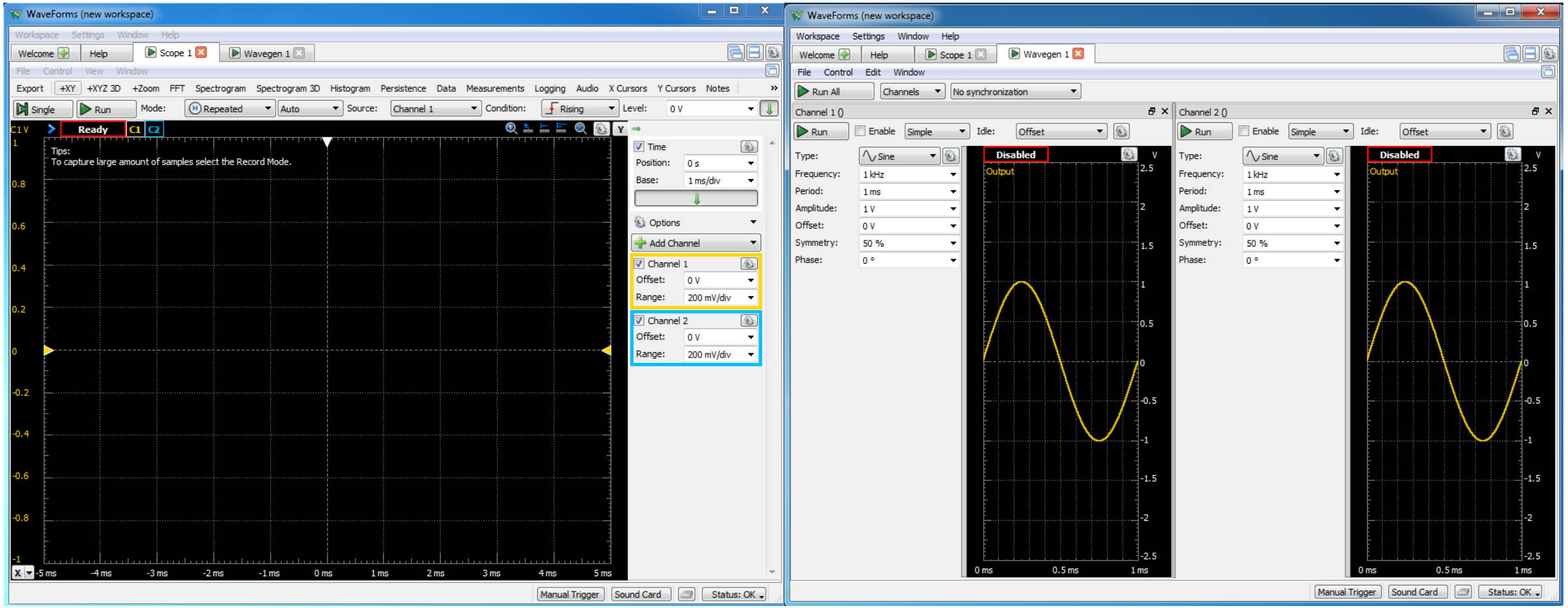
Digilent Waveforms – work with the PC audio inputs and outputs



Apps that can be used for measurements (3)

