INDUCTANCE CAPACITANCE METER

By UpThrust

UpThrust

OPERATION OVERVIEW

- Power On: Press the Power Button to turn on the device.
- Mode Selection: Use the Mode Button to choose the desired measurement mode: Inductance or Capacitance.
- Range Selection: Adjust the range using the Range Up or Range Down buttons to suit the component being measured.
- Component Insertion: Insert the capacitor or inductor into the measuring probe.
- Result Display: The measurement result is shown on the display.

PRODUCT FUNCTIONALITY

Inductance Measurement

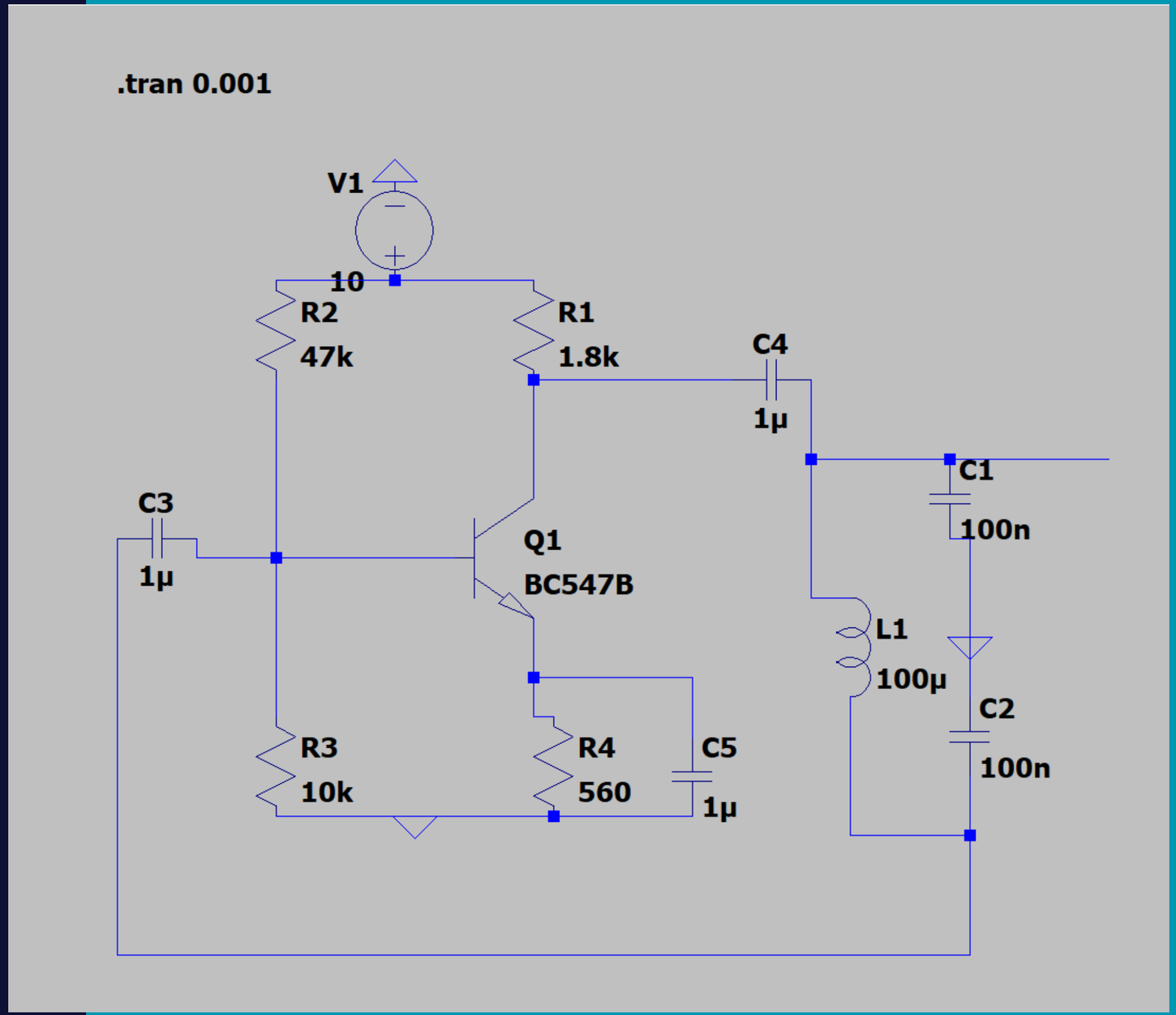
Determines the resonance frequency by resonating the unknown inductor with a capacitor and converts it to a corresponding voltage to calculate the inductance.

Capacitance Measurement

Charge the unknown capacitor while comparing it to a reference voltage. Then measure its capacitance by generating a ramp and sampling it at a desired time and measure the voltage at that time.

INDUCTANCE MEASUREMENT

Schematic Diagram



CALCULATION

$$L = \frac{1}{4\pi^2 f^2 \cdot C_{eq}}$$

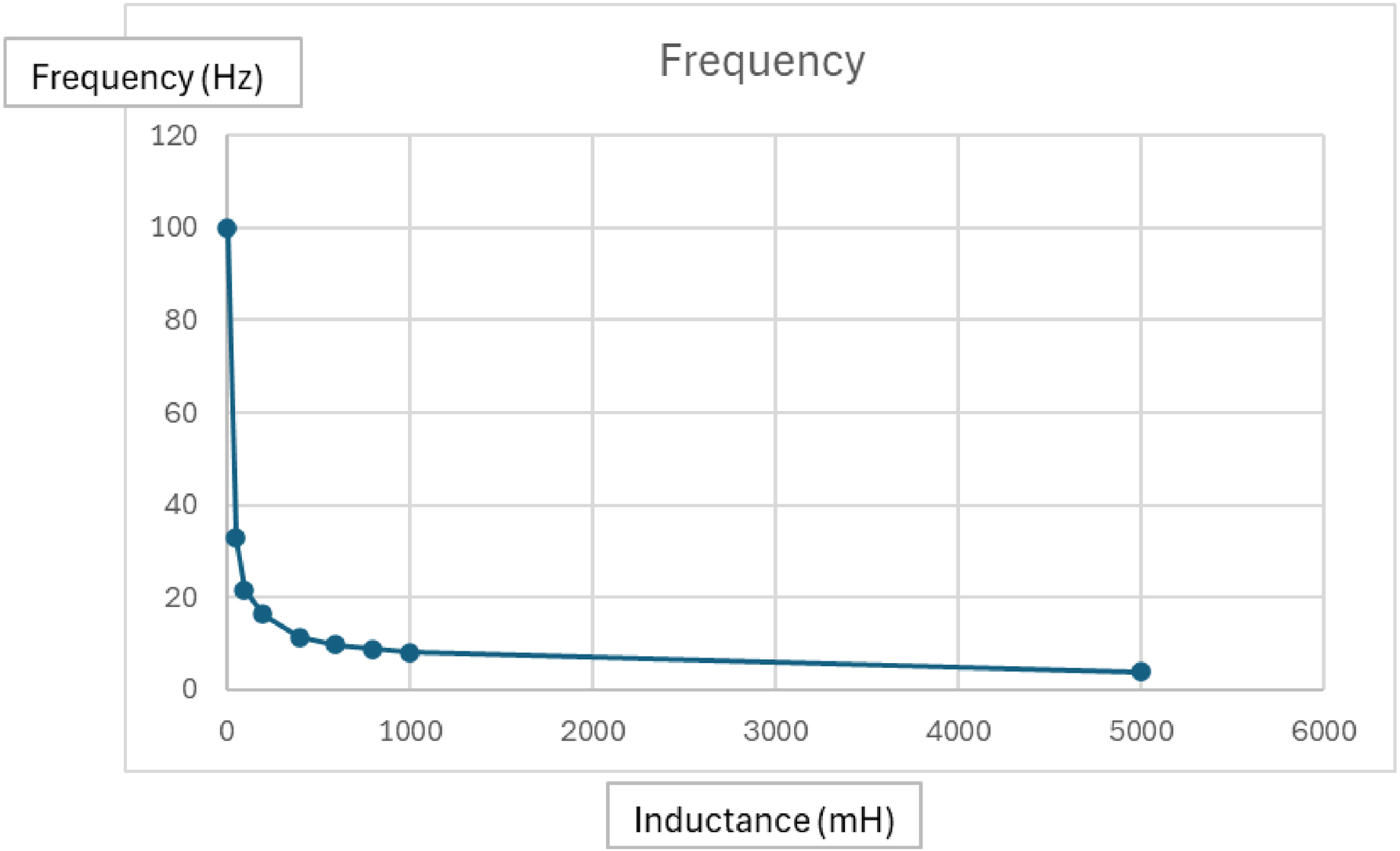
where:

- f = frequency of oscillation (in hertz)
- L = inductance (in henries)
- C_{eq} = equivalent capacitance (in farads), given by:

$$C_{eq} = \frac{C_1 \cdot C_2}{C_1 + C_2}$$

where C_1 and C_2 are the two capacitors in the Colpitts oscillator circuit.

