Analog Electronic Circuits

Project

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Overview

- Introduction
- Need of Quadrature Operations
- Quadrature oscillator
- Switch (Mixer)
- Low Pass Filter
- Complete Circuit
- Conclusions

Introduction

Overview of Circuit

- The input signal is first mixed with the Quadrature-phase and the In-phase signal generated by the oscillator to get the two intermediate signals. These signals are then transmitted through the Low Pass Filter of the pre computed frequency to retrive our original signal, as well as a phase shifted - Quadrature signal

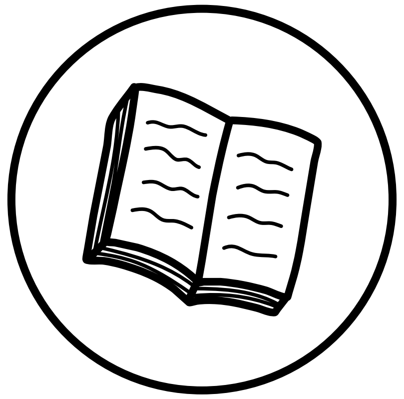
Mixer

- The switch or the mixer is implemented by a simple NMOS device which is biased at its threshold voltage and then given a controlling signal. This signal Controls the mixing as when the signal is greater than zero mos device turns on, and the signal passes whereas, when it is less than zero it does not allow signal to pass.

Oscillator

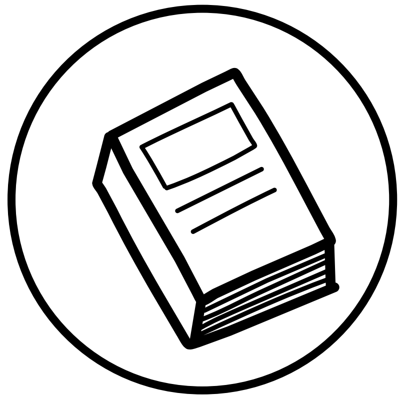
- The oscillator we made was Quadrature oscillator, which utilizes two op amps to produce a 90 degrees phase shifted signals (sin and cos). It utilizes the systems noise and positive feedback configuration.

Need of Quadrature Operations



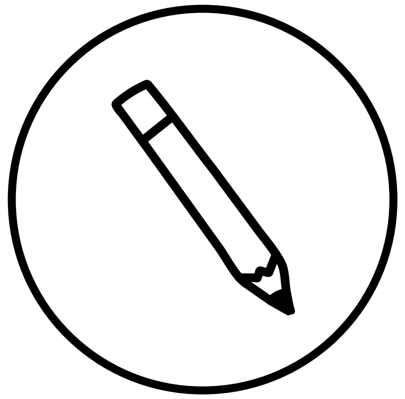
Digital Signal Processing

In digital communication systems, for instance, quadrature modulation techniques like Quadrature Amplitude Modulation (QAM) are extensively used to transmit digital data efficiently over communication channels.



Complex Number Arithmetic

A complex number consists of a real part and an imaginary part, which can be interpreted as quadrature components. Operations like addition, subtraction, multiplication, and division of complex numbers involve quadrature operations.

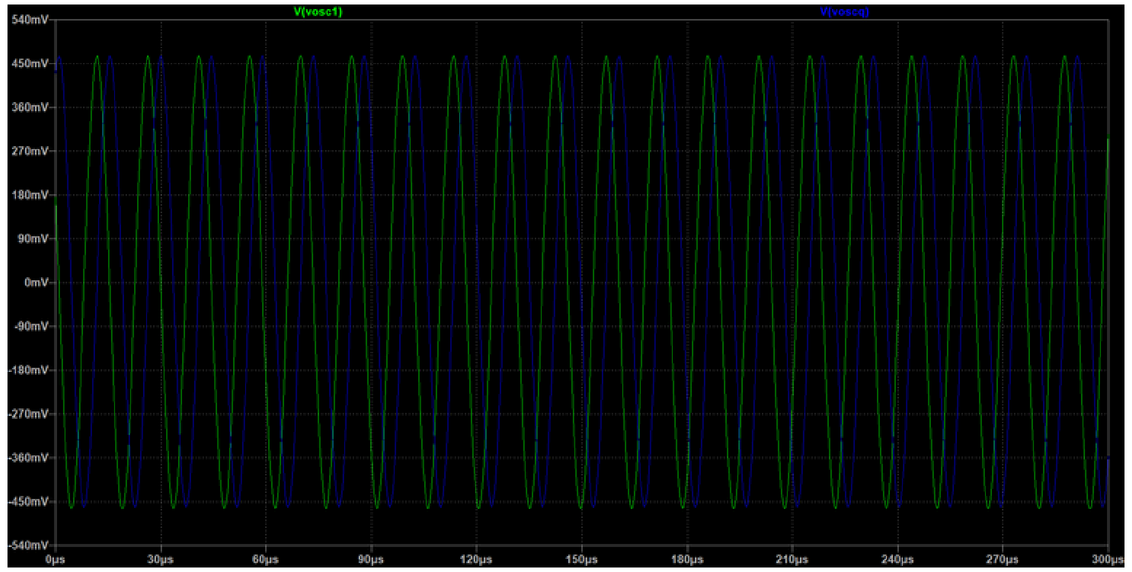


Control Systems

Quadrature signals are used in control systems for tasks like signal conditioning, feedback control, and motion control. In systems involving rotating machinery or robotic arms, quadrature encoders are used to measure angular position accurately.

