DESIGN AND IMPLEMENTATION OF A 10 KHZ WIEN BRIDGE OSCILLATOR WITH SAWTOOTH WAVEFORM CONVERSION

Analog Lab Project
Problem Statement 19

TEAM MEMBERS

Kshithij Singhania	230002035
Prateek	230002057
Anshita Pandey	230002010
Ayush Jindal	230002014

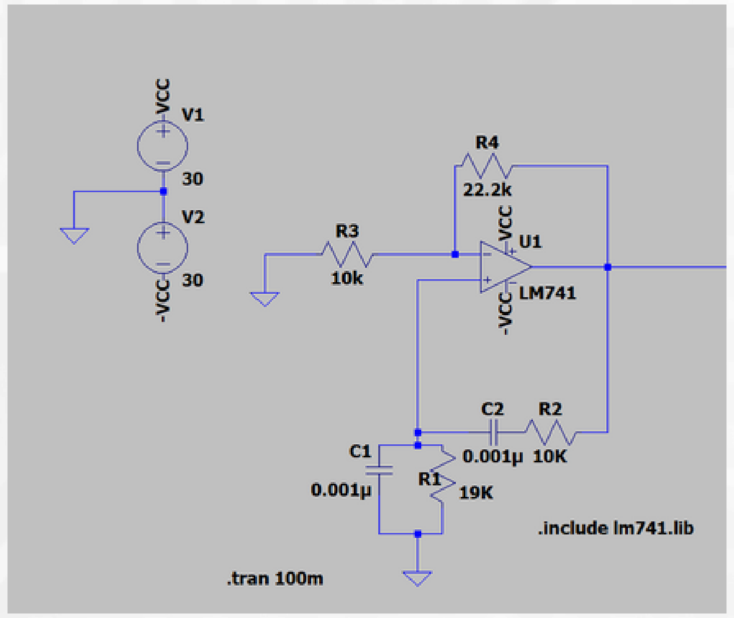
INTRODUCTION

Context

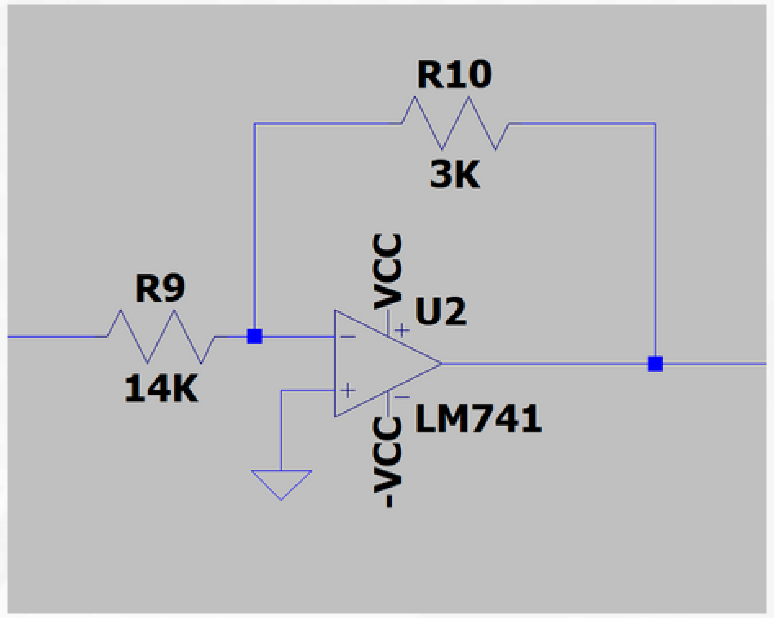
Generating precise waveforms is essential in many electronic systems. This project focuses on designing a Wien Bridge Oscillator to produce a stable 10 kHz sinusoidal output. To adapt this waveform for further applications, the sine wave is first converted into a square wave with a 90% duty cycle, providing longer high periods. This square wave is then processed to generate a sawtooth waveform with a rising time of 90 microseconds and maximum voltage swing.

The project highlights fundamental techniques in analog waveform generation and shaping, providing an efficient and practical solution for various timing and signal processing needs.