CHANGE OF FREQUENCY WITH INDUCTANCE

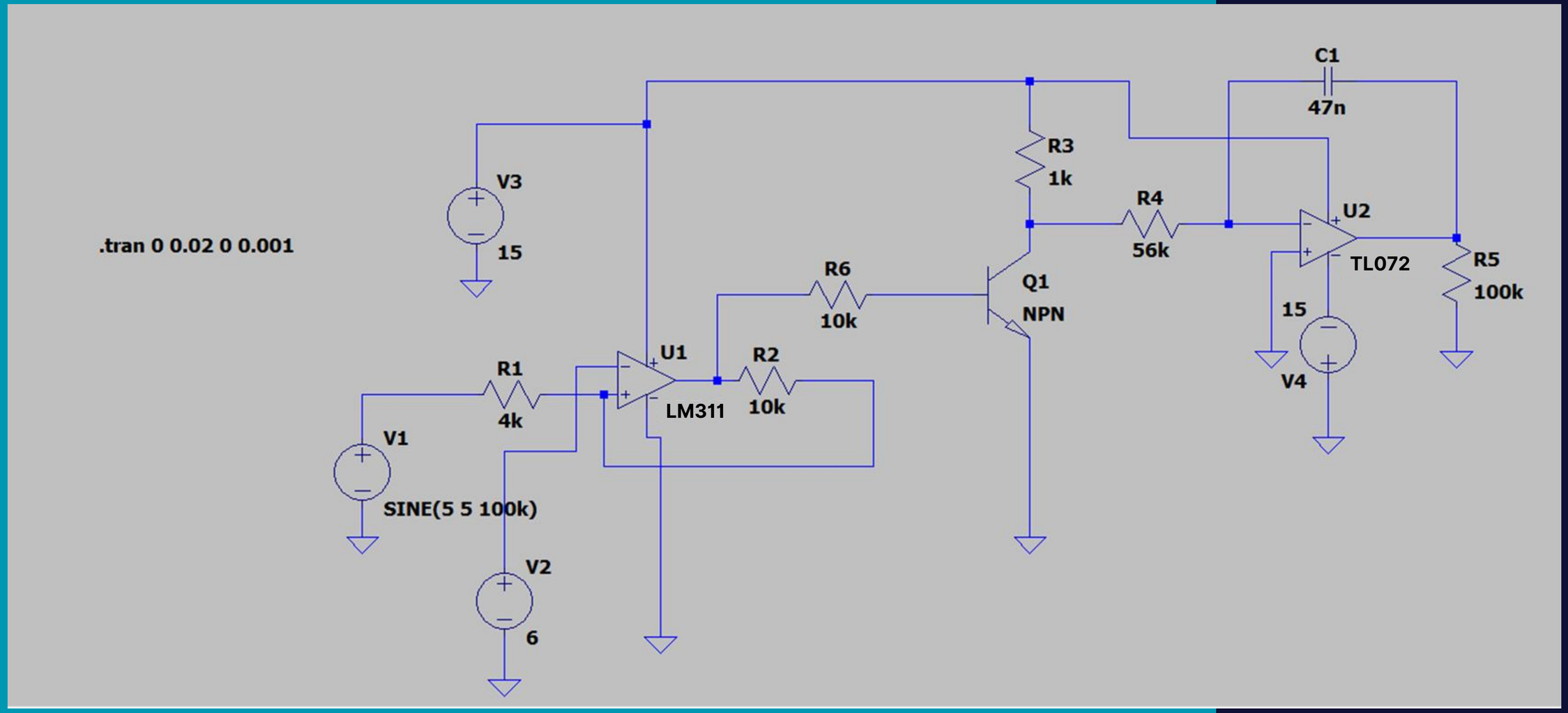


FREQUENCY TO VOLTAGE CONVERTER LOGIC

Squarize the sine wave → Make a pulse train of that frequency → Integrate

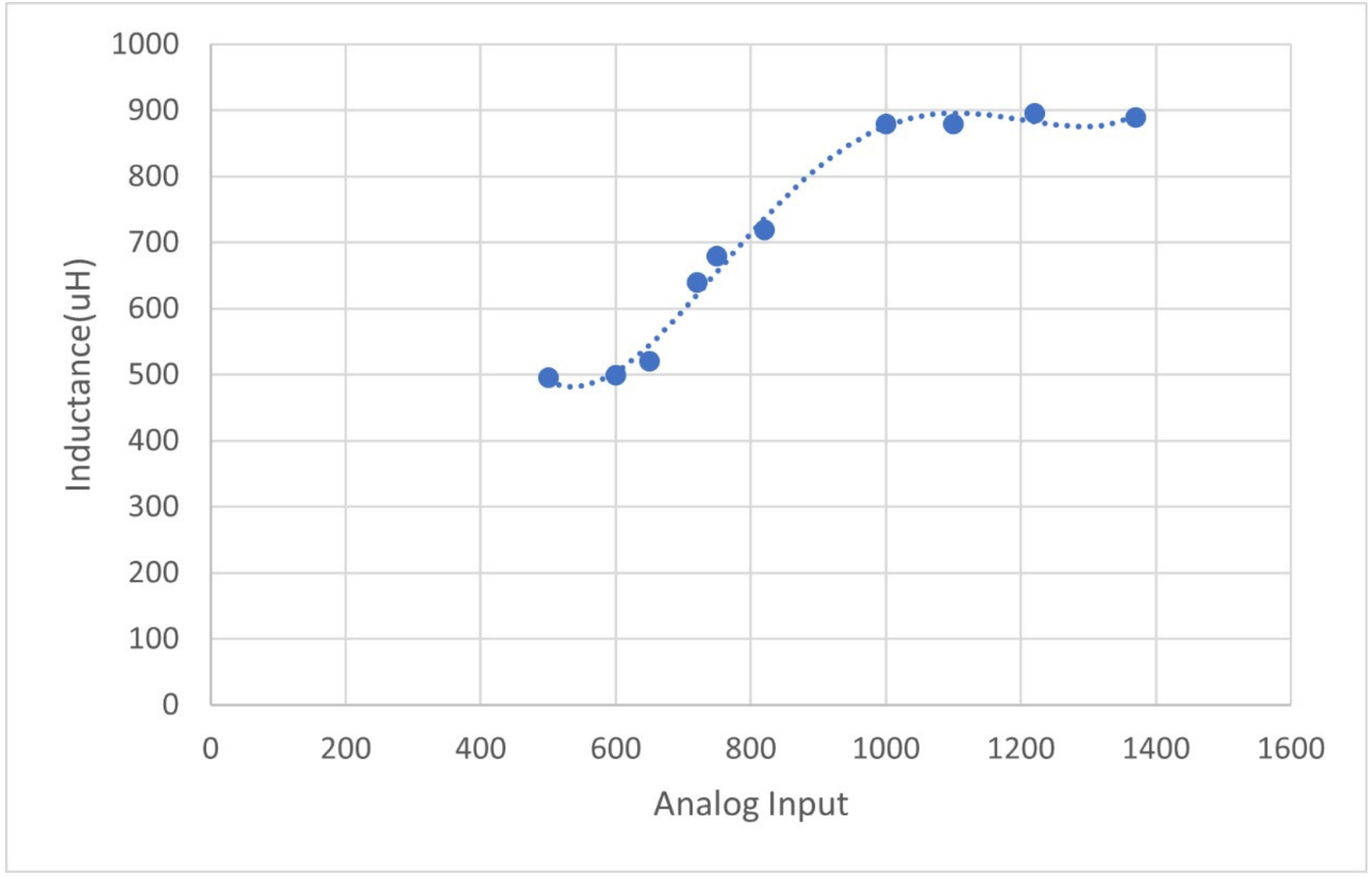
Schmitt trigger/ Comparator → Pulse train of ~50% Duty cycle → $V = A \times D \times \frac{1}{f}$

