

Workshop Skills for Electronics Logbook

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Contents

Proteus Simulation.....	3
Bread Board Simulation	5
PCB Build.....	7
Conclusion.....	9

Proteus Simulation

Proteus Design Suite was used to simulate a non-inverting amplifier circuit shown below. In total, there were 4 resistors, 3 capacitors and an LM741 amplifier with a gain of three.

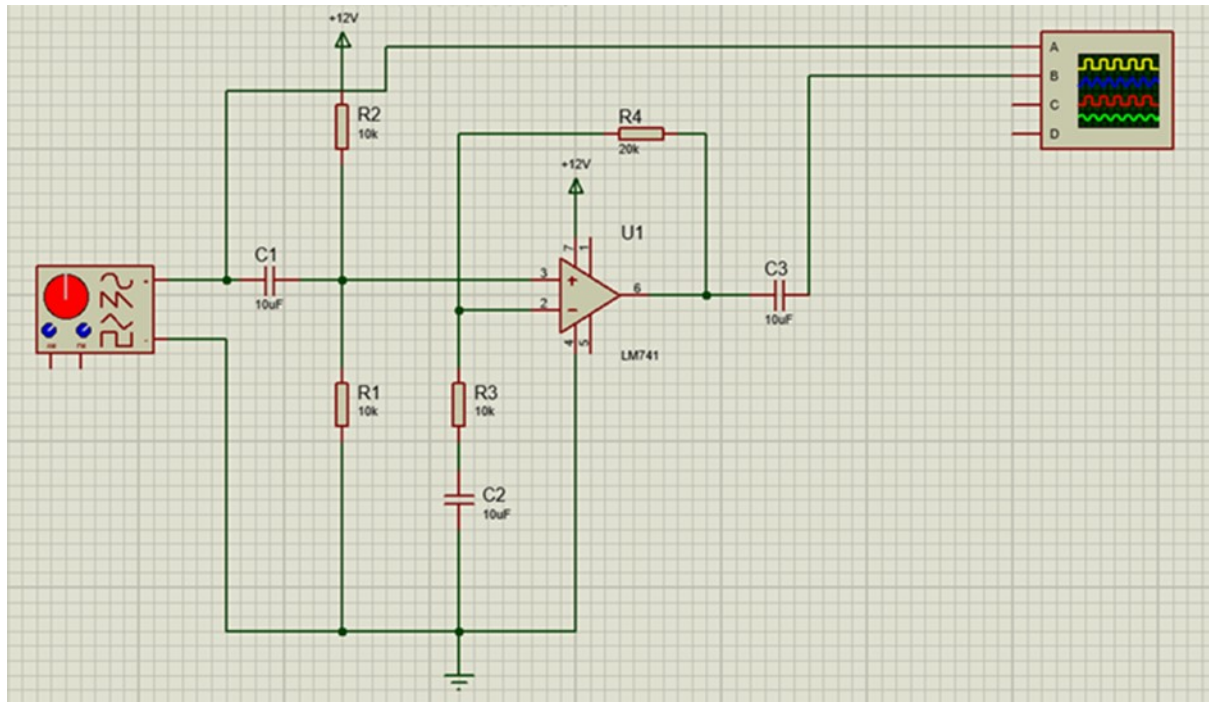


Figure 1 – Design of circuit in proteus software

From the raw data, we can see that Frequency influences Vout and gain. Gain is calculated using the following equation:

$$A = \frac{V_{out}}{V_{in}}$$

Note- Gain is a dimensionless quantity.

Frequency (Hz)	Vin (V)	Vout (V)	Gain
100	2.00	3.46	1.73
200	2.00	4.56	2.28
500	2.00	6.00	3.00
1000	2.00	6.00	3.00
2000	2.00	6.00	3.00
5000	2.00	6.00	3.00
10000	2.00	6.00	3.00
20000	2.00	5.78	2.89
50000	2.00	2.14	1.07
100000	2.00	2.10	1.05
500000	2.00	2.10	1.05
300000	2.00	2.10	1.05

Figure 2 – Raw data from proteus simulation

From 0.5-10kHz the gain remains at a constant value of three. This is in due to the output voltage being exactly double that of the input voltage.

