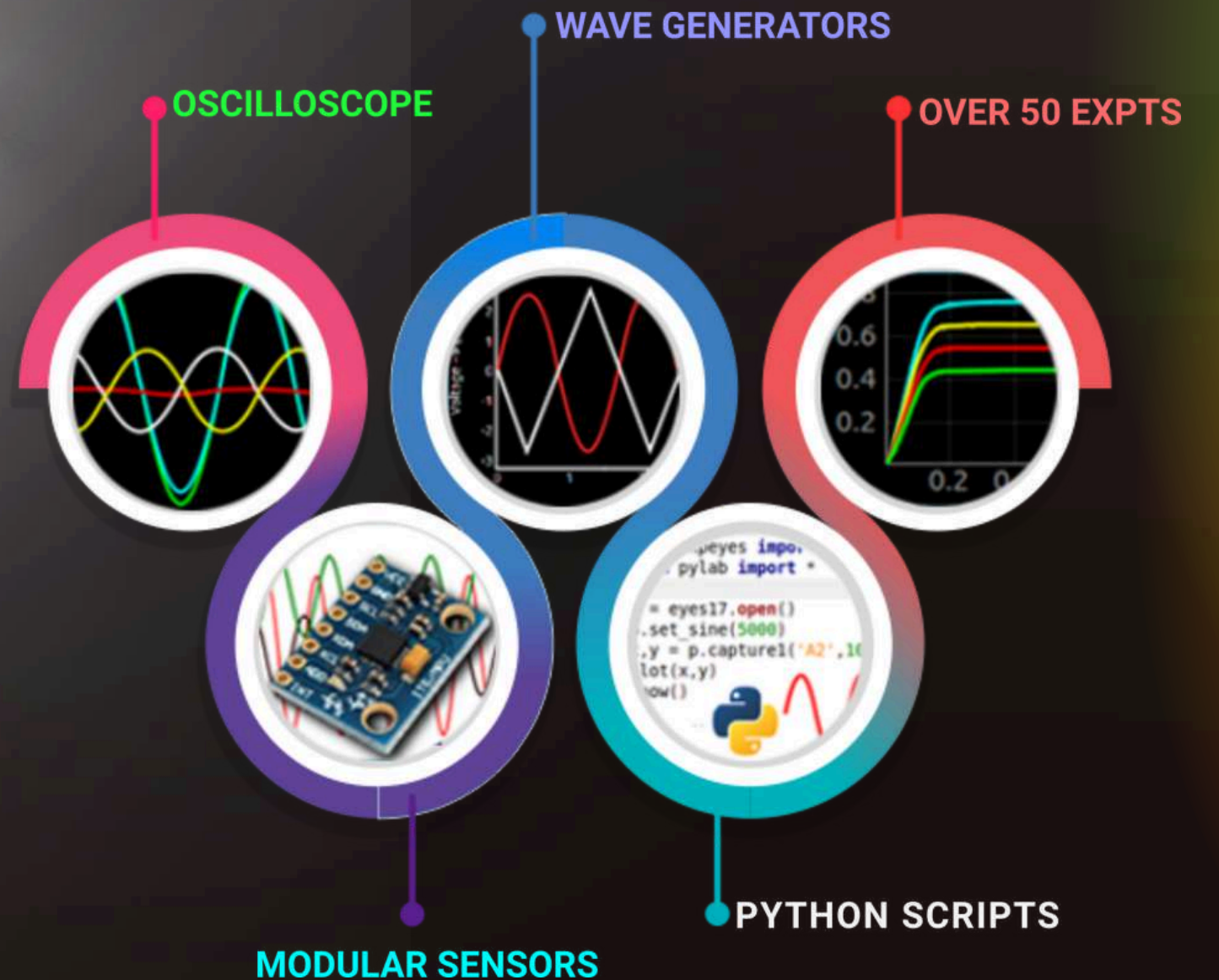
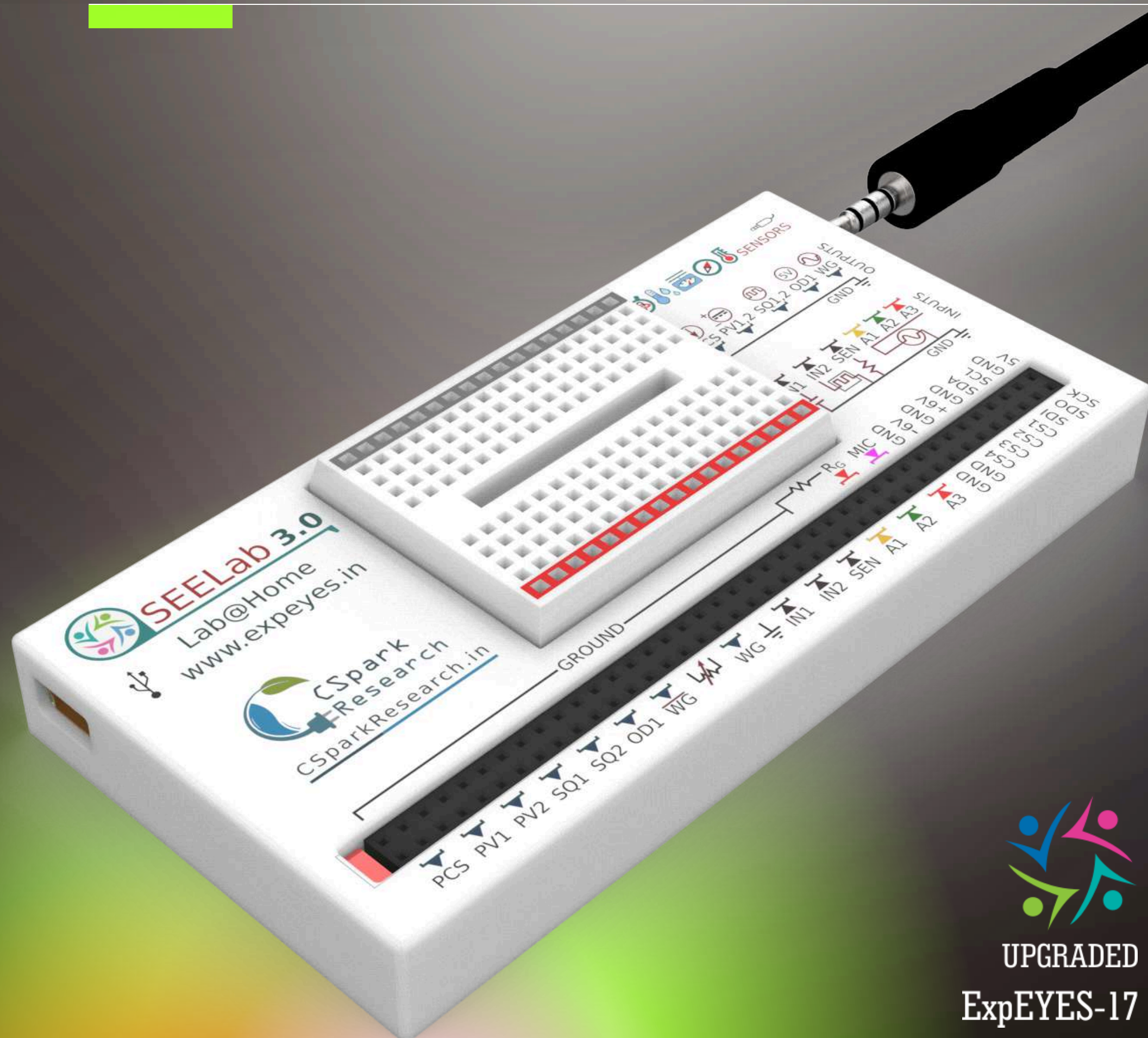


# SEELab3

A Multi Purpose Test and Measurement Tool



UPGRADED  
ExpEYES-17



# SEELab3 : YOUR LAB @ HOME

100+ SCIENCE EXPERIMENTS

## WAVEGEN

WG,  $\overline{WG}$

The WG Pin outputs a 3 volt amplitude sine/triangle wave signal with adjustable frequency from 4Hz to 5kHz. The amplitude can also be adjusted down to 80mV, and a 180 phase shifted signal is available on  $\overline{WG}$

## 2MSPS OSCILLOSCOPE

A1, A2, A3, MIC, SEN, IN1

4 Input channels to record up to a million voltage readings within one second. Useful for studying voltage fluctuations, and calculating frequencies and phase shifts of periodic signal inputs. A1/A2 +/-16Volts, A3: +/-3V, Microphone Input, and an Internally pulled up SEN Input. Also used as 12 bit voltmeters

## VOLTAGE SOURCES

PV1 PV2 OD1 5V +/-6V

12 bit programmable outputs PV1: +/-5V, PV2: +/-3 V. 5V Direct USB power. +6V and -6V for powering Op-Amp circuits. OD1 digital output

## SQUARE WAVE

SQ1 SQ2

0 to 5V Square wave outputs with adjustable frequency and duty cycle. 0.015Hz to 1MHz. Output Impedance 100Ohm. Measure digital signal timings on IN2/SEN

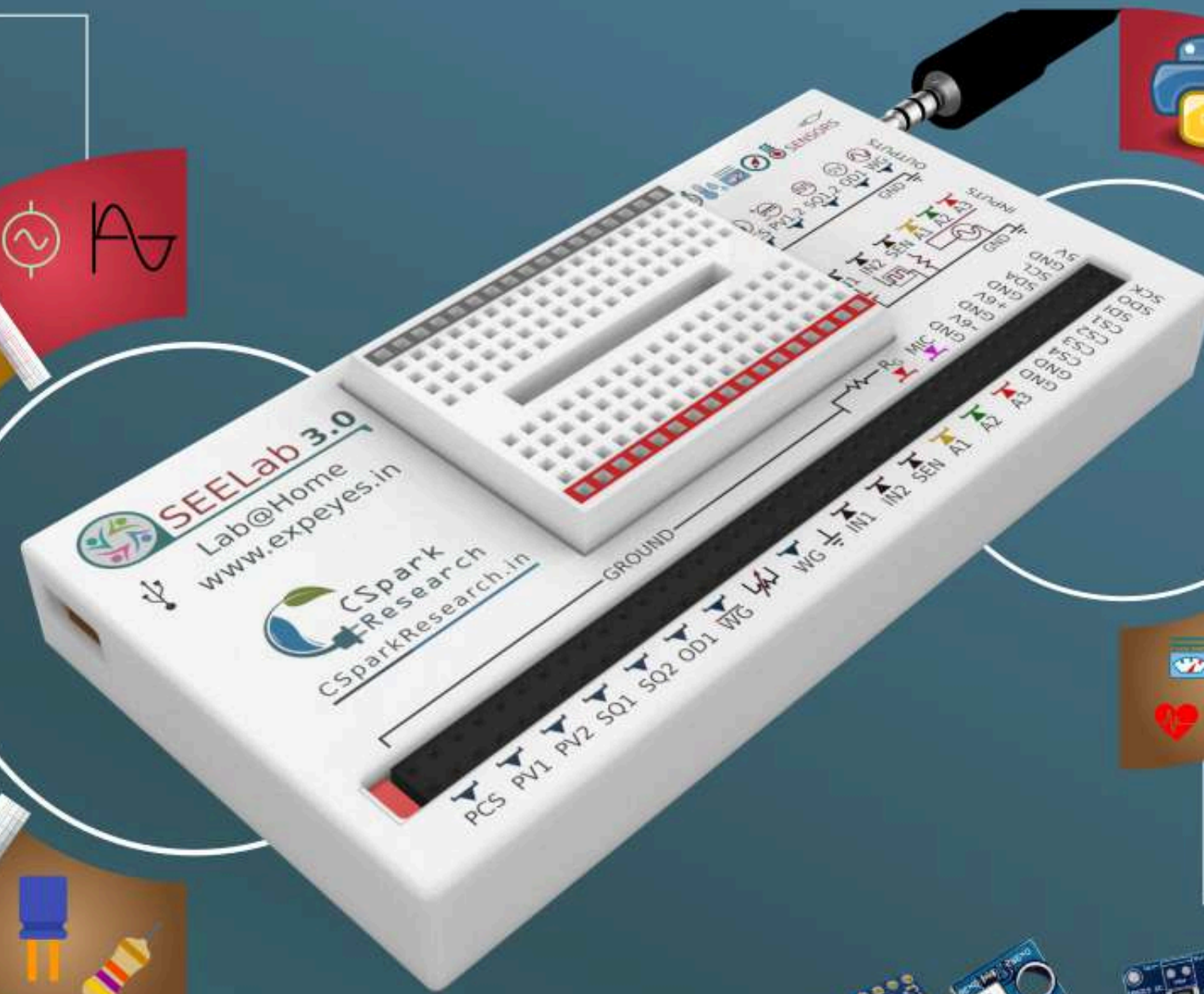
## RC METER

SEN IN1

Measure resistance and capacitance



PIN DIAGRAMS AND FEATURES



## PYTHON PROGRAMMABLE

Access all control and measurement tools via the Python library or the PyQt based graphical software for Ubuntu/Windows

```
dev=eyes17.open(); print(dev.get_voltage('A1'))
```

## VISUAL PROGRAMS

Connect easy drag and drop blocks to create programs which can collect, visualize, and analyze data

## CROSS PLATFORM

Supported on Ubuntu/Windows/Android. Plug and play via USB.



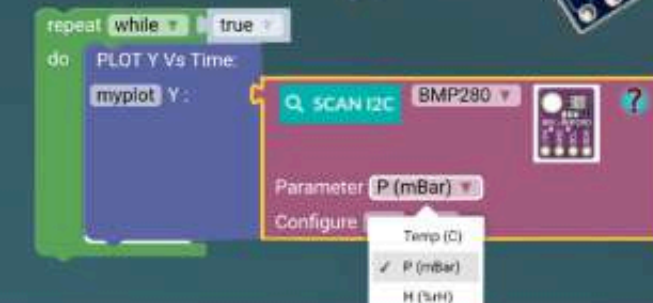
## DATA ANALYSIS TOOLS

Implements feature extraction tools such as curve fitting for sinusoidal and exponential decay data. Precisely determines frequencies, phase shifts, decay factors, offsets and amplitudes.

## ADD-ON SENSORS

SPI / I2C

USE the SPI (SCK,SDI,SDO,CS1-4), or I2C(SCL,SDA pins) buses to enhance experiments. Plug and play over a dozen sensors for physical parameters such as pressure, magnetism, luminosity, humidity, distance etc. control precision waveform generators, servo motors, and robotic arms



Pocket Sized Version : SEELab3

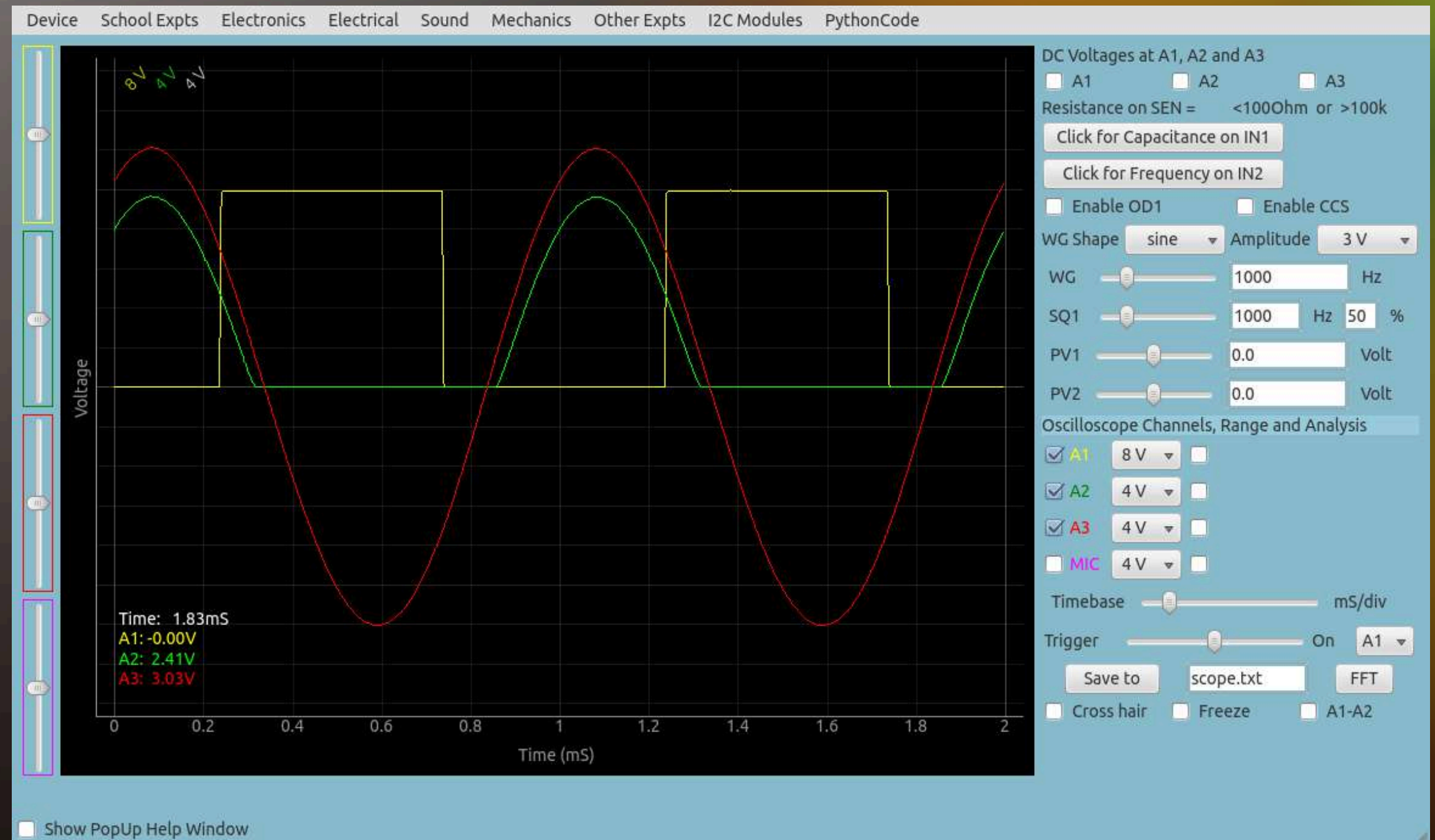
Successor to ExpEYES-17



# The SEELab3 kit Contains an essential set of tools for Electronics and Science Labs

## Input Instruments

- 4 Channel Oscilloscope
  - Up to 2 Million Voltage Readings per second.
  - 2 +/-16 Range Inputs (A1, A2)
  - Software adjustable Input range
  - +/-3V A3 input with Manual gain
  - MIC Input for condensor microphones
- Capacitance Measurement 10pF to 100uF.
- Resistance Measurement.
- Frequency and Timing Measurements.
- 12 bit voltmeter and data logger.
- Analytical tools for extracting frequency, phase difference, amplitudes, Fourier transforms etc.