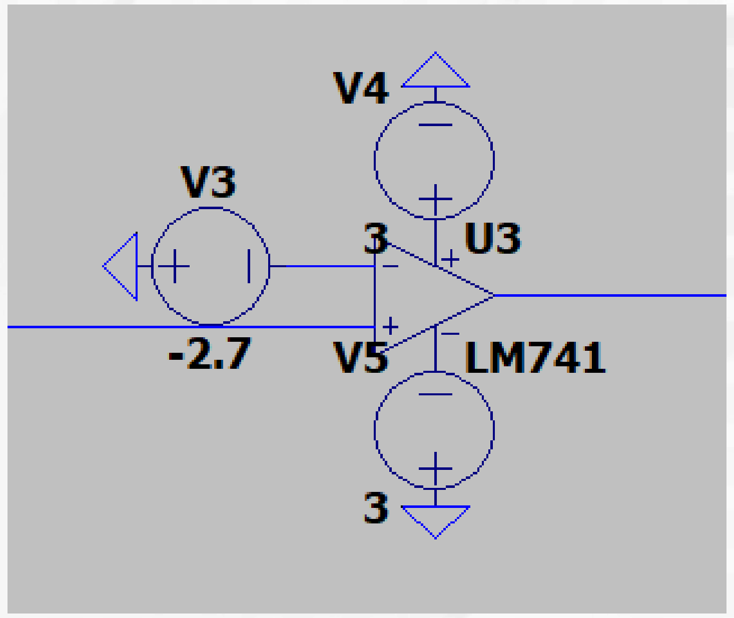
> WIEN BRIDGE



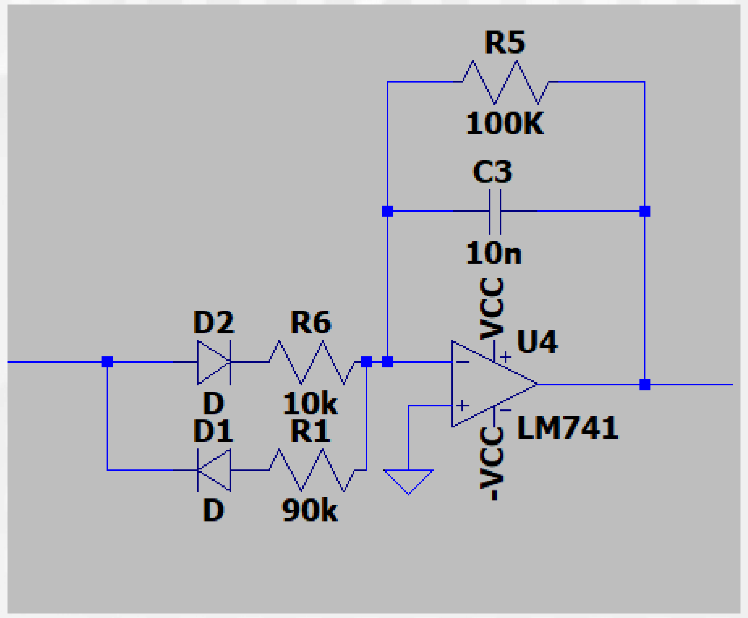
> AMPLIFIER/DAMPING CIRCUIT



> COMPARATOR



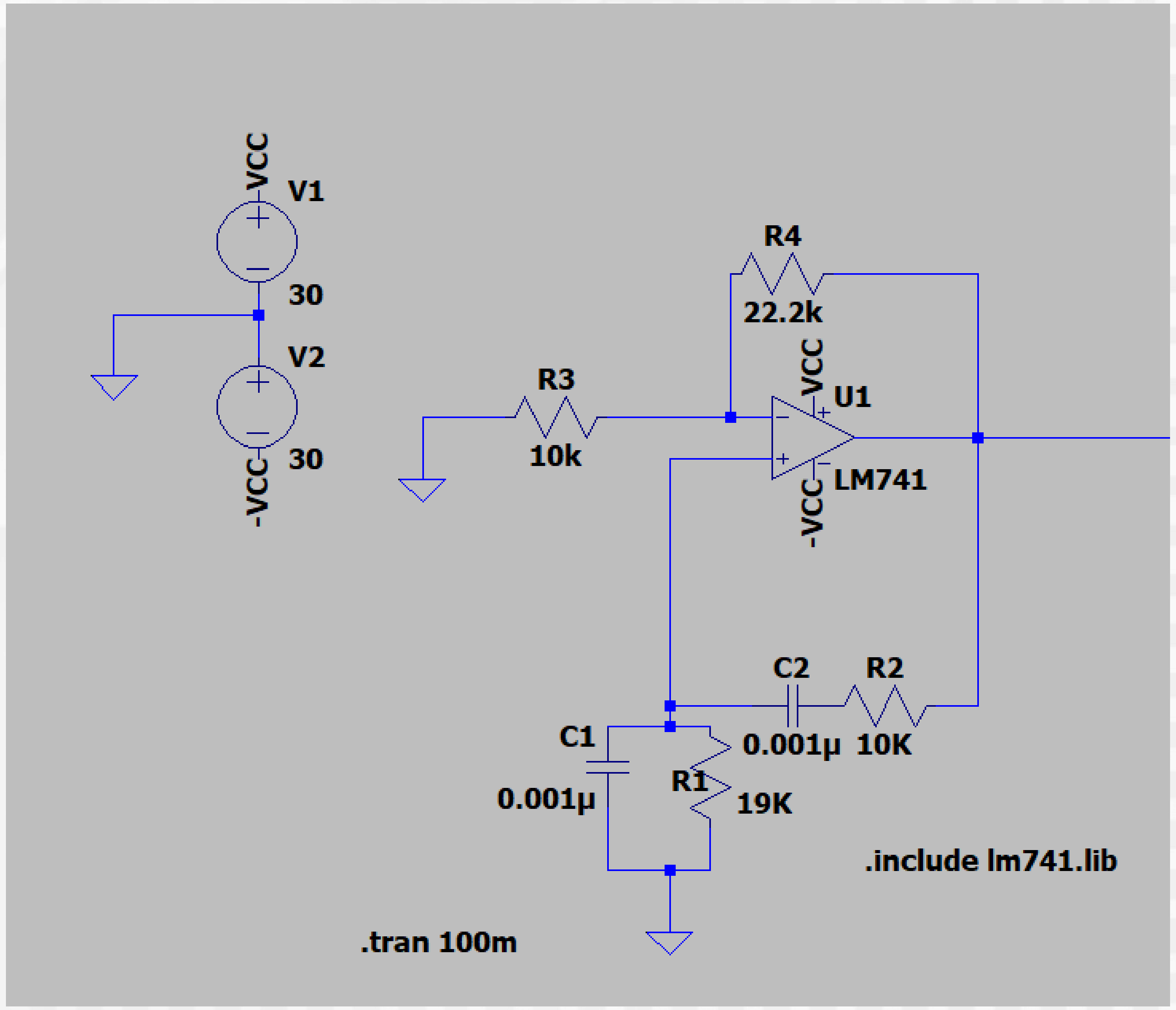
> INTEGRATOR

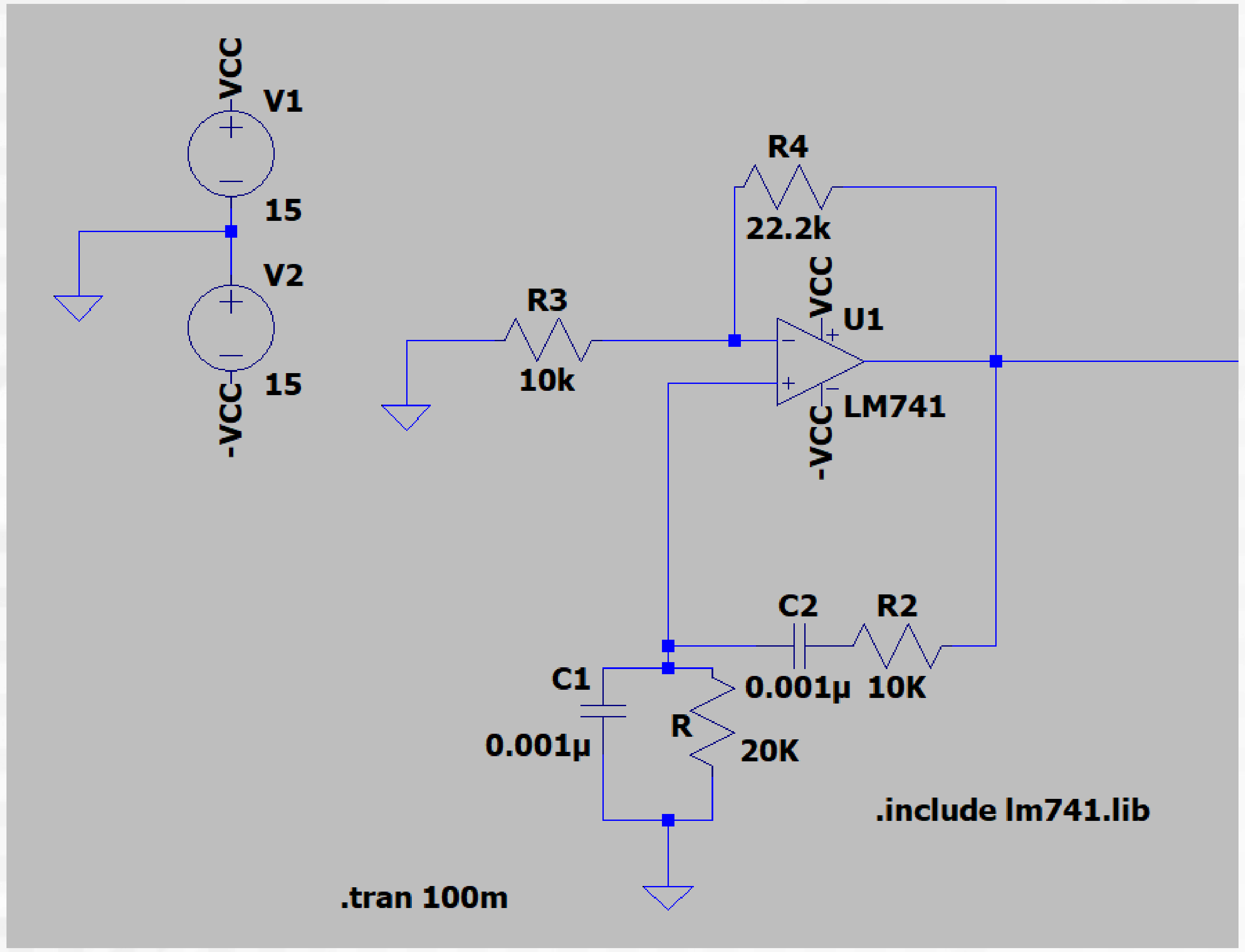


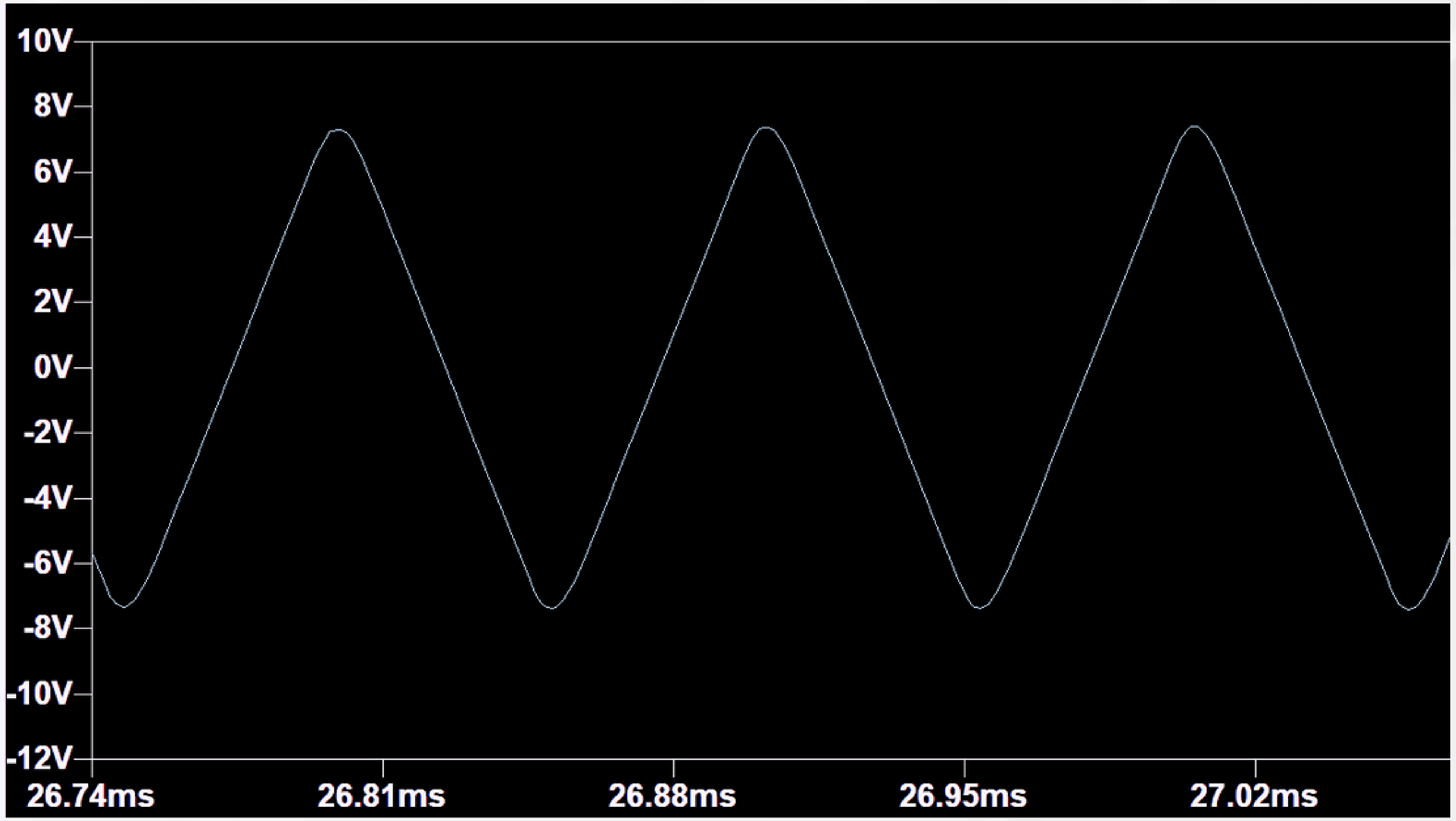
WIEN BRIDGE OSCILLATOR

The Wien Bridge Oscillator is a simple and popular circuit used to generate low-distortion sine waves. It uses an RC network to determine the frequency of oscillation and provides stable output without requiring external triggering. It is widely used for audio, signal processing, and waveform generation applications.

- PRODUCES PURE SINE WAVES.
- FREQUENCY SET BY RC NETWORK.
- USES POSITIVE FEEDBACK FOR OSCILLATIONS.
- STABLE AMPLITUDE WITH GAIN CONTROL.
- SIMPLE AND EASY TO DESIGN.