When plotted graphically, a clear plateau is seen corresponding to the gain value of 3. The Gain begins at around 1.7, increasing and plateauing to 3, then falls to around 1 before forming a new, smaller plateau around a value of 1.

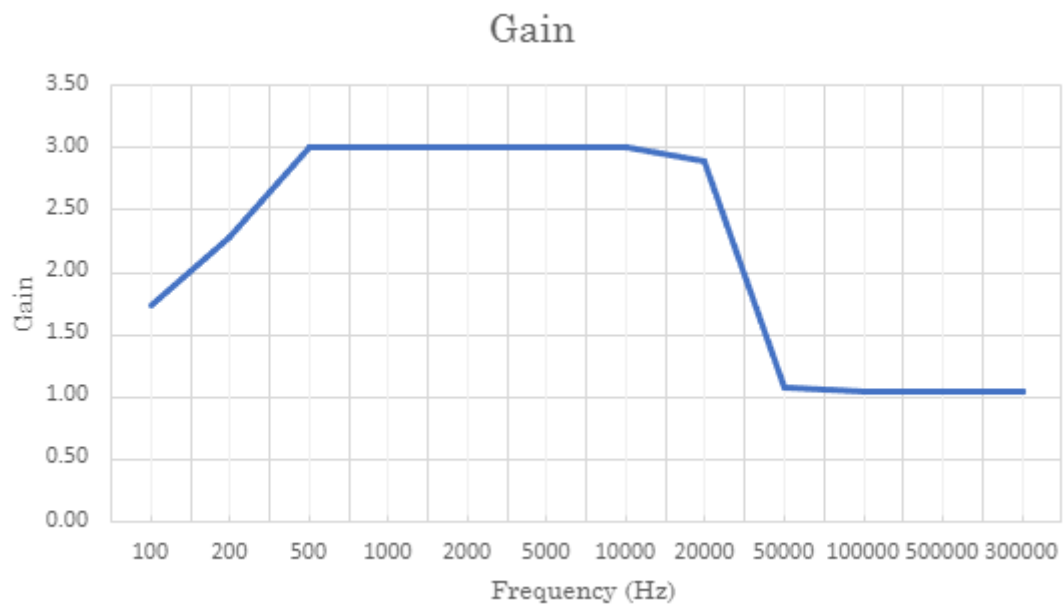


Figure 3 - Gain plotted against frequency (Hz) for Proteus Simulation

Bread Board Simulation

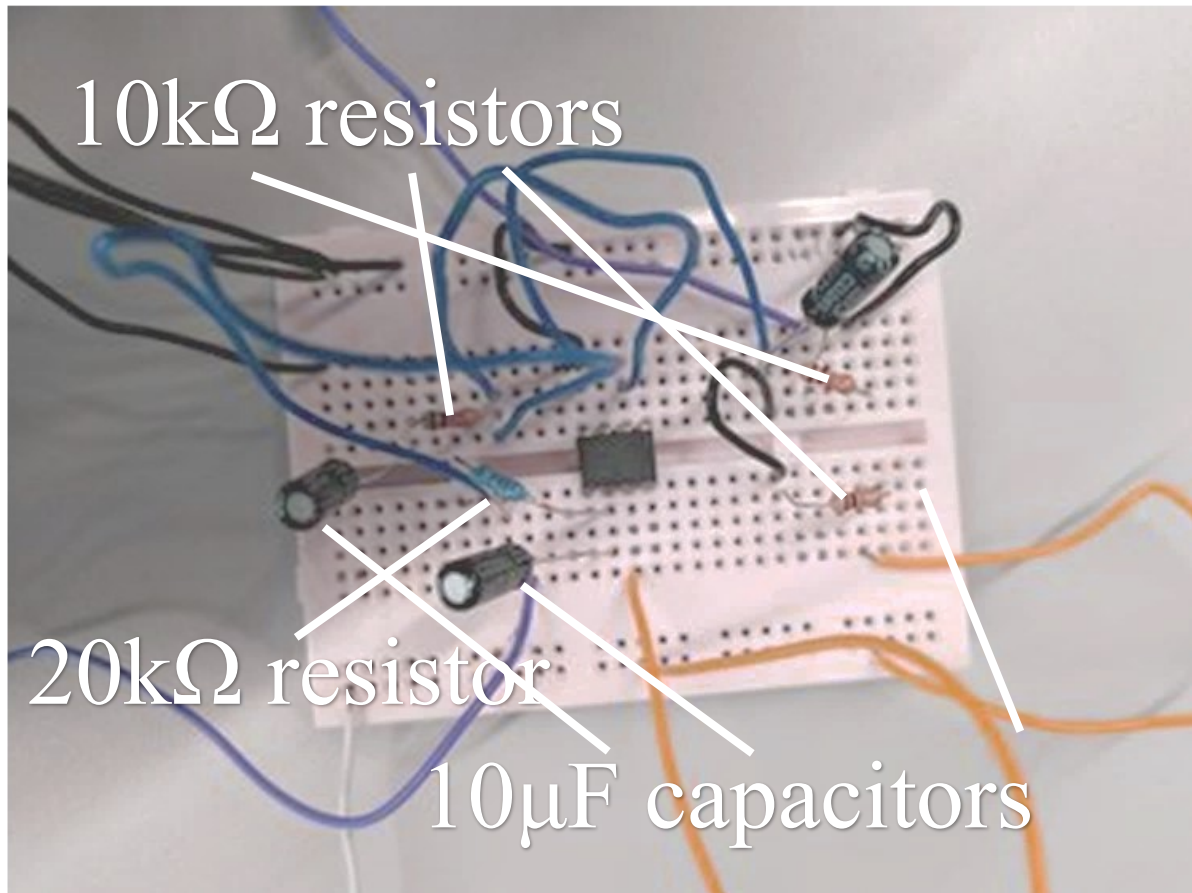


Figure 4 – diagram of breadboard with some components labelled.

Bread board may be seen here with components labelled. During the evaluation of the breadboard circuit, a sinusoidal input signal with an amplitude of 200mV and frequencies ranging from 100Hz to 2MHz was applied. The resultant output was monitored using an oscilloscope, and the gain was subsequently computed.

The input waveform from the signal generator was grounded and directed to the right terminal of component 3, which serves as a DC blocking capacitor, facilitating the transmission of the signal to pin 2 of the integrated circuit (IC).

The output waveform was observed at the right terminal of component 5, another DC blocking capacitor, which sourced its signal from pin 6 of the IC.

As the circuit performed as anticipated, it produced an output sinusoidal waveform with a peak-to-peak amplitude of 600mV, affirming its functionality.

Frequency (Hz)	Vin (V)	Vout (V)	Gain
100	2.00	3.46	1.73
200	2.00	4.56	2.28
500	2.00	6.00	3.00
1000	2.00	6.00	3.00
2000	2.00	6.00	3.00
5000	2.00	6.00	3.00
10000	2.00	6.00	3.00
20000	2.00	5.78	2.89
50000	2.00	2.14	1.07
100000	2.00	2.10	1.05
500000	2.00	2.10	1.05
300000	2.00	2.08	1.04
350000	2.00	2.08	1.04
400000	2.00	2.08	1.04

Figure 5 – Raw data from breadboard

From the raw data we can see a clear maximum gain of 3 spanning from 0.5-10kHz which is