Quadrature Oscillator

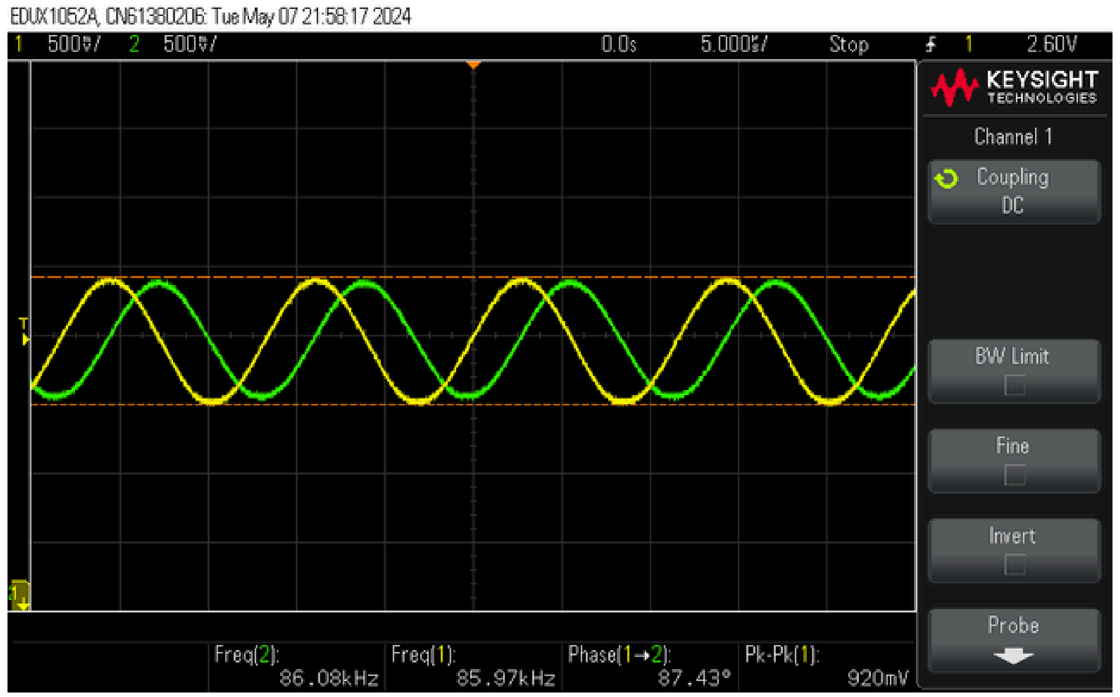
LT Spice



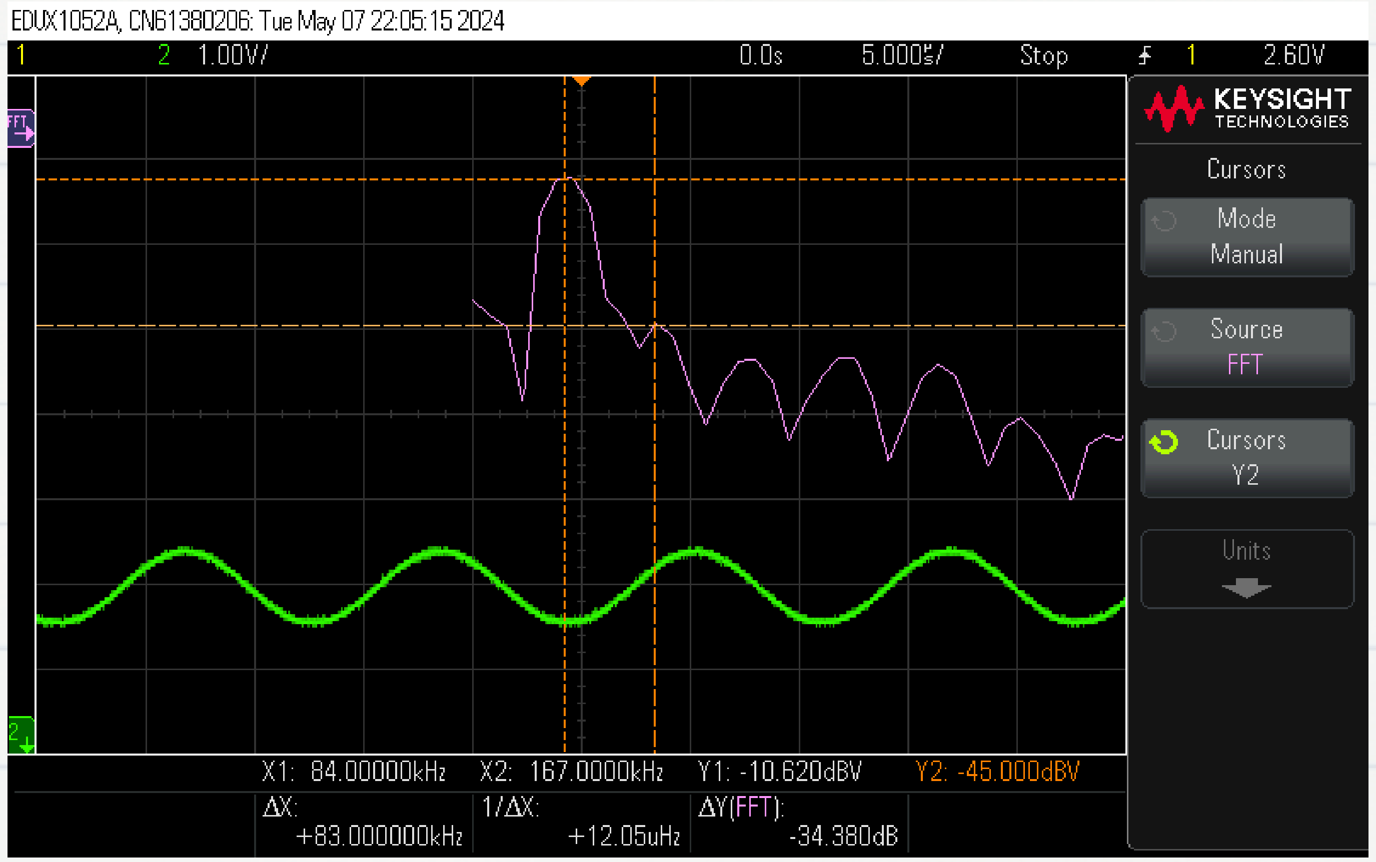
Characteristics

The two signals generated differ in phase by 90 degrees and are of same amplitude