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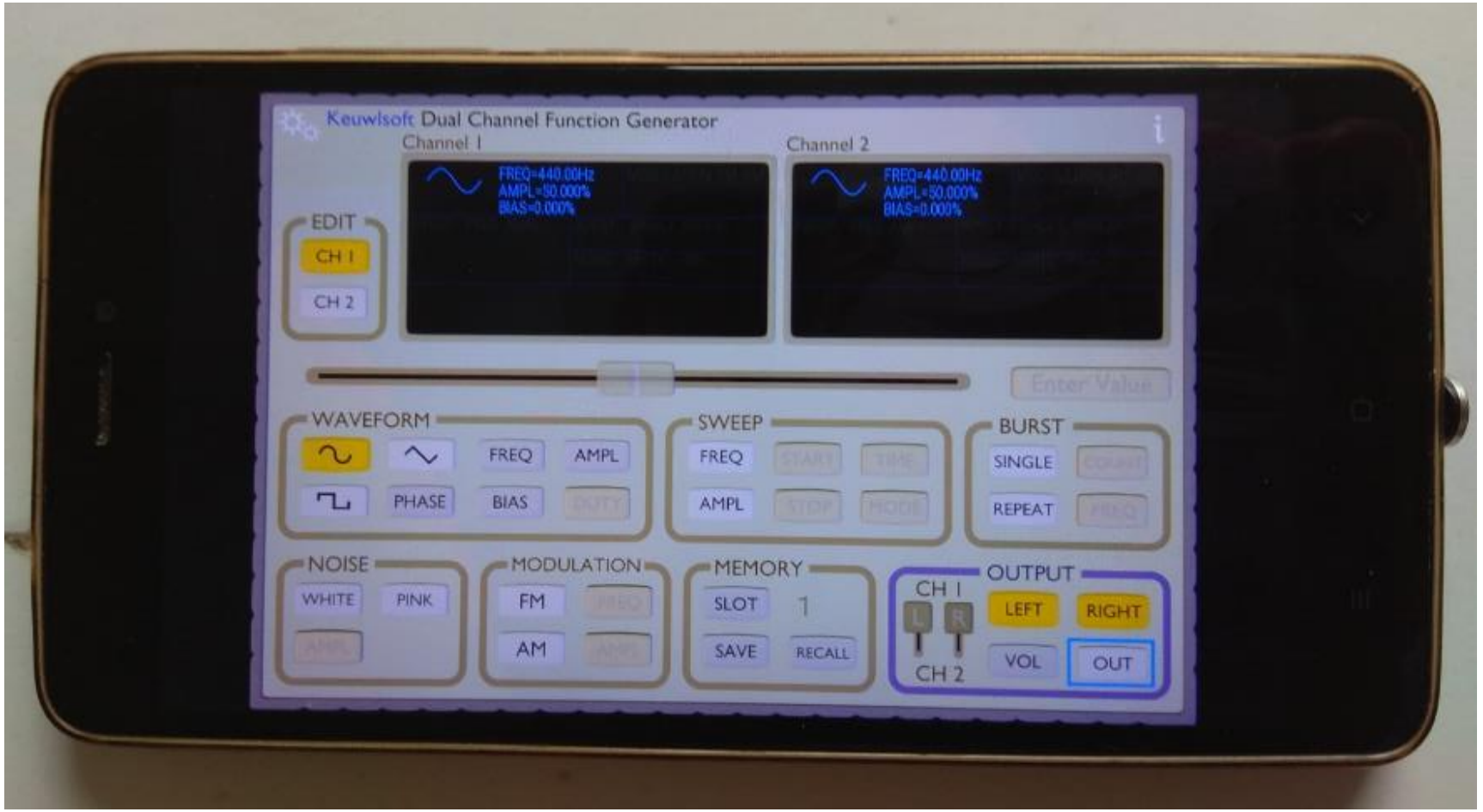
Function generator from KEUWLSOFT for Android.

https://www.keuwl.com/FunctionGenerator/



Ground loop isolators

- Are used to reduce hum (mains and low frequency noise)
- Include transformer in every channel to isolate ground potentials
- Block DC with a capacitor (not present on the board)
- Up to 1.5 kV isolation stated in some datasheets

Not all the audio cables were born equal

- TS (tip-sleeve, mono) cables are not suitable
- ! TS may short the stereo outputs !
- TRS (tip-ring-sleeve, stereo) are fine
- TRRS - (tip-ring-ring-sleeve, full headset – stereo headphones + mono microphone) are fine too

Some audio cable sockets and adapters

- Are required to connect the isolated signal to a custom circuit (e.g. a breadboard)
- Can be barebone sockets
- Can have pin header
- Can have screw terminals

External USB audio cards

- Usually have headphone stereo output and mono microphone input with separate sockets
- Could be a full single TRRS socket though
- Some even have stereo line input
- CANNOT BE USED SAFELY W/O USB ISOLATOR

Using Bluetooth audio

- Fully wireless
- 2 channel stereo
- A separate transmitter and receiver are required
- Some have built in rechargeable batteries
- If not, use of power bank is recommended