Desktop Application for Windows/Linux showing signals input to A1, A2, A3



# Compatible with PCs as well as Android Phones.

## Output Instruments

### Waveform Generators

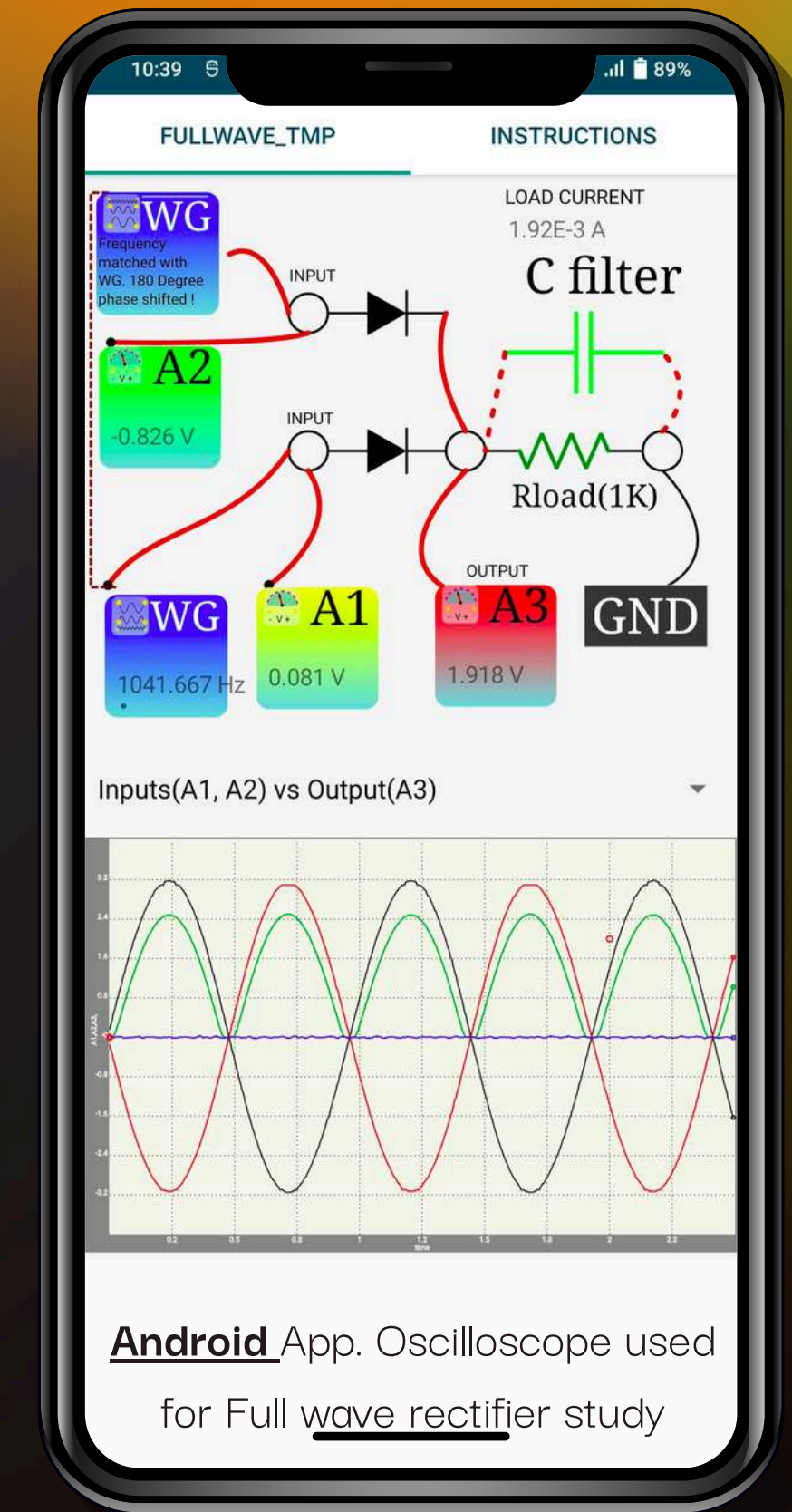
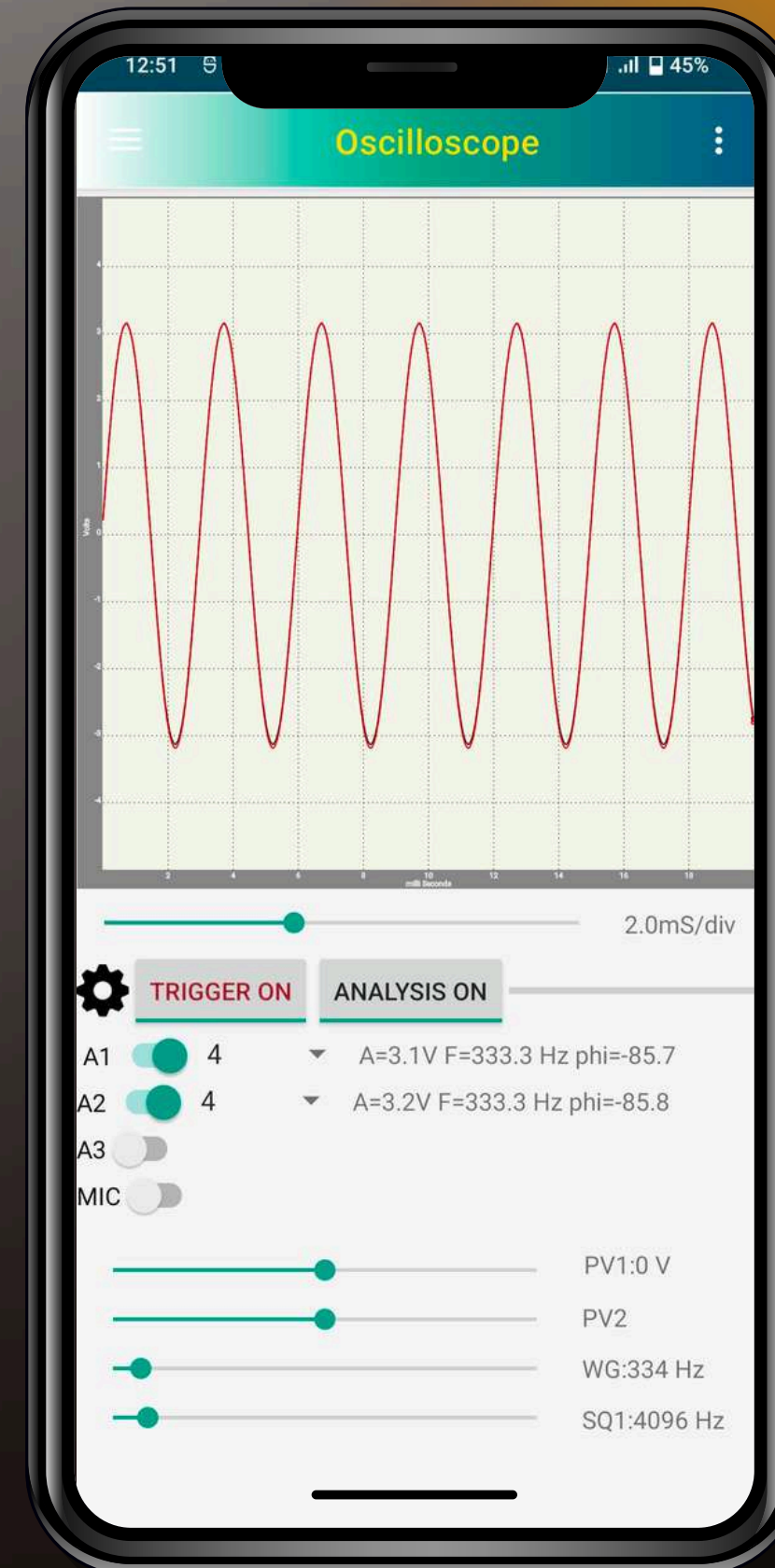
- WG: +/-3V Sine Wave generator. 4Hz to 5000Hz. Amplitude attenuable to 80mV
- SQ1,SQ2: 0-5V Square Wave outputs. 0.1Hz to 1MHz
- Optional Add-On Module for 24-Bit sine wave generator up to 2MHz. 0.015Hz step size.

### Voltage Outputs

- PV1 : 12 bit, +/-5V voltage source. 20mA
- PV1 : 12 bit, +/-3V voltage source.
- PCS: 12 bit constant current source. max 3mA

### Digital outputs ; 0-5V outputs

- OD1, CS1, CS2, CS3, CS4



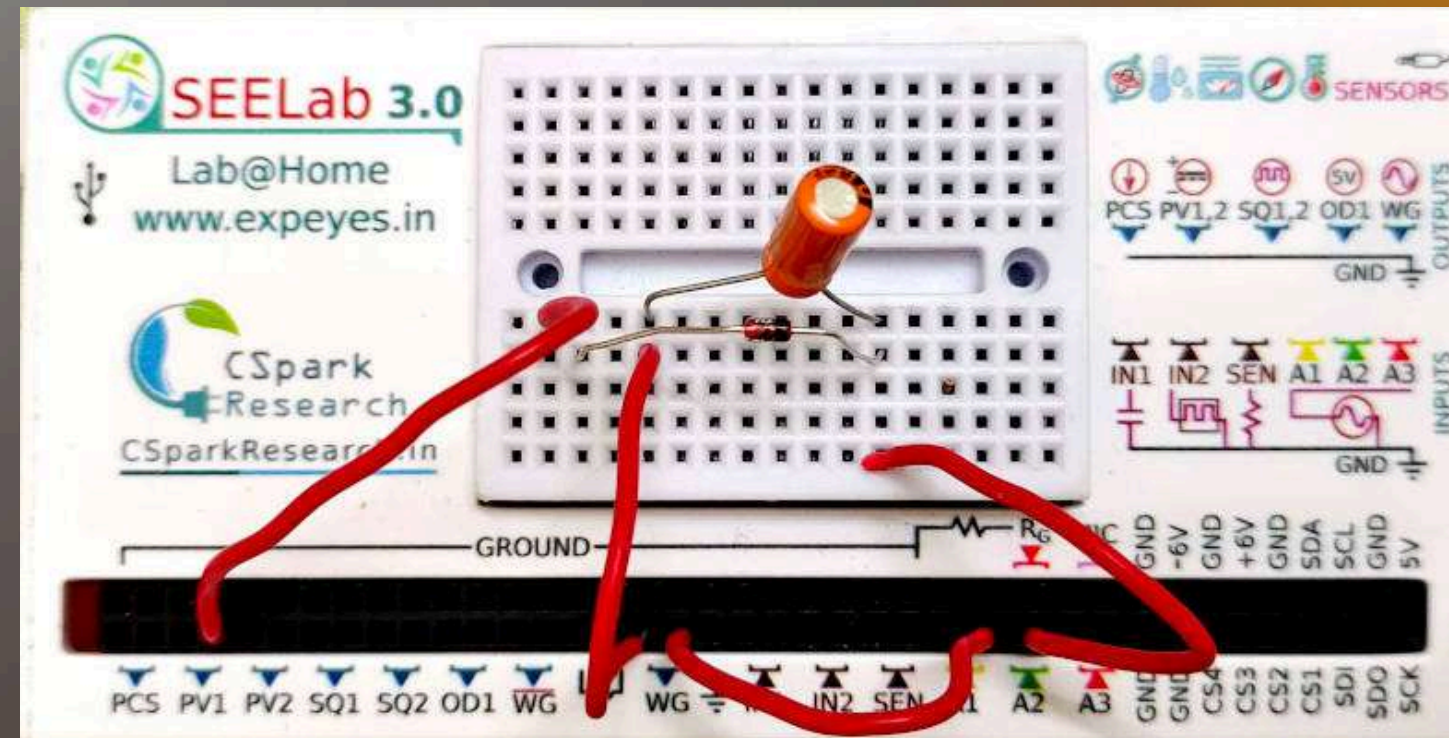
Download the SEElab 3.0 App  
3000+ active community (Google Play)



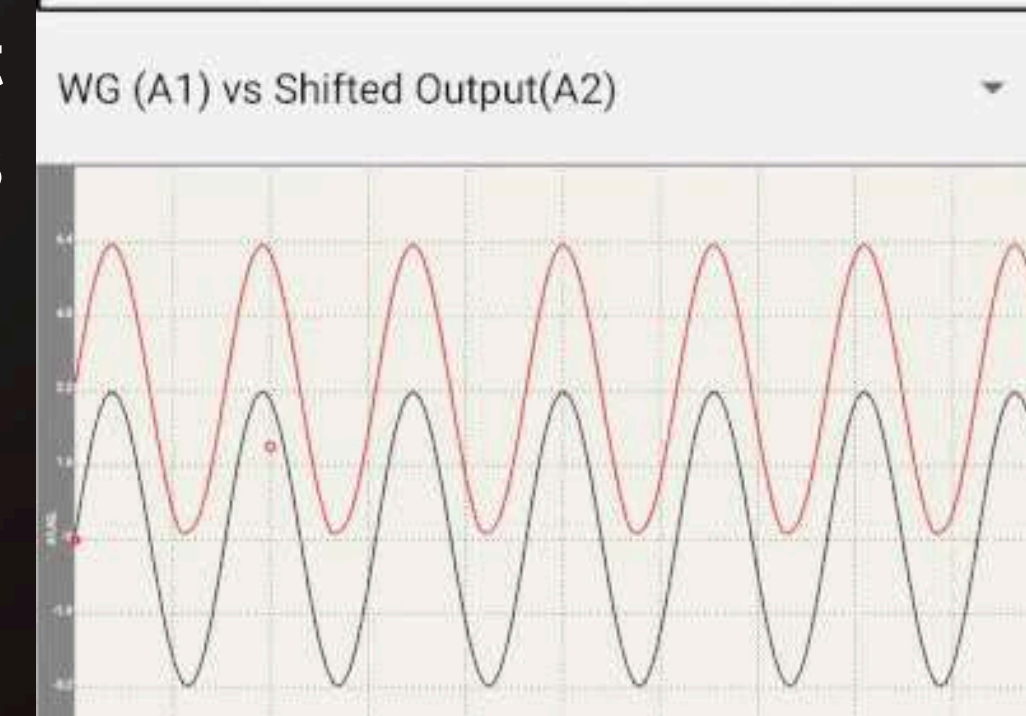
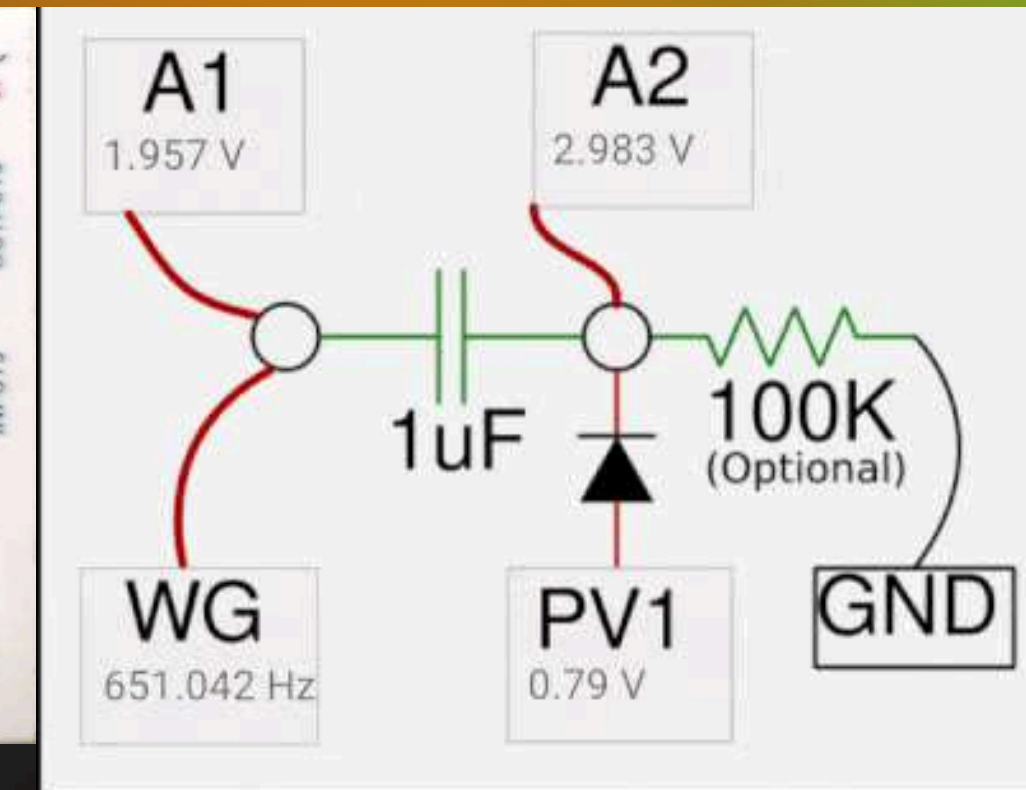
**Over a 100 experiments can be performed with this collection !**

## Electronics 101 Lab

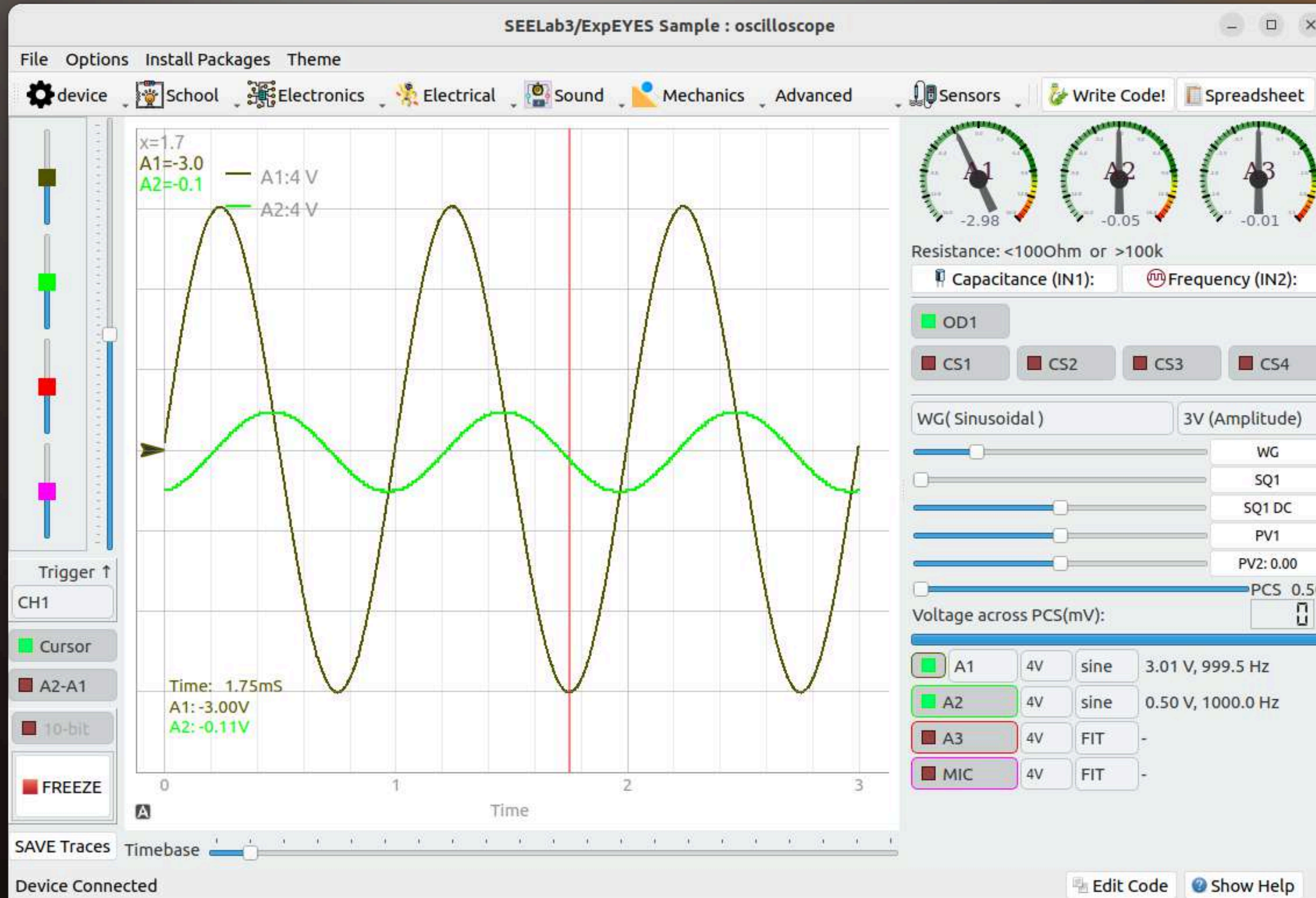
- Transistor CE Characteristics
- Full and Half Wave Rectifiers
- Opamp amplifier circuits
- Diode Clipping/Clamping Circuit
- Summing Amplifier
- Logic Gates, Clock dividers
- Many more characterisation experiments can be performed using the voltage sources, waveform generator, oscilloscope, and timing measurements
- Embedded Circuit simulator
- Programmable in Python/Visual Programming



**Diode Clamping Circuit and Measurements**







## Installation

Currently available on PyPi

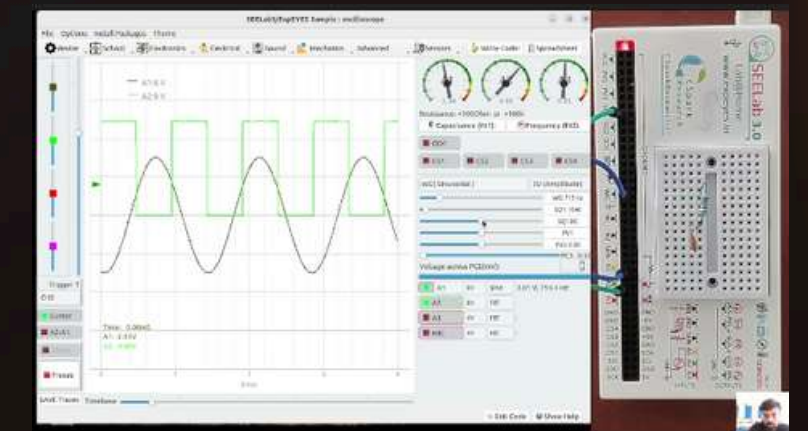
## WINDOWS

- Install Python (Make sure The path option is enabled)
- open cmd
- `python -m pip install --upgrade pip`
- `python -m pip install seelab_examples`
- `python -m seelab_examples`

## Linux

- `pip install seelab_examples`
- `seelab_examples`

Includes embedded python notebook, circuit simulator, visual programming, and AI based computer vision examples.