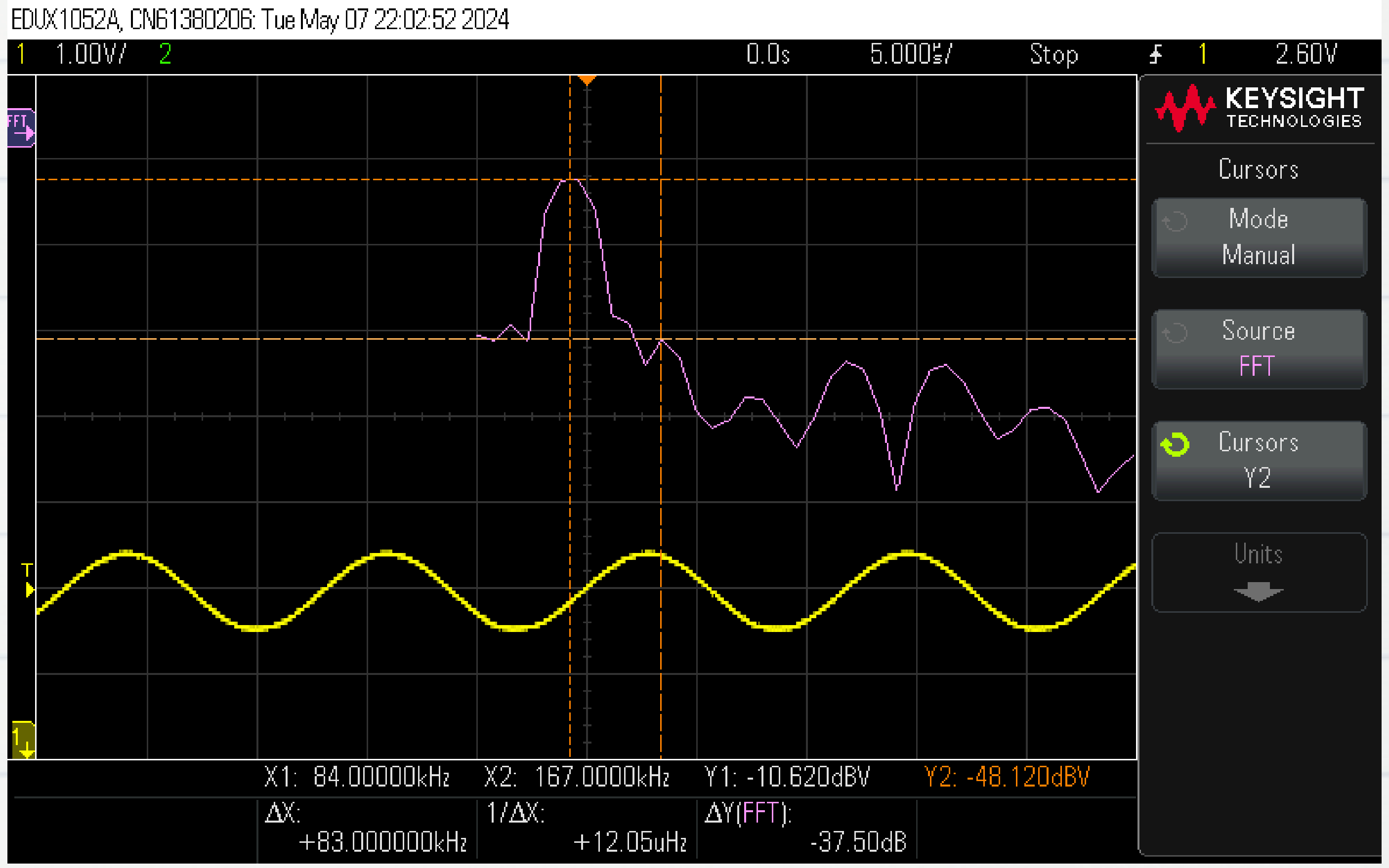
Hardware



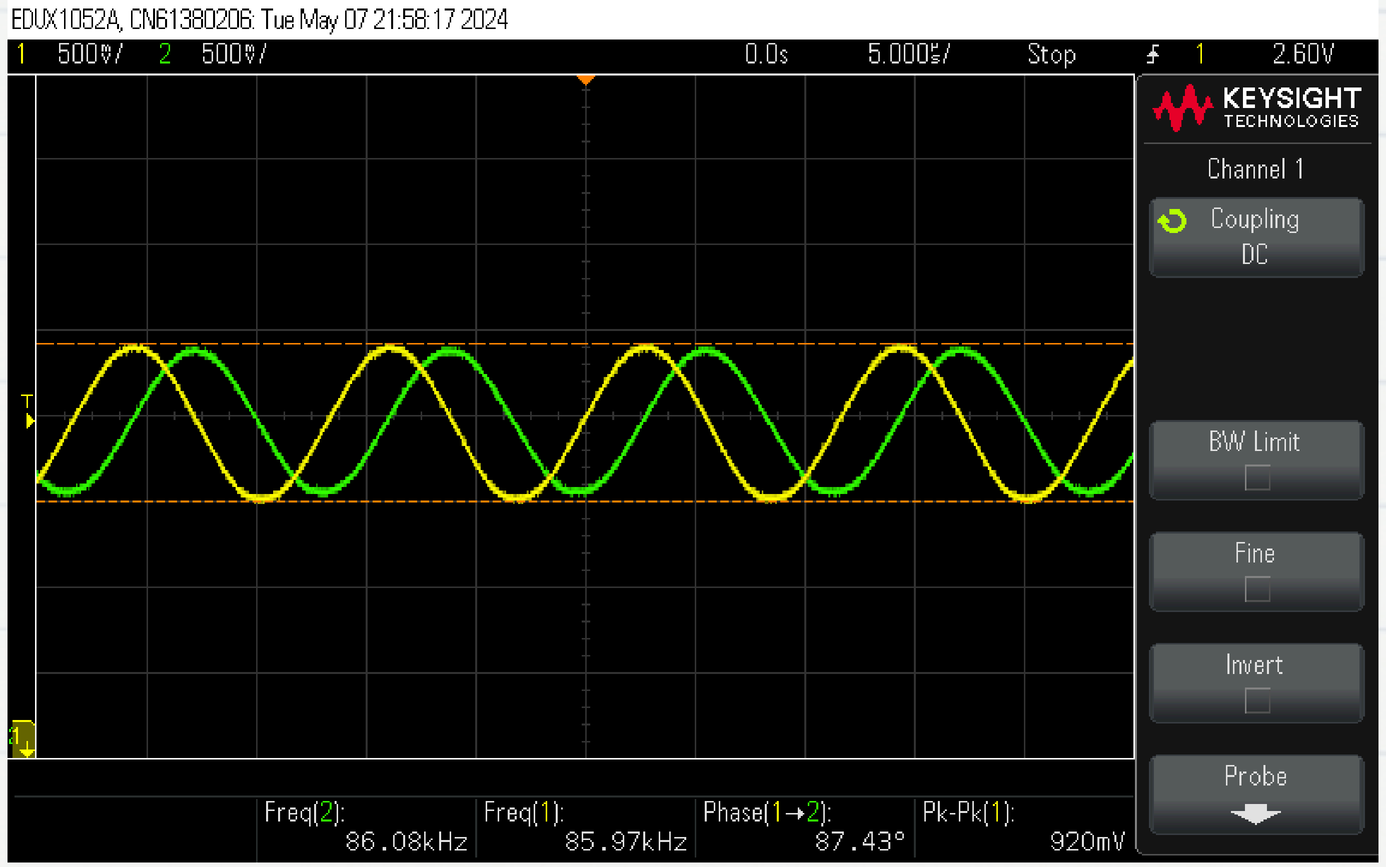
Values and ffts



Cos Wave and its FFT



Sine Wave and its FFT



Sin and Cos Waves

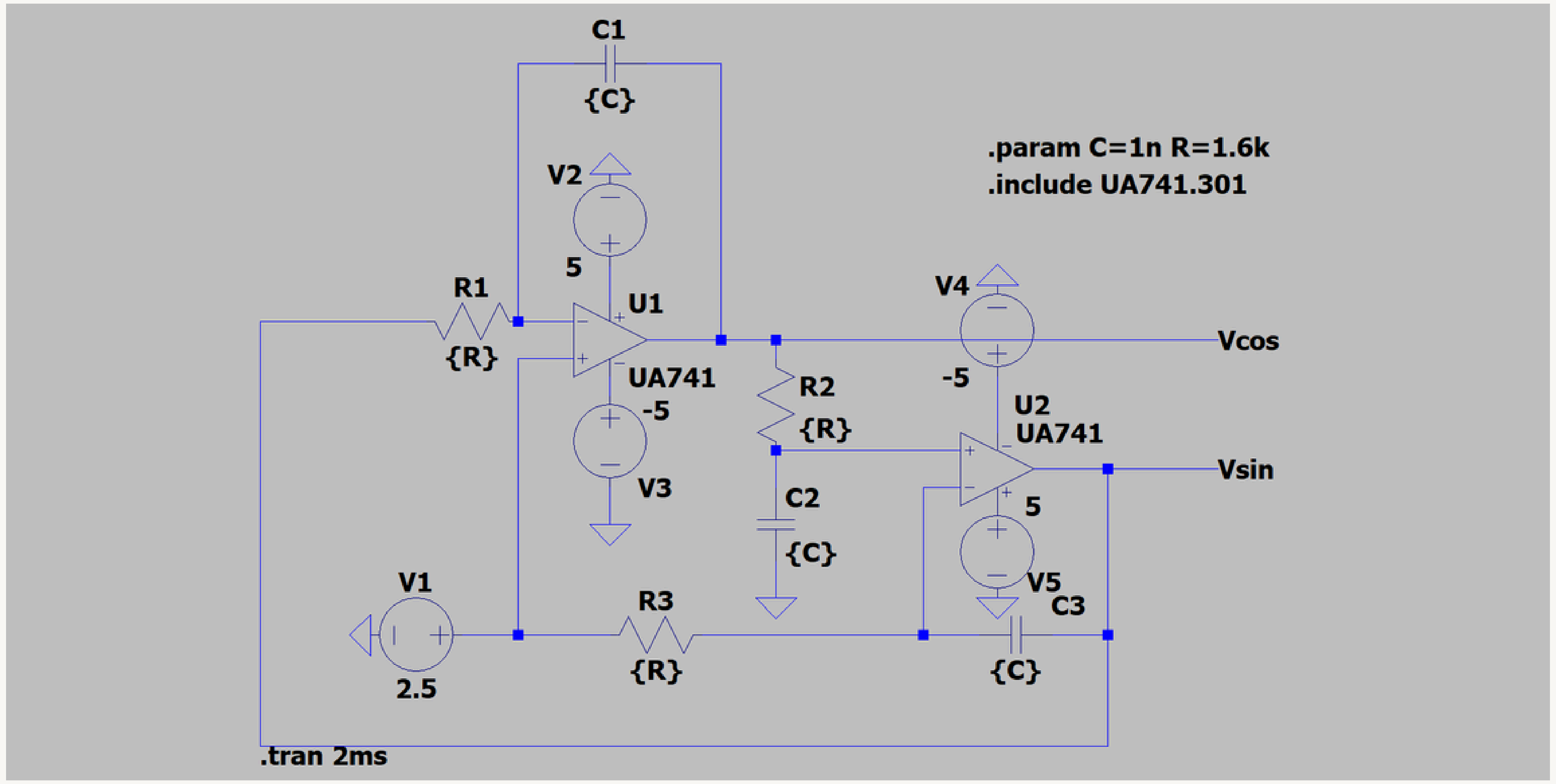
Resistor and Capacitor Values

Resistor values

R1 = R2 = R3 = 1.5kOhm

Capacitor values

C1 = C2 = C3 = 1nF