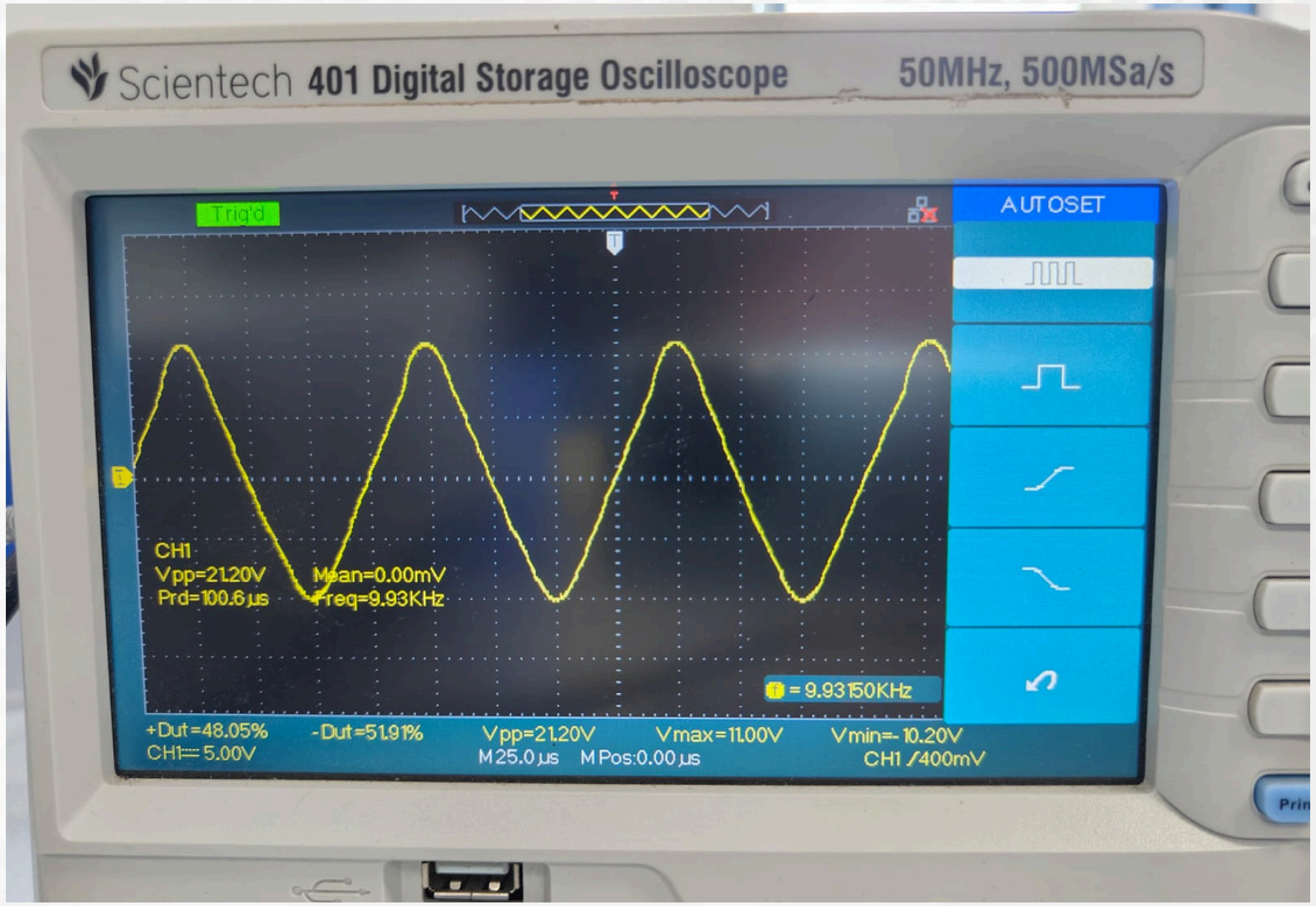


> LT SPICE CIRCUIT

> OUTPUT WAVEFORM

$R = 10\ K\Omega$
$C = 0.01uF$
$R2 = 25.3\ K\Omega$
$f = 1/(2\pi RC) = 10KHz$

Practically
$R = 20K\Omega$ to get 10KHz



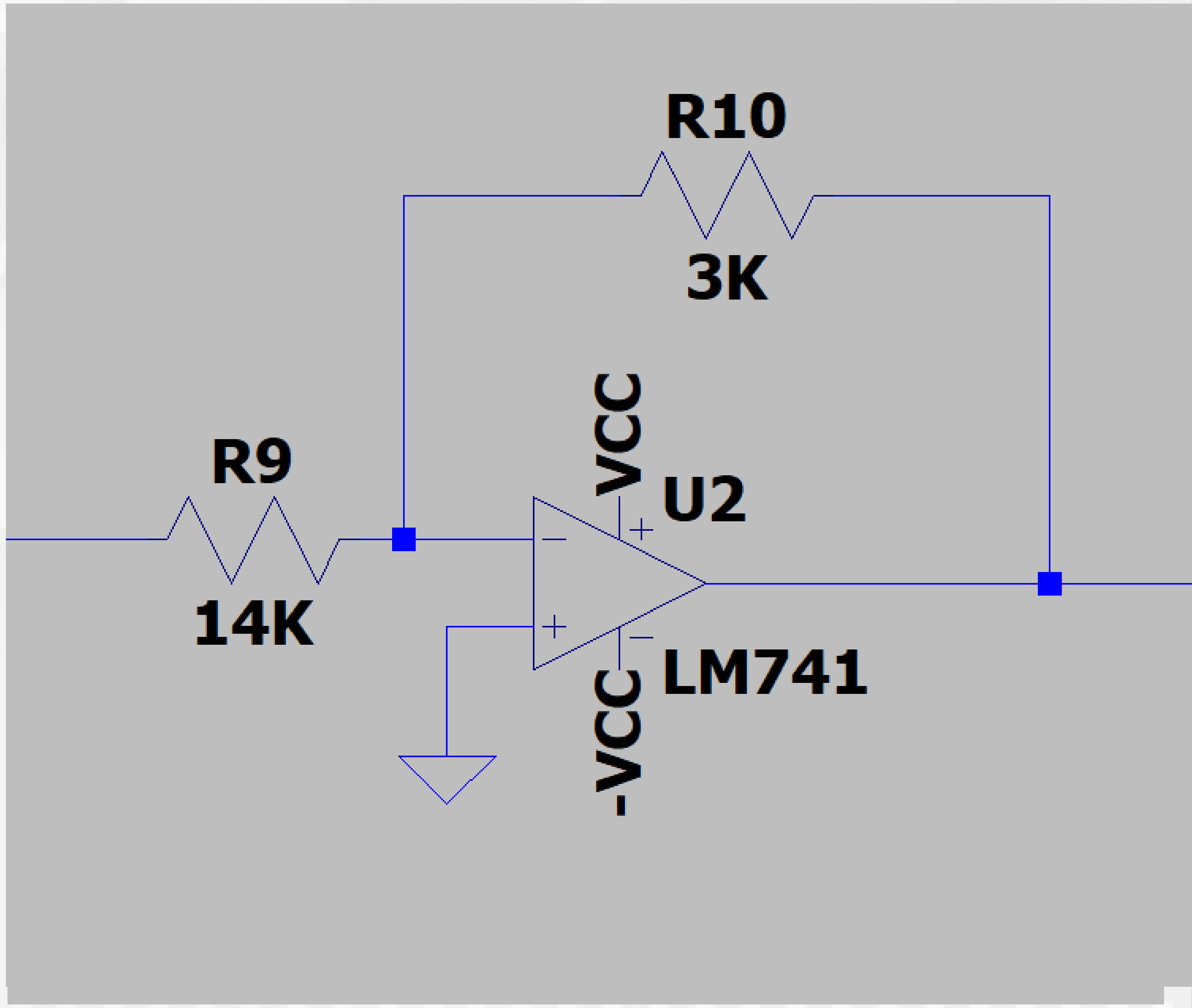
> CALCULATIONS

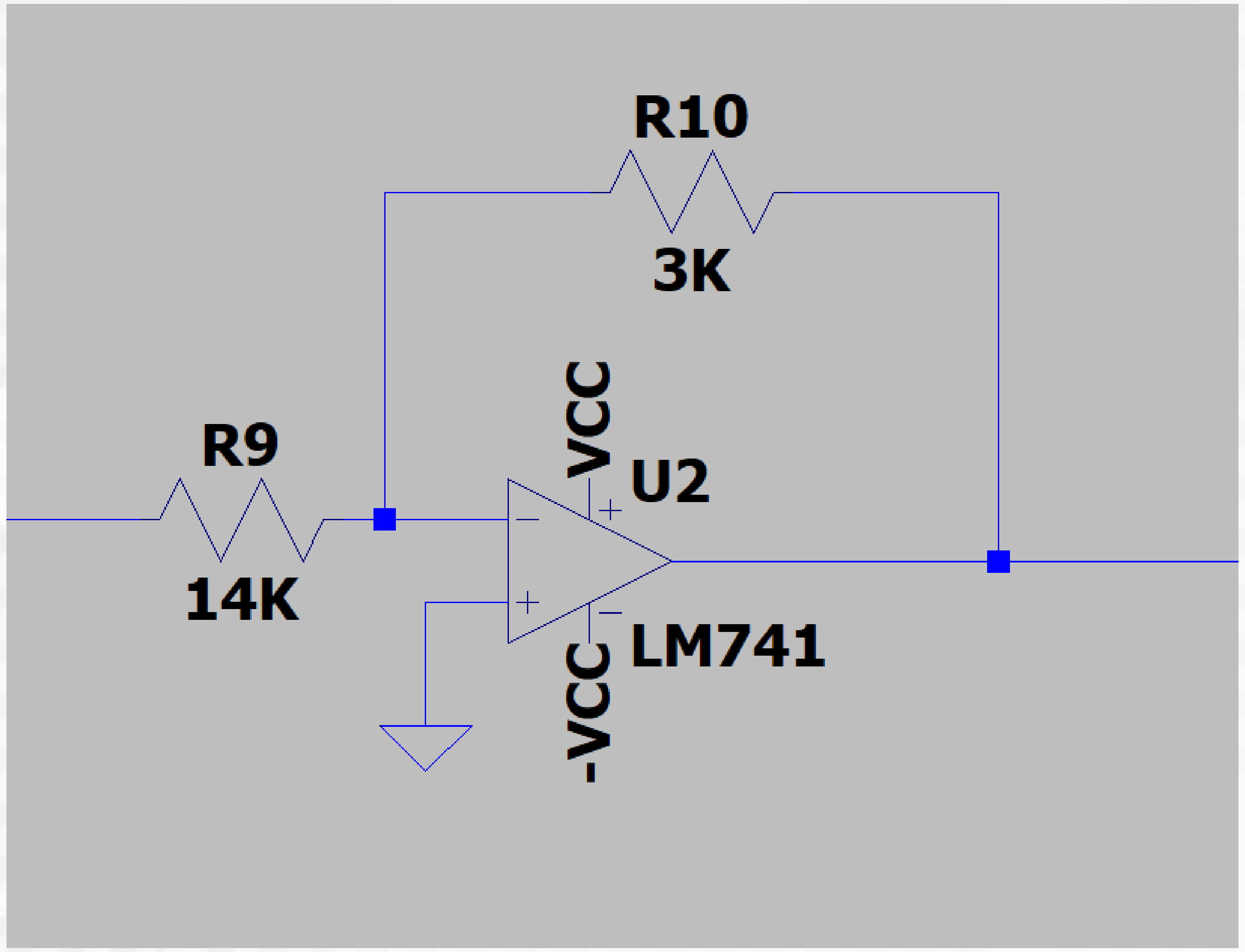
> DSO WAVEFORM

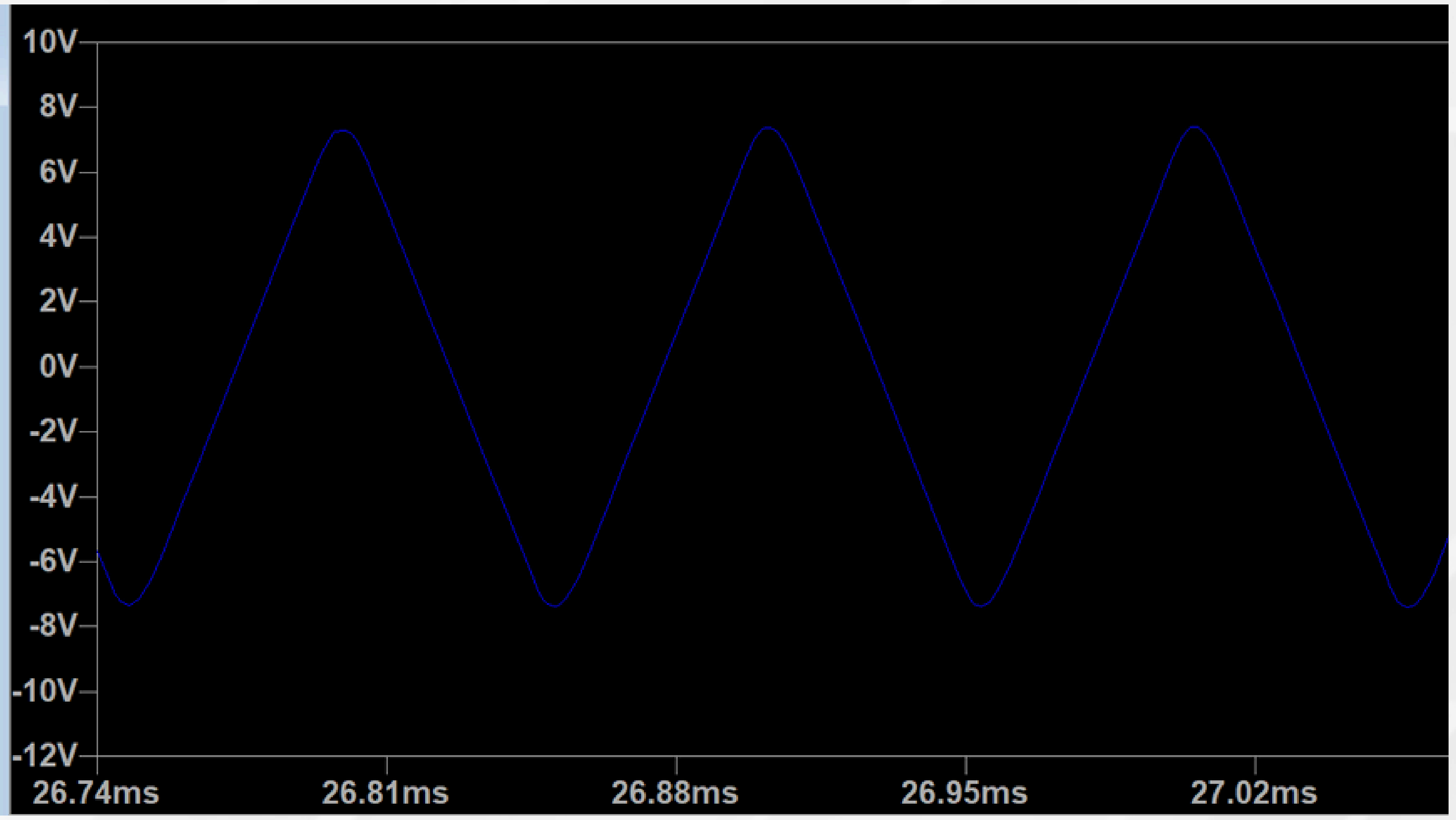
AMPLIFIER/DAMPER CIRCUIT

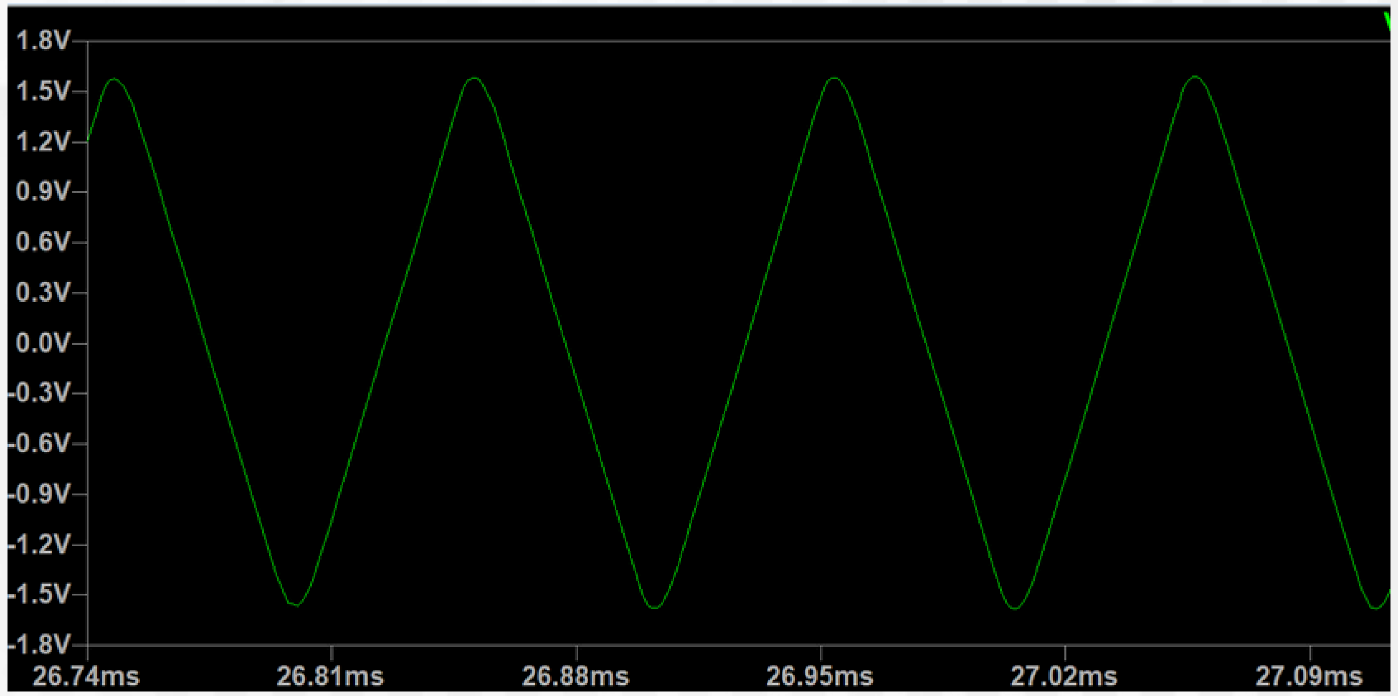