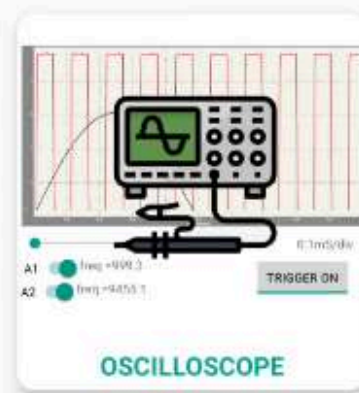
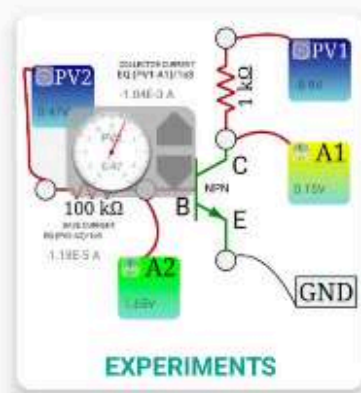
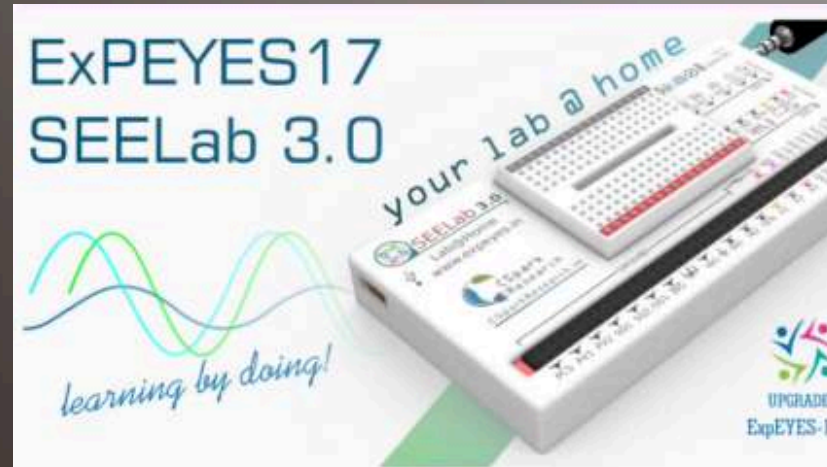


[INTRODUCTION \[VIDEO\]](#)



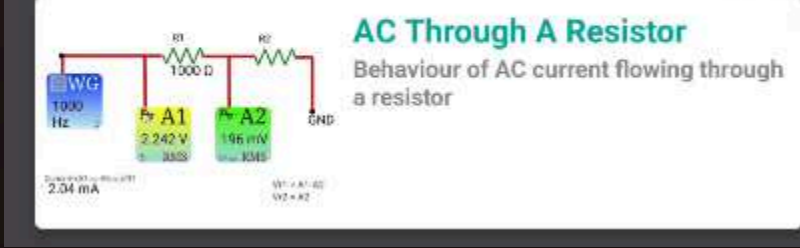
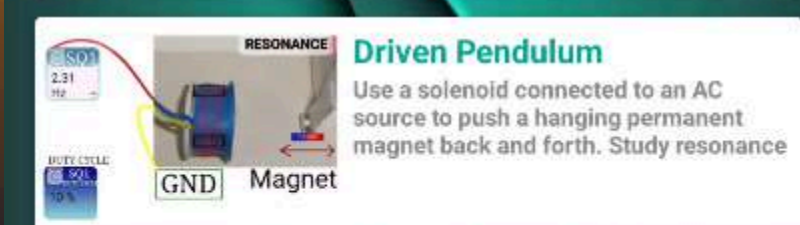
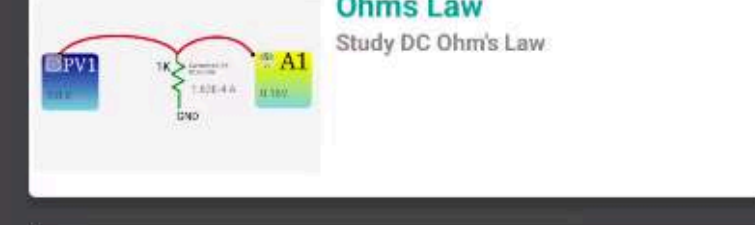
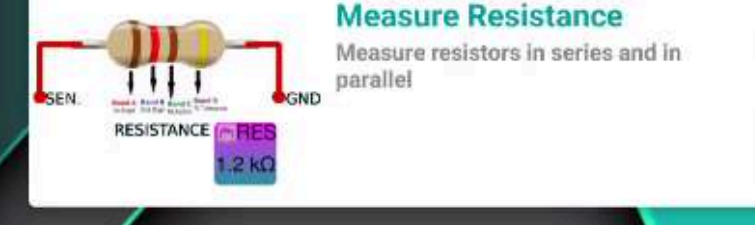
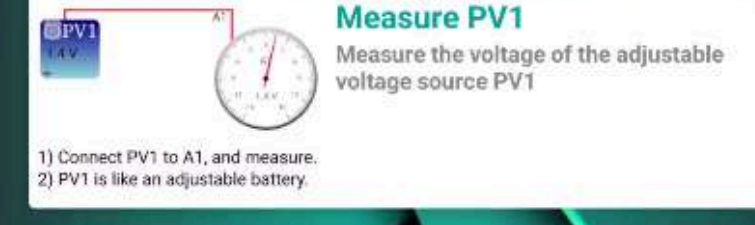
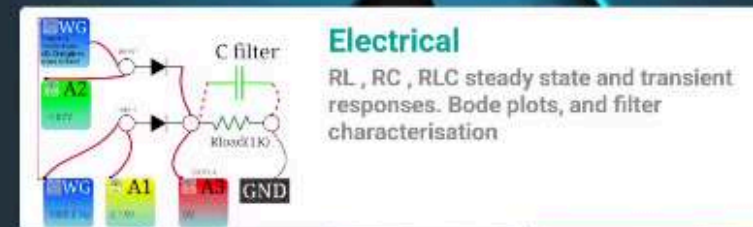
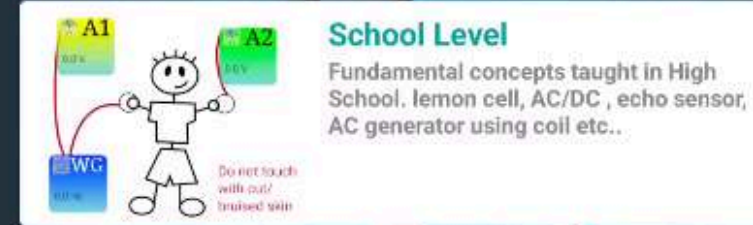
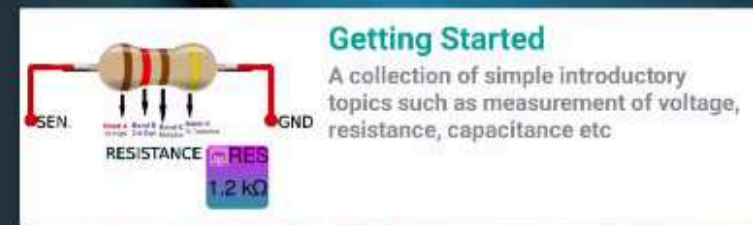
# Introduction : Experiments

Categorized into clear skill levels ranging from school to post graduate experiments



```
This function plays a music note ♪  
to playNote with: frequency, long  
SET FREQUENCY WG frequency  
if long  
do wait 0.1 seconds  
wait 0.1 seconds  
SET FREQUENCY WG 0  
wait 0.2 seconds
```

VISUAL CODING





**AC Through A Capacitor**  
Behaviour of an AC current flowing through a capacitor

**AC Through An Inductor**  
Behaviour of an AC current flowing through an inductor

**AC Through Series LCR**  
Behaviour of an AC current flowing through a series LCR Circuit

**Measuring the Conductivity of Water**  
Measure AC and DC conductivity of water

**AC Resistance of Human Body**  
Measure resistance of the human body with an AC signal

**Mutual Induction**  
Use 2 coils and create a working model of a transformer

**AC Powerline Pickup**  
Understand electrical noise due to 50/60Hz power lines surrounding us

**Generating and Digitizing Sound**  
Measure sound and visualize it

**Stroboscope**  
Measure speed of a rotating object using a flashing LED

**Distance using ultrasound echo module SR04**  
Measure distance using an SR04 Echo module

**Optical Communication**  
Transmit signals from one device using a laser connected to SQ1, and receive on another device

**XY plotting, Lissajous figures**  
Make Lissajous figures by plotting A1 vs A2

**AC-DC Separating**  
Separate AC and DC components from a mixed signal

**Duty Cycle measurement**  
Measure Duty Cycle(Ratio of ON vs OFF Time) on digital inputs IN2/SEN

**RC Transient**  
Study transient behaviour of RC Circuits

**RL Transient**  
Study transient behaviour of RL Circuits

**RLC Transient**  
Study transient behaviour of RLC Circuits

**RLC Steady State**  
Study Steady State behaviour of RLC Circuits

**Study of Filter circuits**  
Study passive and active filters. Plots amplitude and phase vs frequency

**Ohms Law using AC**  
Study Ohm's Law with AC signals using their RMS amplitude

**Output Impedance**  
Study Output Impedance

**2 Phase AC Generator**  
Use 2 solenoids and a rotating magnet to generate 2 phase electricity

**3 Phase AC Generator**  
Use 3 coils and a rotating magnet to generate 3 phase signals

**Fourier Transformations**  
Take the fourier transform of sinusoidal

**HELP** **STUDY AN ELECTROMAGNET**

Place a Compass or a small magnet suspended from a string to observe the magnetic field.

Choose PV1 to create an oscillating field

Choose WG instead of PV1 to create an oscillating field



**HELP** **DRIVEN PENDULUM**

2.2 Hz

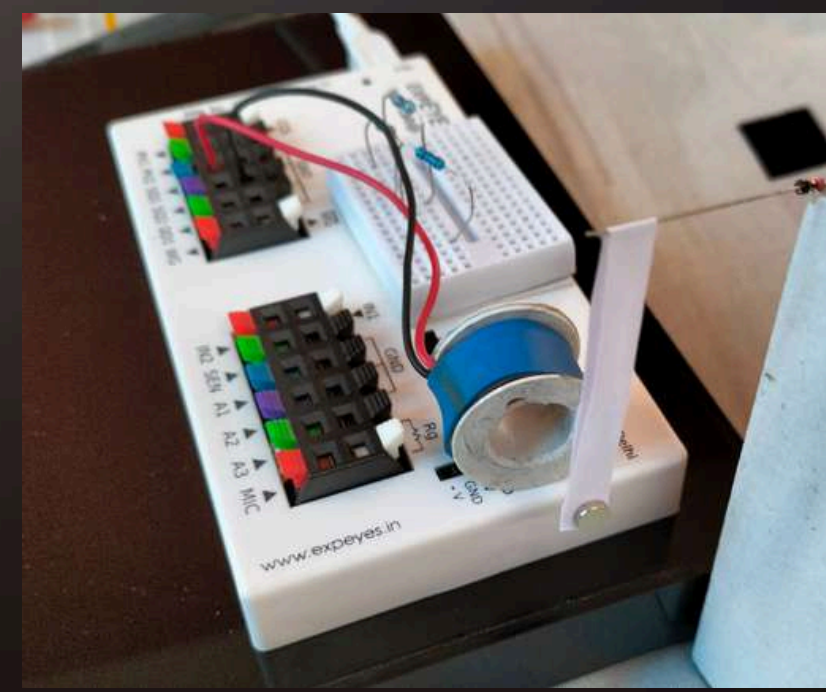
DUTY CYCLE 10%

COIL

Magnet

GND

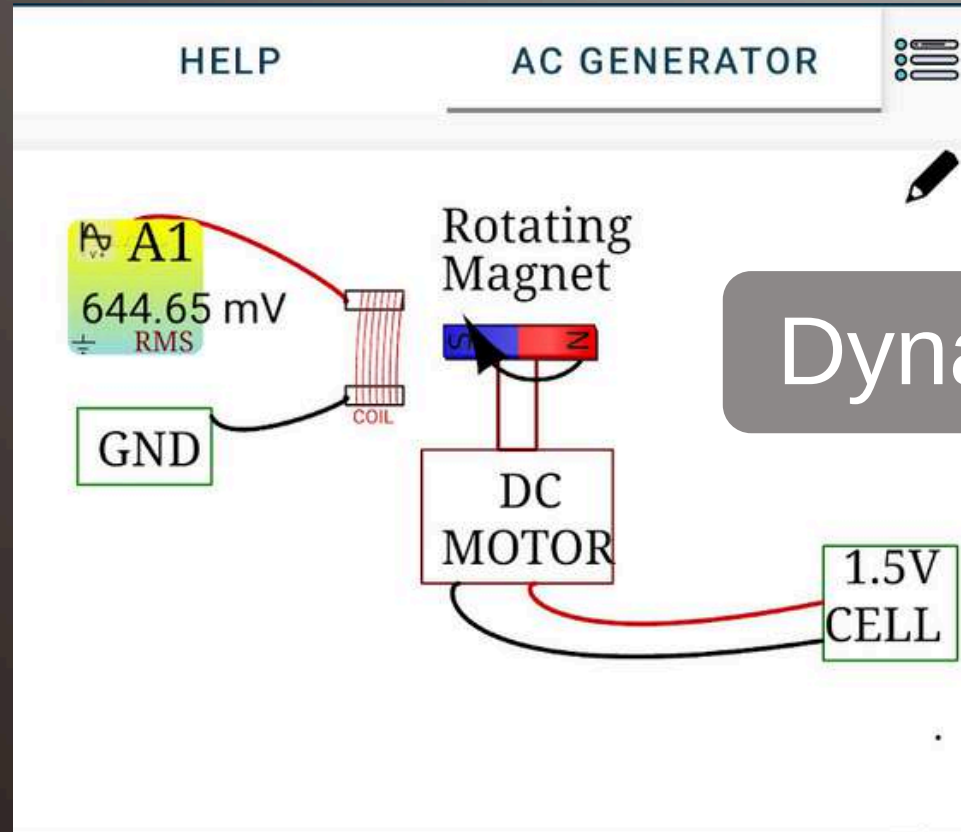
measure natural frequency (A1-coil..)



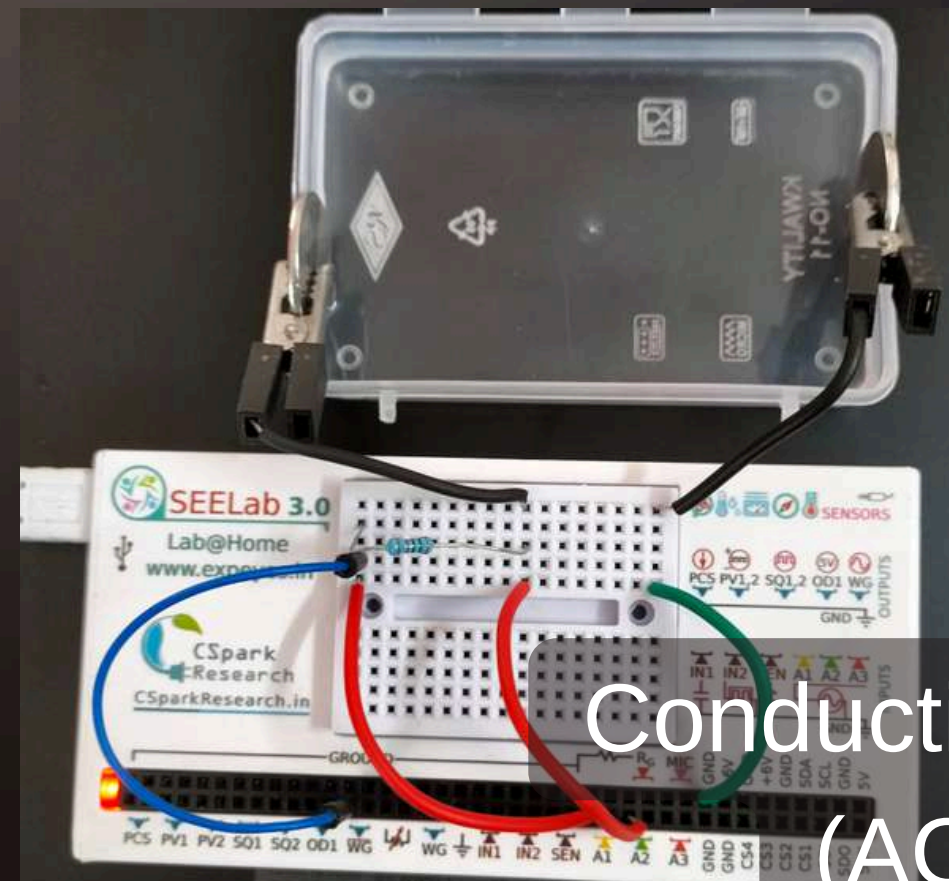
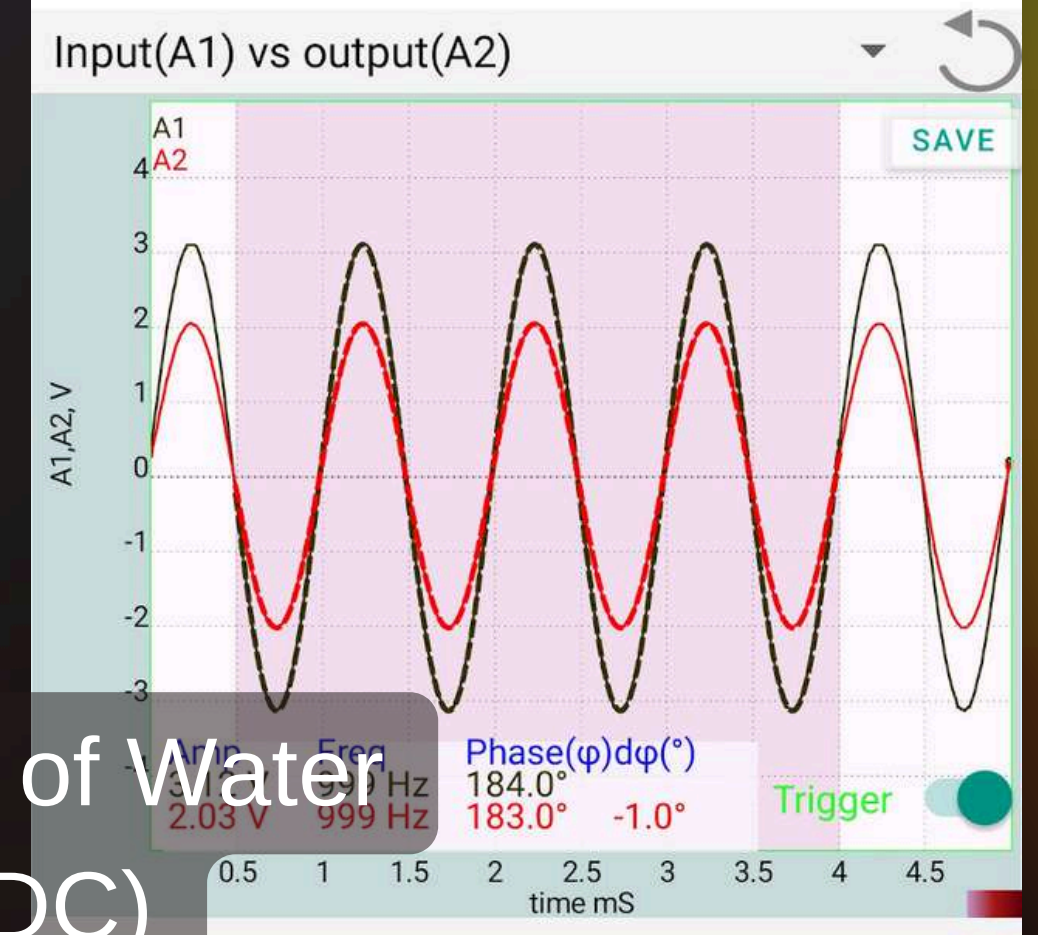
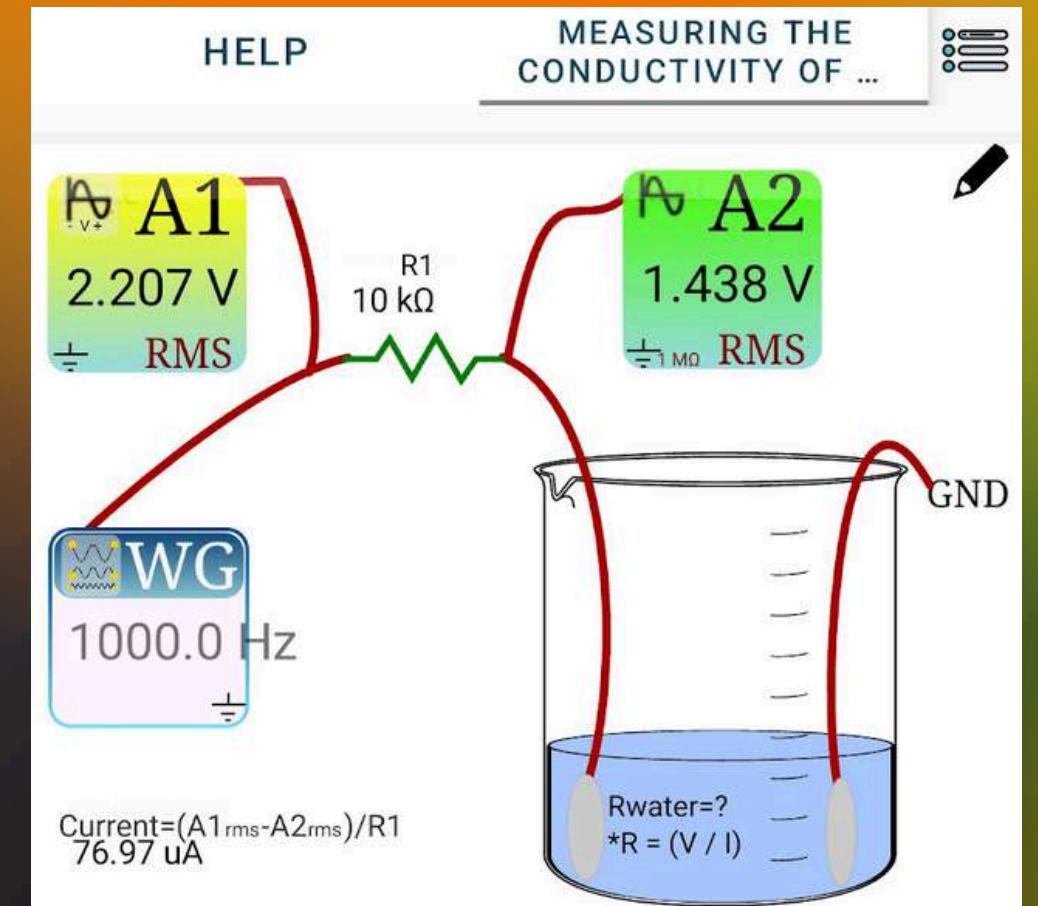
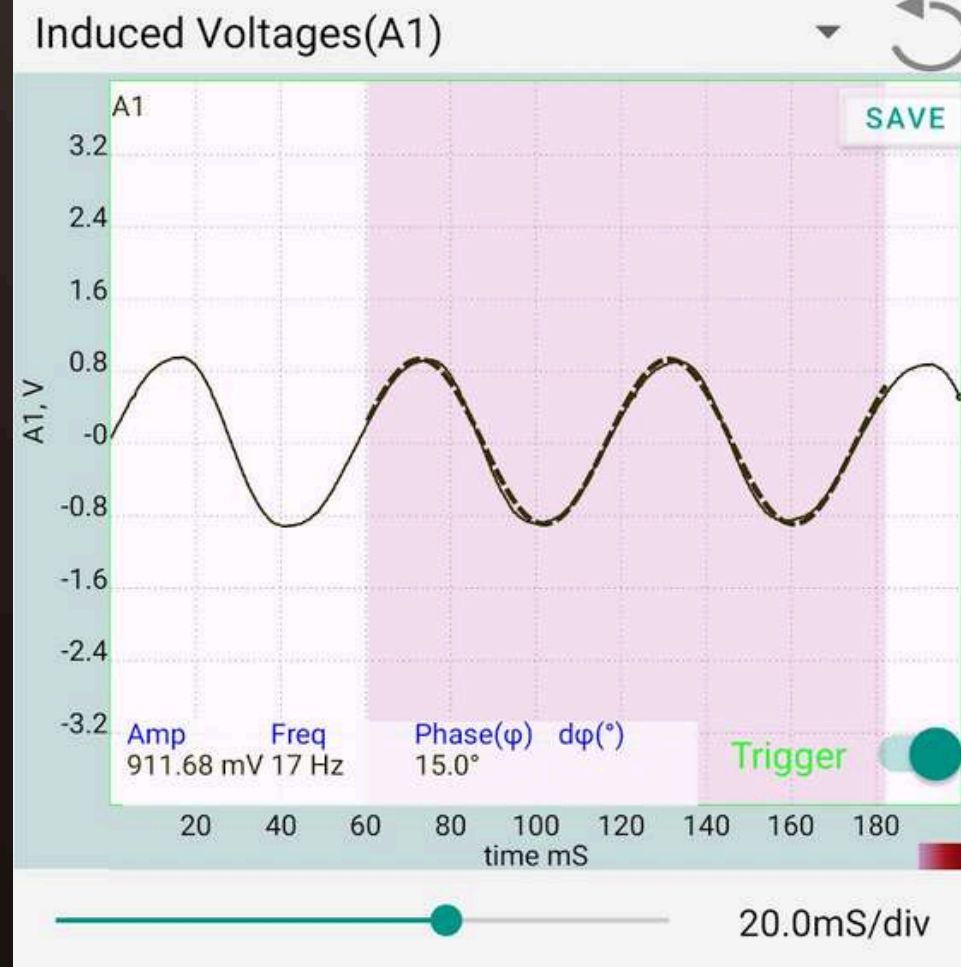
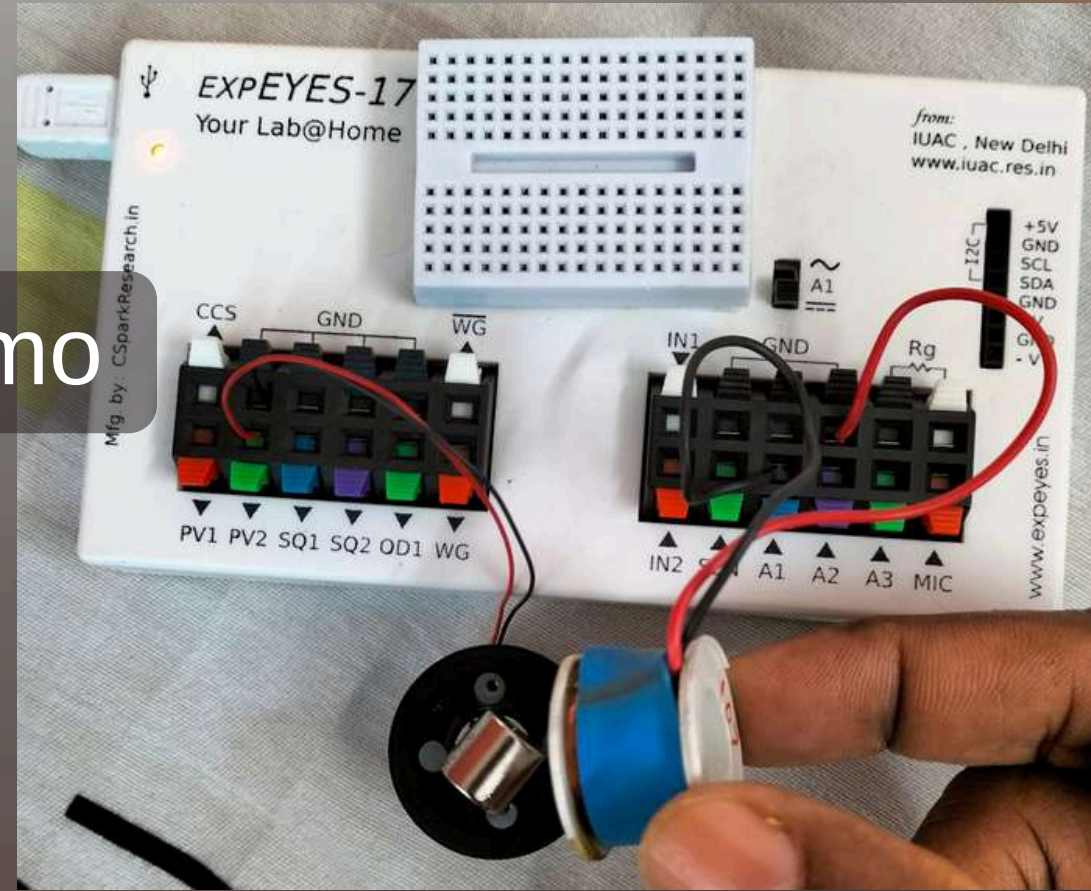
# Electricity & Electromagnetism