Switch/Mixer

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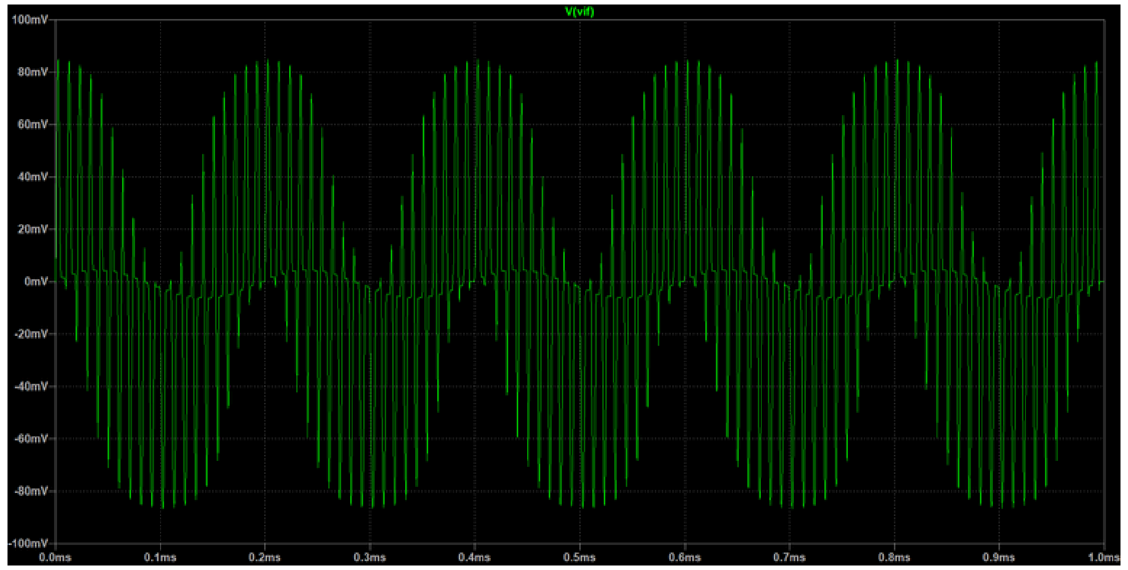
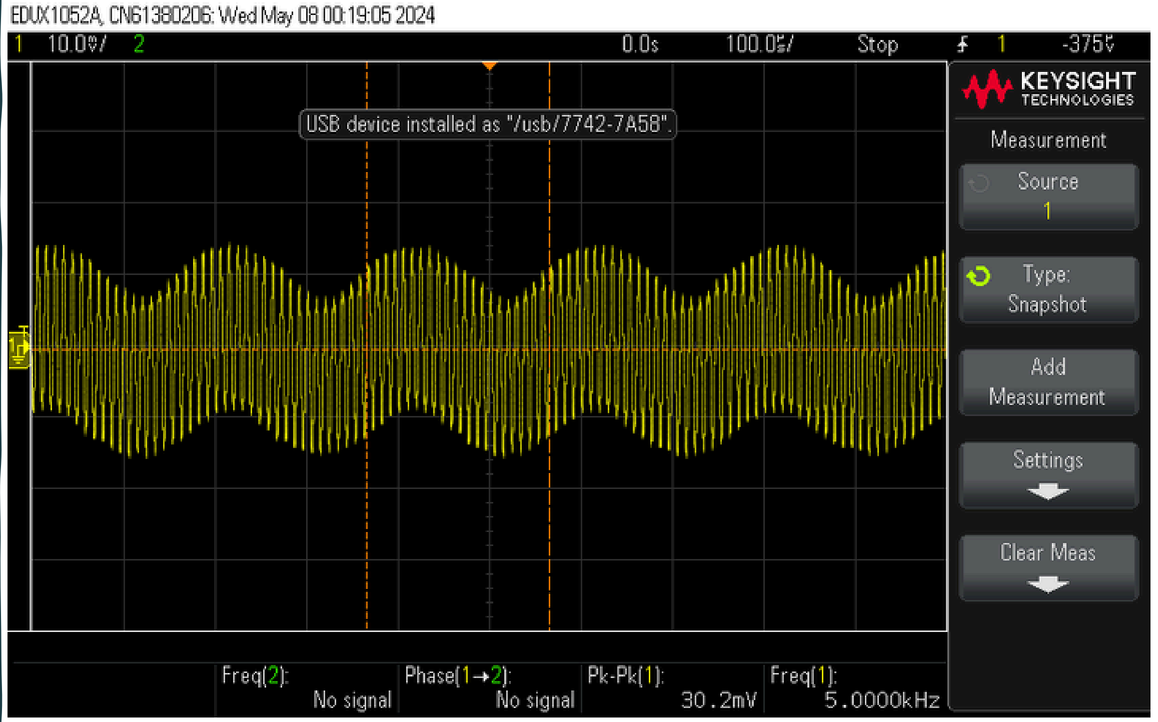


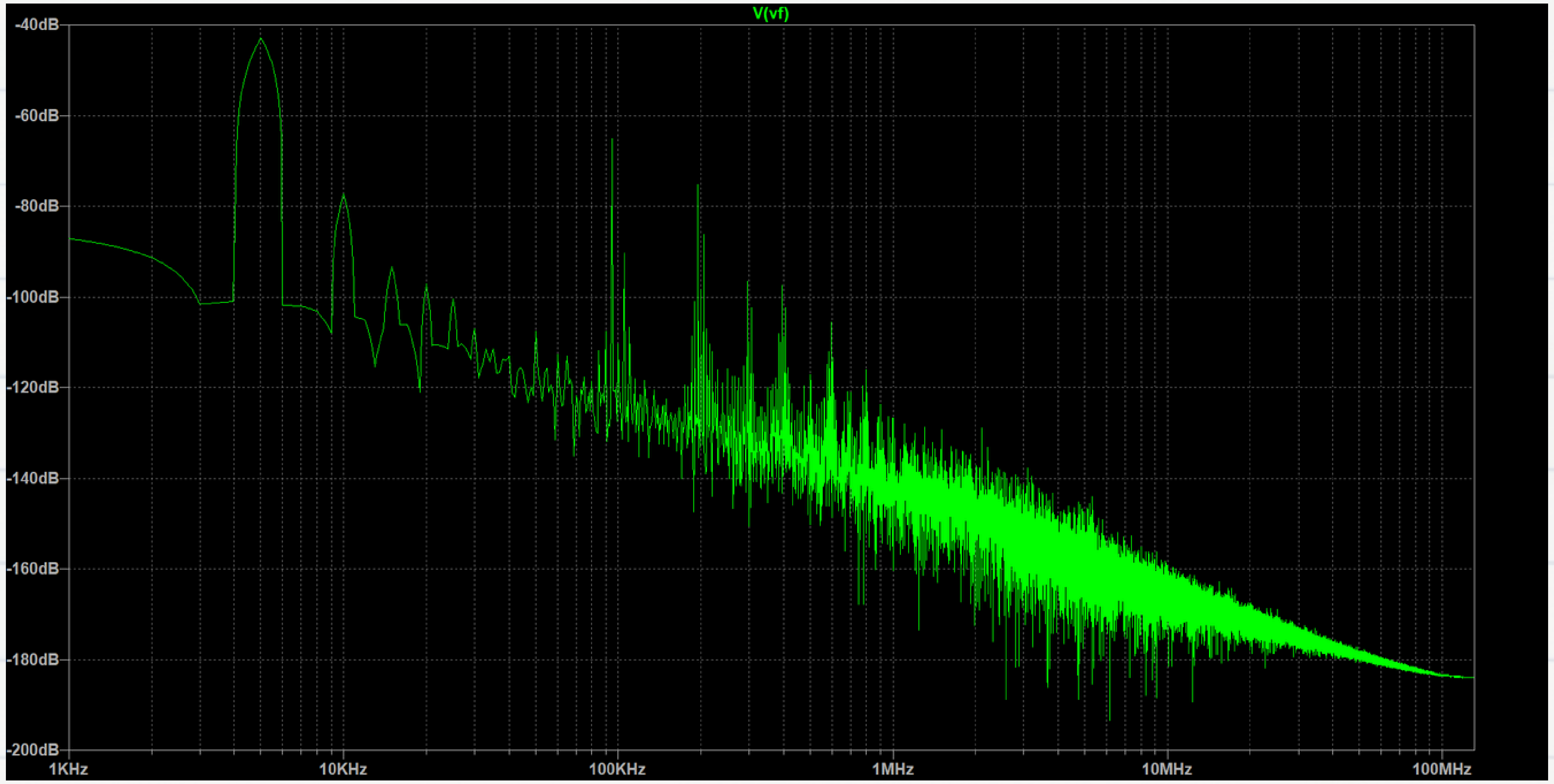
Characteristics

We obtain a mixed (multiplied) signal of the two signals - Vosc and Vin. The outer packer is of the lower of the two frequencies