FREQUENCY TO VOLTAGE CONVERTER CIRCUIT



FUNCTION DERIVATION

500-1000 uH Range



350-500 uH Range

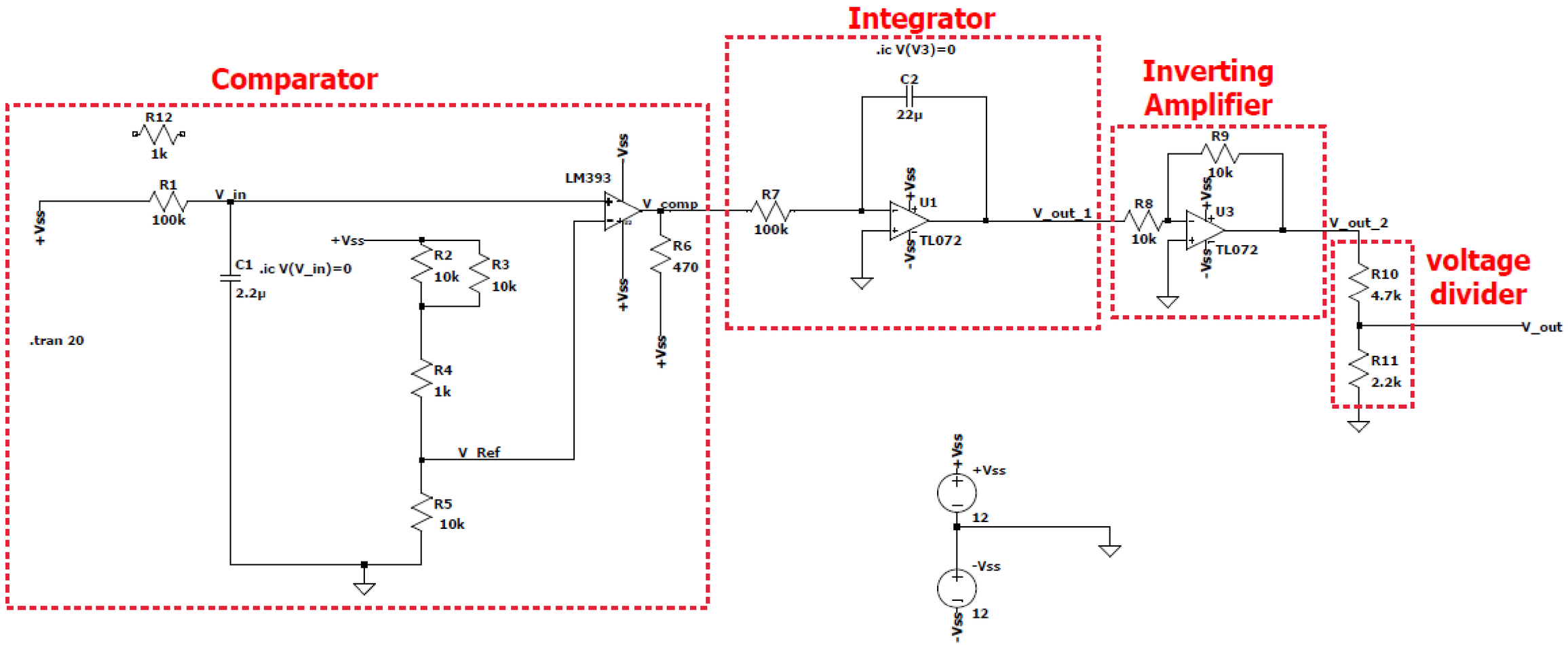
COMPONENT SELECTION

- Op-Amp suitable for high frequencies
  - High Slew rate
  - High GBP
- Better if
  - Low Input Offset Voltage
  - High CMRR
- Comparator IC-LM 311
  - High Frequency Comparator functionality
  - Low Noise
- Integrator IC-TL072