Introduction : Experiments



Dynamo



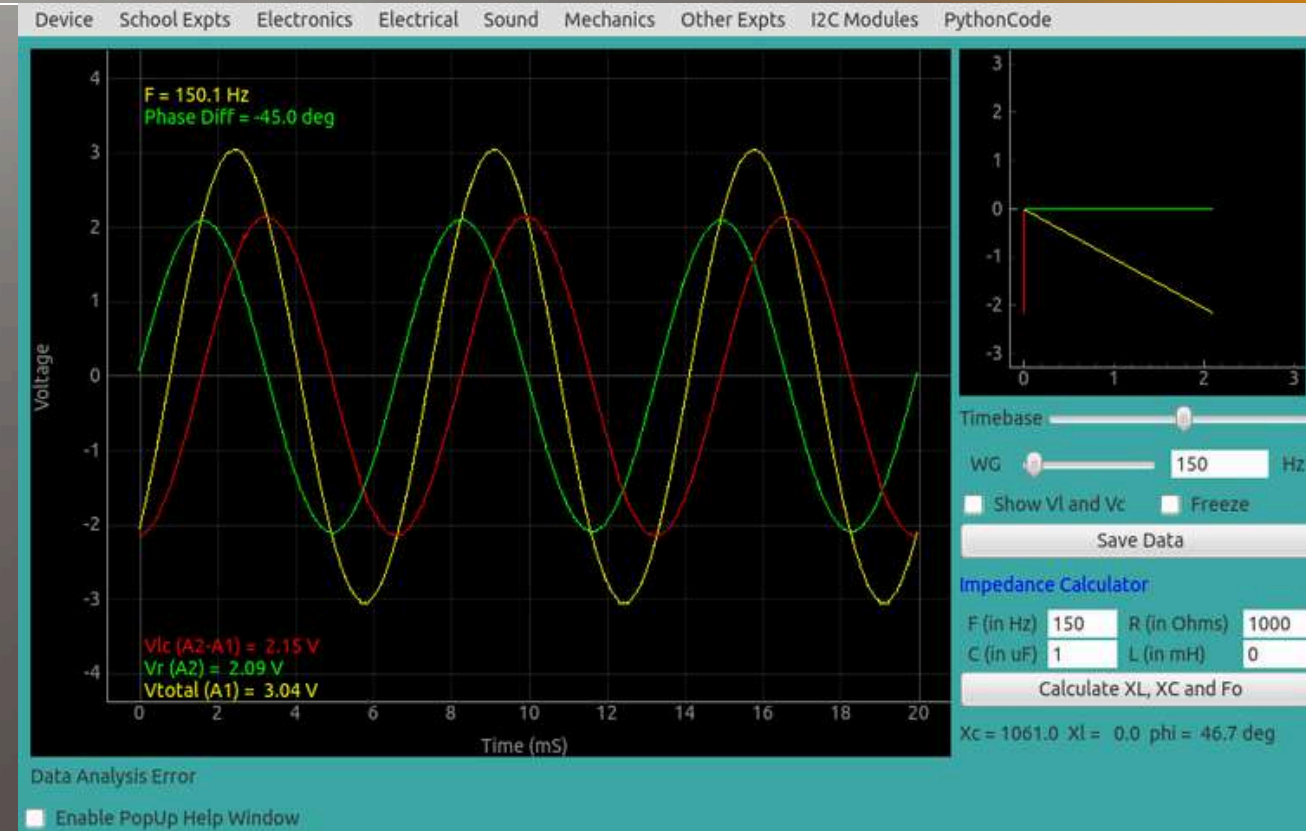
Conductivity of Water (AC & DC)



### Electronics 101 Lab

- LCR Resonance
- Frequency response of band pass/low pass/high pass filters [Bode Plots]
- Diode IV Characteristics

Verify formulae for capacitive and inductive reactance using precisely extracted phase shifts



LCR Resonance Curve

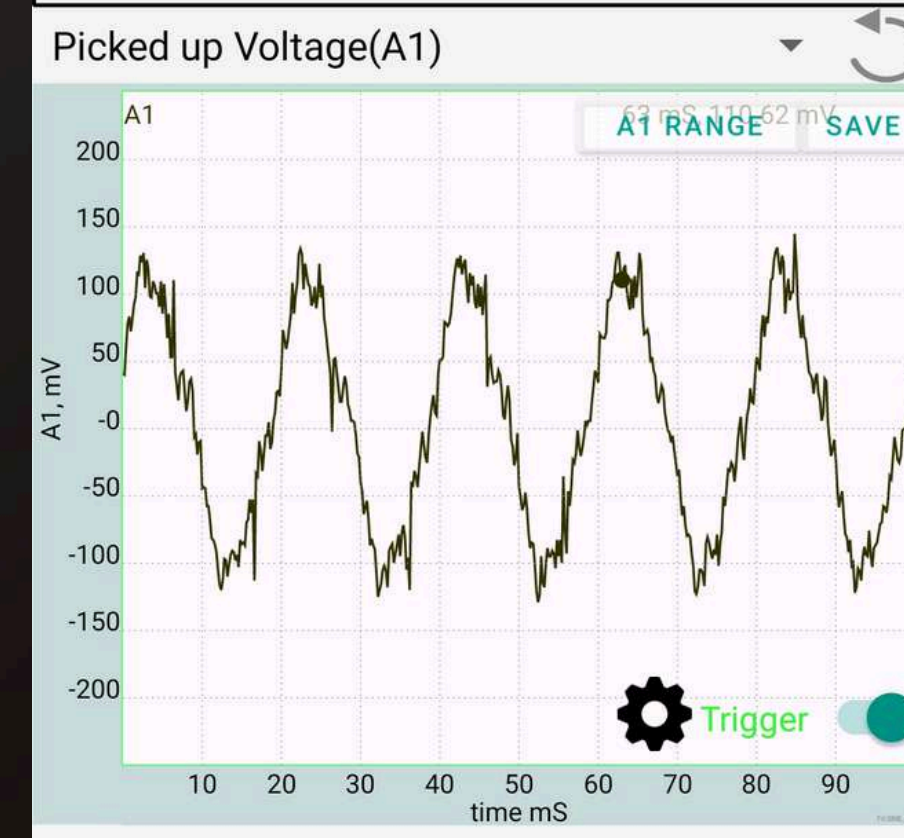
HELP      AC PICKUP

**A1**  
-48.56 mV

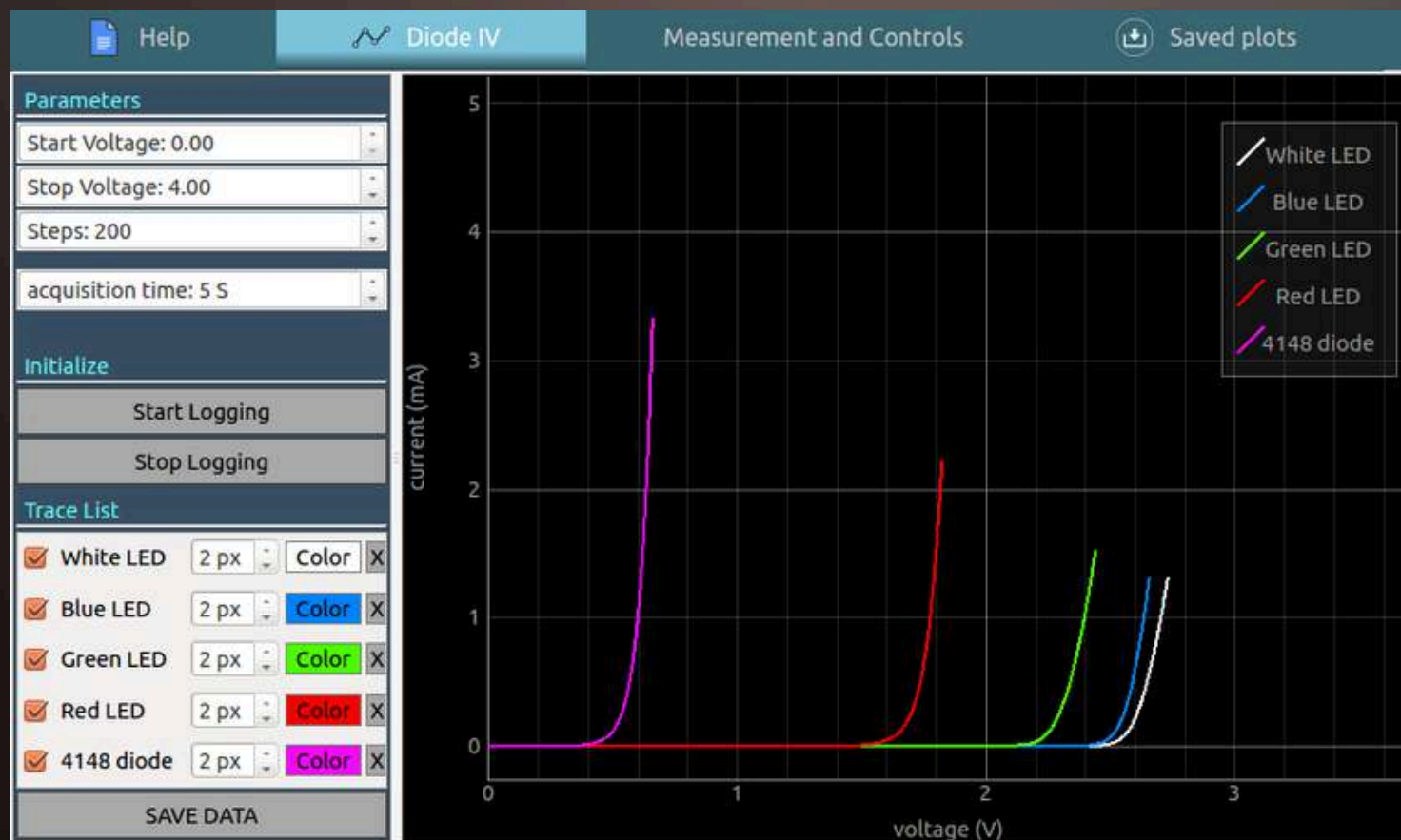
## AC Pickup !

Insert a wire in the A1 input and touch the other end to see electrical noise caused by AC power lines around you.