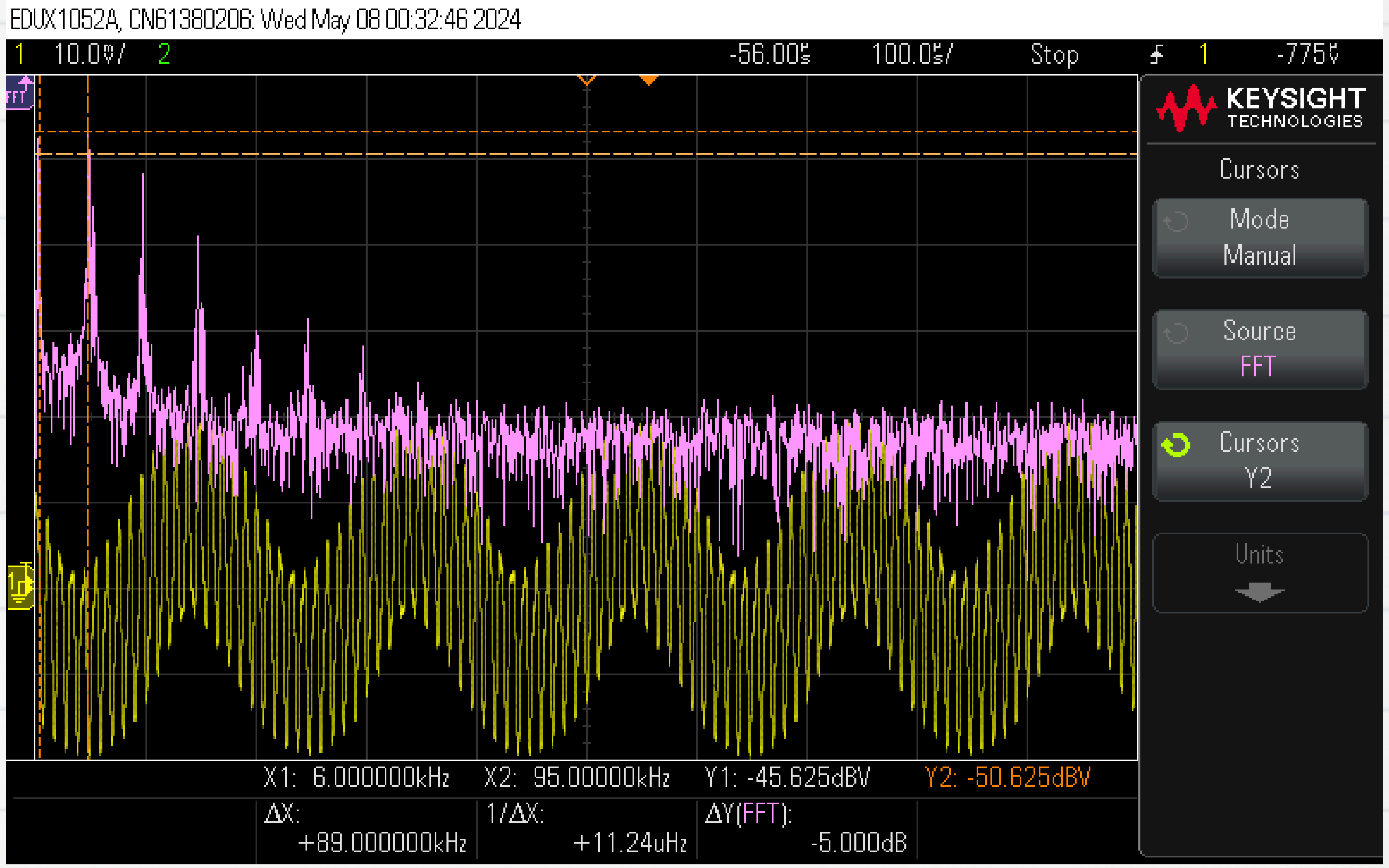
Hardware



Values and ffts



LT SPICE Simulation and its fft



Hardware Implementation and its fft

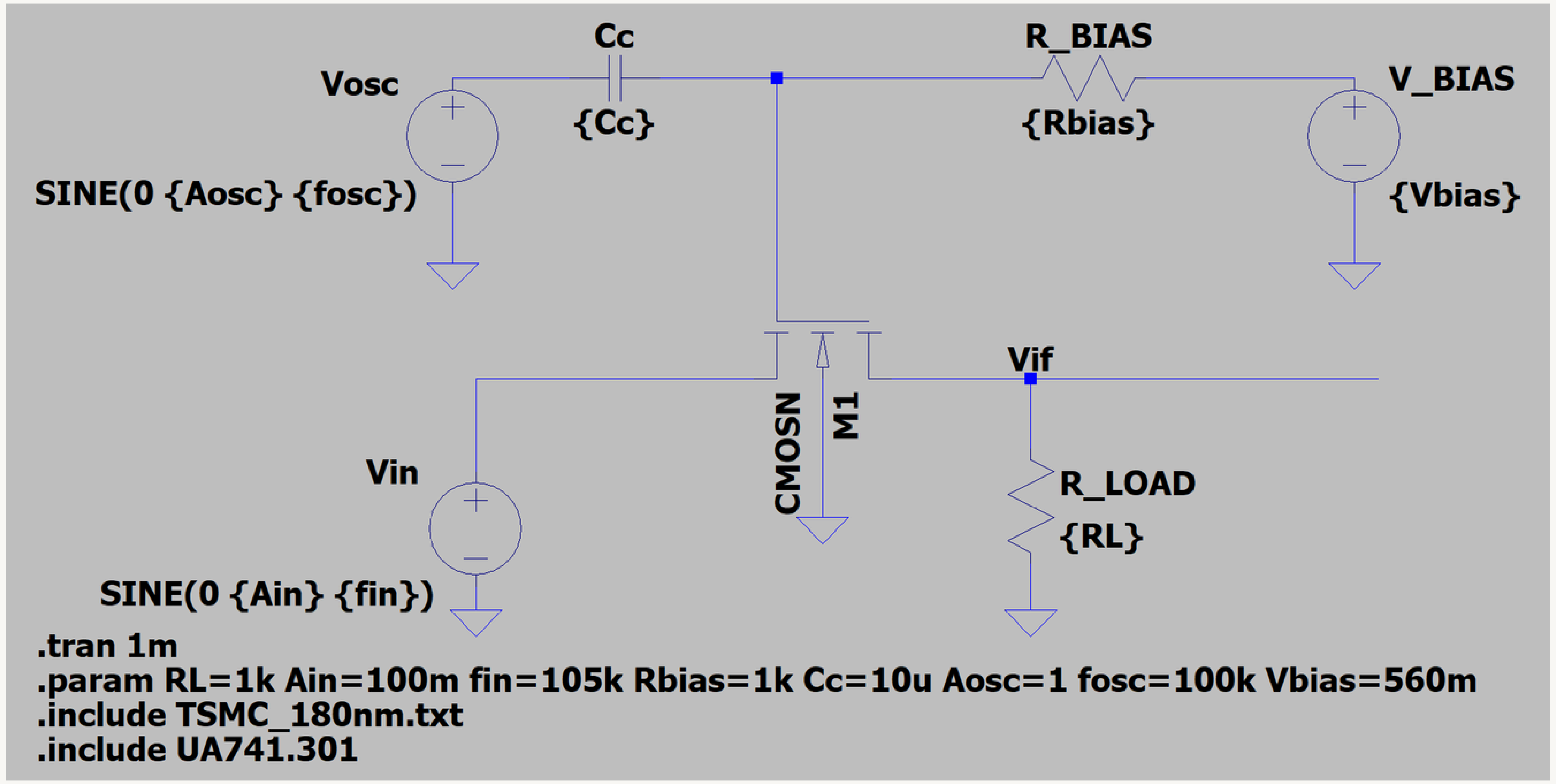
Resistor and Capacitor Values

Resistor values

Rbias = 1kOhm
Rload = 1kOhm

Capacitor values

Cc = 10uF



Low Pass Filter

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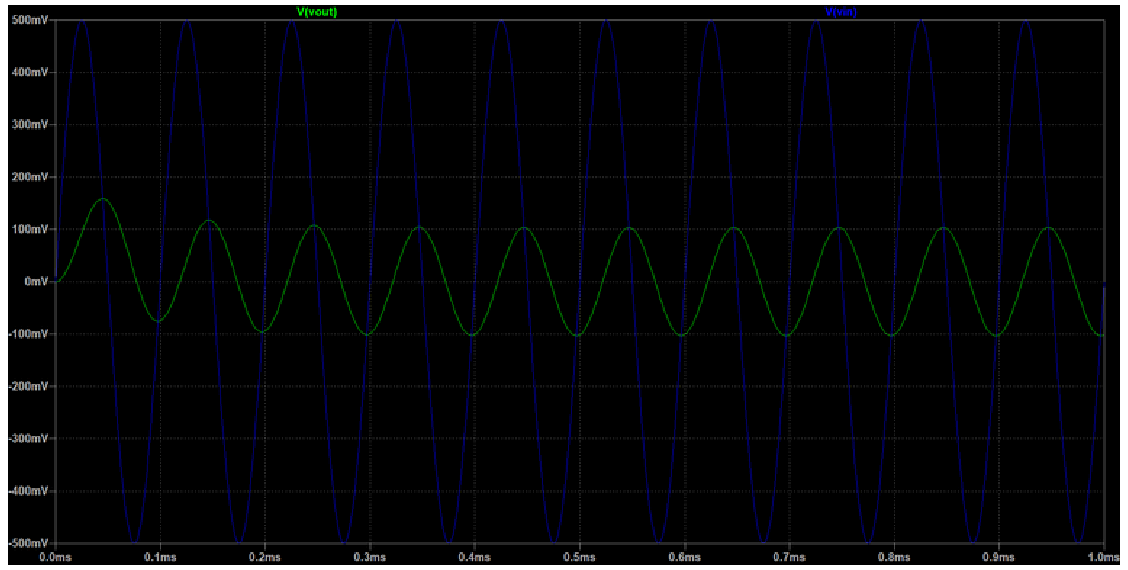
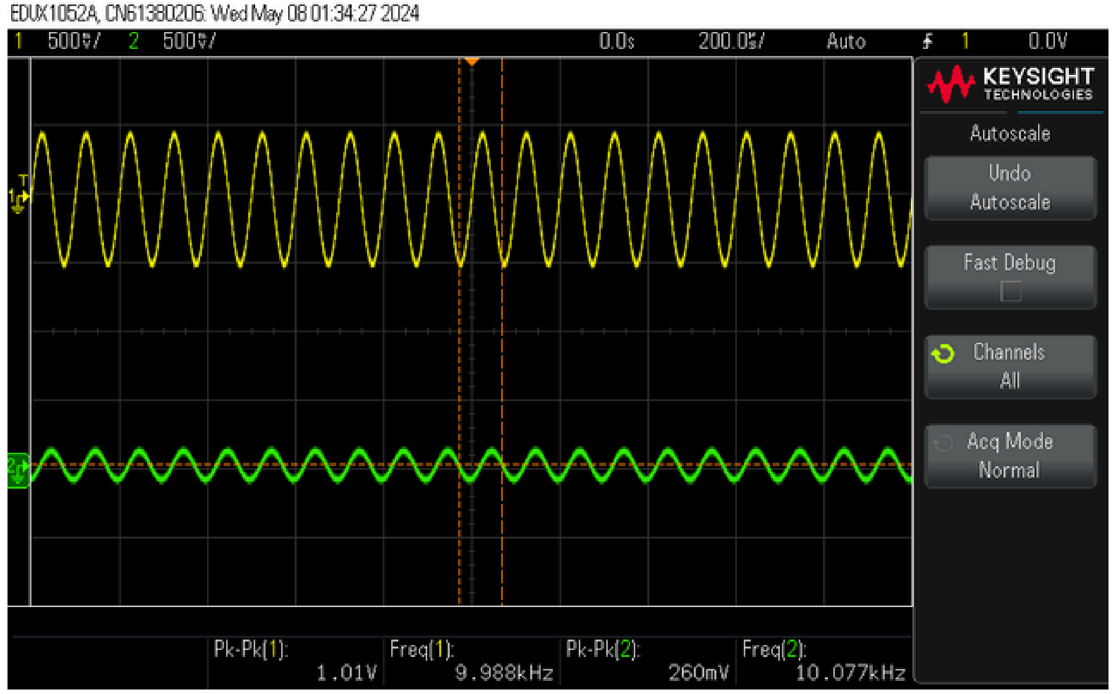