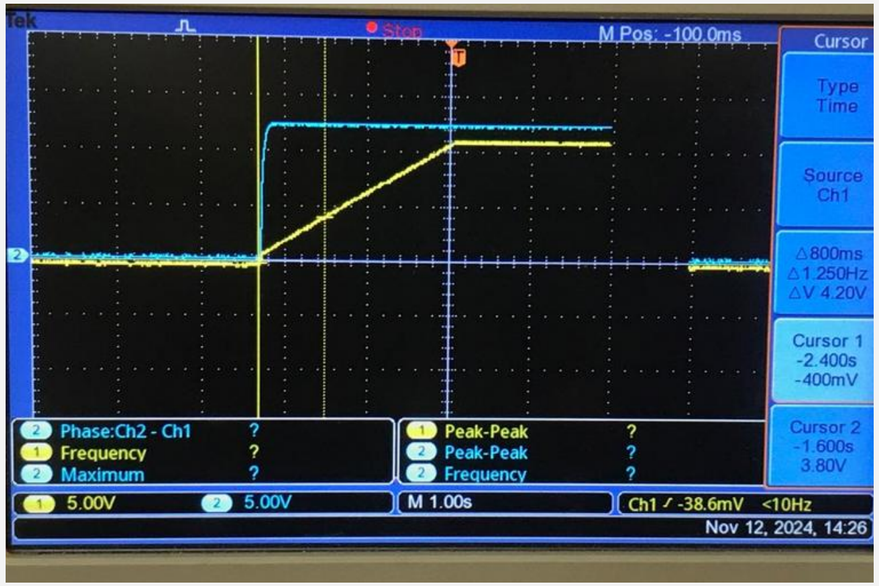
TEST RESULTS

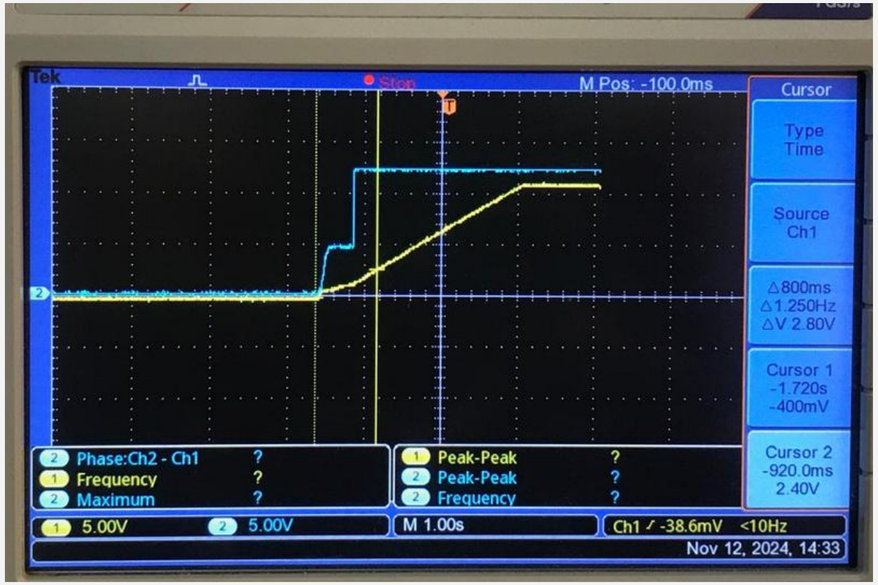
CAPACITANCE MEASUREMENT

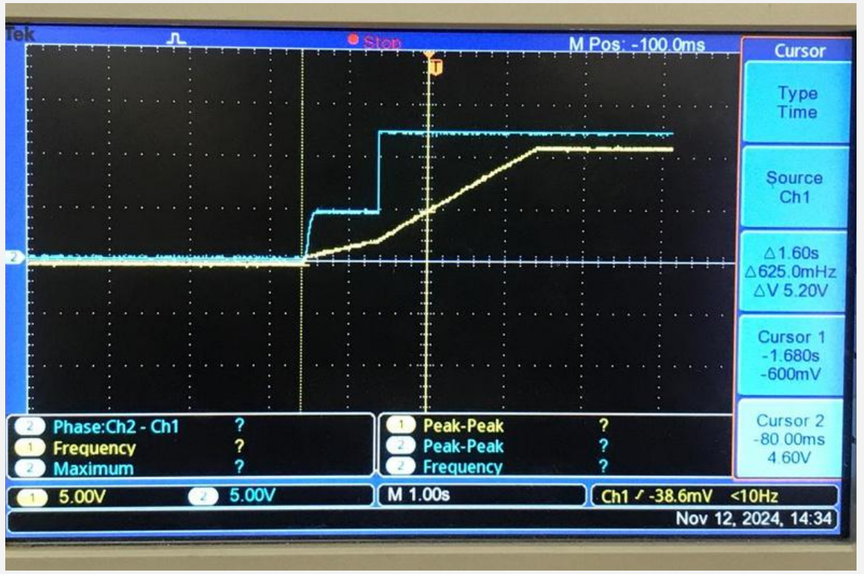
Schematic Diagram



TEST RESULTS

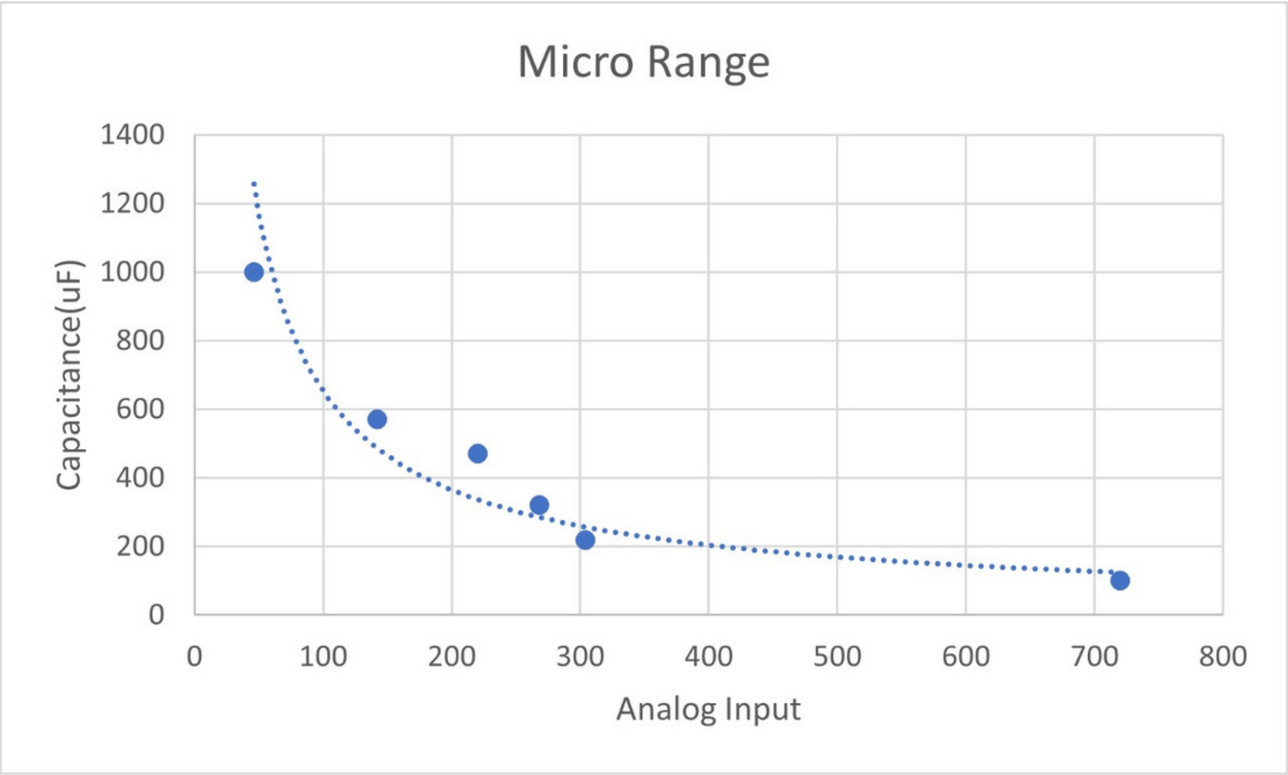




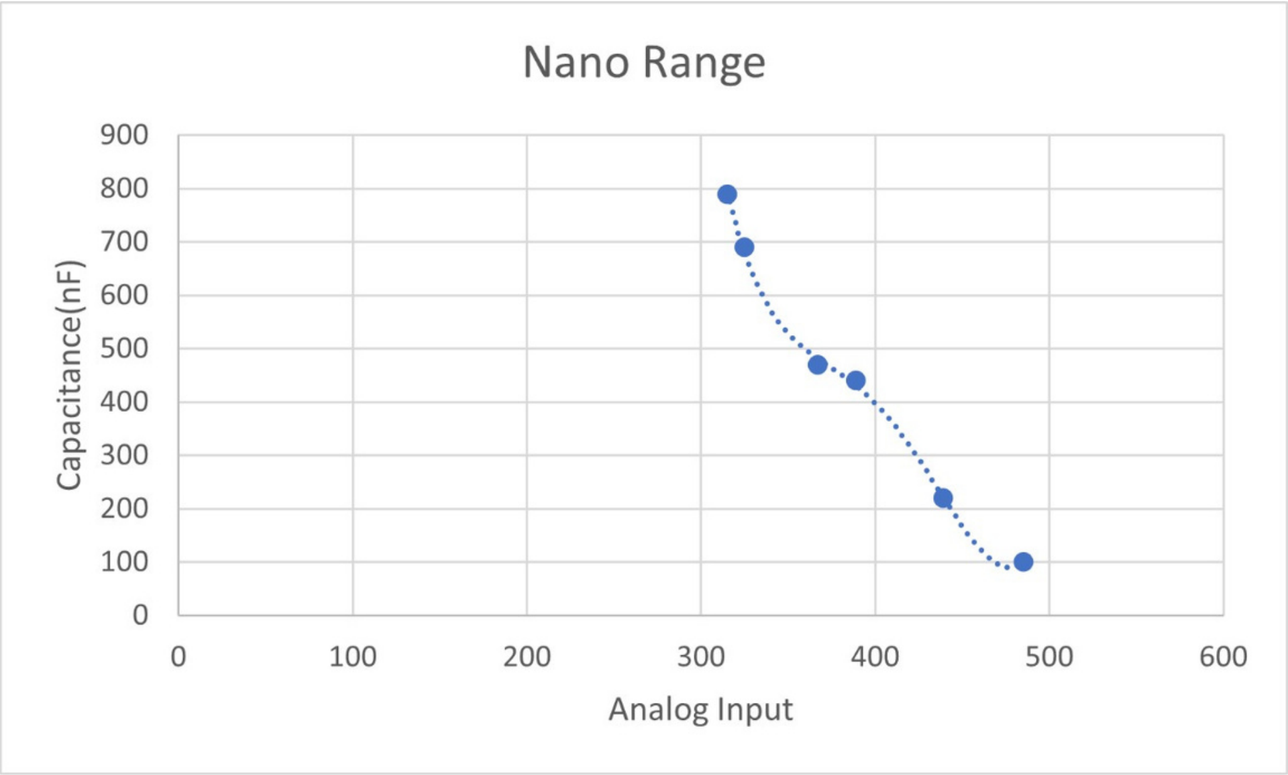


FUNCTION DERIVATION

uF Range



nF Range

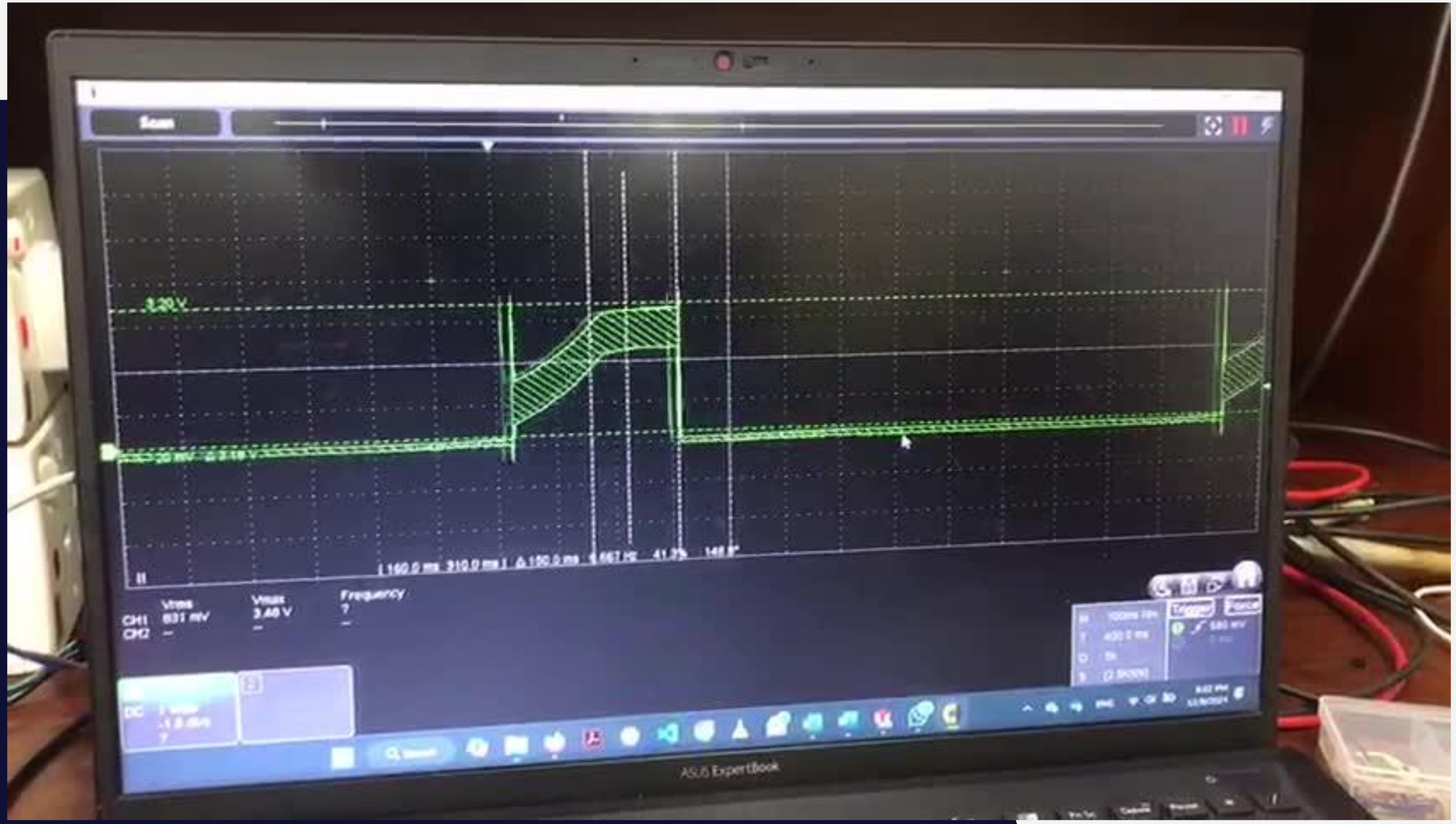


TEST RESULTS

uF Range

TEST RESULTS

nF Range



IC SELECTION

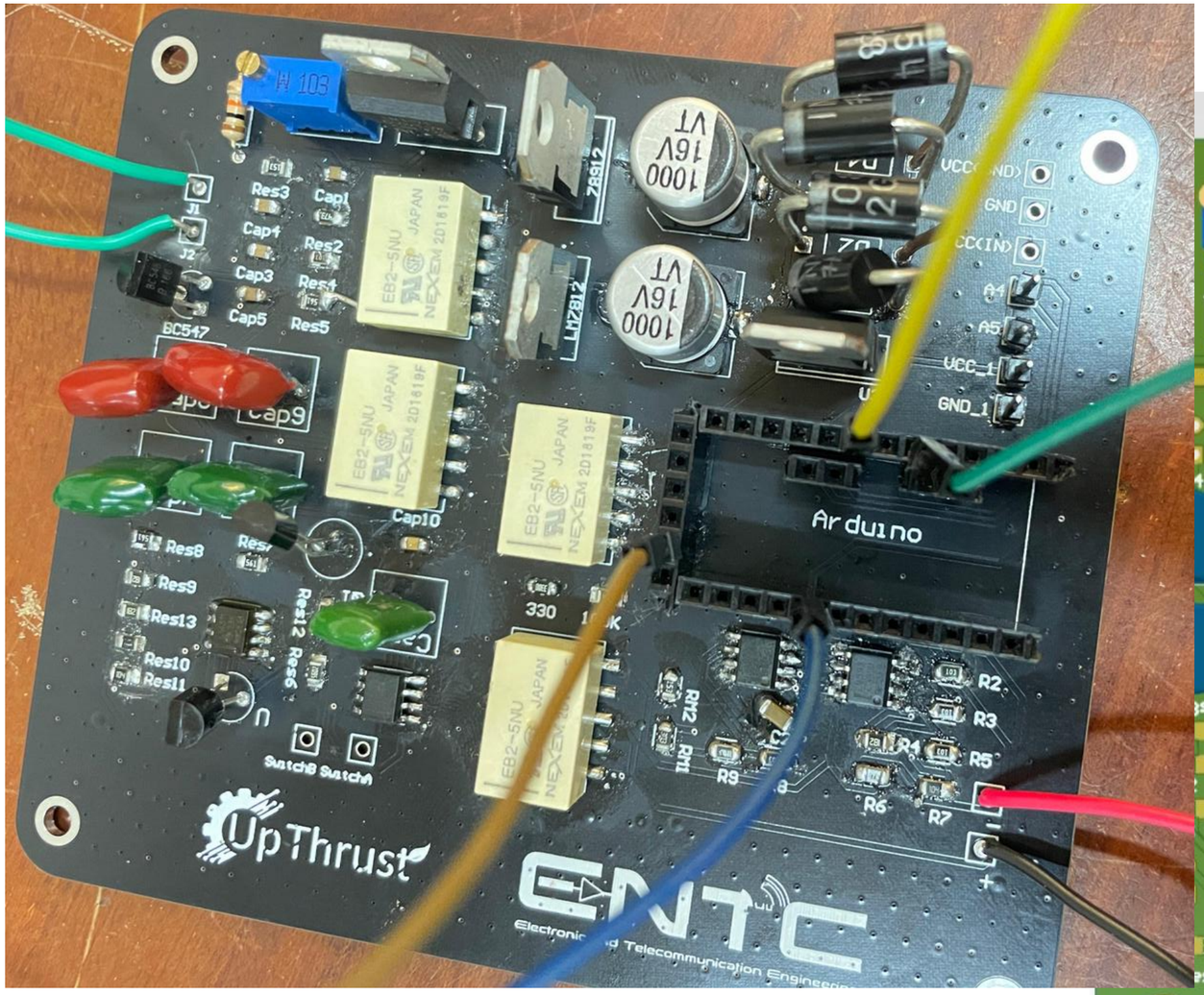
Integrator IC Selection

	TL072	OPA064	LM741
Slew Rate	**13V/µs**	25V/µs	0.5V/µs