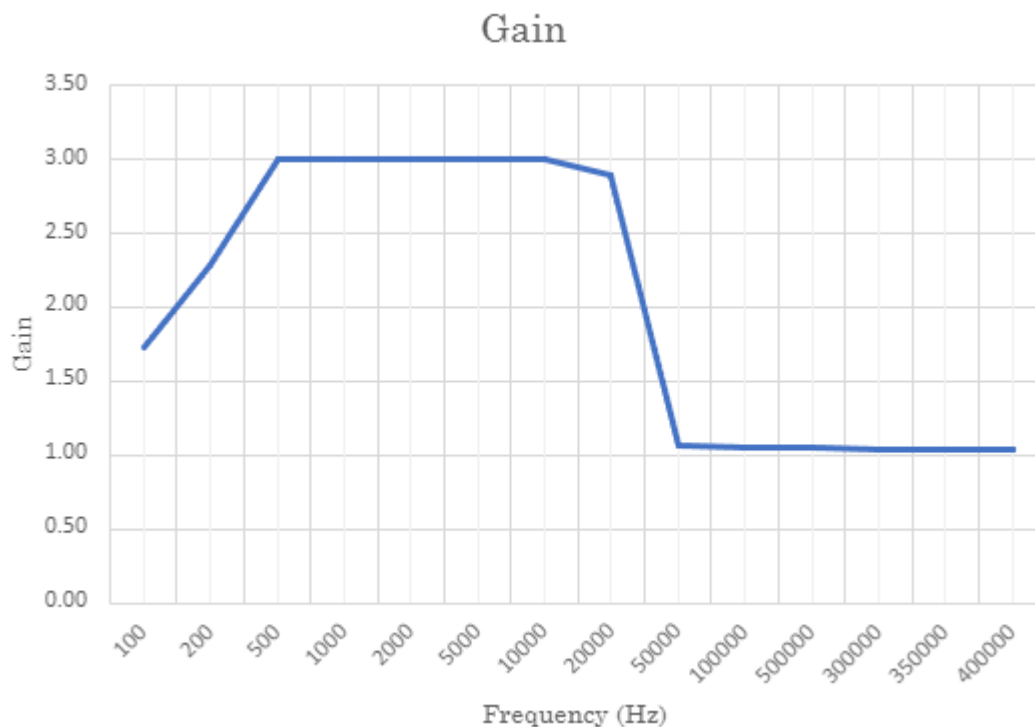


Figure 6 – Gain plotted against frequency (Hz) for bread board.

surprisingly congruent with the proteus simulation. The later values of gain are offset by 0.01 between proteus and breadboard.

An almost exact replica of the previous graph, this graph shows the exact same relationship as with proteus. The gain increases to a maximum gain of 3, then falls to a lower constant value of around 1. The Proteus simulation and breadboard simulation have shown high congruence in this experiment.