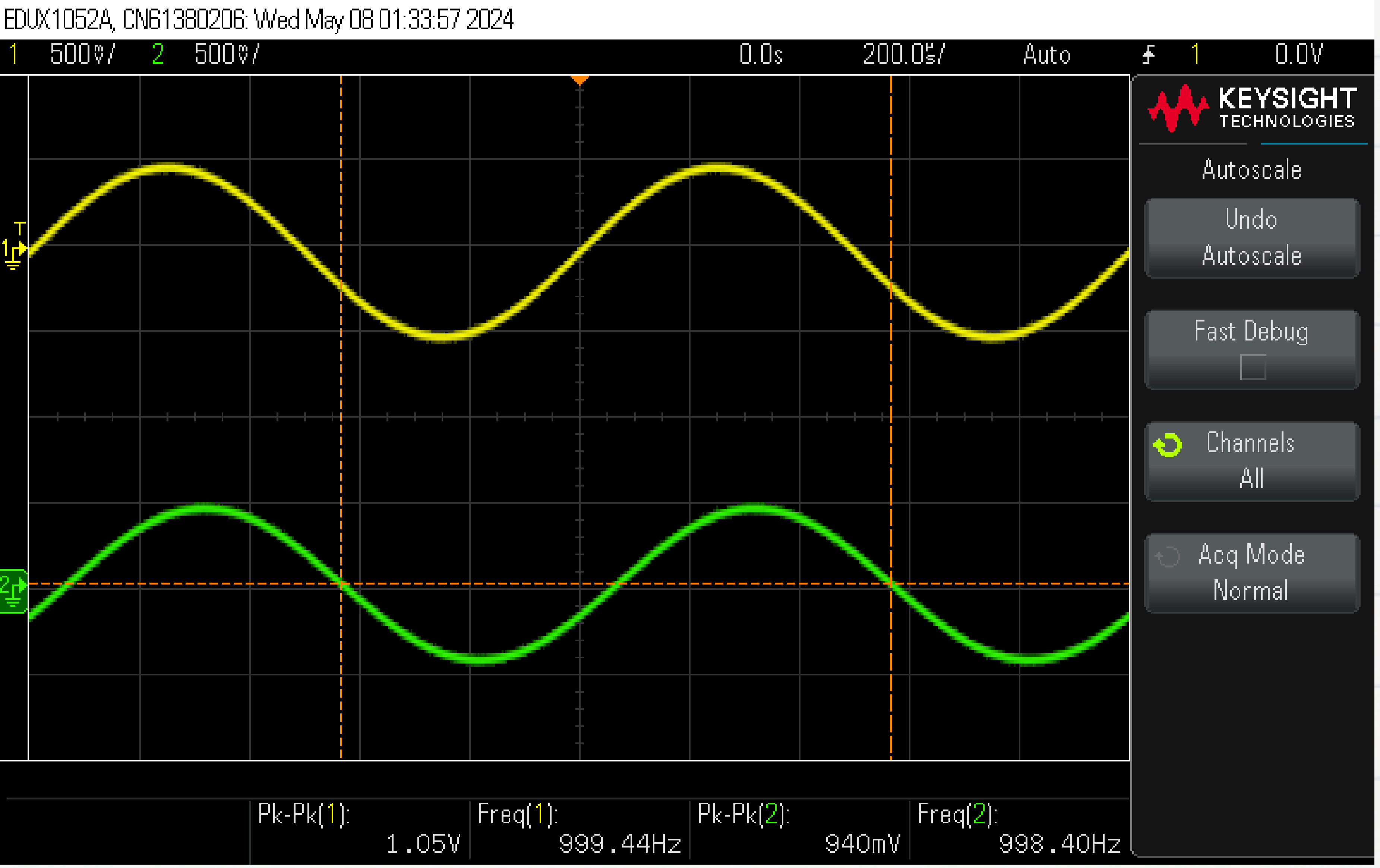
Characteristics

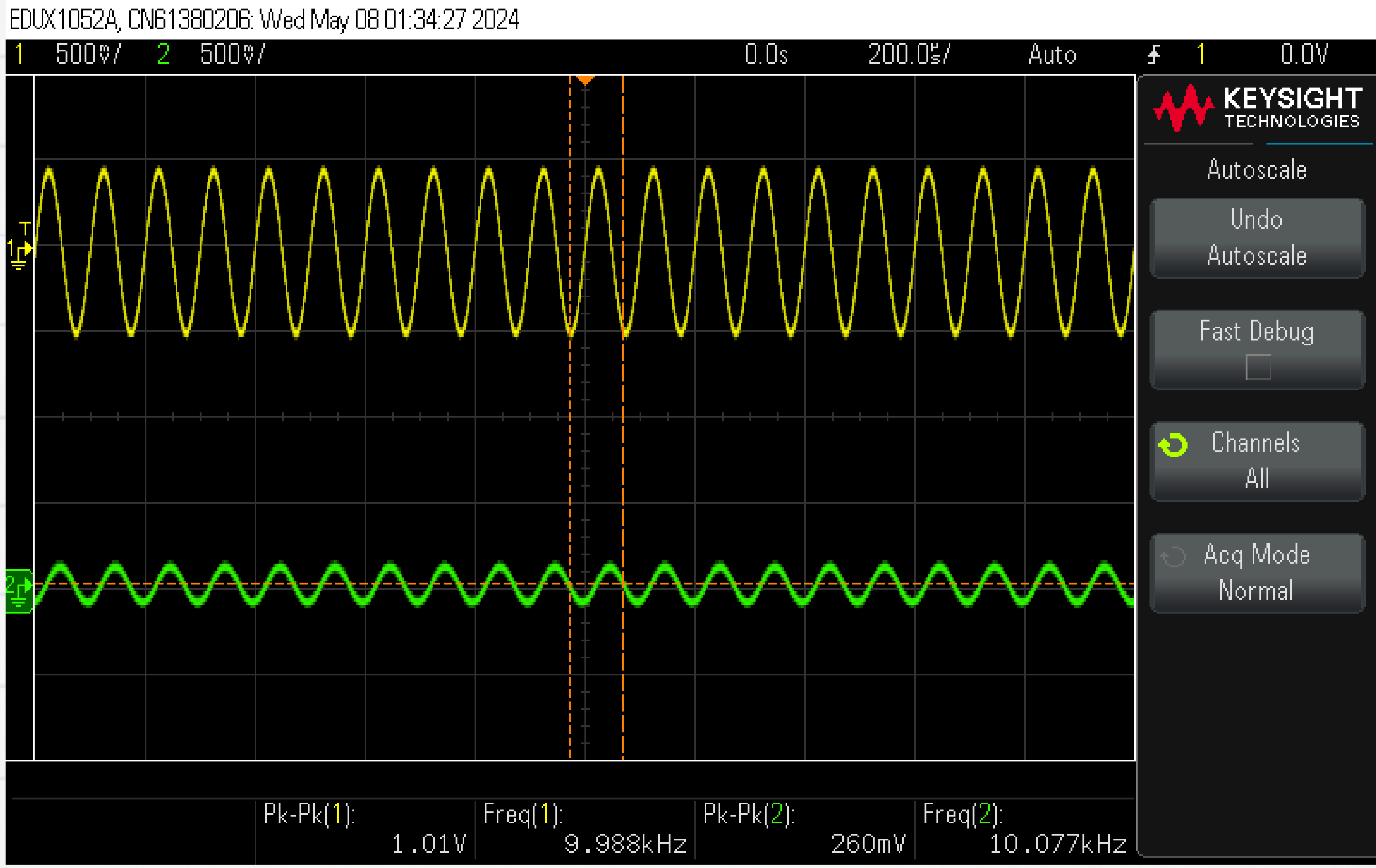
The attenuation observed starts at 2200 Hz. Below that the attenuation is minute.