Gain Bandwidth Product	**3MHz**	20MHz	1MHz
Input Bias Current	**65pA**	50pA	80nA
Price (1 piece)	**Rs.50($0.17)**	Rs.1020($3.48)	Rs.30($0.10)

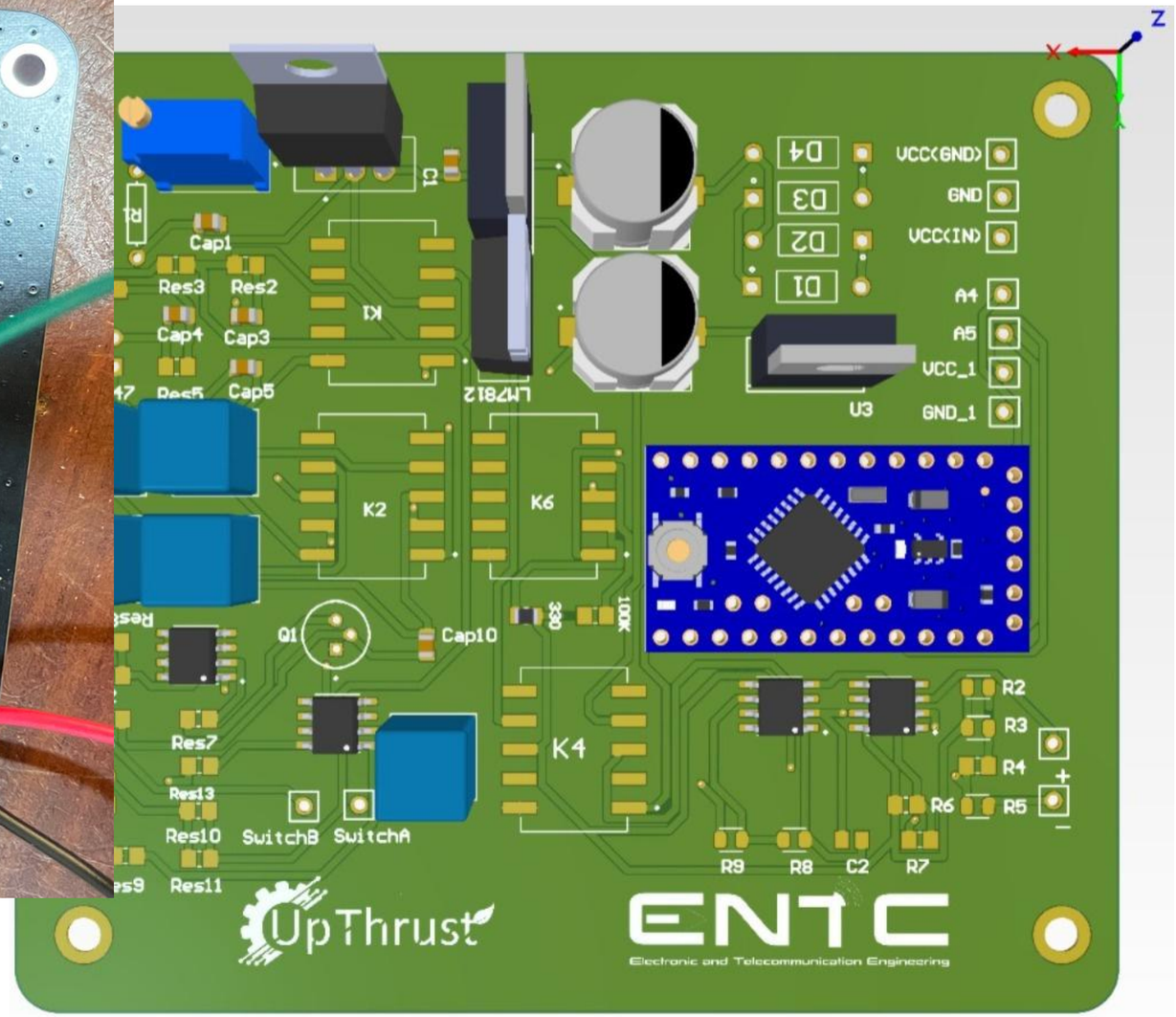
Comparator IC Selection

	LM393	LM339	LM741
Functionality	**Comparison**	Comparison	General Purpose
Number of Comparators	**2**	4	-
Response Time	**1.3 µs**	1.3µs	1-5 µs (varies)
Input Offset Voltage	**±1.0mV**	±2.0mV	±15.0mV
Output Type	**Open-collector**	Open-collector	Push-pull
Price (1 piece)	**Rs.20($0.07)**	Rs.30($0.10)	Rs.30($0.10)