PCB Build

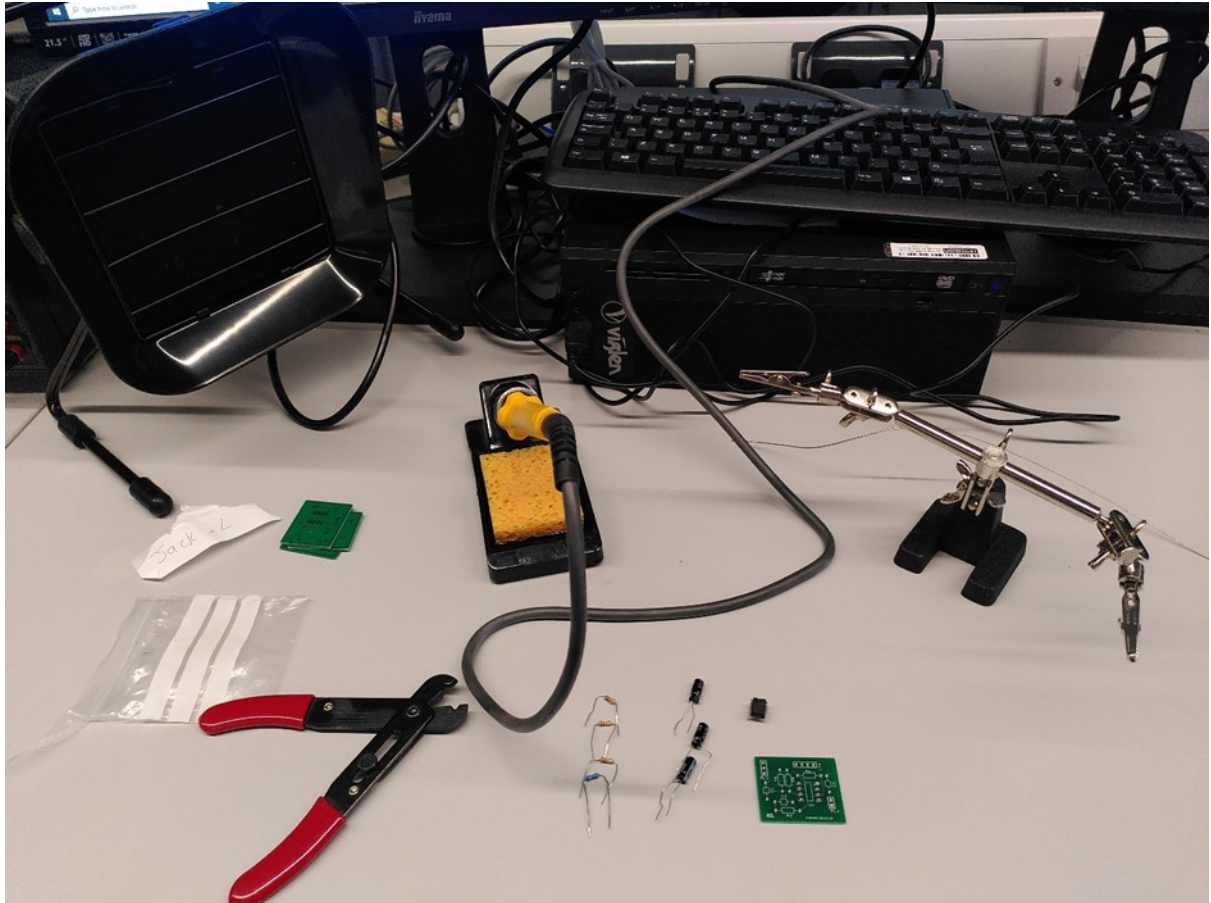


Figure 7- view of soldering equipment with PCB and some of the components to be installed.

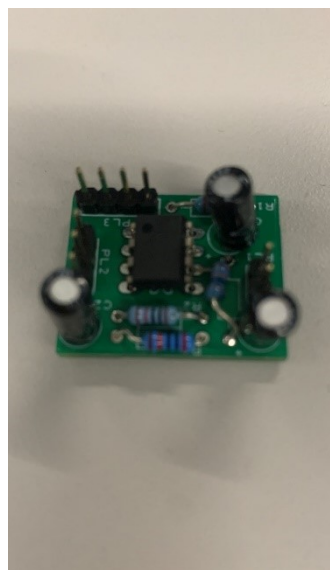


Figure 8 – Above view of PCB with all components installed.

Prior to commencing the assembly of the PCB (Printed Circuit Board), checks were conducted on each component to verify both their condition and correct technical qualities. The workspace was organised, and tools were prepared accordingly. Particular attention was paid to ensuring the soldering iron was adequately tinned upon reaching the required temperature to prevent corrosion of its tip. Additionally, the extractor fan was activated to maintain a ventilated environment.

The initial soldering process began with fixing the resistors onto the board. This decision was based on their resilience to inadvertent damage during subsequent soldering activities. The 20k Ω resistor was placed first due to its distinct value, which minimised the likelihood of incorrect placement.

Each resistor leg was methodically inserted through the designated hole and bent sideways to securely hold it in position, snug against the board during soldering. Upon confirming a secure connection, both legs were carefully trimmed with flush snips to prevent inadvertent electrical contacts that could result in short circuits.

The same approach was applied to soldering the three 10k Ω resistors, adhering to the process above. Visual inspections were conducted post-soldering to ensure the integrity of each resistor connection.

The assembly process was replicated for each of the three capacitors on the board. It is worth noting that two capacitors were inadvertently soldered with incorrect polarity, resulting in a non-trivial and less organised rectification process. To mitigate such errors in future iterations, it is recommended to include polarity labels on the PCB silkscreen.

The final stage of assembly involved soldering the Op-amp into position. Special care was exercised to orient it correctly, ensuring alignment of the notch and circle indicators with the top of the board to denote pin 1 at the upper left position. This step was intentionally completed until last due to the Op-amp's heightened susceptibility to accidental damage during preceding soldering activities. Unlike other components, pin trimming was unnecessary due to their inherent shorter length.

Following assembly, the PCB underwent testing utilising a 200mV input sine waveform, with subsequent recording of output waveforms across various frequencies. The obtained data closely mirrored that of both the breadboard and proteus simulation, albeit with a marginally reduced gain, thus confirming the circuit's operational integrity.

The circuit exhibited an input of 200mV peak-to-peak sine wave (Channel 1, depicted in yellow) and produced a 600mV sine wave output (Channel 2, depicted in blue), resulting in an anticipated gain of 3.