We are receiving a 14 V peak-to-peak signal, but to prevent saturation in the next stage, we are reducing the amplitude to 3 V peak-to-peak using a simple inverting amplifier.

- INVERTS AND AMPLIFIES THE INPUT SIGNAL.
- GAIN IS DETERMINED BY $-R_F/R_{IN}$
- SIMPLE DESIGN WITH HIGH INPUT IMPEDANCE.
- COMMON IN AUDIO AND SIGNAL PROCESSING.









> LT SPICE CIRCUIT

$R_f = 3\ K\Omega$

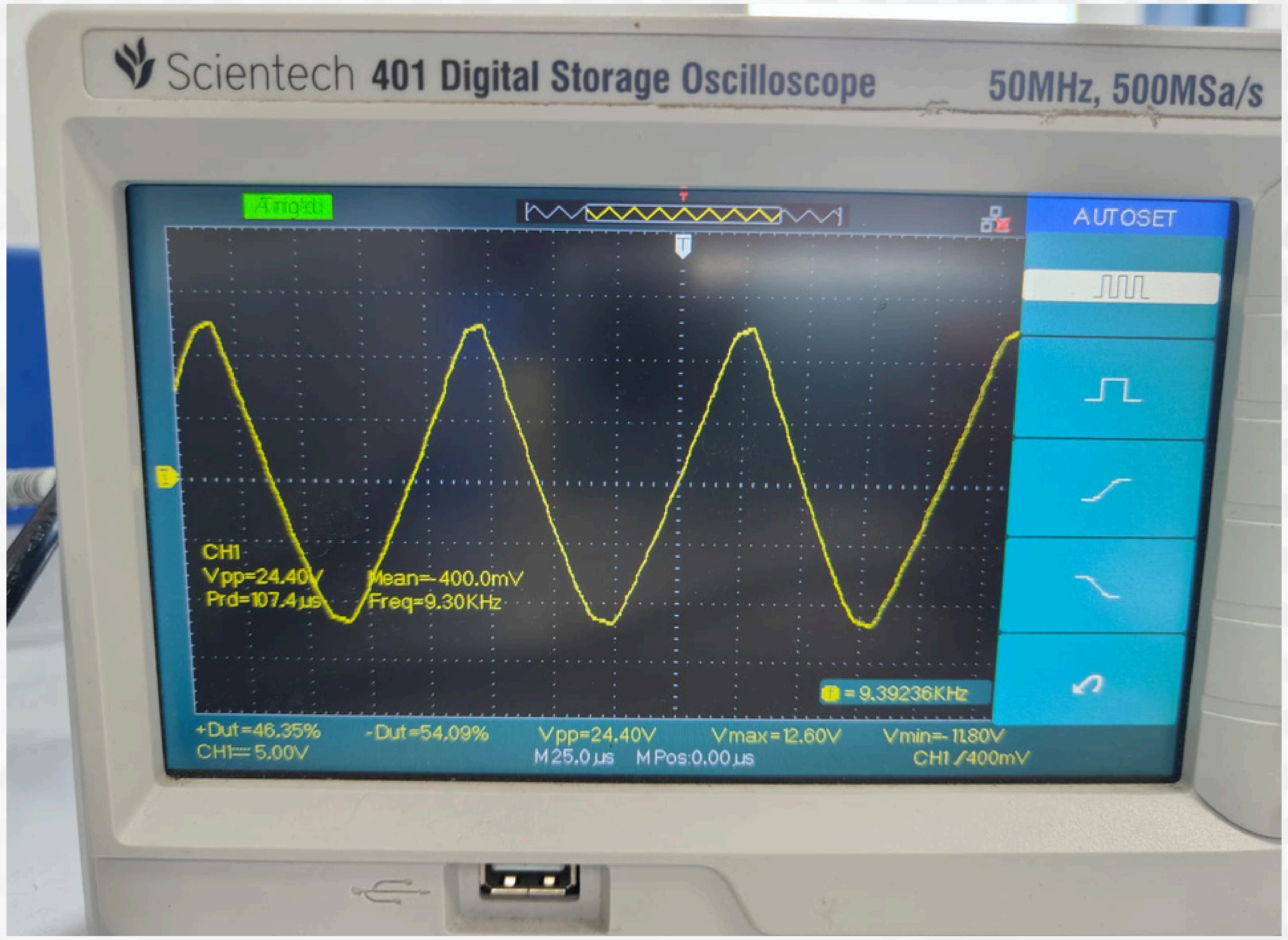
$R_{in} = 14\ K\Omega$

$R2 = 25.3\ K\Omega$

$Gain = -R_f/R_{in} = 3/14$

Practically

$A = 3/14$ (Almost)