Hardware



Values





At 1kHz, Vin is equal to Vout

At 10kHz, Vout is attenuated

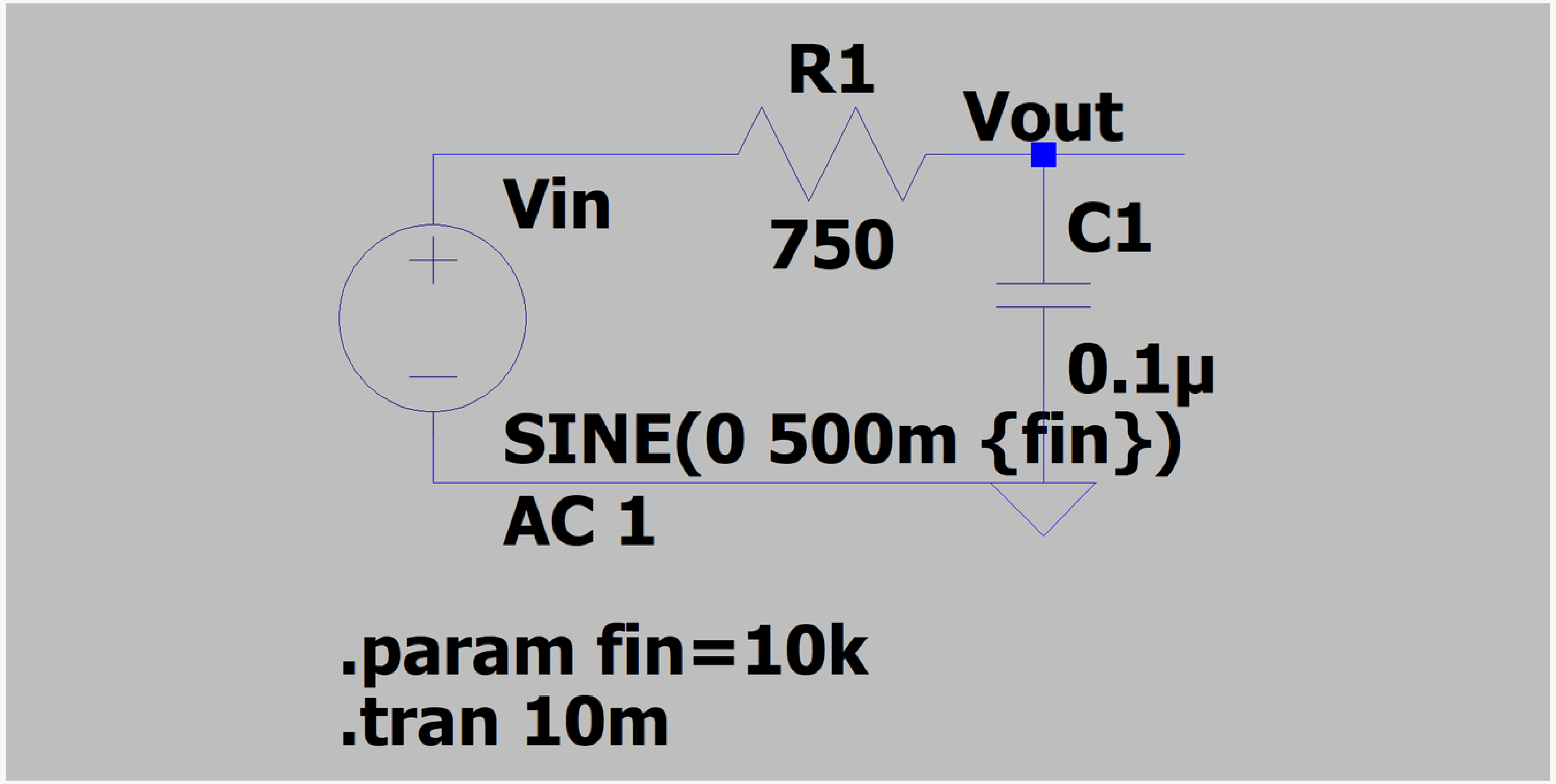
Resistor and Capacitor Values

Resistor values

R = 750Ohm

Capacitor values

Cc = 0.1uF



Complete Circuit

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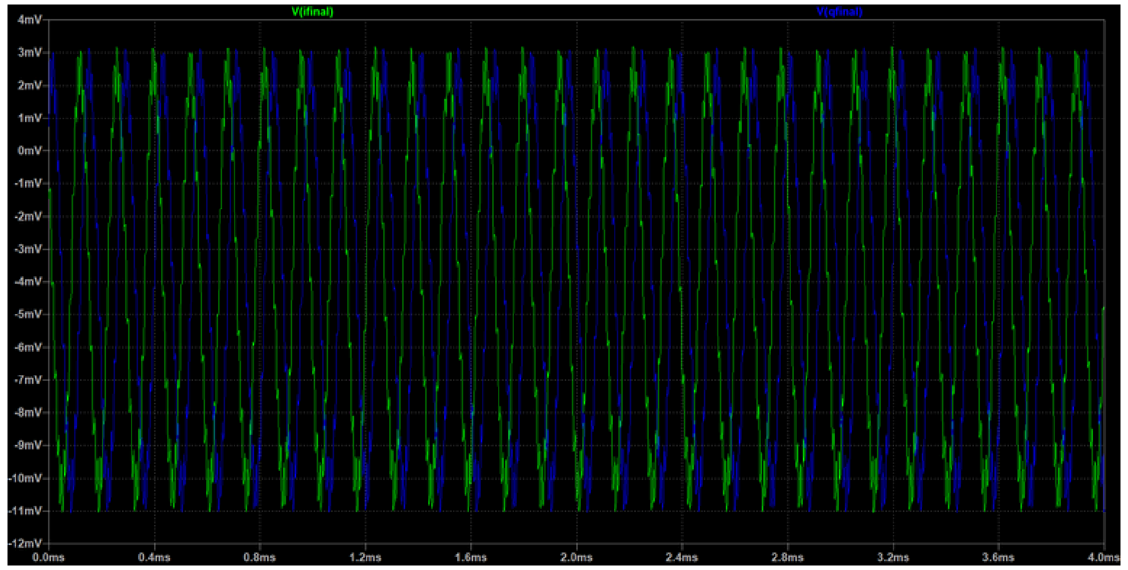
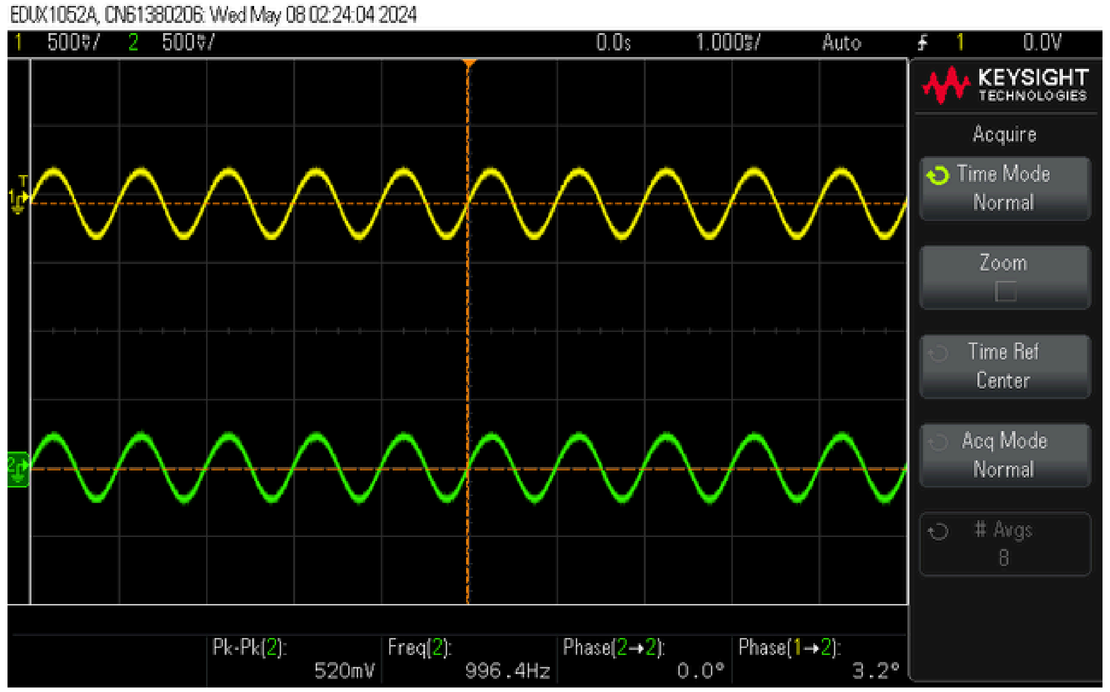


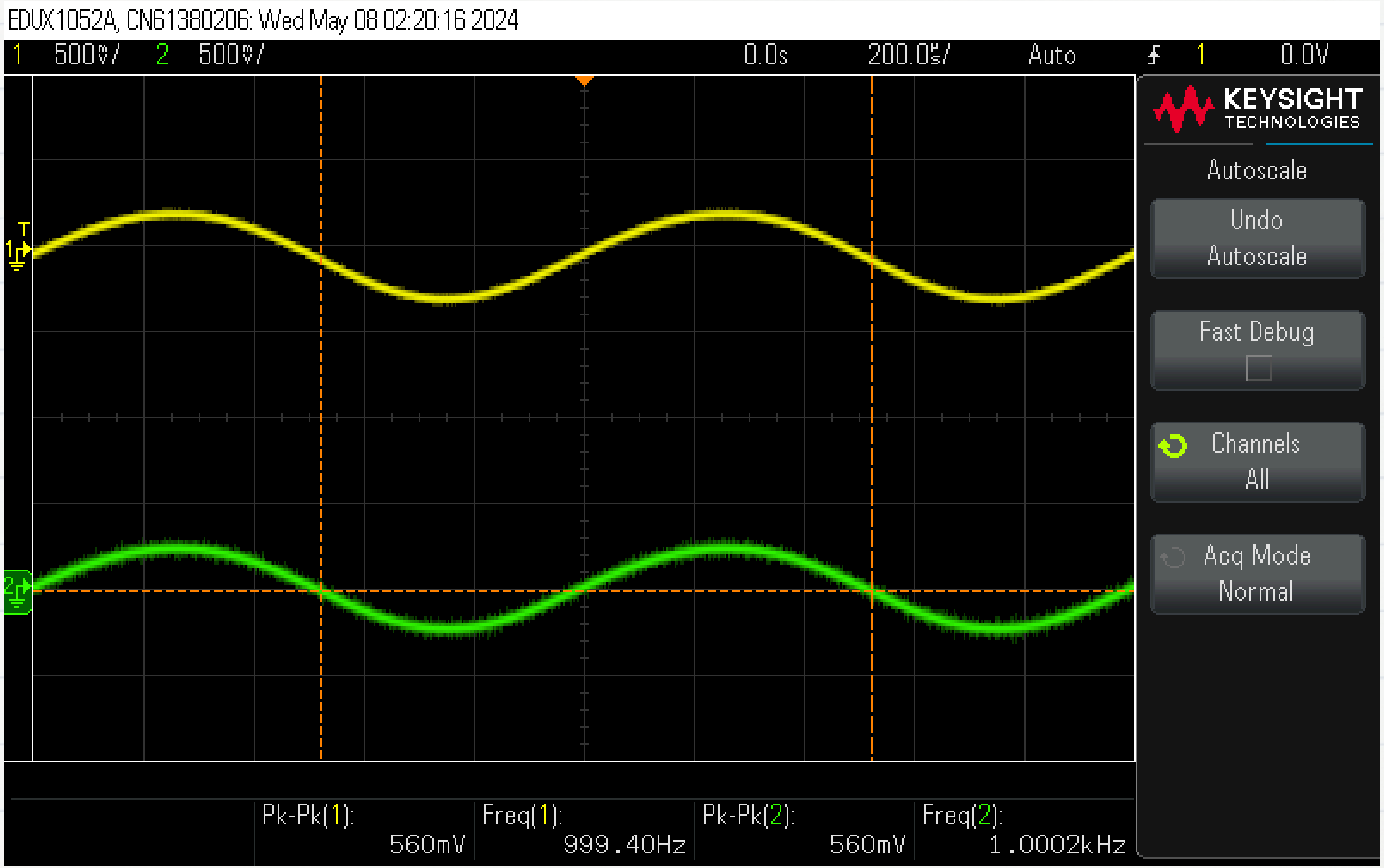
Characteristics

The two signals in the output differ 90 degreees in phase giving in phase and quadrature phase outputs.

Hardware



Values



Output Waves.

Conclusions

01

The circuit is giving both in phase and quadrature phase outputs.

02

Quadrature signals form an important part of our daily life.

03

The outputs observed are as expected within experimental errors

Parameters	Simulated	Measured	Expected
Oscillator Frequency	100 kHz	98.7 kHz	100 kHz
Oscillator Amplitude (I-phase)	950mV	800mV	1V
Oscillator Amplitude (Q-phase)	950mV	800mV	1V
Input Frequency	100kHz	100kHz	100kHz
IF	2kHz	2KHz	2kHz
Supply	2.5V	3V	2.5V
V_{BIAS}	560mV	1.8V	1.7V
C_c	10μF	10μF	10μF
R_{BIAS}	10kΩ	10kΩ	10MΩ
R_1, R_2, R_3	1.5$k\Omega$	1.5$k\Omega$	1.5$k\Omega$
C_1, C_2, C_3	1nF	1nF	1nF

Thank's For Watching