PCB DESIGN



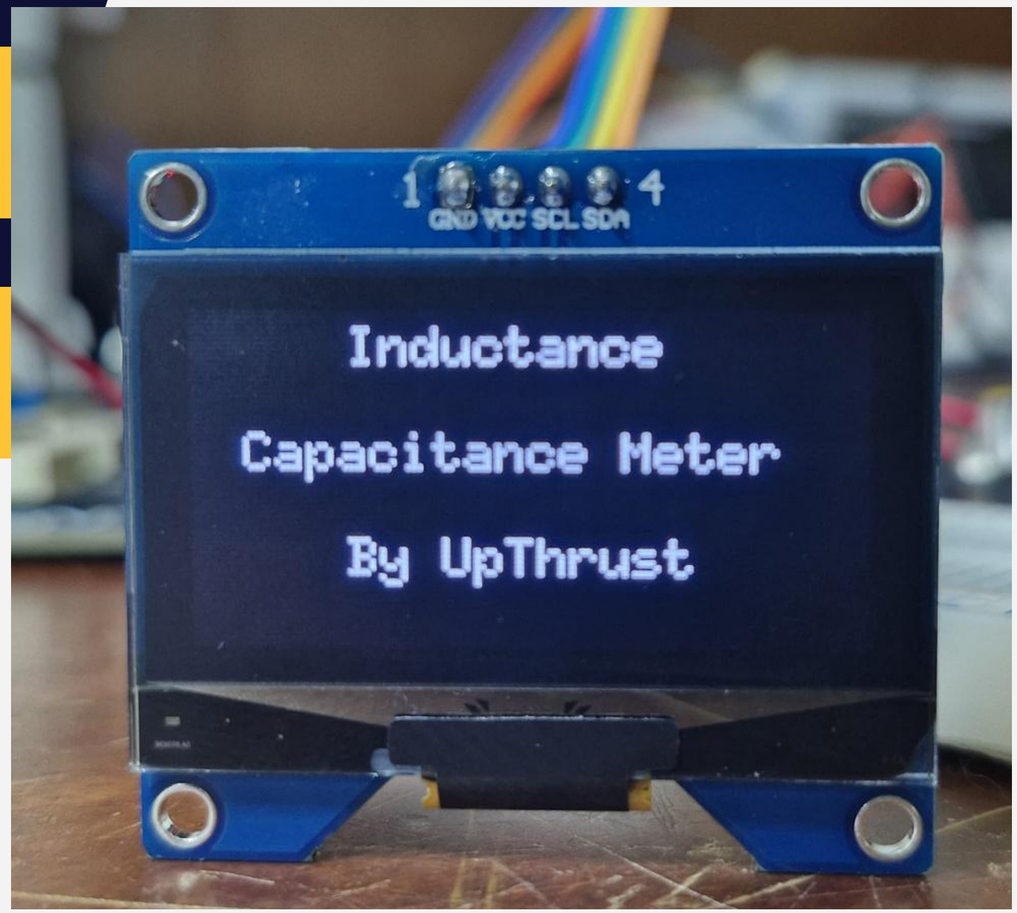
3D Model



INTERFACE

- 1.54 inch 128*64 I2C Oled is used to display the output.
- Arduino Pro mini used.
- 4 buttons used to:

1. Power on/ off device
2. Select mode
3. Move range up
4. Move range down



COMPONENTS

1.54 inch oled

- High Contrast and Clarity
- Compact Size
- Cost-effective

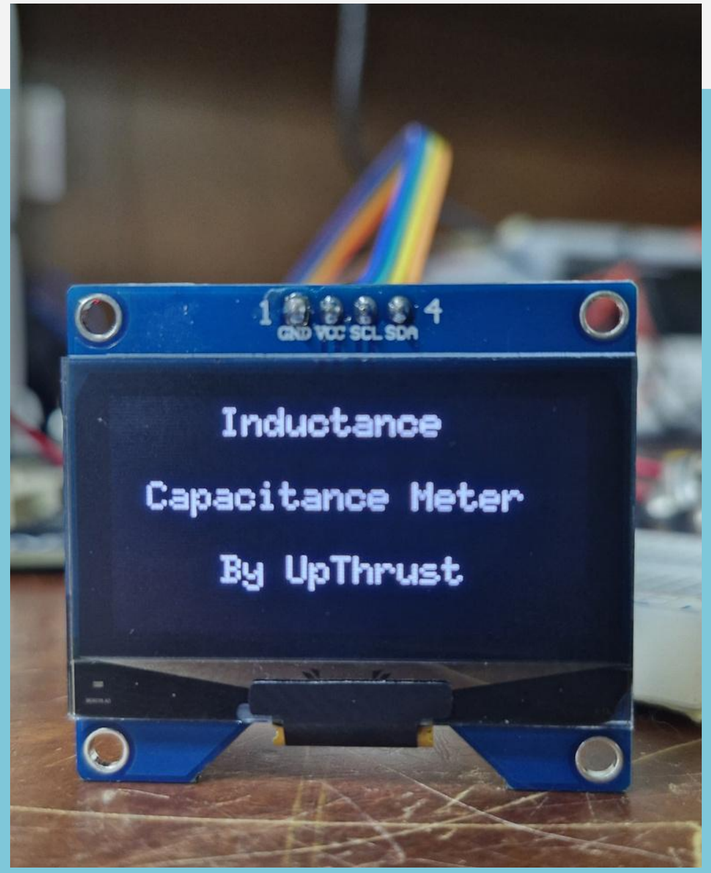
Arduino Pro Mini

- Sufficient I/O pins
- Cost effective
- Compact size

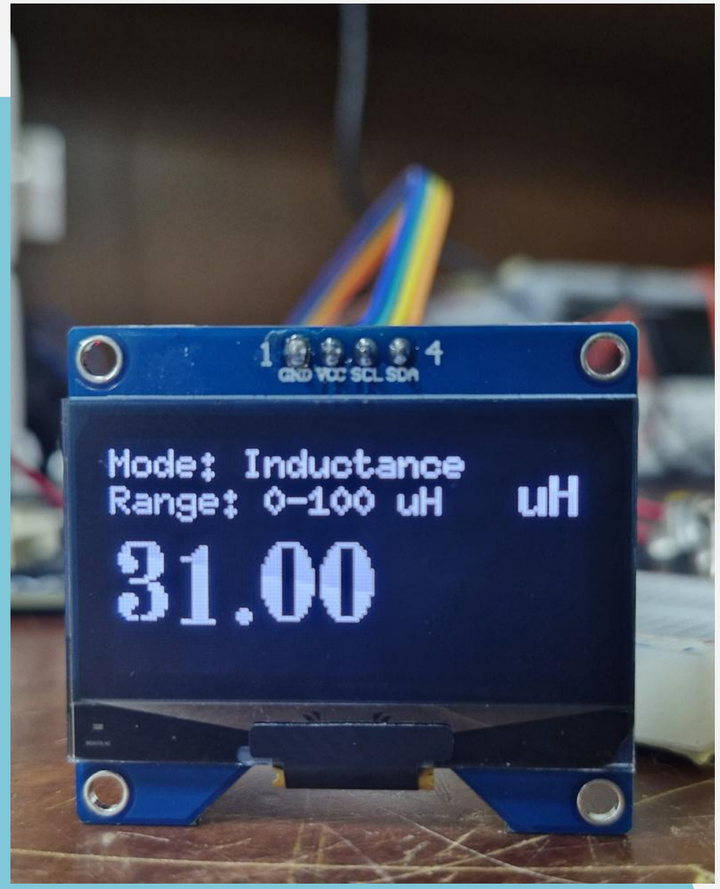
HOW THE INTERFACE WORKS

- The device powers up when the power on/off button is pressed and displays a welcome message
- The mode and the range changes according to button presses
- The inductance or capacitance value is displayed