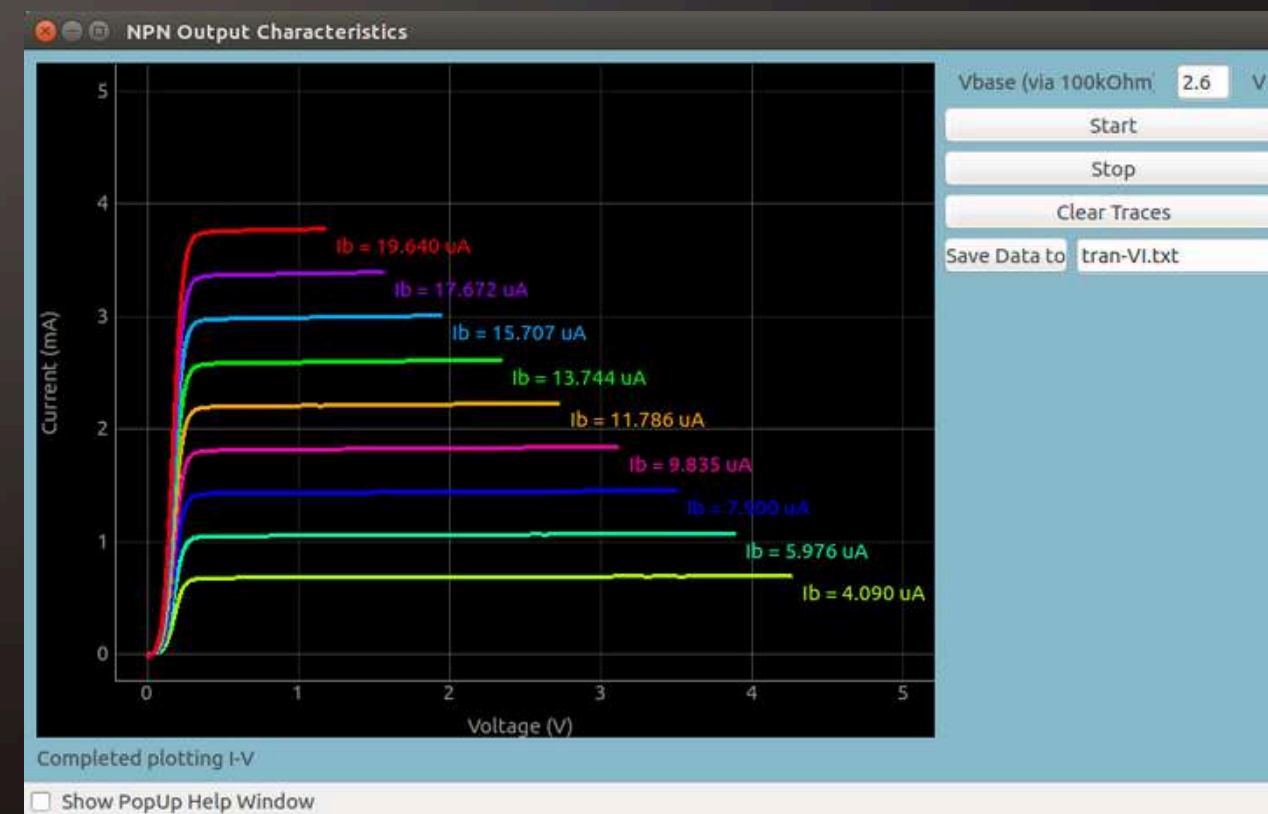
You are acting as an antenna here



50 Hz NOISE

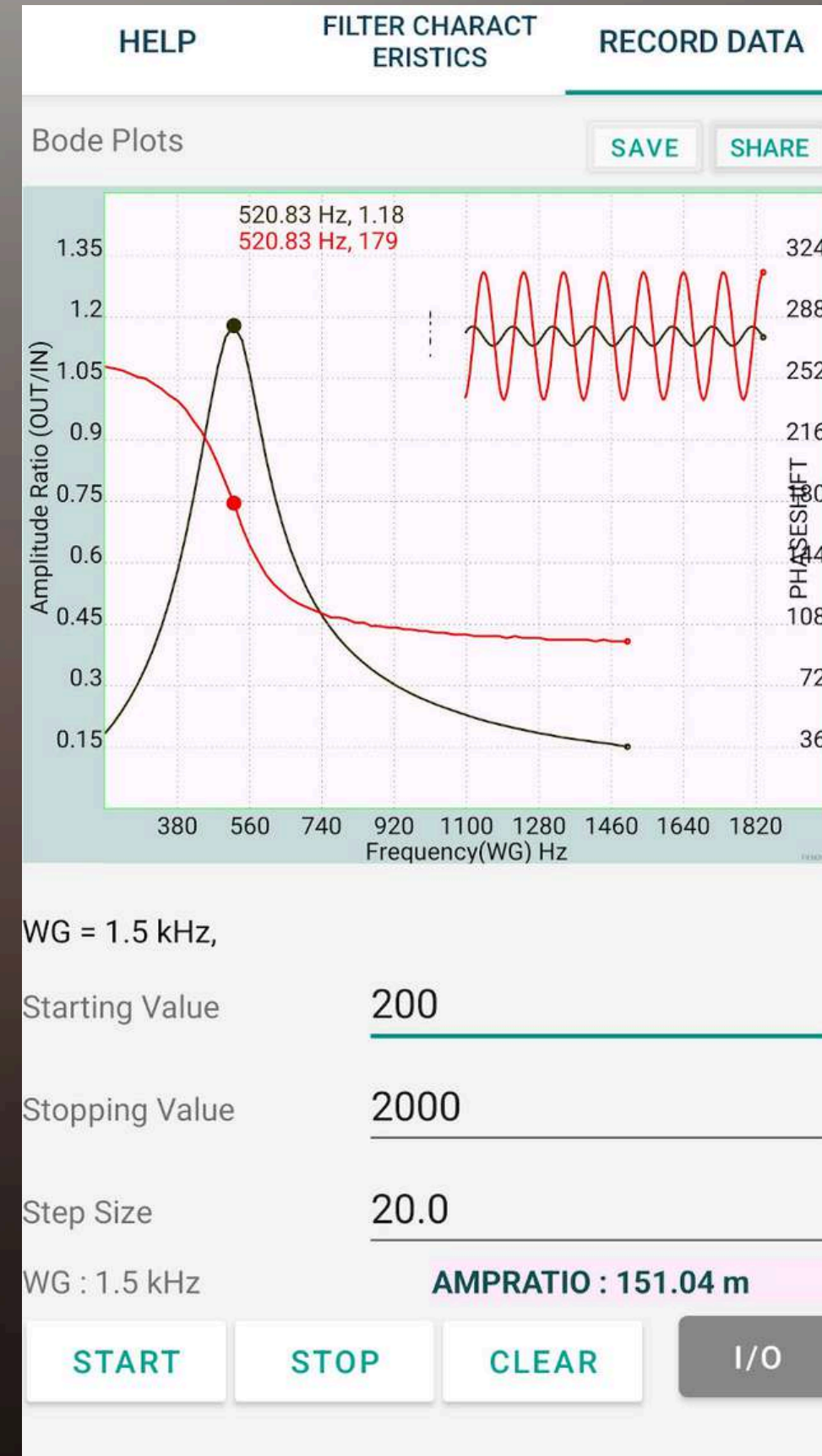
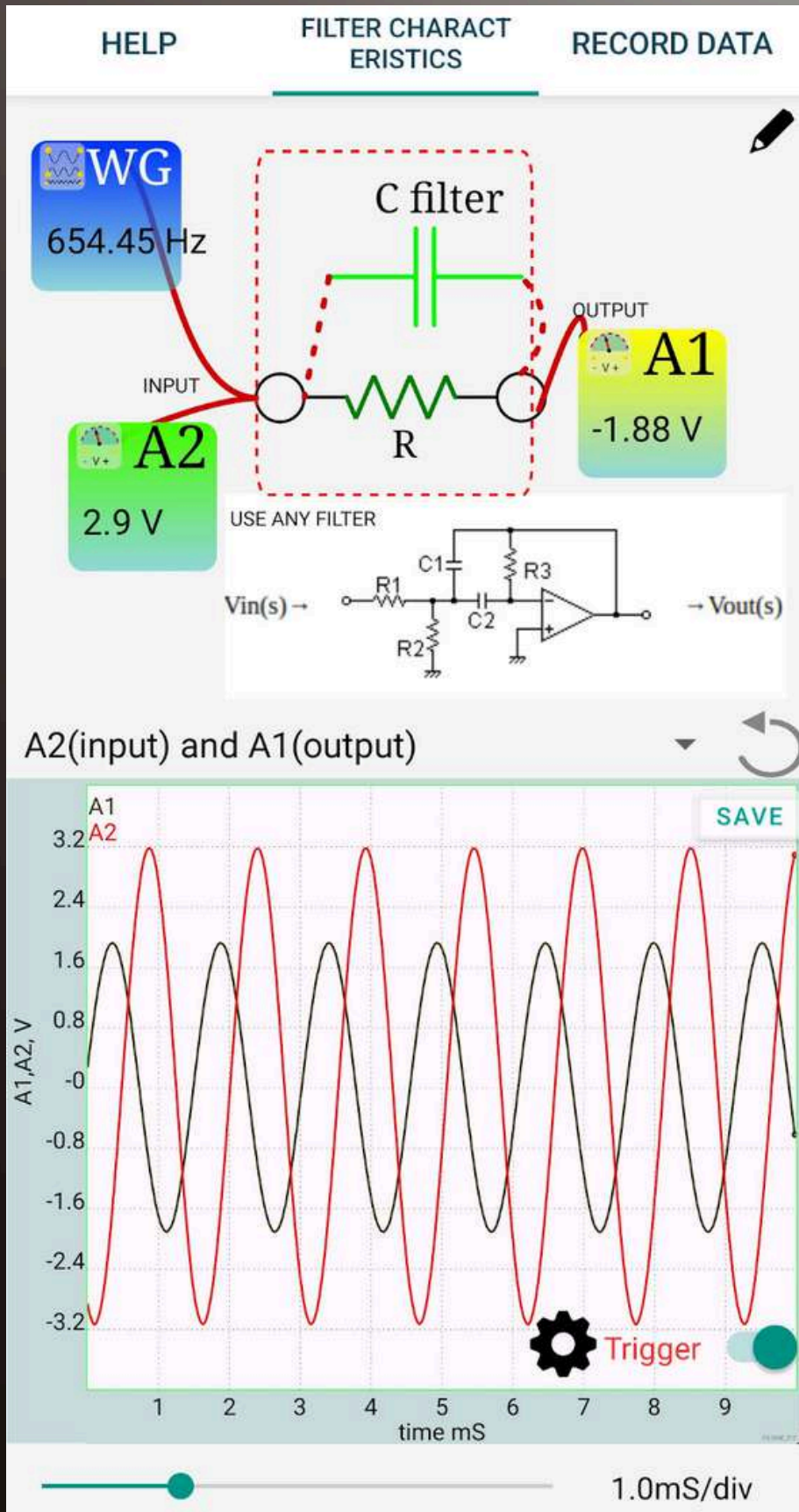


Diode IV Characteristics for various diodes and LEDs

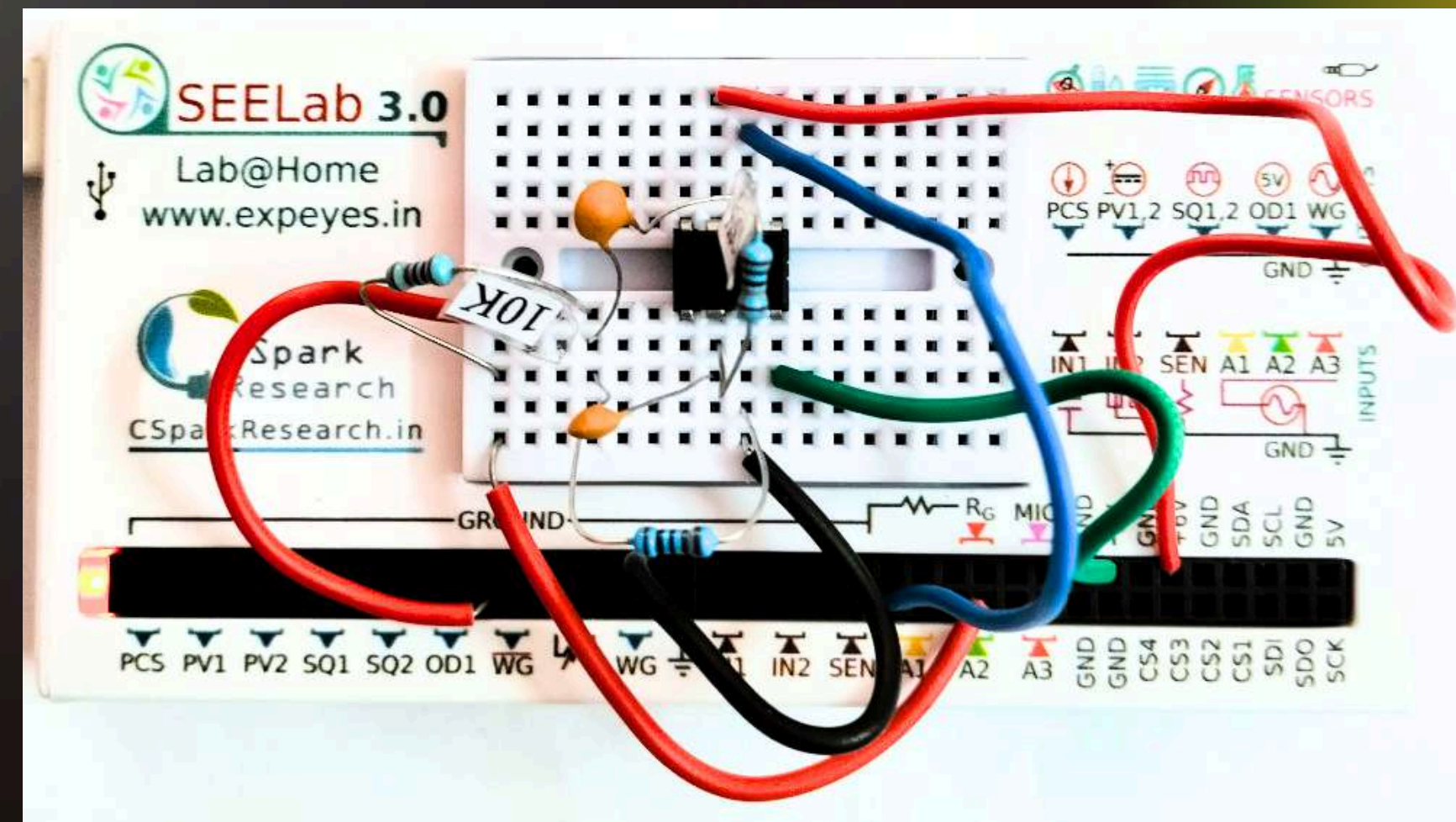


Transistor Output Characteristics





# Advanced Electronics: Characteristics of a band pass filter



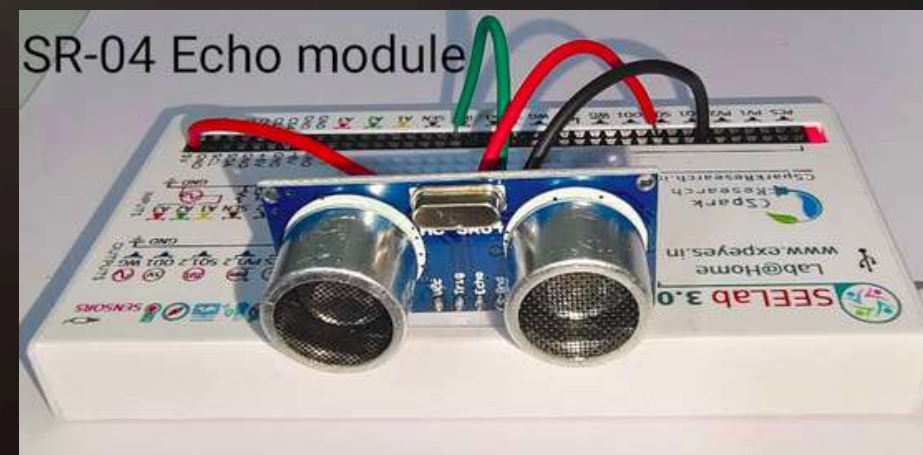
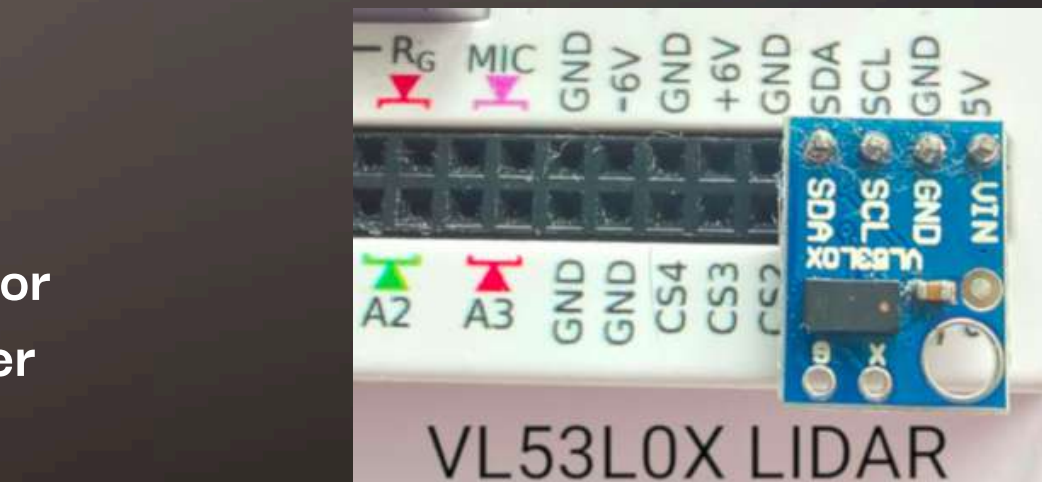




# Low cost add-ons : Simply plug 'n play

I2C/SPI communication interfaces, and software support for several common sensors

- BMP280 : Pressure and temperature Sensor
- BME280: Humidity measurement
- TSL2561/BH1750: Light intensity sensor
- MPU6050: Gyroscope, accelerometer
- MPU9250 : Accel/Gyro/Magnetic Fields
- VL53LOX : Distance measurement (LIDAR)
- MLX90614: Passive IR temperature sensor
- AD8232 : ECG instrumentation amplifier
- AD9833: Precision Sine Wave generator
- Servo Motors via SQ1, SQ2, or PCA9685
- AHT10, AHT21: Humidity Sensor
- MAX44009; Visible Spectrum Luminosity sensor
- QMC5883L/HMC5883L : 3 Axis Magnetometer
- ML8511 : UV sensor
- MAX30100: Heart rate and pulse oximetry
- INA219 : High Side Current Sensing
- ADS1115 : 16 bit , 4 channel voltmeter
- TCS34725 : RGB Color sensor
- ADXL345: 3 axis accelerometer
- SR04 : Distance sensor (Sound based)





# TIMING MEASUREMENT OF PROJECTILES

Add on accessories

**GRAVITY BY TIME OF FLIGHT**

Relay to Hold the Ball 5V GND

$S = 1/2 * g * t^2$

Relay Coil

Steel Ball

OD1 DIGITAL OUTPUT OFF (0V)

TAP TO TOGGLE

Drop the ball and Measure Time

**TIMING Intervals**

**269.77 mS**

TAP TO REFRESH

Check that SEN changes state (3.3V becomes 0V, or vice versa) when the switch is pressed.

SEN 3.3 V

Gap that closes when the ball lands GND



## CALCULATIONS:

$$0.5 * 9.8 * .26977 * .26977 =$$

**0.35660167921**

**Get precise results!**



# Visual programming interface : Simple blocks for making all sort of measurements.

The image displays a comprehensive visual programming interface for hardware measurements. On the left, a sidebar lists various categories: Minimize, Variables, Values, Operators, Logic, In / Out, Loops, Math, Lists, PLOTS, Functions, ExpEYES (Captures, Analysis, Sensors, Sliders), and Phone Games. The main workspace is filled with numerous color-coded blocks:

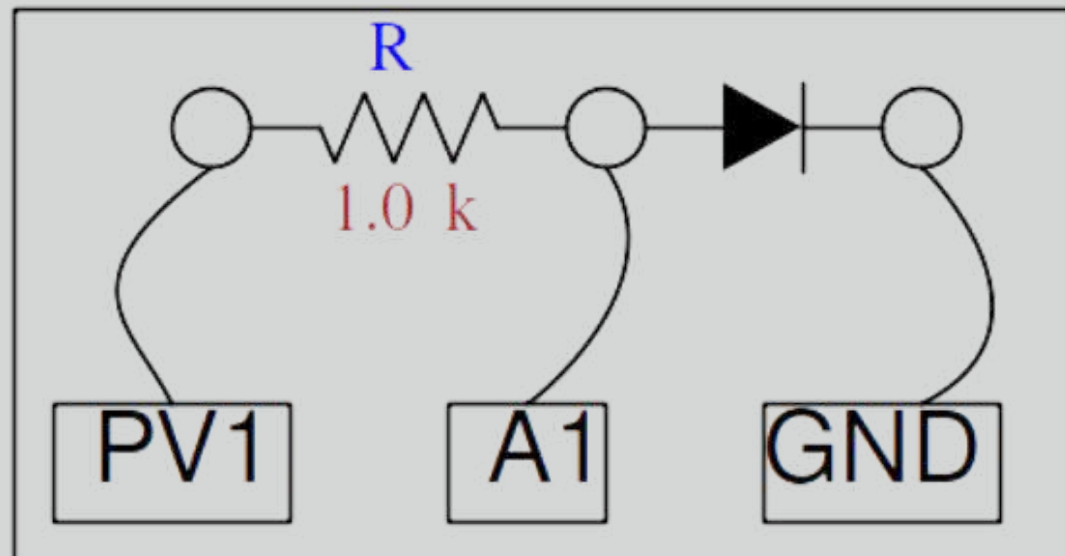
- Reading and Setting:** READ VOLTAGE (A1), SET VOLTAGE (PV1), Sine(WG) Amplitude (3V), SET FREQUENCY (WG), READ FREQUENCY (IN2), READ RESISTANCE (SEN, GND), READ CAPACITANCE (IN1, GND), Rising Edge Timer (IN2, Skip: 0, Timeout: 2), SET (OD1, ON), Digital Timer (IN2, rising, Edges: 4, Timeout: 2), Digital Timer (SET (OD1, ON) at t=0, IN2, rising, Edges: 4, Timeout: 2), SERVO (SQ1, Angle).
- Sensors and I2C:** Scan I2C port, and get a list of detected sensors; Scan I2C port, and get detected sensors in a comma separated string; Read I2C Sensor: BMP280 (Address: 13); Read SR04 Distance(cm); Read BMP280 (PRESSURE); Read MPU6050 (Ax); Read Temperature from MAX6675 Module on (CS1); Read VL53LOX (Distance(mm)); Read HMC5883L (Hx); Read QMC5883L (Hx); Read MAX30100 (RED, LED, Heart Rate); Read ML8511 (UV Light mW/cm^2); Set AD9833 (CS1, Frequency); SERVO(PCA9685) (1, Angle).
- Data Capture and Analysis:** Select (A1, Range: 16, V); Oscilloscope Trigger (Channel 1, Level: 512); Capture 1 (A1, SAMPLES 100, TIMEGAP(uS) 1, Data in Variables: timestamps, data1); Capture 2 (Chan 1: A1, Chan 2: A2, SAMPLES 100, TIMEGAP(uS) 2, Data in Variables: timestamps, data1, data2); Capture 4 (Chan 1: A1, Chan 2: A2, SAMPLES 200, TIMEGAP(uS) 5, Data Variables: timestamps, data1, data2, data3, data4); Capture And Plot (Chan 1: A1, Chan 2: A2, SAMPLES: 500, TG(uS): 5, timestamps, data1, data2); Set OD1 (ON(5V), Capture A1, SAMPLES: 500, TIMEGAP(uS): 5, Plot: timestamps, data1).
- Waveform Analysis:** Amplitude (ANALYZE ARRAY X[], ARRAY Y[]); Amplitude Ratio[Gain] (ANALYZE ARRAY X[], ARRAY Y[], ANALYZE ARRAY X2[], ARRAY Y2[]); Fourier Transform (Time Array X[], Amplitude ARRAY Y[], fftx, ffty).