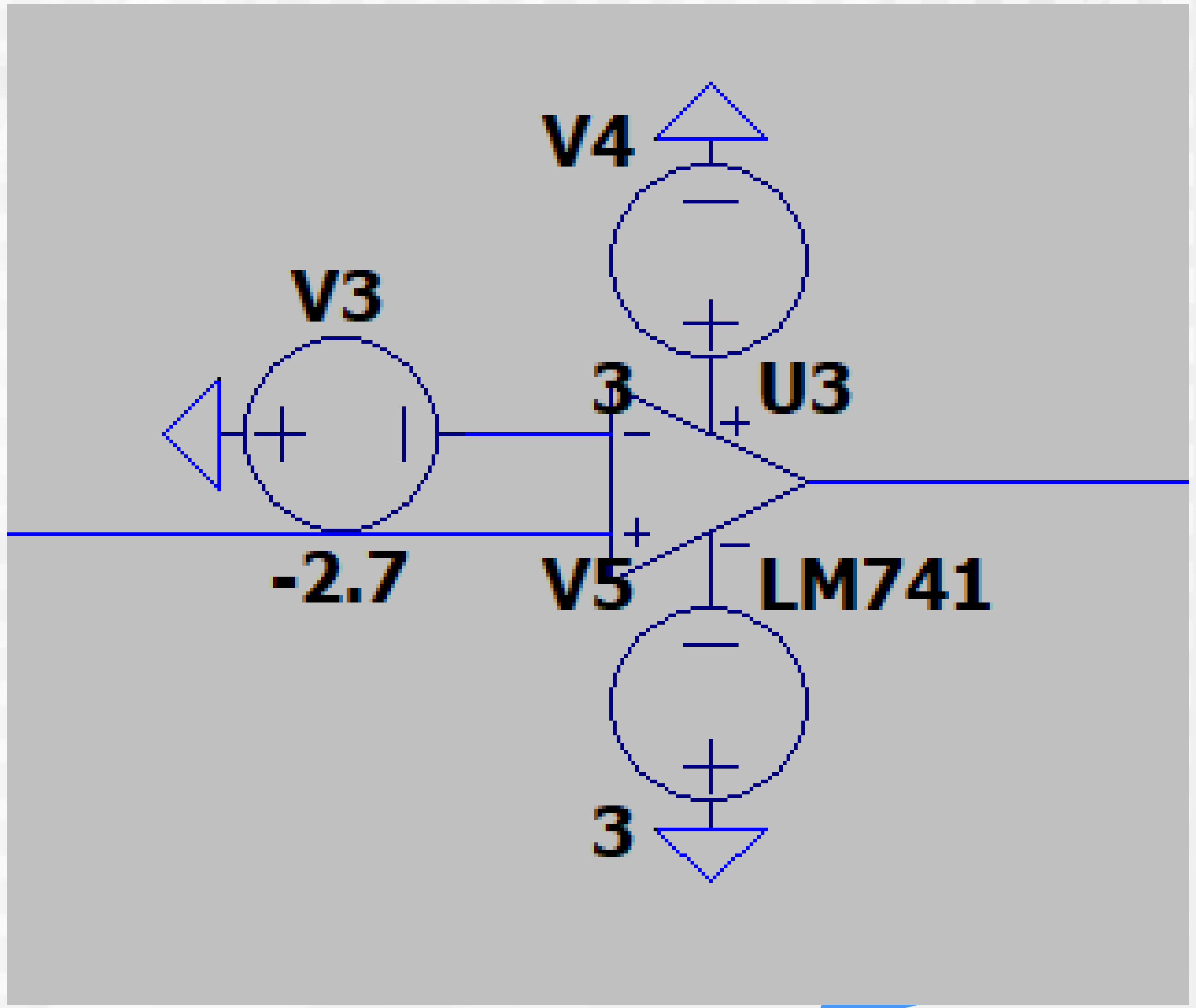
> CALCULATIONS

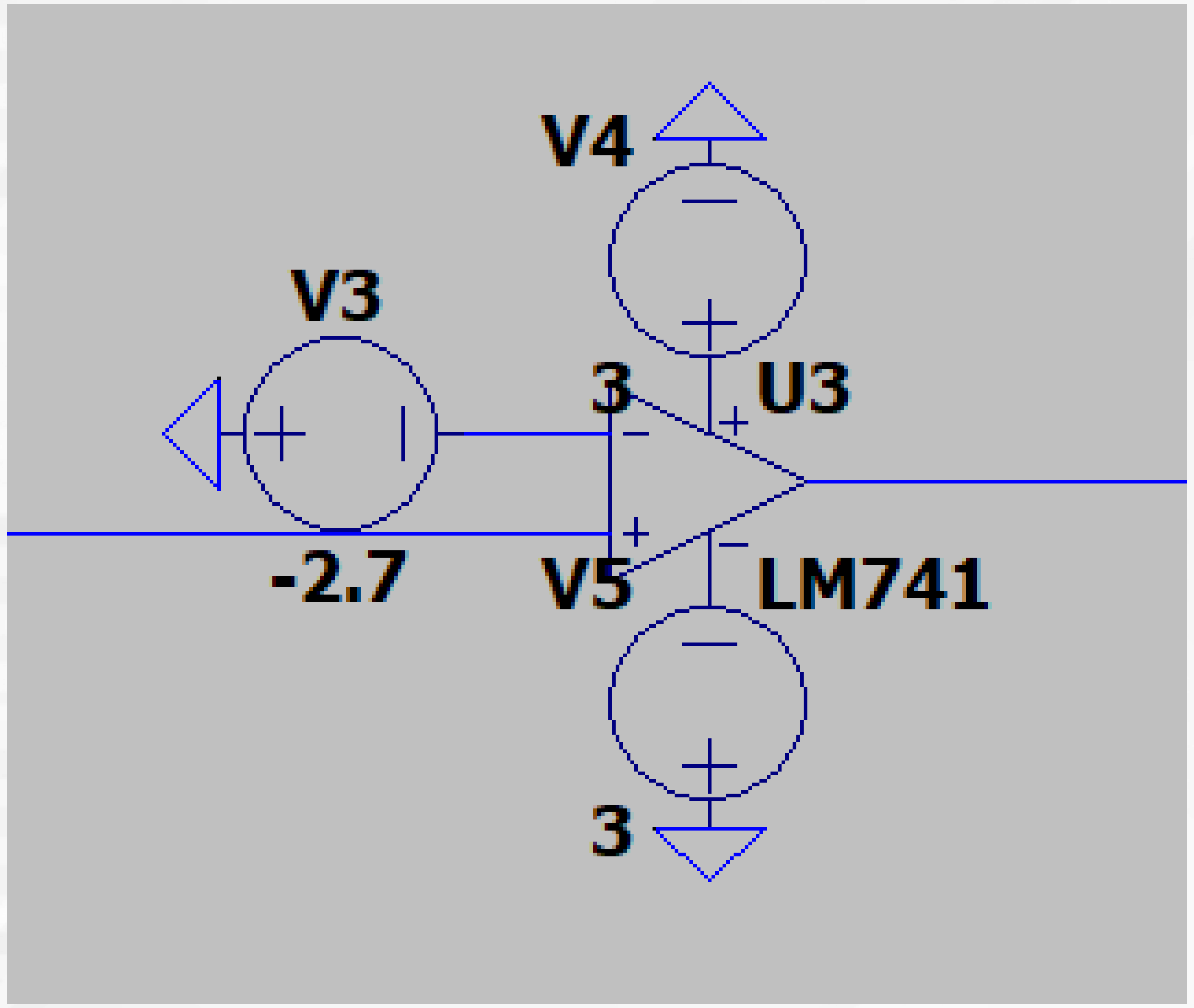
> DSO WAVEFORM

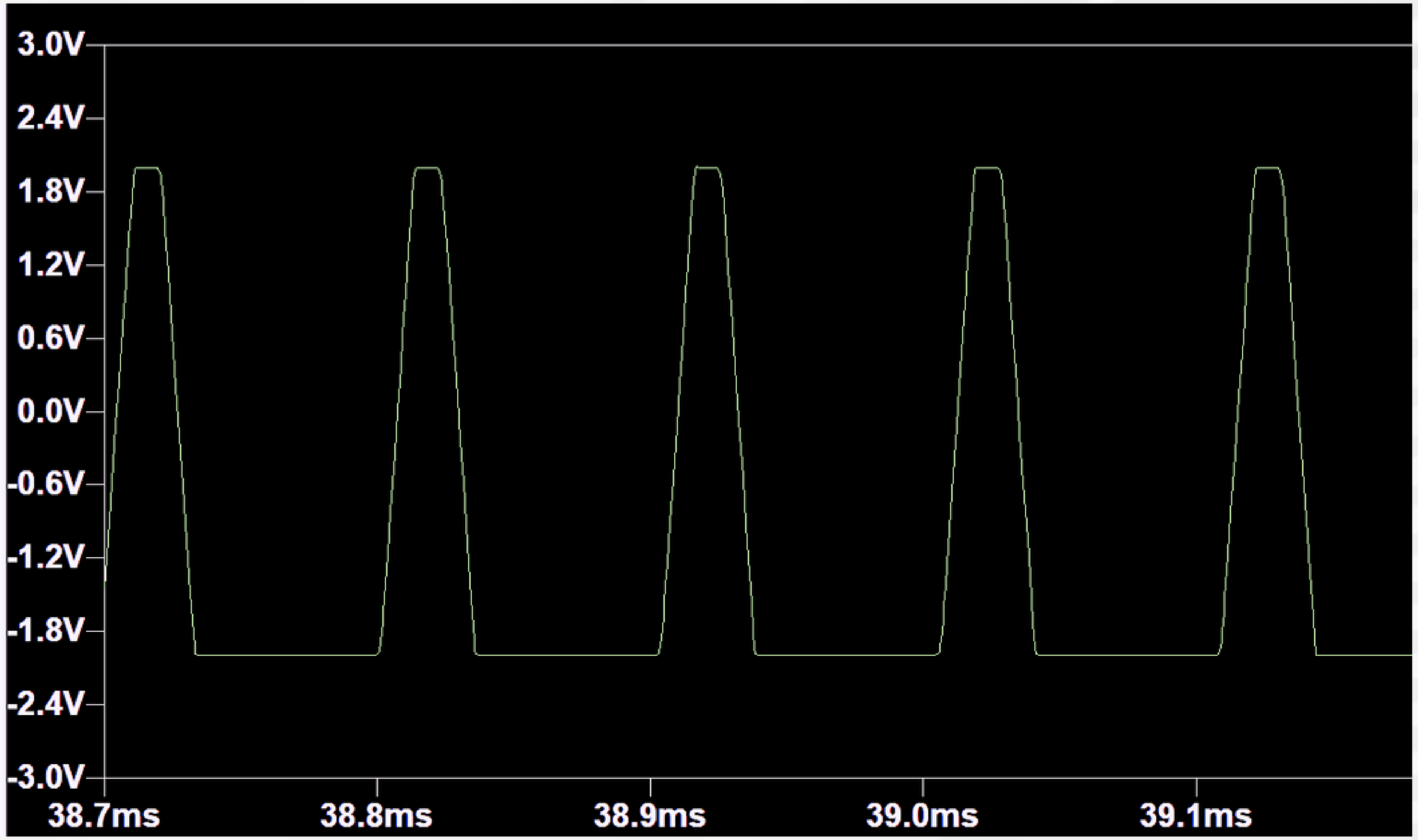
COMPARATOR CIRCUIT

A comparator is a circuit that compares two input voltages and outputs a digital signal (high or low) based on which input is greater. It has no feedback, meaning the output switches abruptly when the input voltage crosses a certain threshold. Comparators are widely used in zero-crossing detectors, pulse-width modulation (PWM), and analog-to-digital conversion.