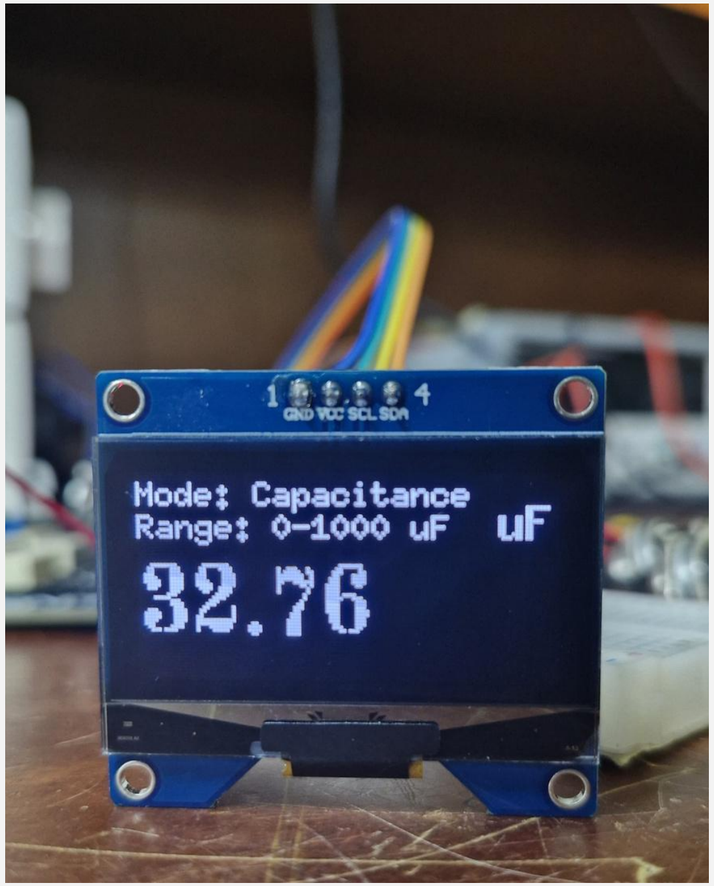
DISPLAY



Welcome Screen



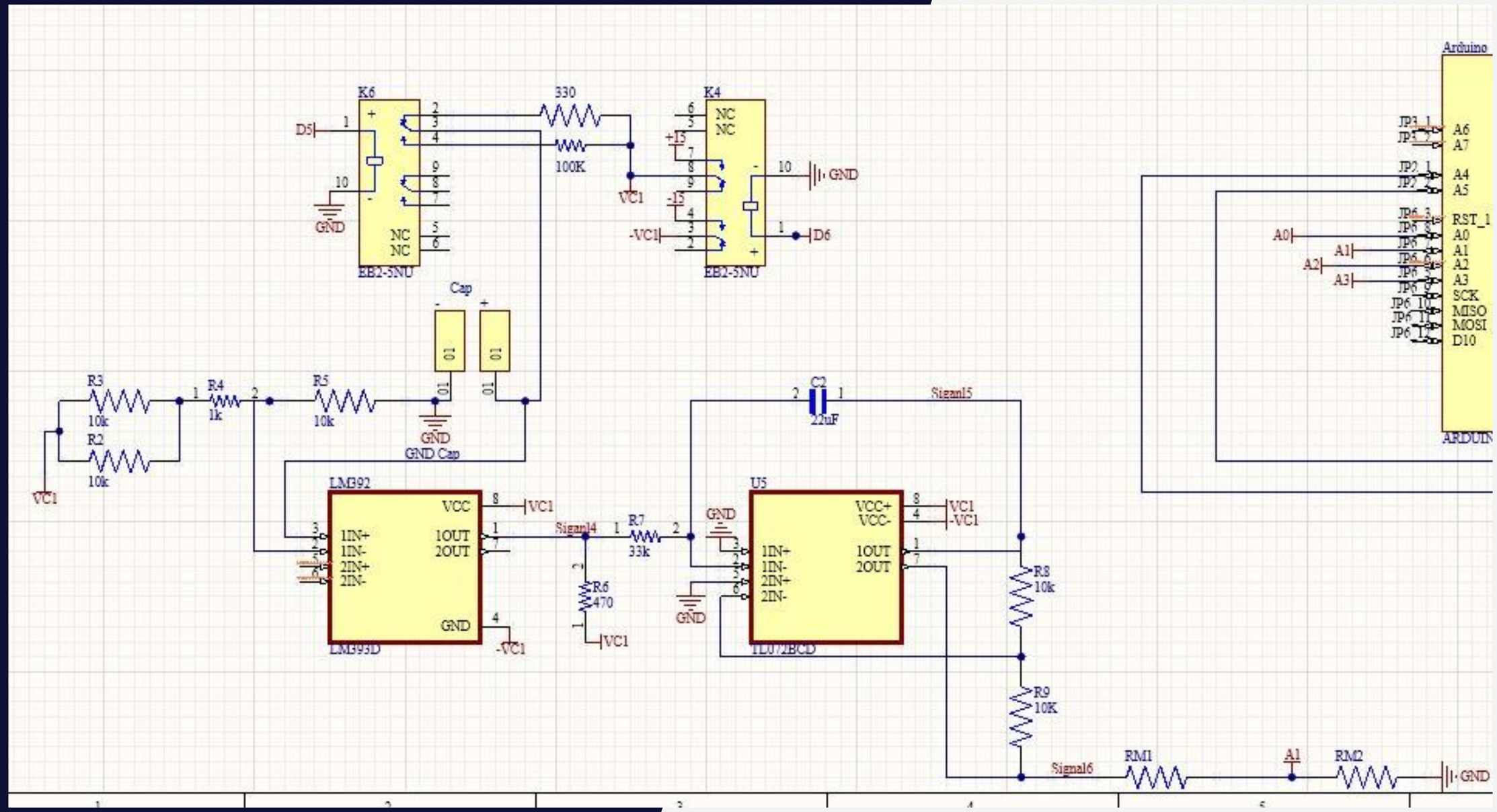
Inductance Mode



Capacitance Mode

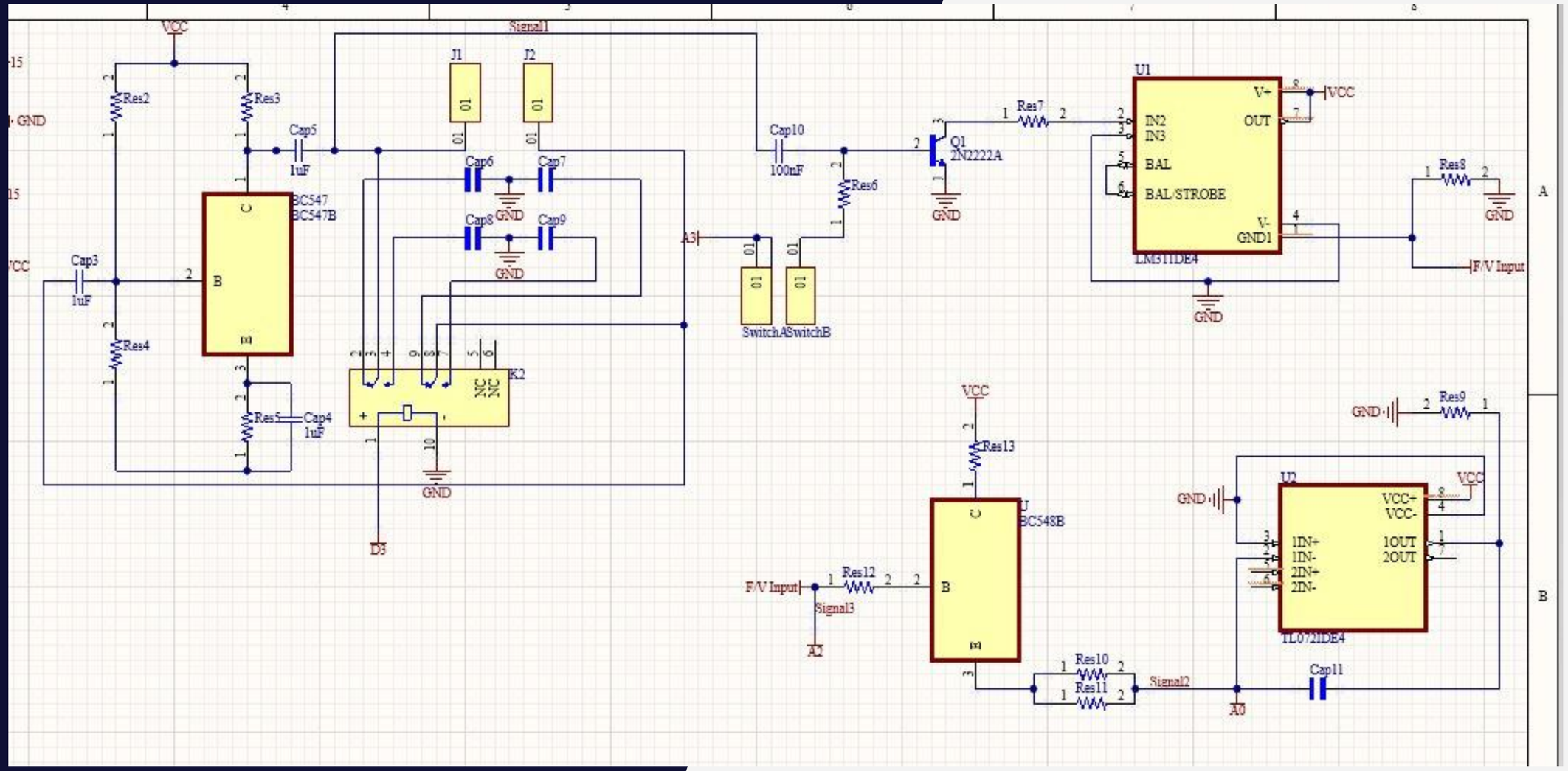
SCHEMATIC DIAGRAM

Capacitance circuit



SCHEMATIC DIAGRAM

Inductance circuit



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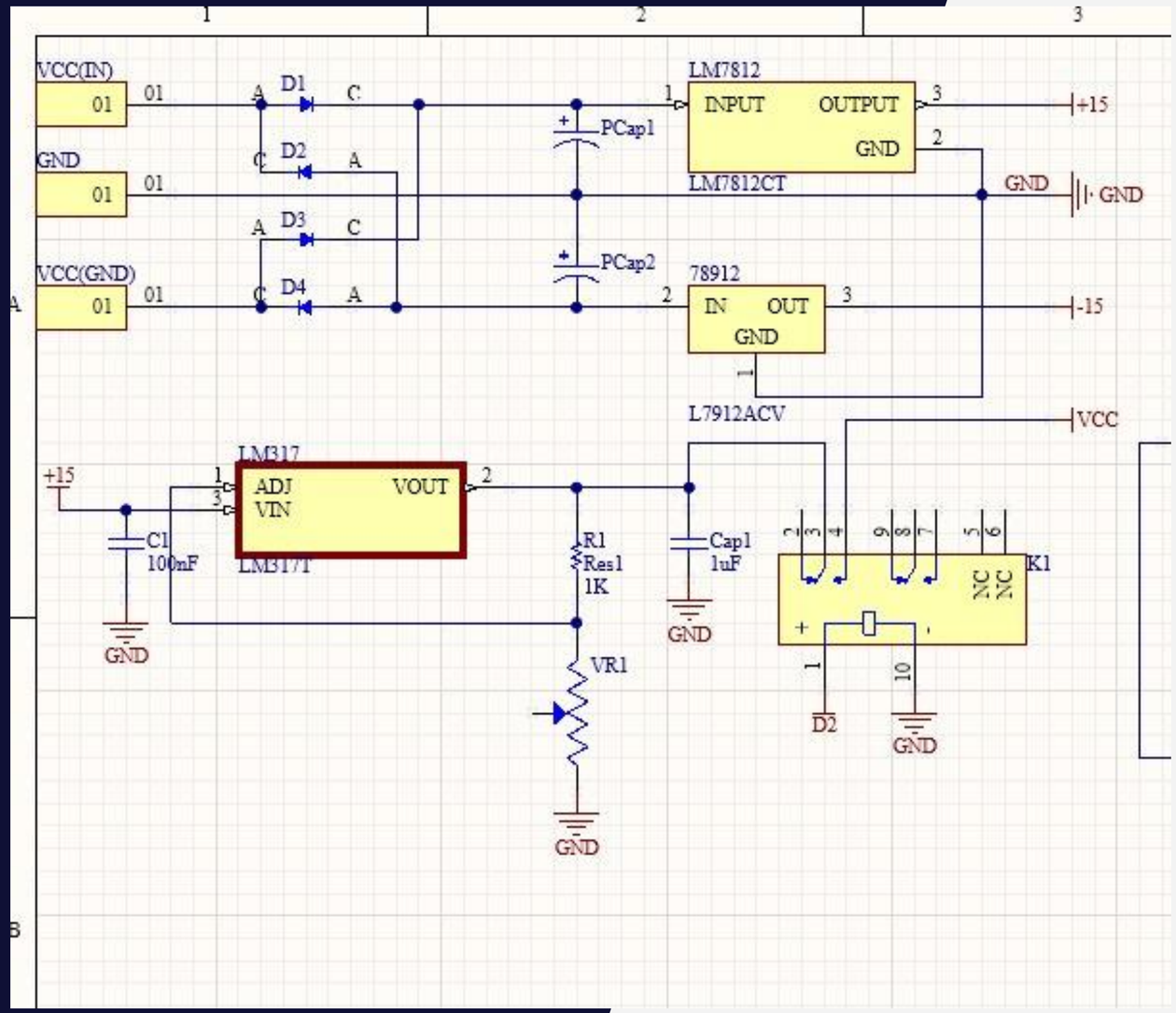