On the right side, there is a control panel with buttons for Stop, Minimize, Variables, Values, Operators, Logic, and an Output window. Below the control panel is a graph showing a waveform with a red sine wave and a blue square wave. The graph has a y-axis from -3 to 3 and an x-axis from 0.0 to 1.0. A slider is visible below the graph. To the far right, a vertical toolbar contains icons for Save, Open, Share, Edit JavaScript, Python Code, Broadcast, and Listen.



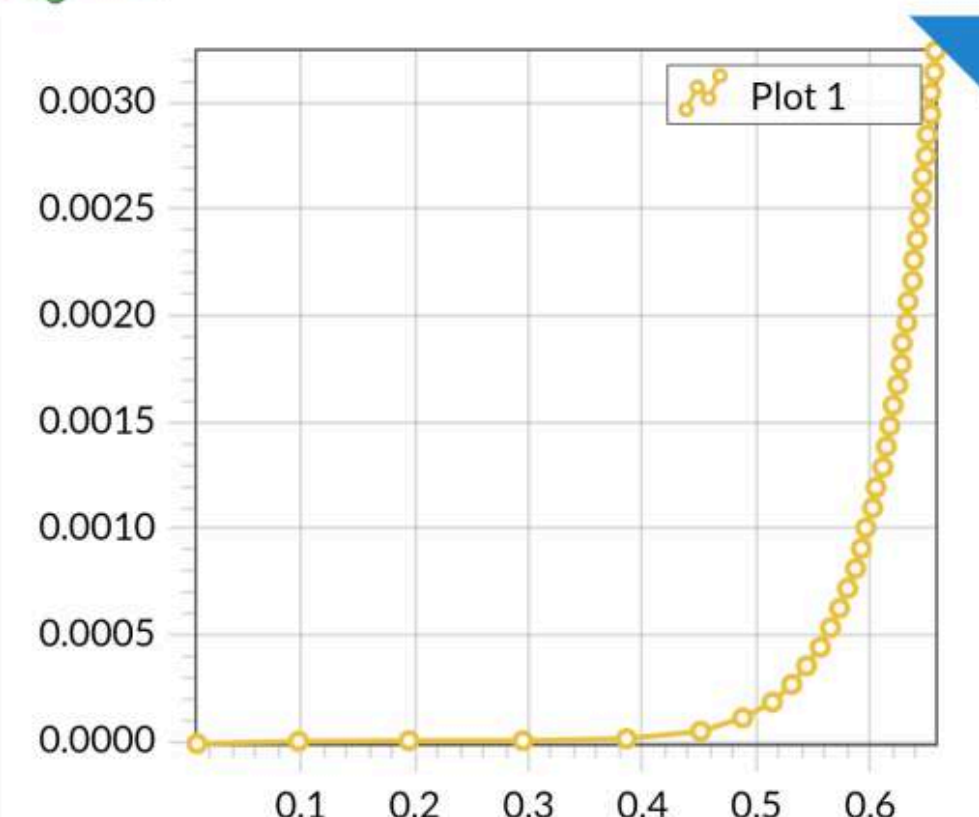
Diode IV Characteristics : The voltage across PV1 is incremented, and the voltage drop across the diode is measured. Current is calculated as  $(PV1 - A1) / R$  using Ohm's law.

## Schematic Diagram



## Components required

## Program and Results



```
//Equivalent JavaScript Code
var setv, dv;

for (setv = 0; setv <= 4; setv += 0.1) {
  set_voltage('PV1', setv);
  dv = (get_voltage('A1'));
  sleep(0.001); #Settling delay
  plot_xy(dv, (setv - dv) / 1000)
}
```

```
#Generated Python Code
setv = None
dv = None

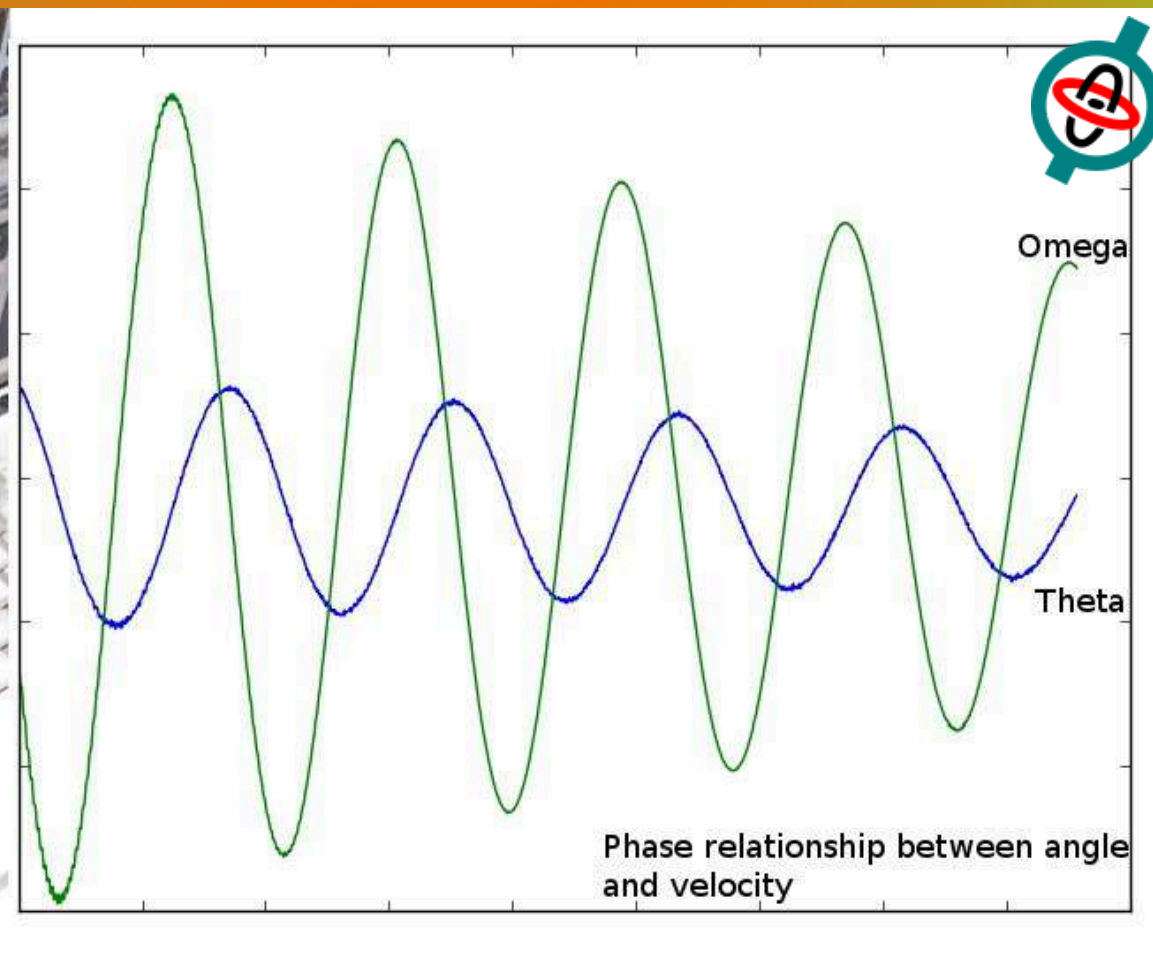
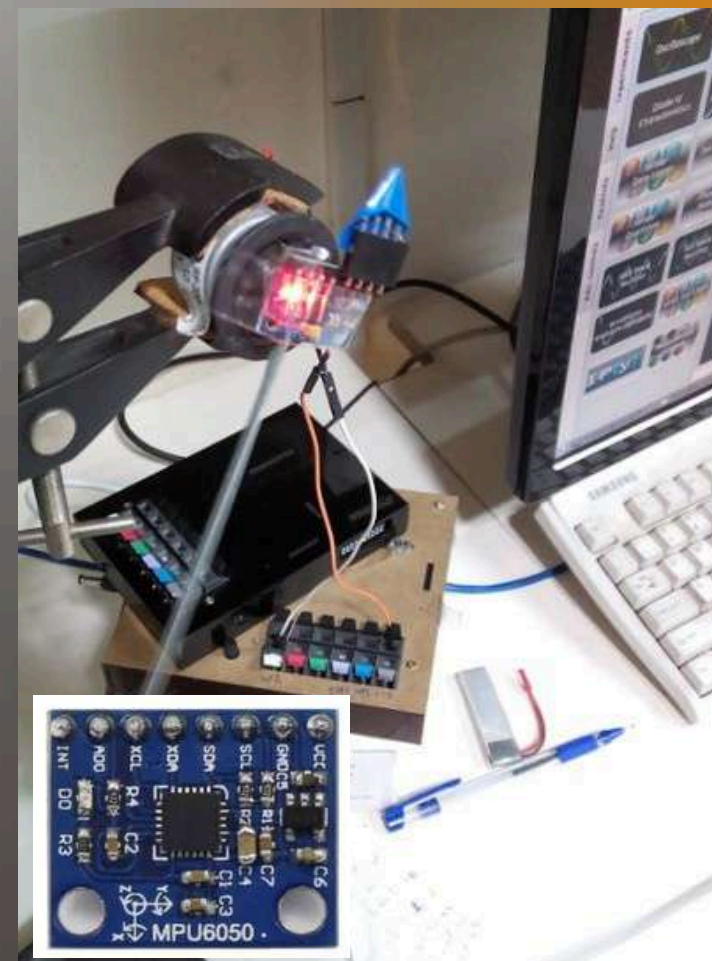
def upRange(start, stop, step):
  while start <= stop:
    yield start
    start += abs(step)

for setv in upRange(0, 4, 0.1):
  set_voltage('PV1', setv)
  dv = get_voltage('A1')
  plot_xy(dv, (setv - dv) / 1000)
```





**Heart rate detector with the Data logger, an LED, and a phototransistor**



**Pendulum oscillations studied with an MPU6050 Accelerometer+Gyroscope**

Software PID Controller

PID controller with any input

HMC5883L-X

Output

Perturbation with a permanent magnet

IN: HMC5883L:X OUT: VOLTAGE: PV1

Setpoint 1 Flip Output RESET

SETP 1: SETP 2: Prop Integ Derivative

-5 1 1 1 0.02

IN: 1 OUT: 3.649 N: 425

START STOP CLEAR I/O

$u(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{d}{dt} e(t)$

HELP FILTER CHARACTERISTICS RECORD DATA

This experiment helps to study filters. Various HIGH, LOW, BAND, Notch filters can be prepared.

For the picture shown below, a multiple feedback active opamp based filter was first simulated, and then characterised.

Amplitude Ratio (A2/A1)

Frequency (W) kHz

Time ms

SEELab 3.0

Simulating values

Simulations can be carried out at Okawa Denshi

The following values were used

- R1=10K
- R2=1K

Cyclic Voltammetry

SAVE SHARE

762.3	-655.46 mV, 99.44 uA
634.8	-654.33 mV, -132.7 uA
507.3	-654.36 mV, 45.29 uA
379.9	-654.55 mV, -158.21 uA
252.4	-654.69 mV, 28.82 uA
124.9	-654.27 mV, -191.35 uA

Current ((PV2:A1)/RT) uA

Voltage(A1-A2) V

Voltage(A1-A2) V

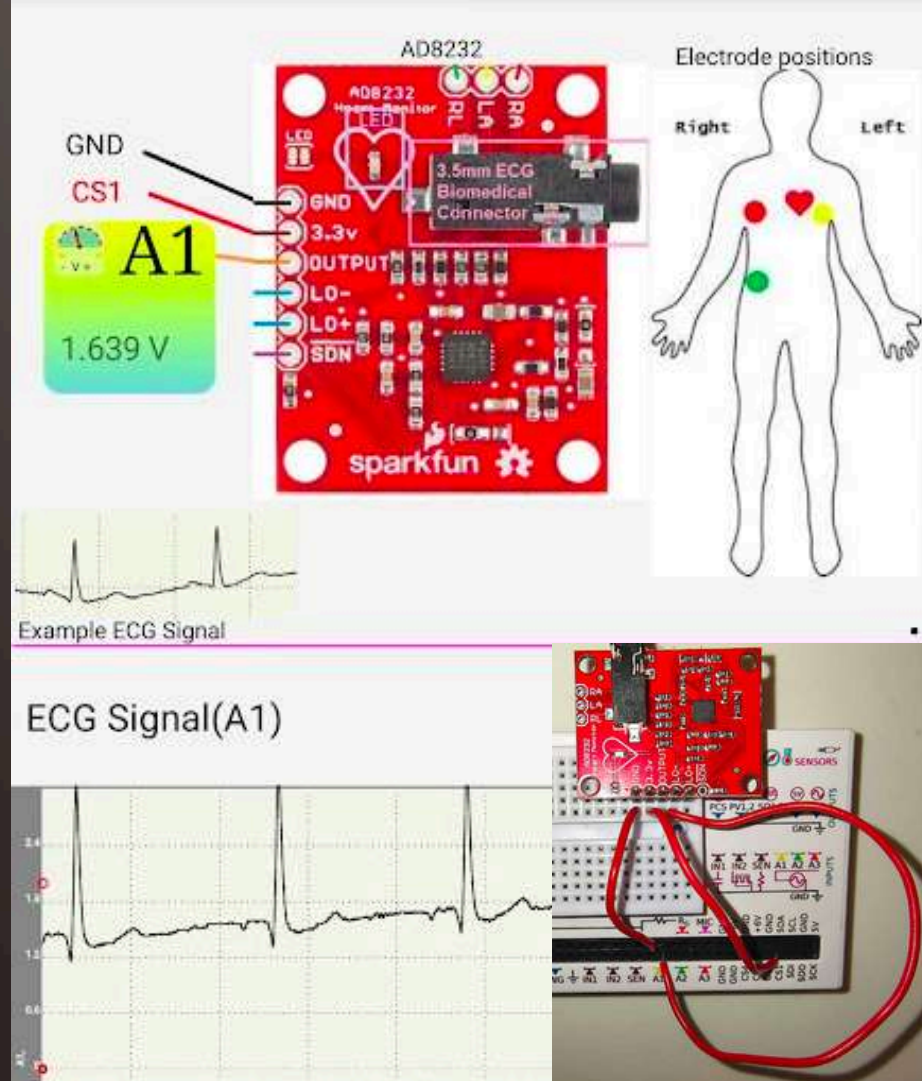


- Super Magnets
- Assorted Resistors, Capacitors, Diodes, Transistors & Inductors
- multi color LEDs & LDR
- Piezo buzzers, 3000 Turn Solenoid, assorted wires.
- Echo Module, DC motor
- 170 point bread-board

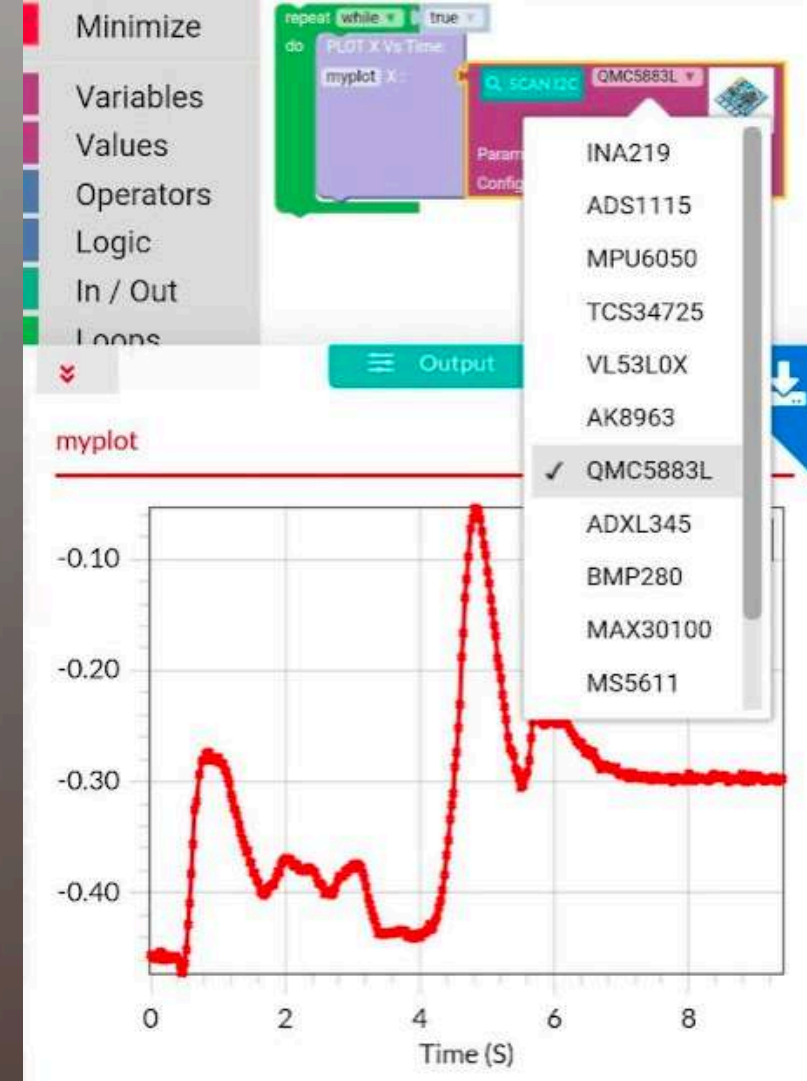
**STANDARD ACCESSORIES**  
**Included with the kit**



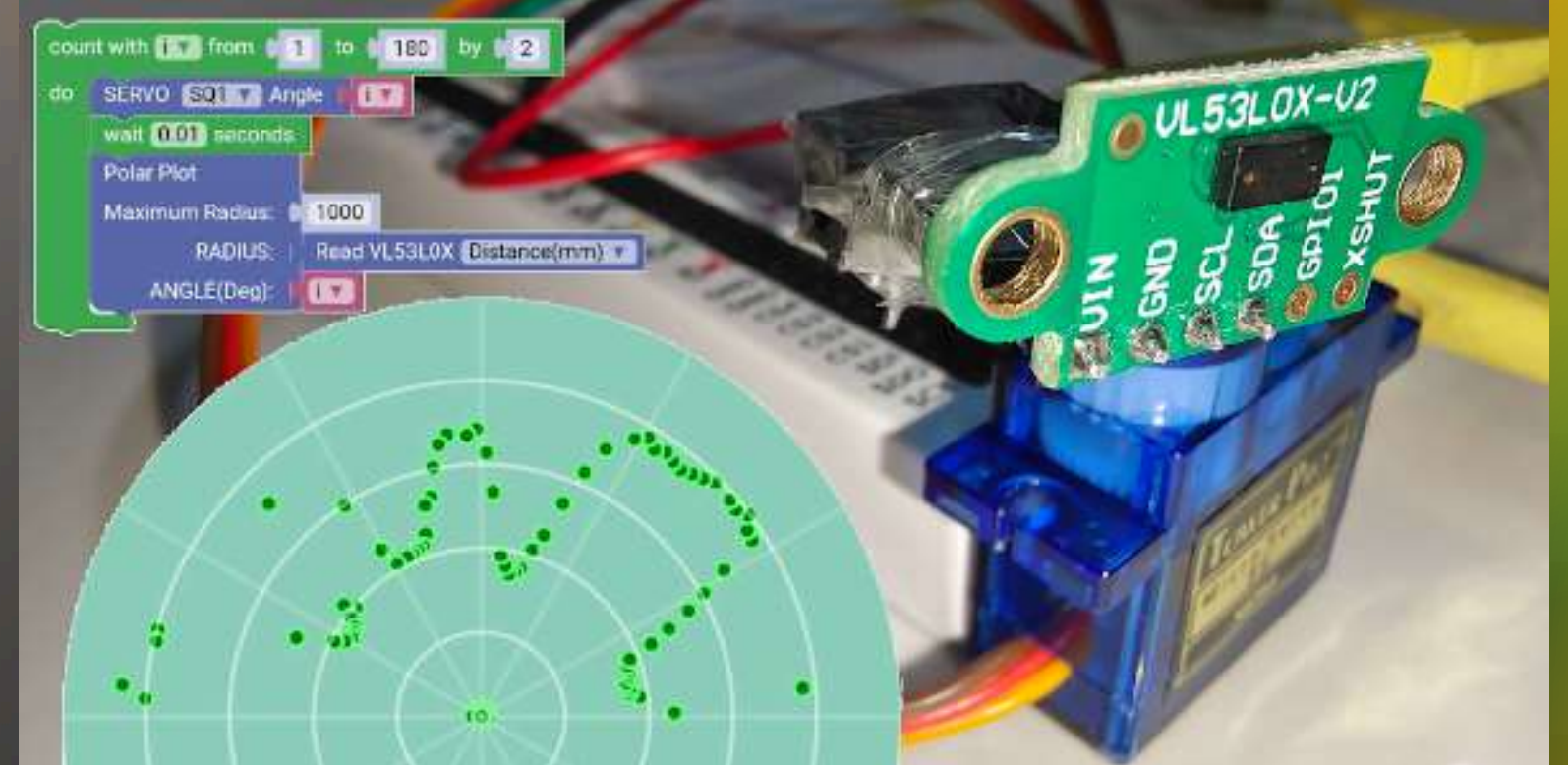
# And Many More Activities ...