- COMPARES TWO INPUT VOLTAGES.
- OUTPUTS HIGH OR LOW BASED ON COMPARISON.
- NO FEEDBACK; ABRUPT SWITCHING AT THRESHOLD.
- USED IN ZERO-CROSSING DETECTORS, PWM, AND ADC.



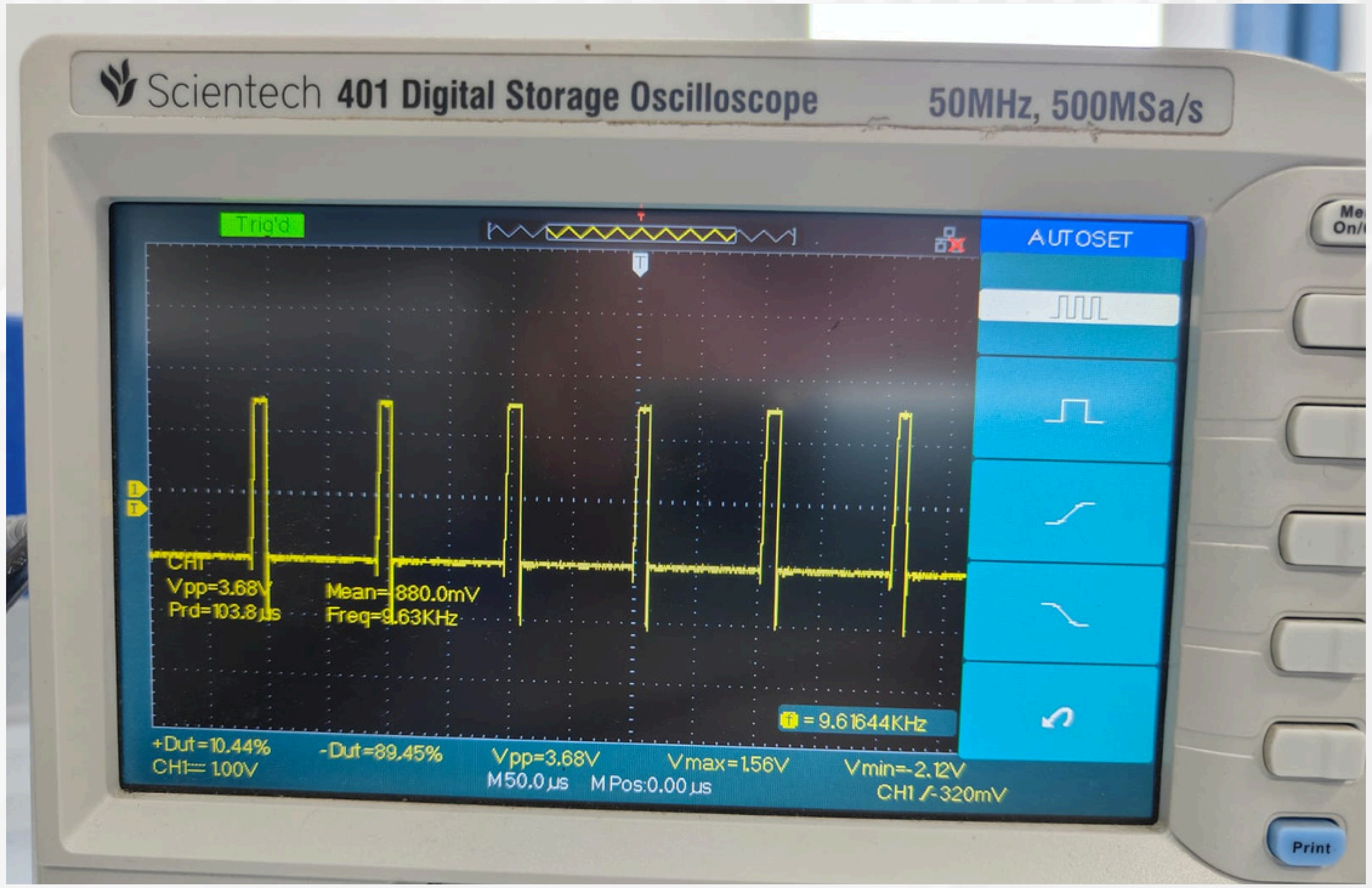




LT SPICE CIRCUIT

OUTPUT WAVEFORM

✅ Input:
Sine wave
3 V peak-to-peak (so ±1.5 V around 0 V, or from -1.5V to +1.5V).
✅ Output:
Square wave
90% duty cycle → HIGH for 90% of the cycle, LOW for 10%.
✅ Method:
Use a comparator with a reference voltage (Vref=+2.7) that is offset — not at 0V.