Arduino Uno: Girino + Girinoscope

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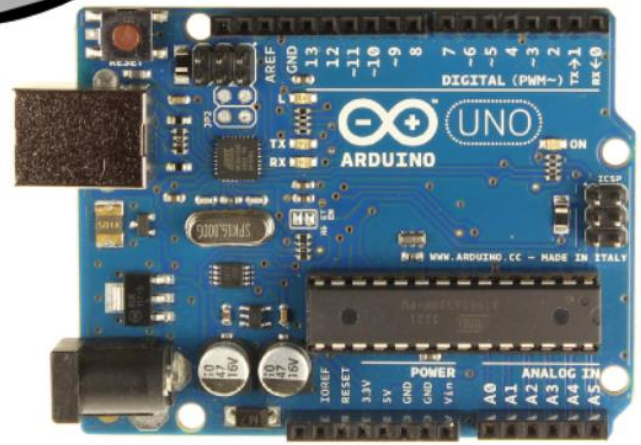
Girino - Fast Arduino Oscilloscope

By Caffeinomane in Circuits > Arduino 867,466 1,008 107 Featured



Chatanga / Girinoscope

- Firmware for Arduino
- 1 ch 40 kHz sampling
- ***Must be used with a USB isolator for safety***
- No generator
- PC front end – Girinoscope from Github
- Usable but not polished

Two more options – USB isolators required !

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EspoTek Labrador Board

★★★★★ (8 customer reviews)

USD $29.00

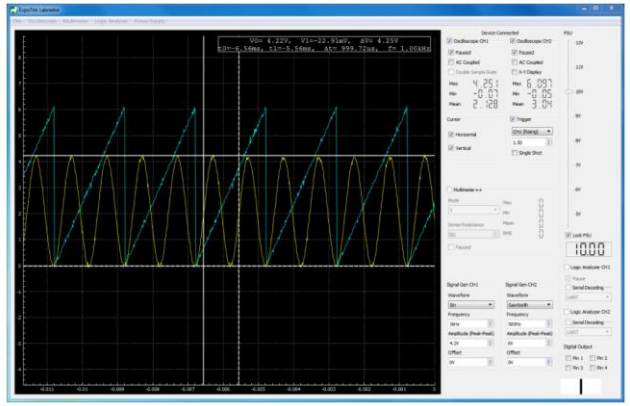
Labrador is now back in stock globally!
Sorry about the disruption.

EspoTek Labrador Board
All-in-one USB Oscilloscope, Signal Generator, Power Supply, Logic Analyzer Multimeter
Shipping is free, worldwide!

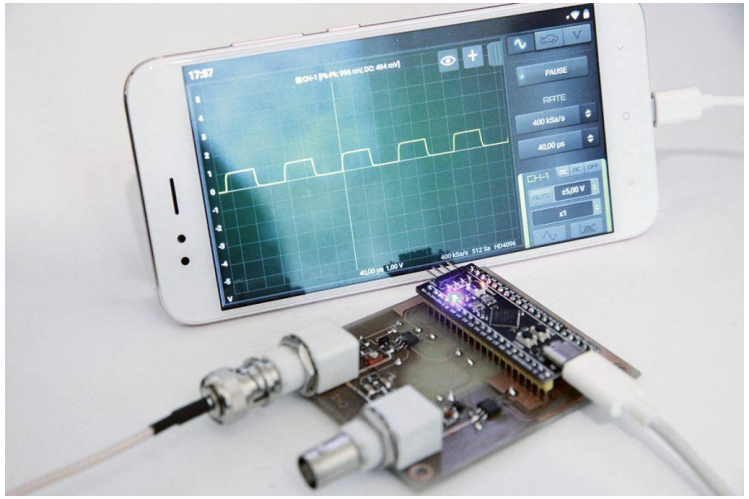
10% discount when you purchase 2 or more units!

Martin.Loren

PC front end



HS402 DIY Oscilloscope



Android front end

Conclusions

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- It is possible to repurpose standard gadgets using off-the-shelf parts
- The easiest option is to use two ground loop isolators with a PC's audio line input and output
- Inexpensive USB audio cards commonly provide only one channel microphone input, and require a USB isolator
- Bluetooth modules provide the best isolation but require two devices + two adaptors. For example, an Android phone sending the waveform to a BT receiver driving the circuit, and a BT transmitter acquiring waveforms to be sent to a BT equipped laptop
- Low-cost customised or bespoke developments are viable too