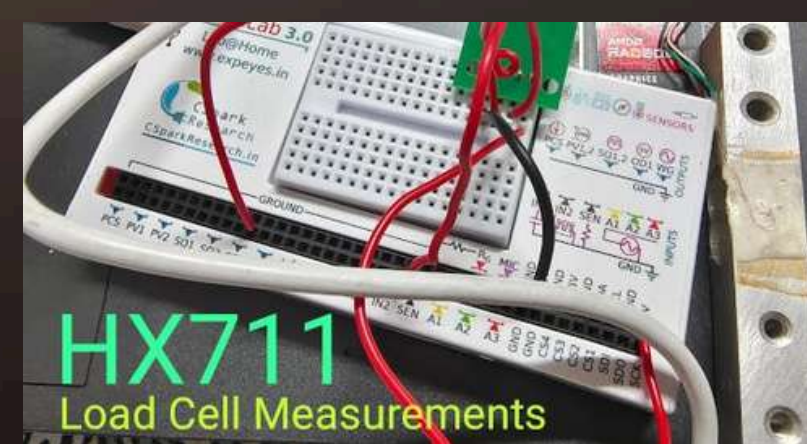
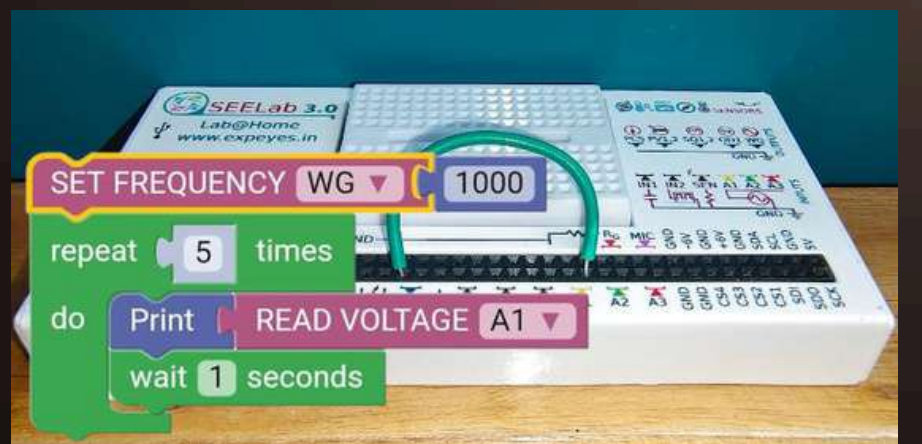
USE THE DATALOGGER TO RECORD ECG SIGNALS AT HOME !



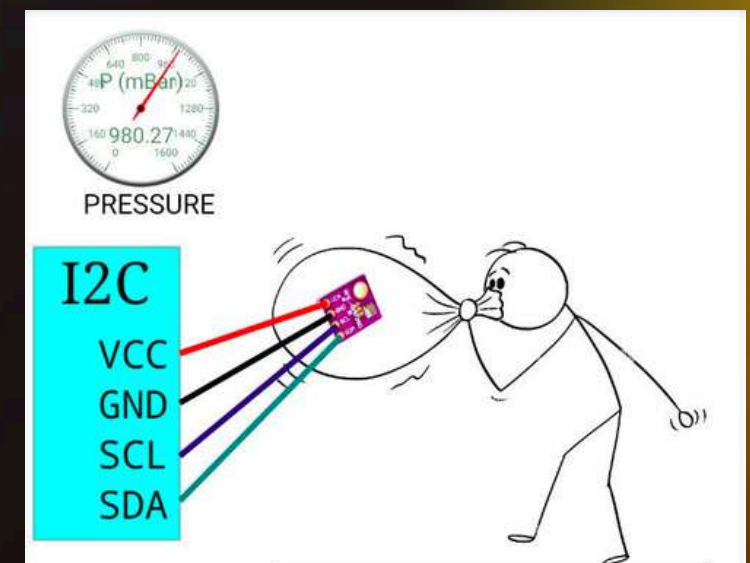
MAGNETIC FIELD READINGS FROM A 3 AXIS MAGNETOMETER



SCANNING RADAR WITH A DISTANCE SENSOR AND A SERVO MOTOR



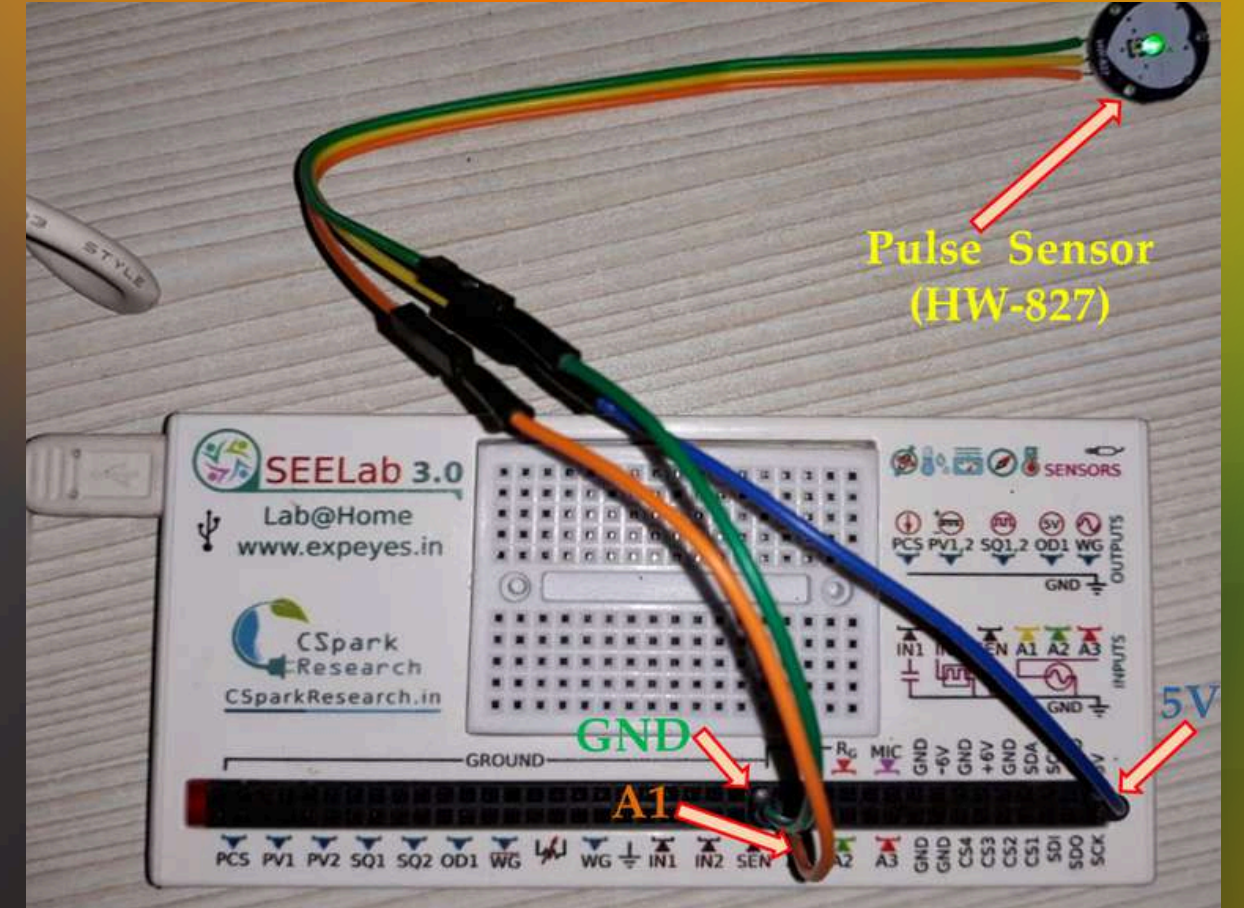
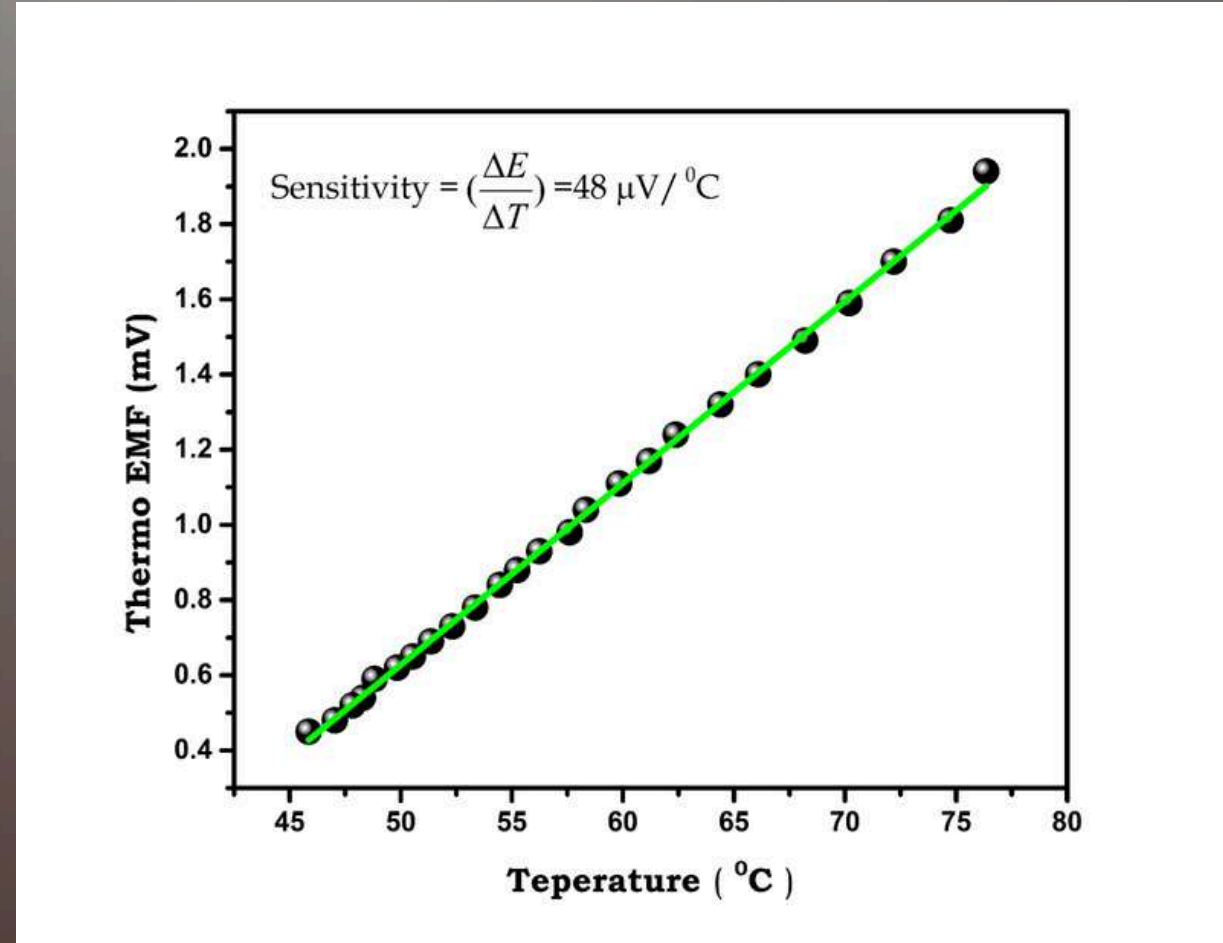
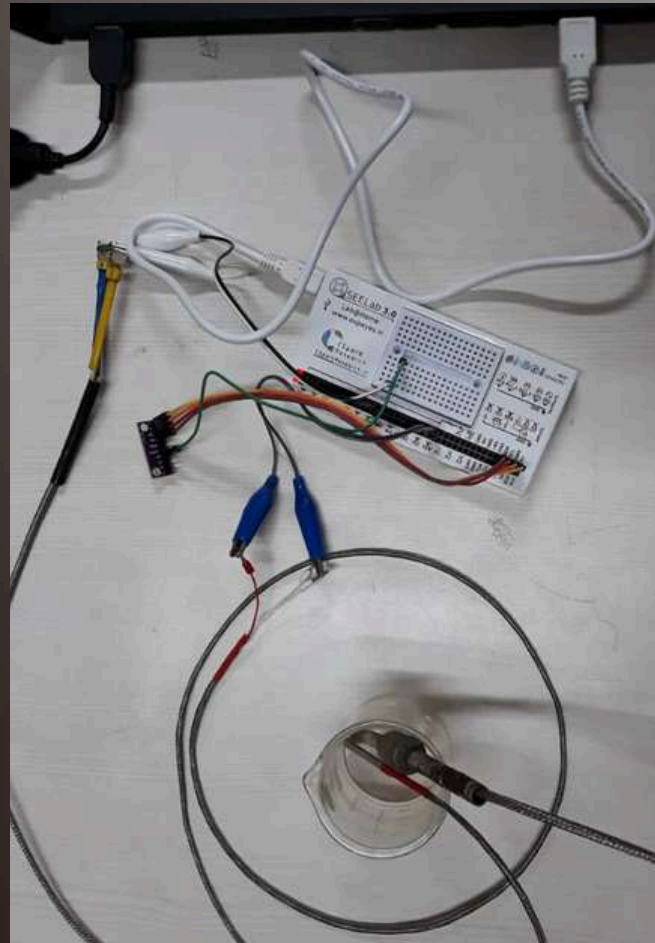
PLUG AND PLAY I2C SENSORS



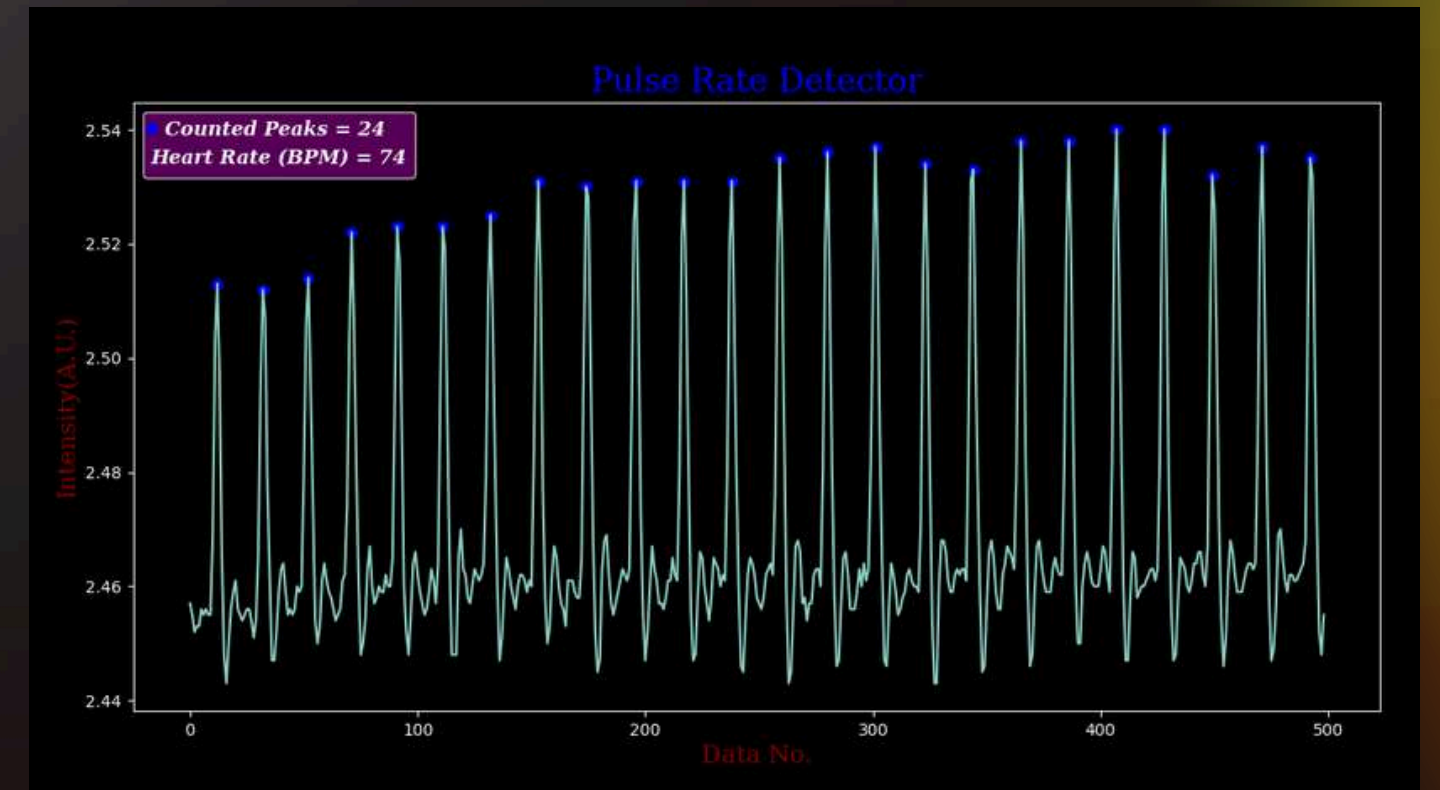
PRESSURE SENSOR



### Thermoelectric measurements by Dr Ujjwal, NSHM Academy



**Add-Ons:**  
**ADS1115 16-bit ADC , PT1000 temperature sensor.**



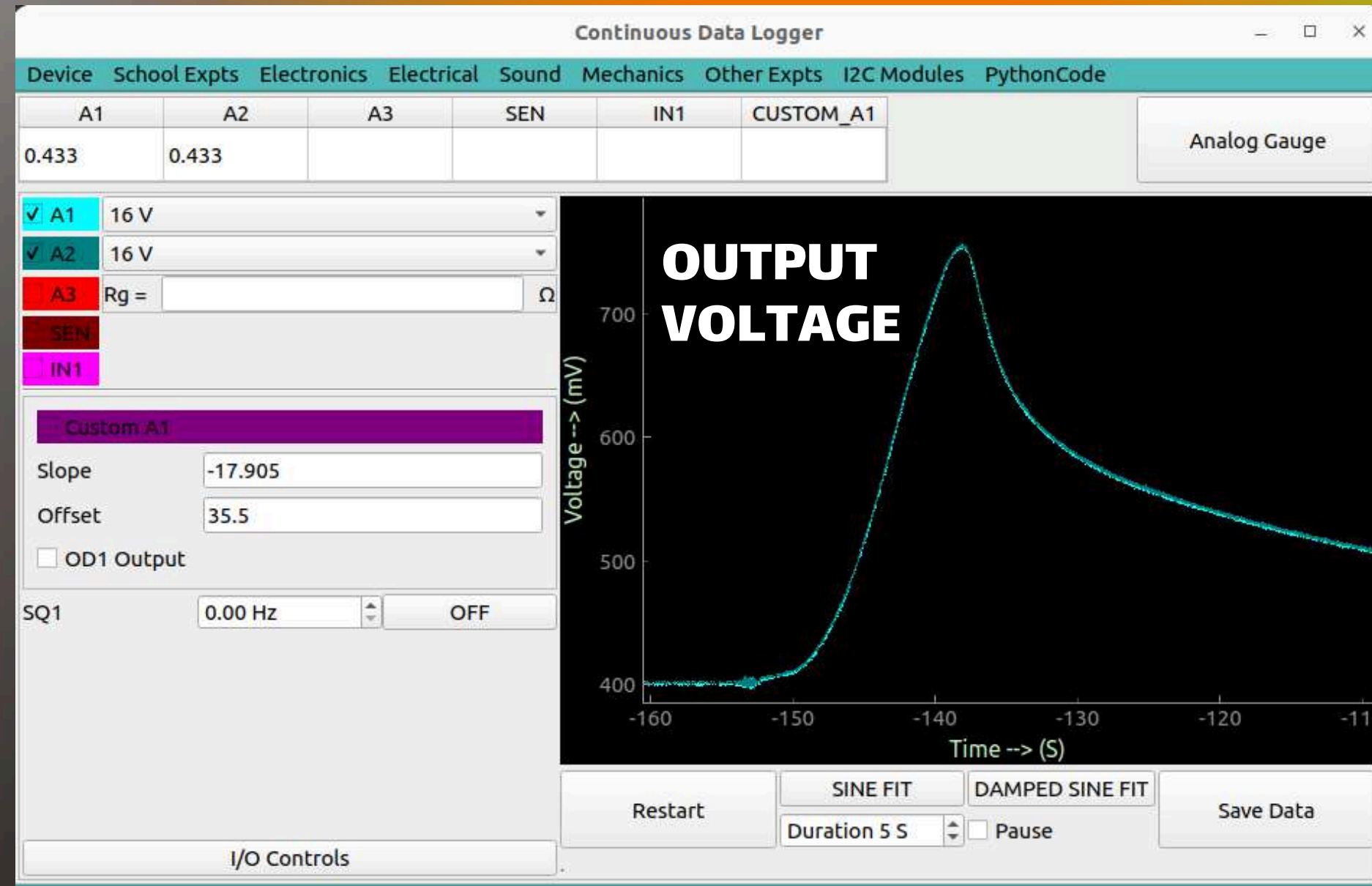


Title	Journal	Author(s)
EXPLORES THE TRANSIENT PHENOMENA OF ELECTROMAGNETIC INDUCTION	HBCSE - TIFR	Amit Dhakulkar and Nagarjuna G
Evaluation of Boltzmann's Constant : Revisit using interfaced data analysis	Physics Education 32(3):1-5 · September 2016	Vandana Luthra et al
Analysis of Transient Response of First & Second Order System using ExpEYES	International Journal of Electrical Electronics and Computer Systems (IJEECS)	Omkar S. Vaidya et al.
Optical Sensor Using ExpEyes Junior Kit	International Journal of Innovations in Engineering and Technology (IJJET)	Trilochan Patra
AUDIO FREQUENCY ANALYZER USING EXPEYES AND RASPBERRY PI	3rd international conference on recent innovations in science engineering and management	Haldankar et al.
A Low Cost Open Source Hardware Tool for Integrated Learning Experience in Laboratories	Journal of engineering education transformations DOI: 10.16920/jeet/2015/v0i0/59677	A. B. Raju et al.