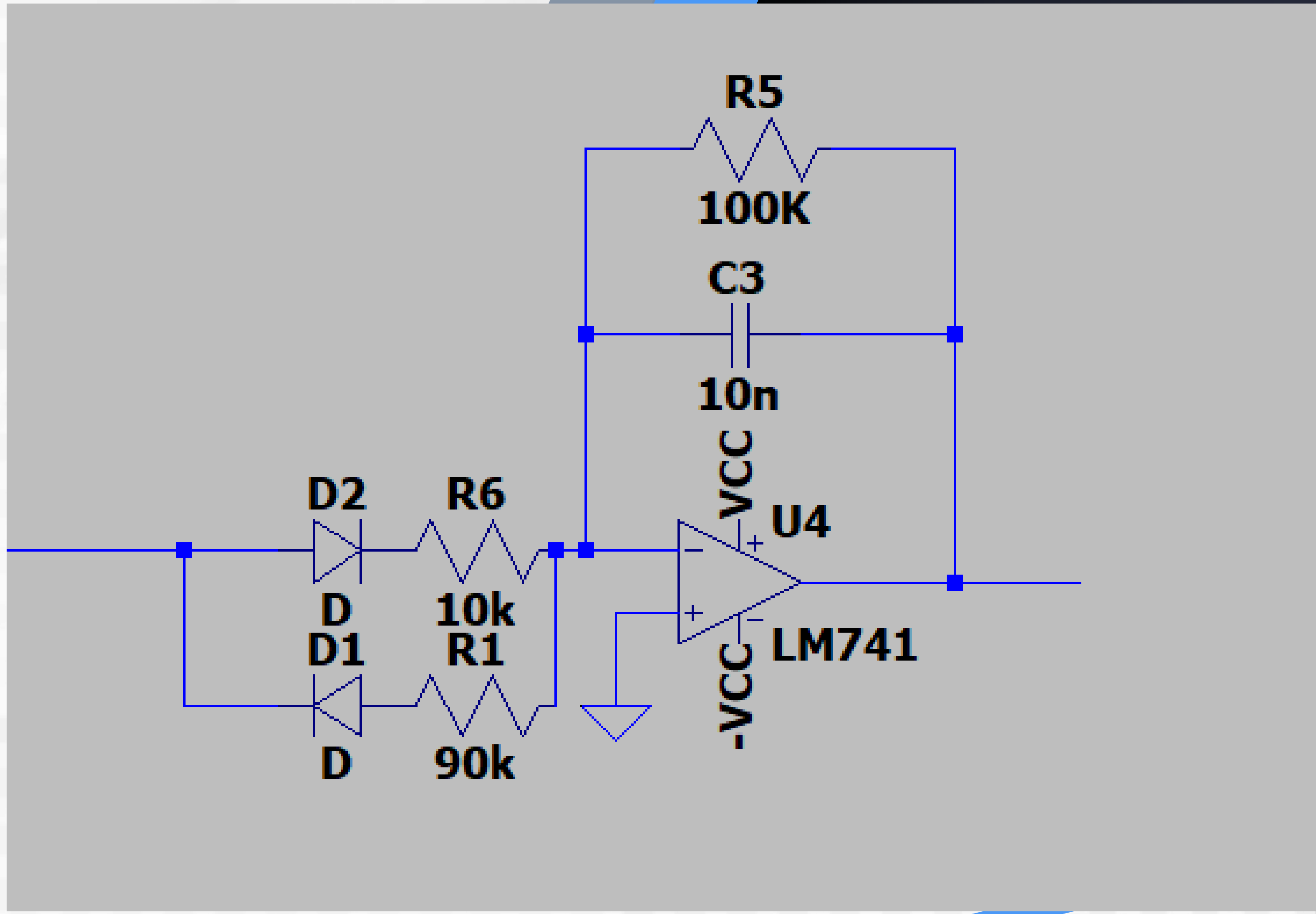


> CALCULATIONS

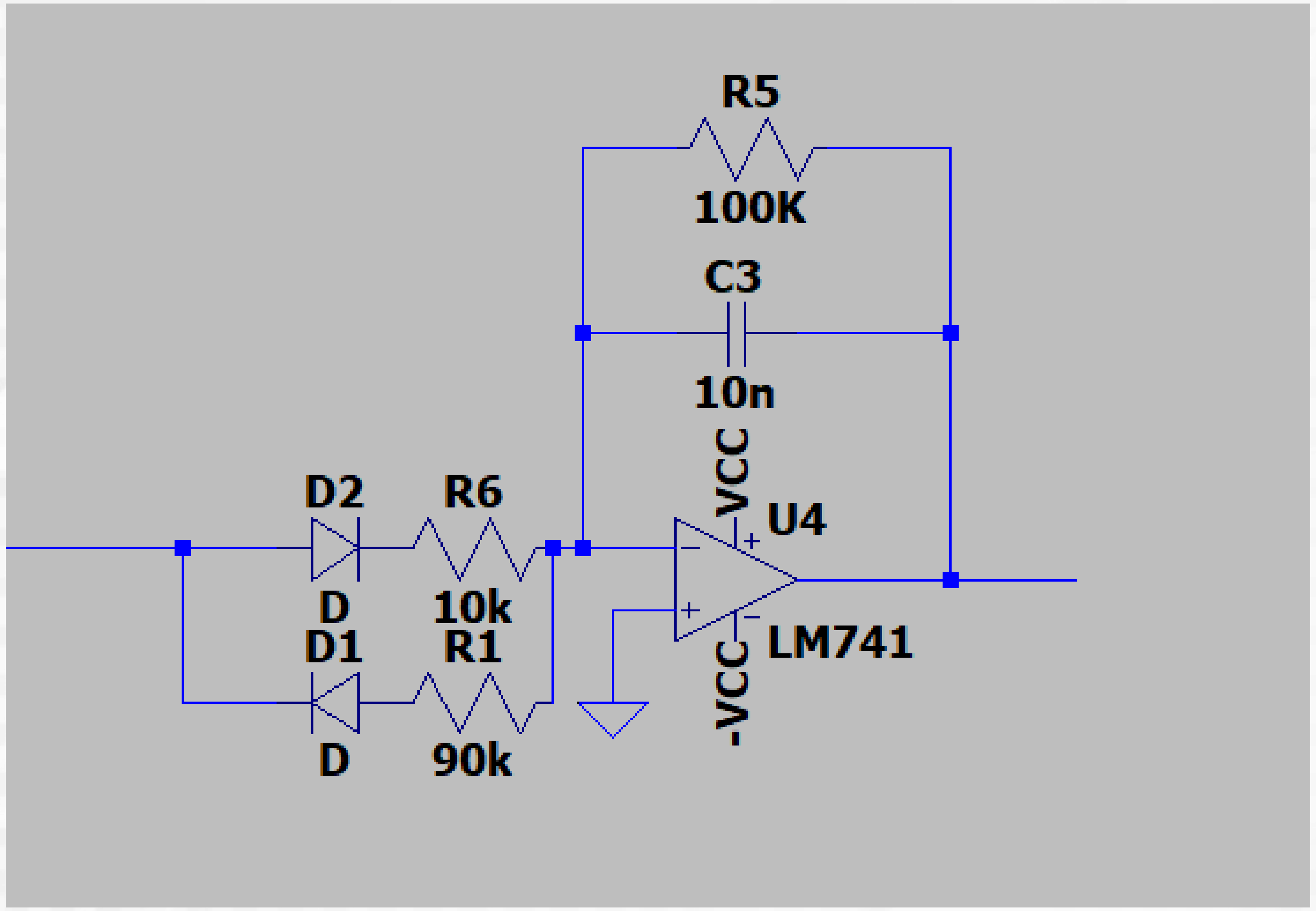
> DSO WAVEFORM

INTEGRATOR CIRCUIT

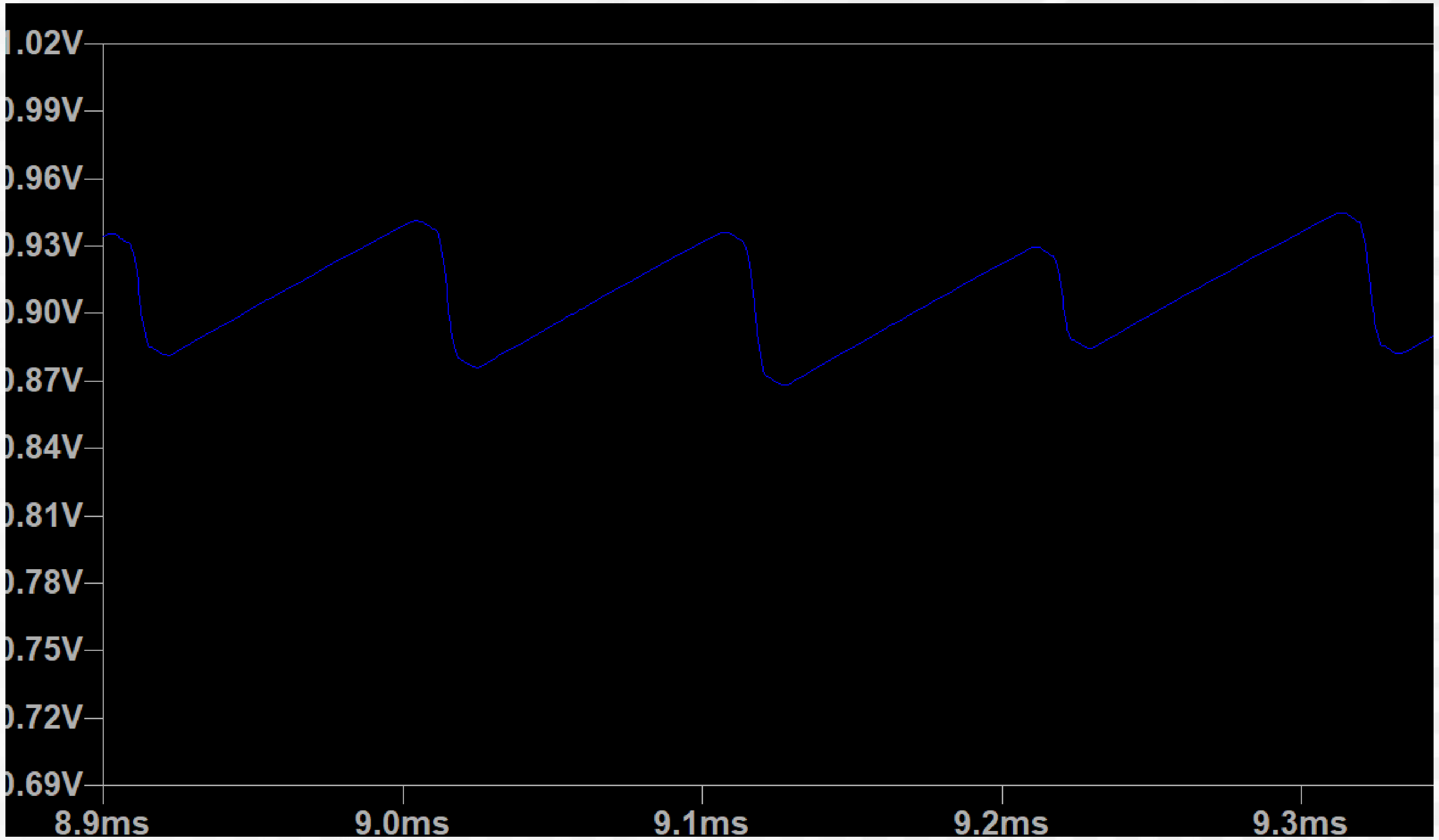
An Integrator Circuit using an op-amp converts an input voltage into its integral, producing a ramp output. It uses a resistor and capacitor in the feedback loop. The output is proportional to the integral of the input signal and is used in signal processing and filtering.