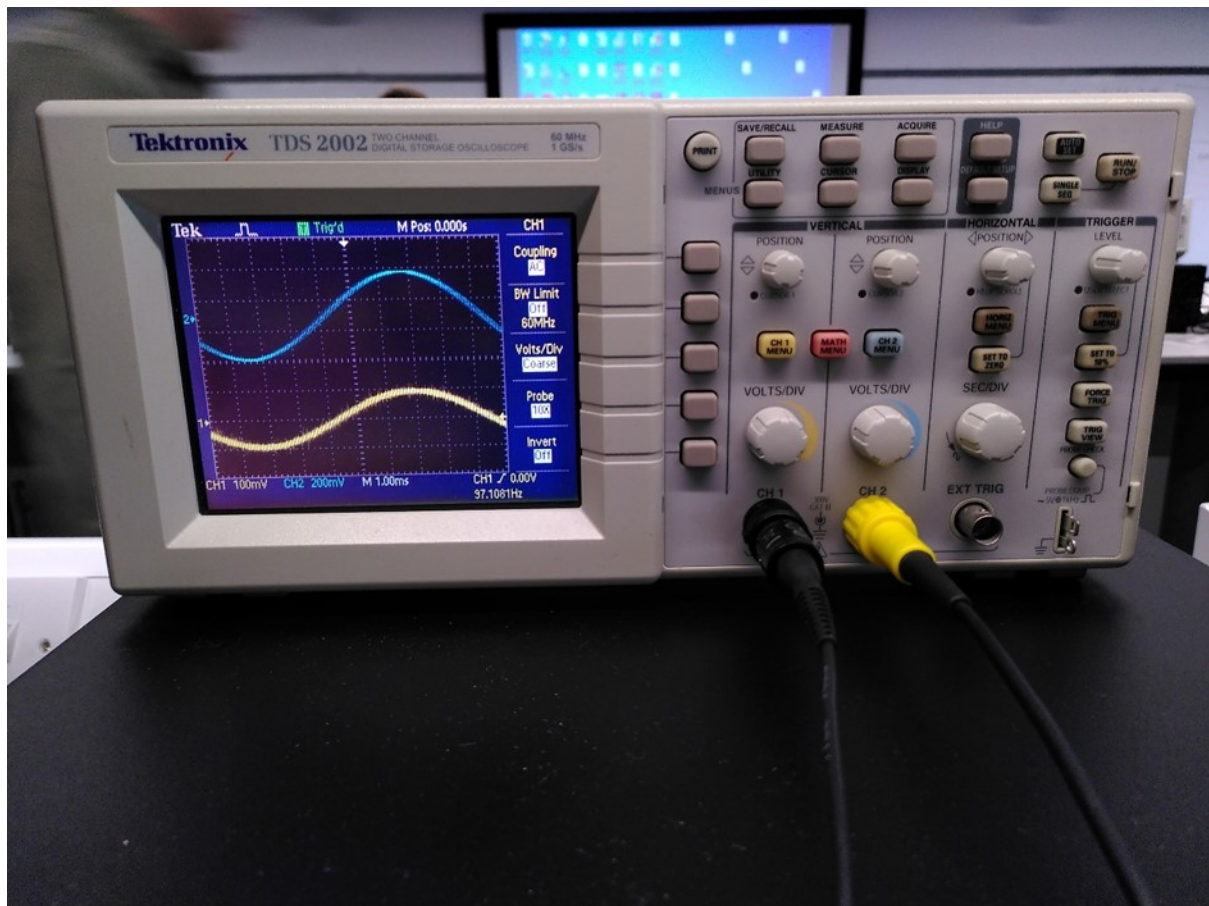


Figure 5 – Oscilloscope display using breadboard circuit.

Conclusion

The journey of building an amplifier circuit across different platforms - from PCB design to circuit simulation software like Proteus and practical implementation on a breadboard - has been enriching and insightful. Through this experience, I've honed crucial skills in circuit design, simulation, troubleshooting, and hands-on prototyping. Each platform offered unique challenges and learning opportunities, ultimately fostering a comprehensive understanding of amplifier circuitry. Moving forward, these acquired skills will undoubtedly serve as a solid foundation for tackling more complex electronic projects and innovations.