INNOVATIVE APPROACH FOR SOLAR RADIATION MEASUREMENT AND DATA ACQUISITION USING expEYES	<a href="http://dx.doi.org/10.29369/ijrbat.2015.03.II.0053">http://dx.doi.org/10.29369/ijrbat.2015.03.II.0053</a>	V S Rahangadale and A K Mitra
Determination of the band gap of germanium and silicon using ExpEYES-17 kit	Physics Education Phys. Educ. 57 025026	Subhrajyoti Biswas
Study of Fourier series of user defined waveforms using ExpEYES-17 kit	Phys. Educ. 57 035008	Subhrajyoti Biswas
Study of magnet fall through conducting pipes using a data logger	SN Applied Sciences( <a href="https://doi.org/10.1007/s42452-019-1086-z">https://doi.org/10.1007/s42452-019-1086-z</a> )	Abdul Kareem Thottoli et al.
Construction and remote demonstration of an inexpensive but efficient linear differential variable transformer (LVDT) for physics or electronics teaching during COVID-19 pandemic	Physics Education, Volume 58, Number 1(10.1088/1361-6552/ac93de)	Arijit Roy et al 2023 Phys. Educ. 58 015007
Microcontroller based study of diode thermometers for online demonstration of undergraduate laboratory classes in COVID-19 lockdown	Physics Education, Volume 57, Number 4 (10.1088/1361-6552/ac563f)	Subhrajyoti Biswas and Durjoy Roy 2022



# Studying a low-cost glucometer (Amperometry)



Op-Amp outputs are monitored with A1, A2 voltmeters and plotted to study what the meter sees!

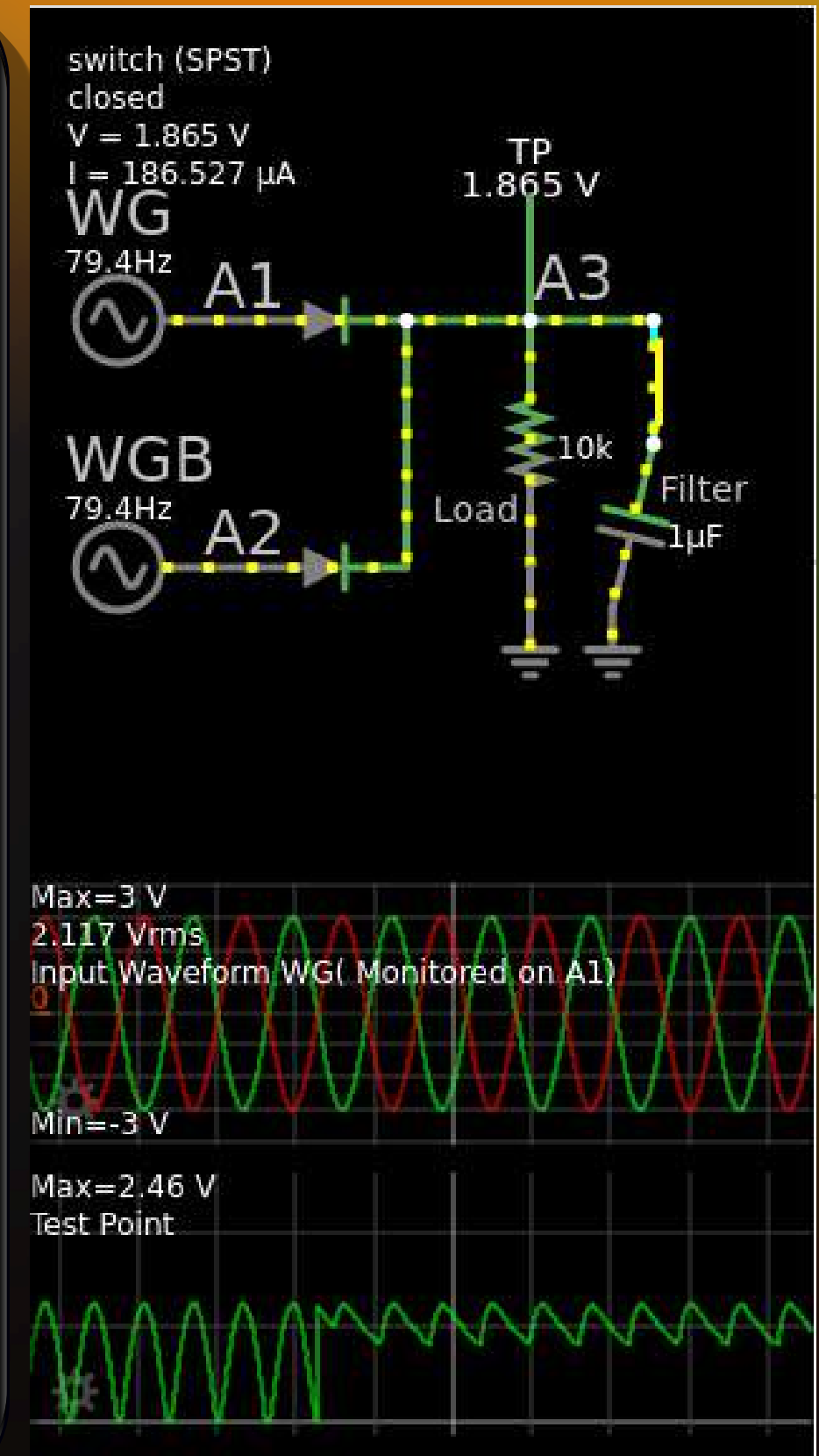
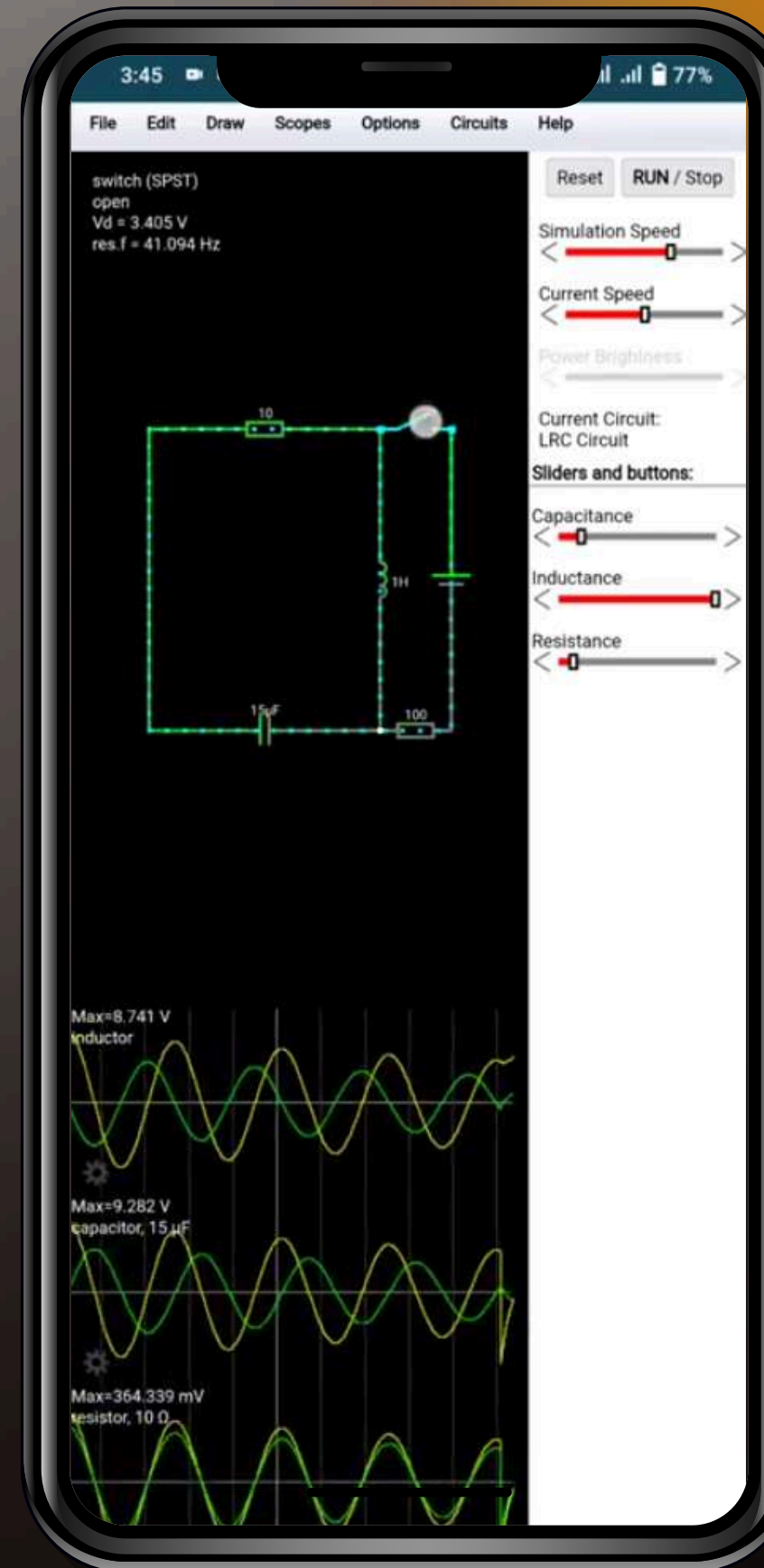


This device can be reprogrammed! Make your own enzymatic sensors!



## Circuit Simulator: Create and visualize circuits. Over a hundred examples

- Built into the desktop application
- Create circuits with a range of predefined components, and visualize current flows, phase differences, and even reflectance
- Also integrated into the mobile app with several extra examples specific to SEELab3.
- Most common circuits are readily available as reference for wiring up for physical studies.

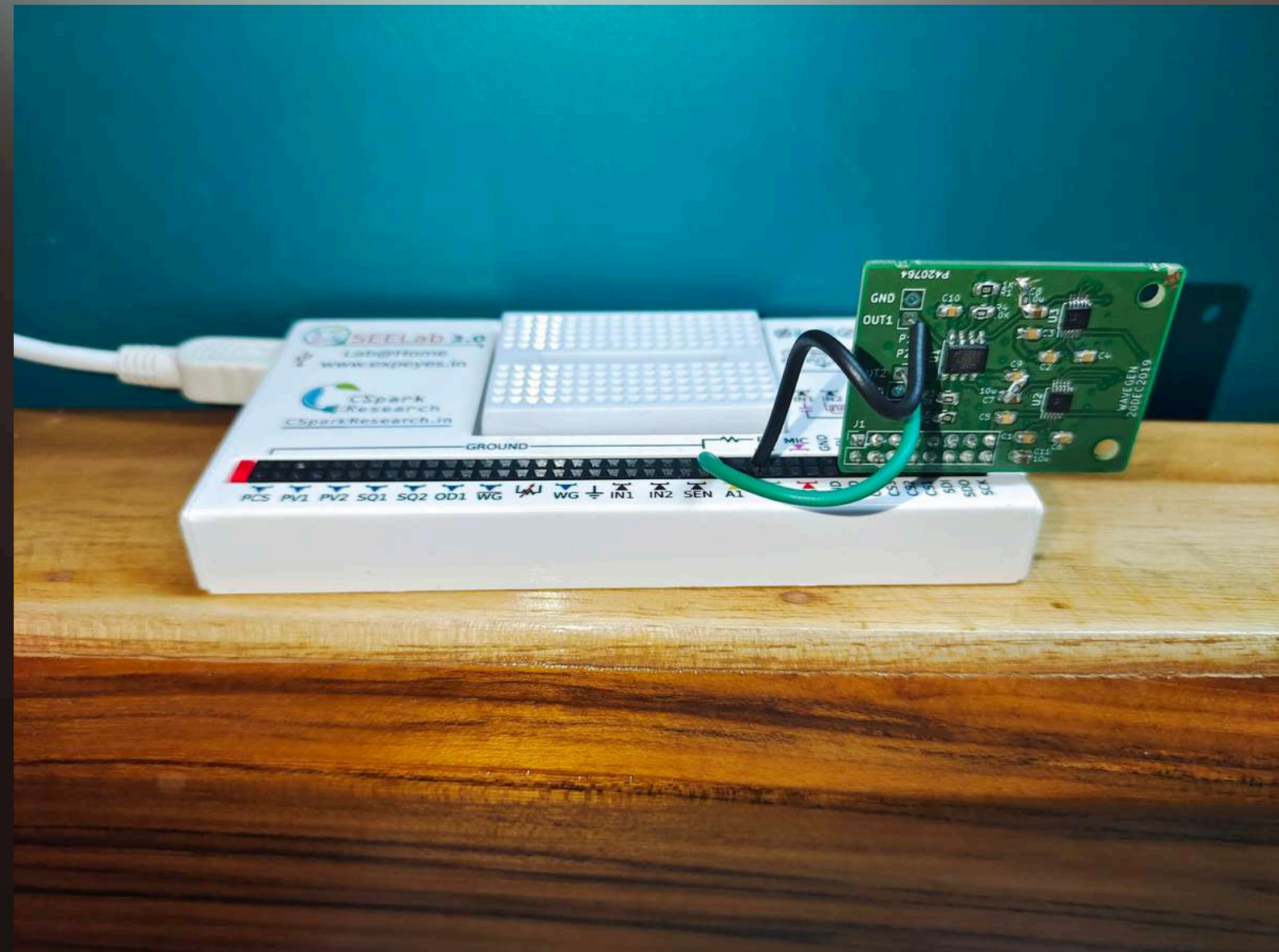
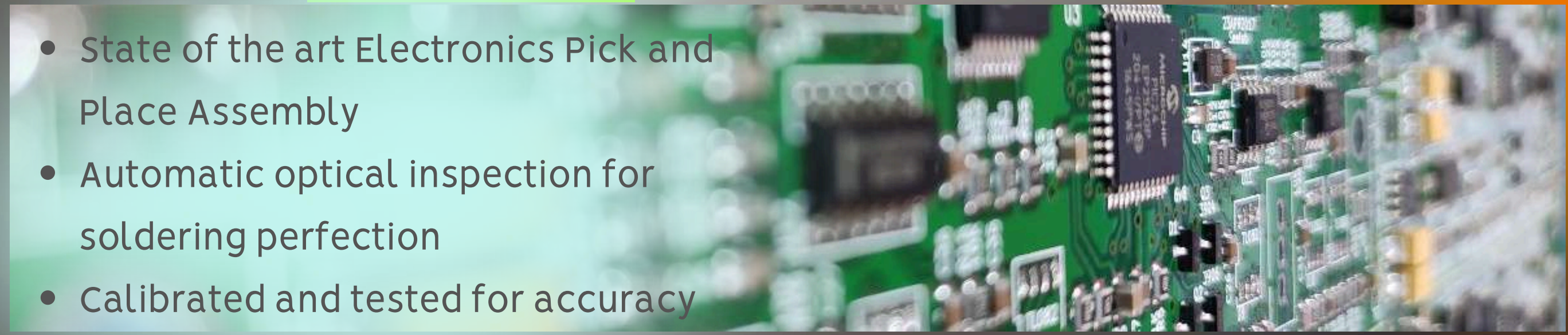




# Manufacturing, Testing, and Calibration



- State of the art Electronics Pick and Place Assembly
- Automatic optical inspection for soldering perfection
- Calibrated and tested for accuracy



Calibration Help!!!

Start Calibration

PV1	ADS0	A1	A2	A3	PV2	VR+	8
2.770	2.774	2.760	2.769	2.783	3.036	3.035	2.050

Select Directory

Warning: Click OK to upload. No to cancel?  
loading [4.339456022606854e-11, 1, 1, 1, 1, 1, 1, 1]  
PCS SCALING:1  
CR0 : 1.000  
CR1 : 1.017  
CR2 : 1.021  
CR3 : 1.000  
RES : 1.008  
Cap RC : 1.038

Error(Readback) --> (mV)

Actual Voltage --> (V)

		Test Group 1		Test Group 2		
		1	2	1	2	3
		021e-10	205.4 pF, 206 pF			test
		KHz	1 kHz, 3 V			test
		000.0	5.000e+03			test
		000.0	992 Ω			test
		0000.0	1.000e+04			test
		e-06	963.3 nF			test
	I2C scan	[ ]	[0, 72]			test
	CAP_SOCKET	4.4e-11	43.4 pF			test
	A1[1x]	Calibration	0.68			test
	A1[32x]	Calibration	6.80			test
	A2[1x]	Calibration	0.42			test
	A2[32x]	Calibration	6.73			test
	MIC/OD1	OD1 DC Bzr	2.4 kHz, 1.14 V			test



Designed and manufactured in India by



**SINE WAVEGEN**  
WG, WG

**OSCILLOSCOPE**  
A1, A2, A3, MIC, SEN, IN1

**VOLTAGE SOURCES**  
PV1 PV2 OD1 5V 4V 6V

**SQUARE WAVE**  
SQ1 SQ2

**RC METER** SEN IN1

INTRODUCING SEELAB3: WORKBENCH

# A versatile collection of test and measurement equipment!

Download App Watch Video

SEELab3: SJ-5.1

ExPEYES17  
SEELab 3.0

learning by doing!

your lab @ home

• PYTHON PROGRAMMABLE

• VISUAL PROGRAMS

• CROSS PLATFORM

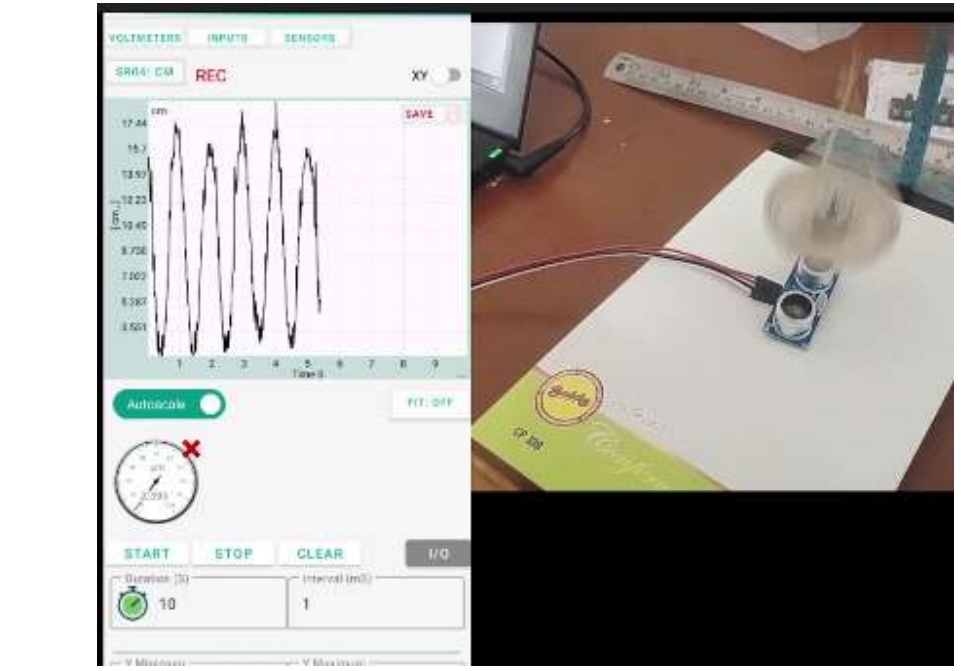
• DATA ANALYSIS TOOL

SCROLL DOWN

APP

**WEBSITE**

<https://csparkresearch.in/seelab3>



**INSTAGRAM**

<https://instagram.com/csparkresearch>

**Phone +91-8851100290**  
csparkresearch@gmail.com

Introduction

[eyes17lib.readthedocs.io/](https://eyes17lib.readthedocs.io/)  
Functions : Accessing the hardware

Analog Waveforms

Digital Sensors

- ✓ **Analog Measurements:** Voltages, Oscilloscope calls etc
  - ✓ Voltage Measurement
  - ✓ Capture calls
  - ✓ Capture configuration such as trigger, select\_range etc
  - ✓ Code Examples
- ✓ **Analog Output:** Set Voltages
  - ✓ PV1, PV2
- ✓ **Waveform Generators:** configure sine, triangle, square wave outputs
  - ✓ sine wave frequency, amplitude, shape configuration
  - ✓ square wave
  - ✓ settings
- ✓ **Digital I/O**