- CONVERTS INPUT VOLTAGE INTO ITS INTEGRAL.
- USES A RESISTOR AND CAPACITOR IN THE FEEDBACK LOOP.
- OUTPUT IS A RAMP SIGNAL.
- FORMULA : $V_{OUT} = -(1/(RC)) \int V_{IN}$



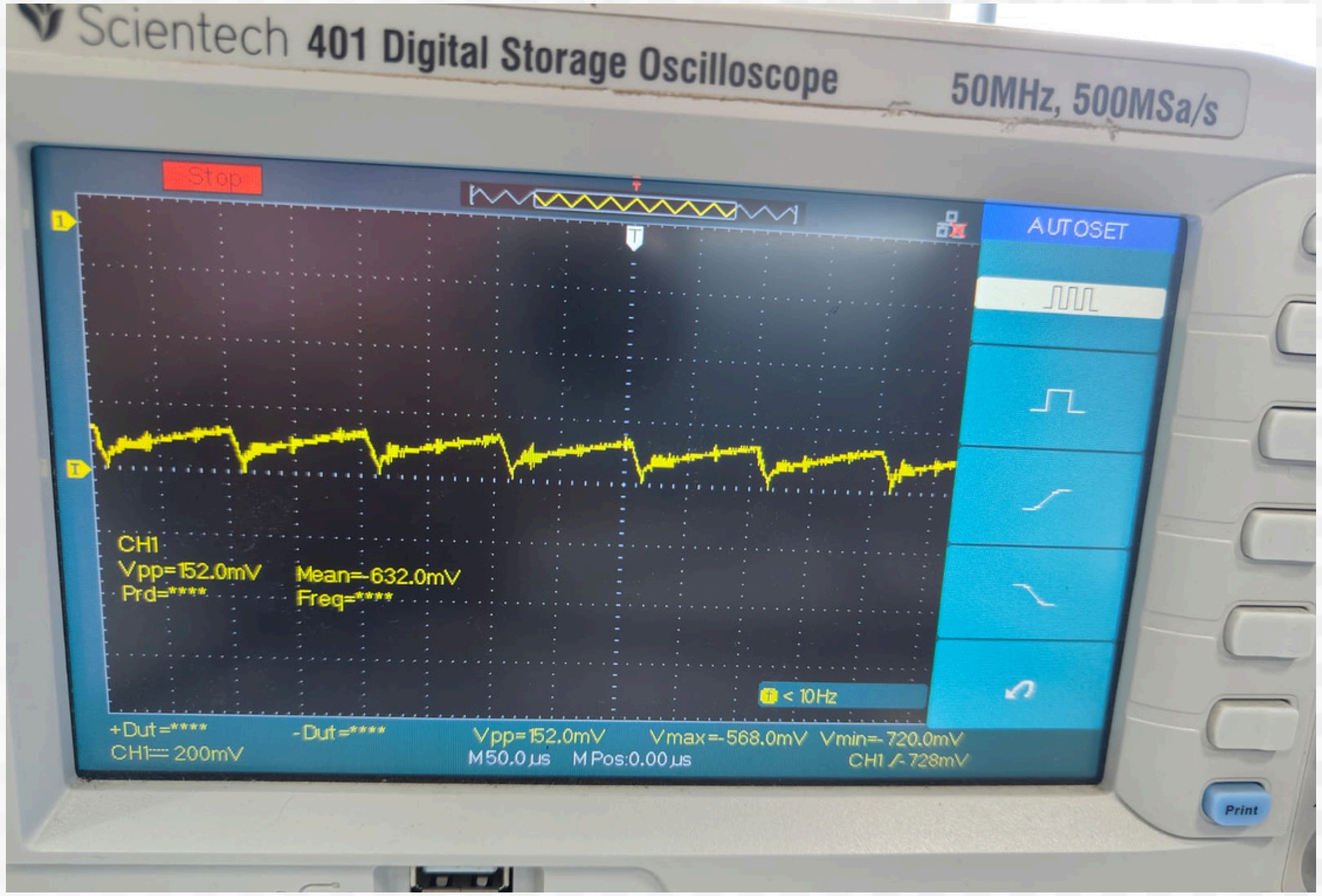
> LT SPICE CIRCUIT



> OUTPUT WAVEFORM

✅ *Goal:*
Convert this into a sawtooth waveform using an integrator.

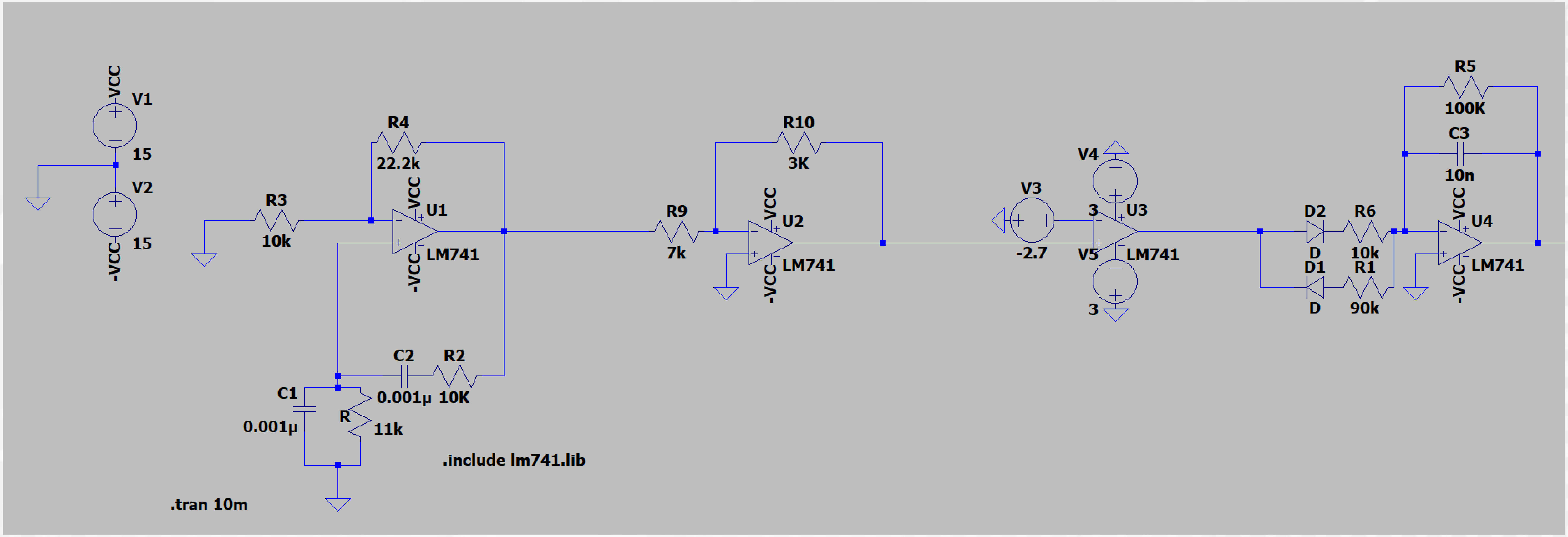
Rf = 100k
C = 10n
For positive cycle R=10k
For negative cycle R=90k



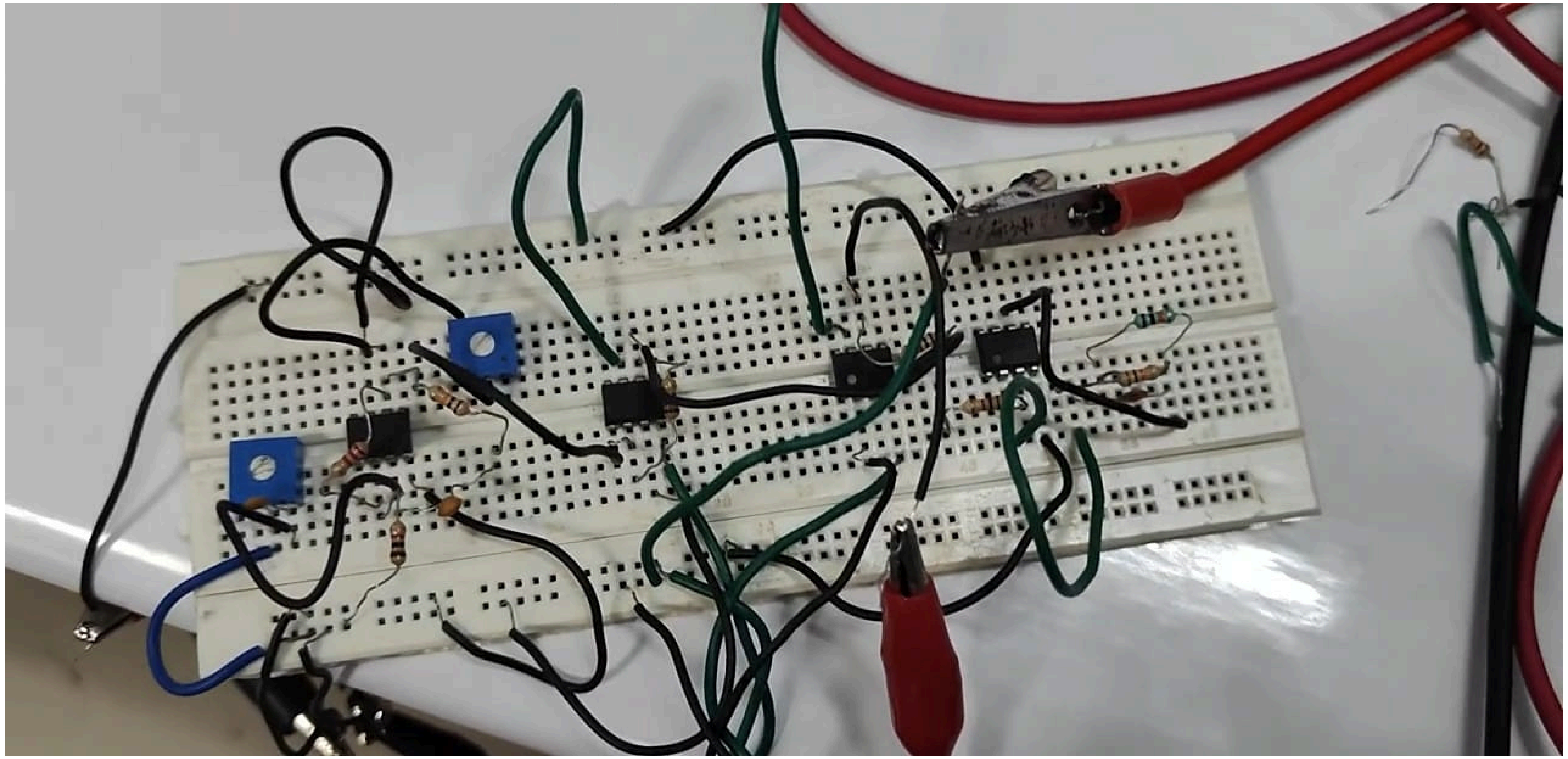
> CALCULATIONS

> DSO WAVEFORM

COMPLETE CIRCUIT



COMPLETE CIRCUIT



SUMMARY

This circuit involves generating a 10 kHz signal using a Wien Bridge Oscillator, which is then reduced in amplitude from 14 Vpp to 3 Vpp using an inverting amplifier. The inverting amplifier provides the required gain adjustment, ensuring the signal avoids saturation in subsequent stages. The resulting signal is then shaped into a sawtooth waveform with a 90 microseconds rising time. This setup integrates various components, including amplifiers and oscillators, to efficiently generate and modify waveforms for signal processing applications.

THANK YOU