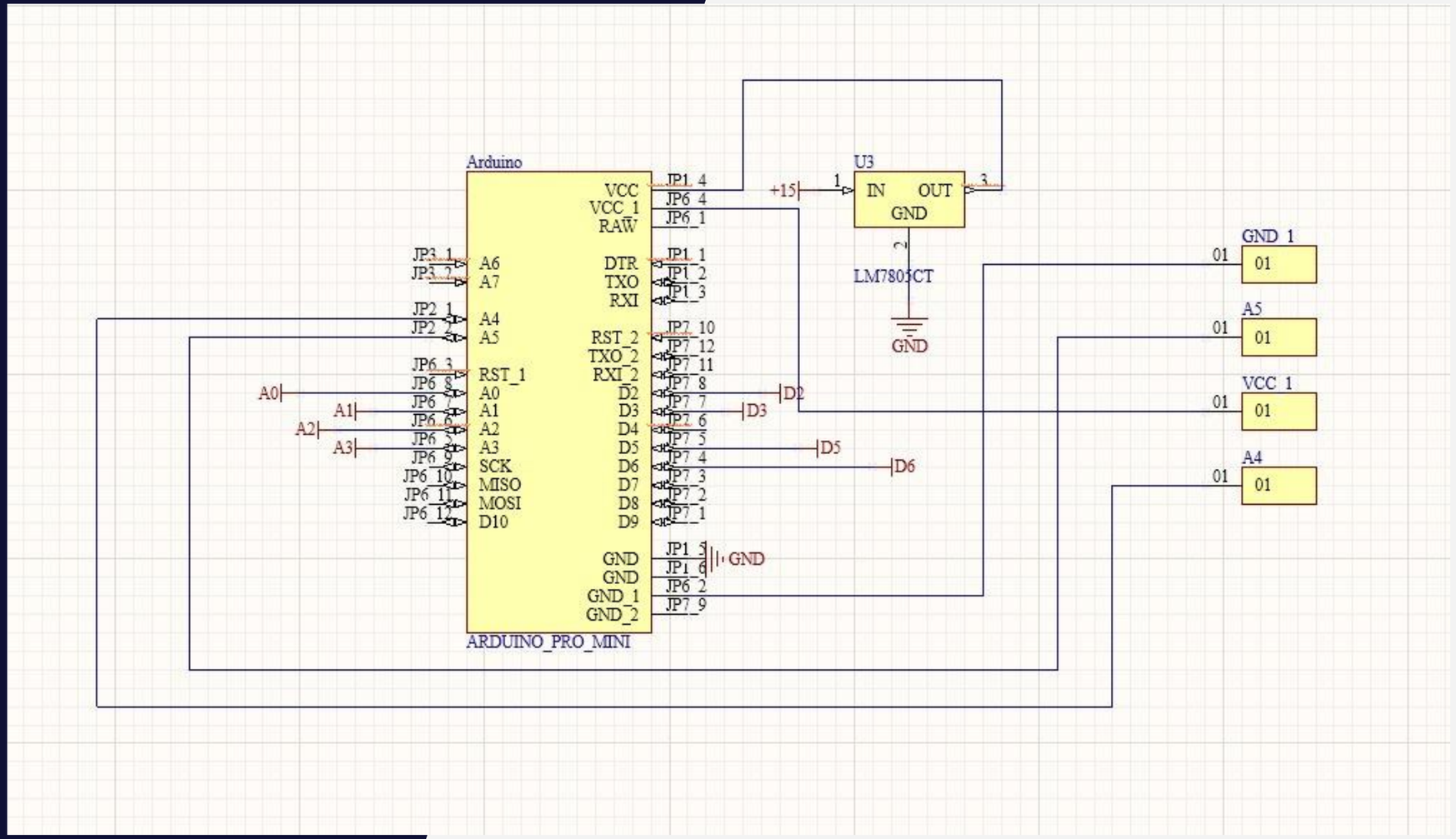


Power supply circuit

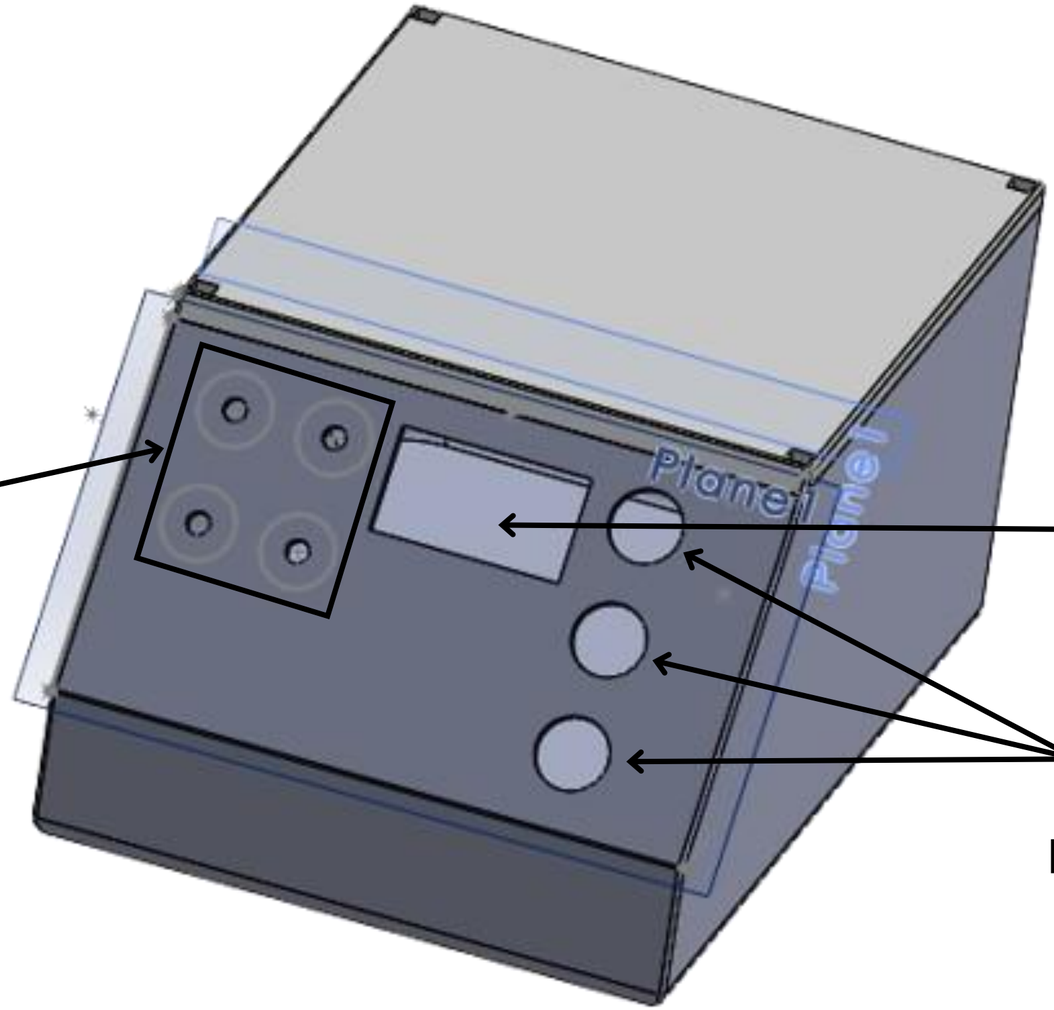
SCHEMATIC DIAGRAM

Microcontroller



ENCLOSURE DESIGN

Probes to measure inductance and capacitance



Display

Buttons for mode and range control

FINAL PRODUCT

THANK YOU