NETWORK ANALYSIS AND SYNTHESIS

(UE21EC242A)

PROJECT

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SALLEN KEY BAND PASS FILTER

CONTENTS:

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Sallen-Key is one of the most common filter configurations for designing first-order (1 st-order) and second-order (2 nd-order) filters and as such is used as the basic building blocks for creating much higher order filters.

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EXPLANATION:

We have seen here in this tutorial that the Sallen-Key configuration, also known as a voltage-controlled, voltage-source (VCVS) circuit is the most widely used filter topologies due mainly to the fact that the operational amplifier used within its design can be configured as a unity gain buffer or as a non-inverting amplifier.

The basic Sallen-key filter configuration can be used to implement different filter responses such as, Butterworth, Chebyshev, or Bessel with the correct selection of RC filter network. Most practical values of R and C can be used remembering that for a specific cut-off frequency point, the values of R and C are inversely proportional. That is as the value of R is made smaller, C becomes larger, and vice versa.

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The Sallen-key is a 2nd-order filter design which can be cascaded together with other RC stages to create higher-order filters. Multiple filter stages need not be the same but can each have different cut-off frequency or gain characteristics. For instance, putting together a low-pass stage and a high-pass stage to create a Sallen and Key band-pass filter.

Here we have looked at designing a Sallen-key high-pass filter, but the same rules apply equally for a Sallen-key low-pass design. The voltage gain, AV of the op-amp determines its response. The voltage gain is preset by the two voltage divider resistors, R1 and R2 remembering that the voltage gain must always be less than 3 otherwise, the filter circuit will become unstable and oscillate.

ADVANTAGES:

- Simple design
- Voltage gain control
- Cascading of filters
- Attenuator to an amplifier
- Wide frequency range
- Different configurationsHigh-order filter design
- Multiple stages and different gains
- Stability

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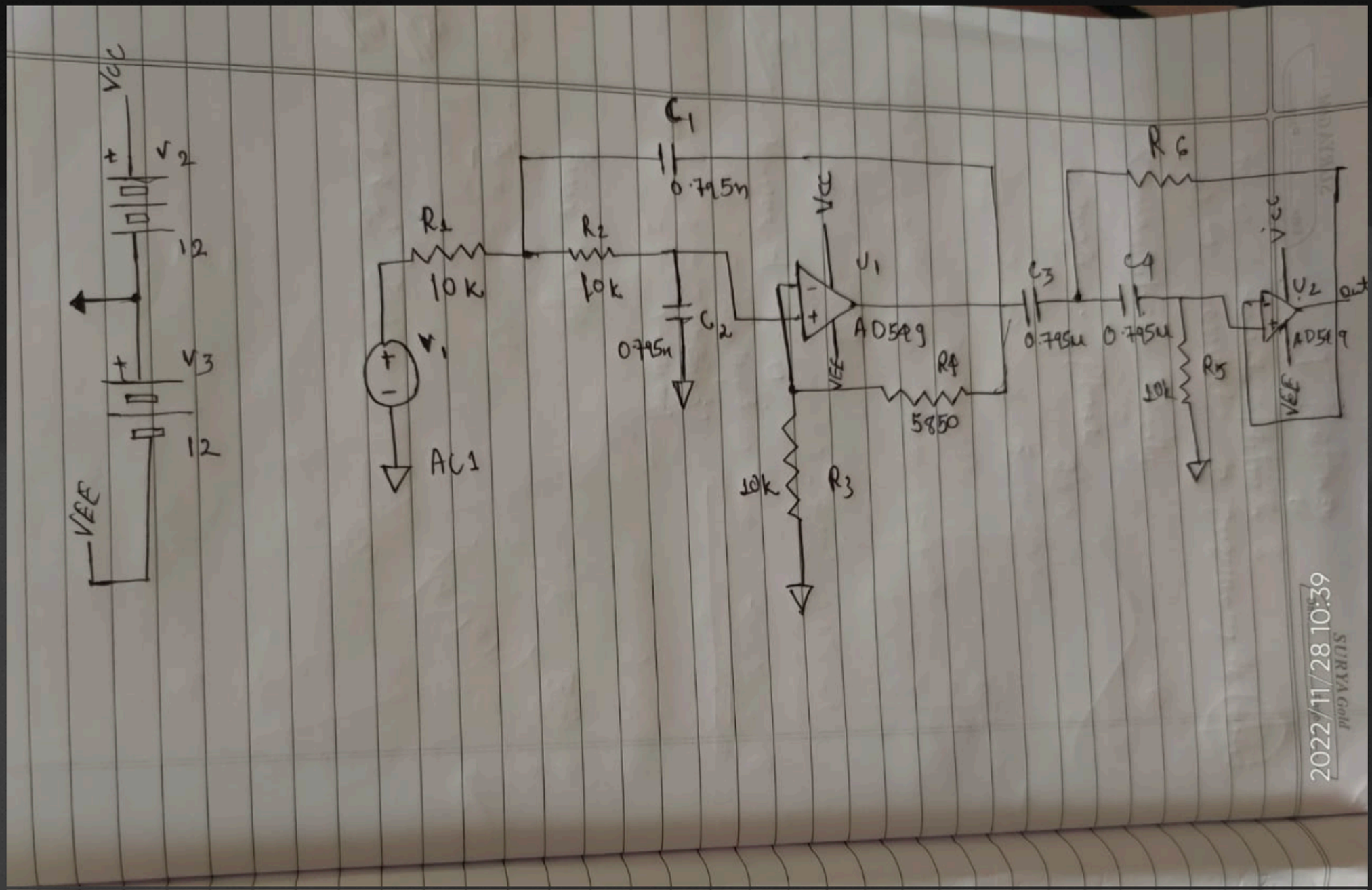
CIRCUIT:



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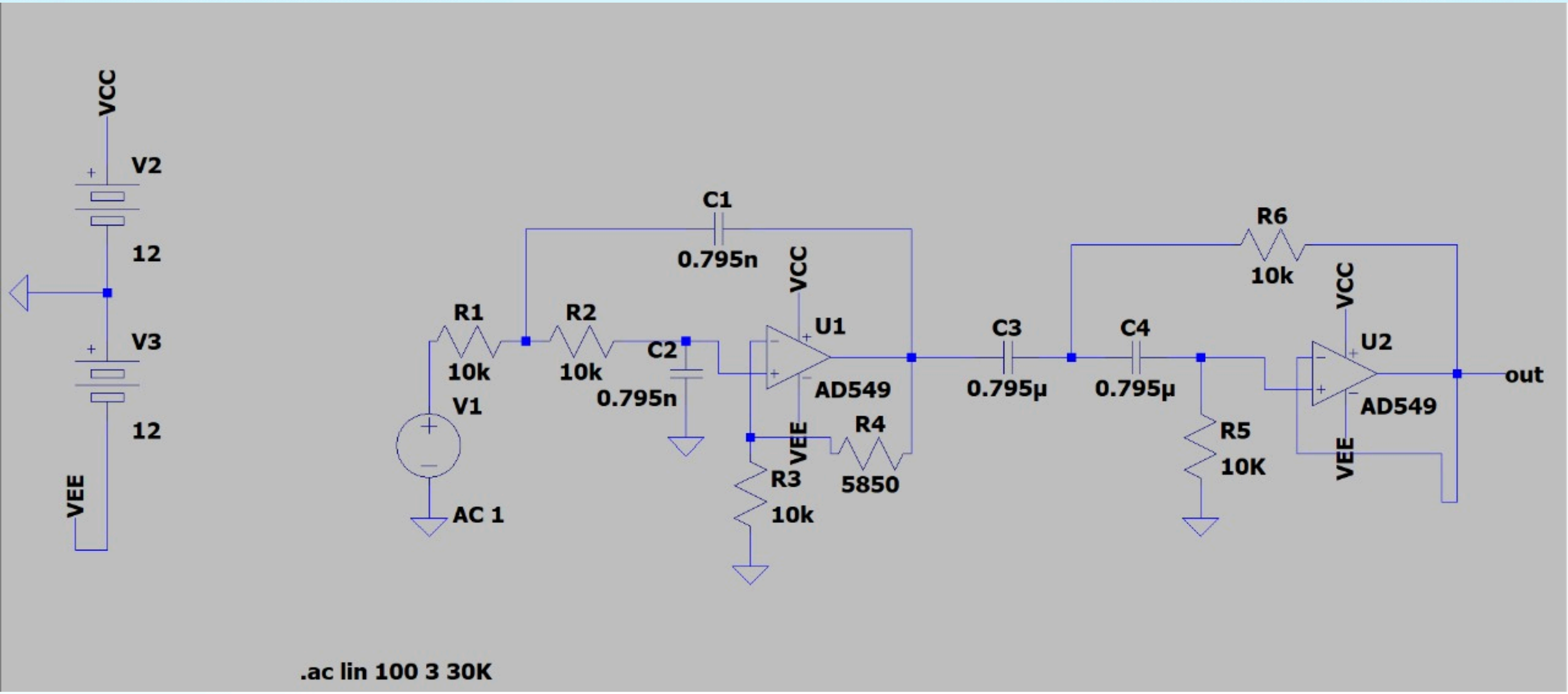
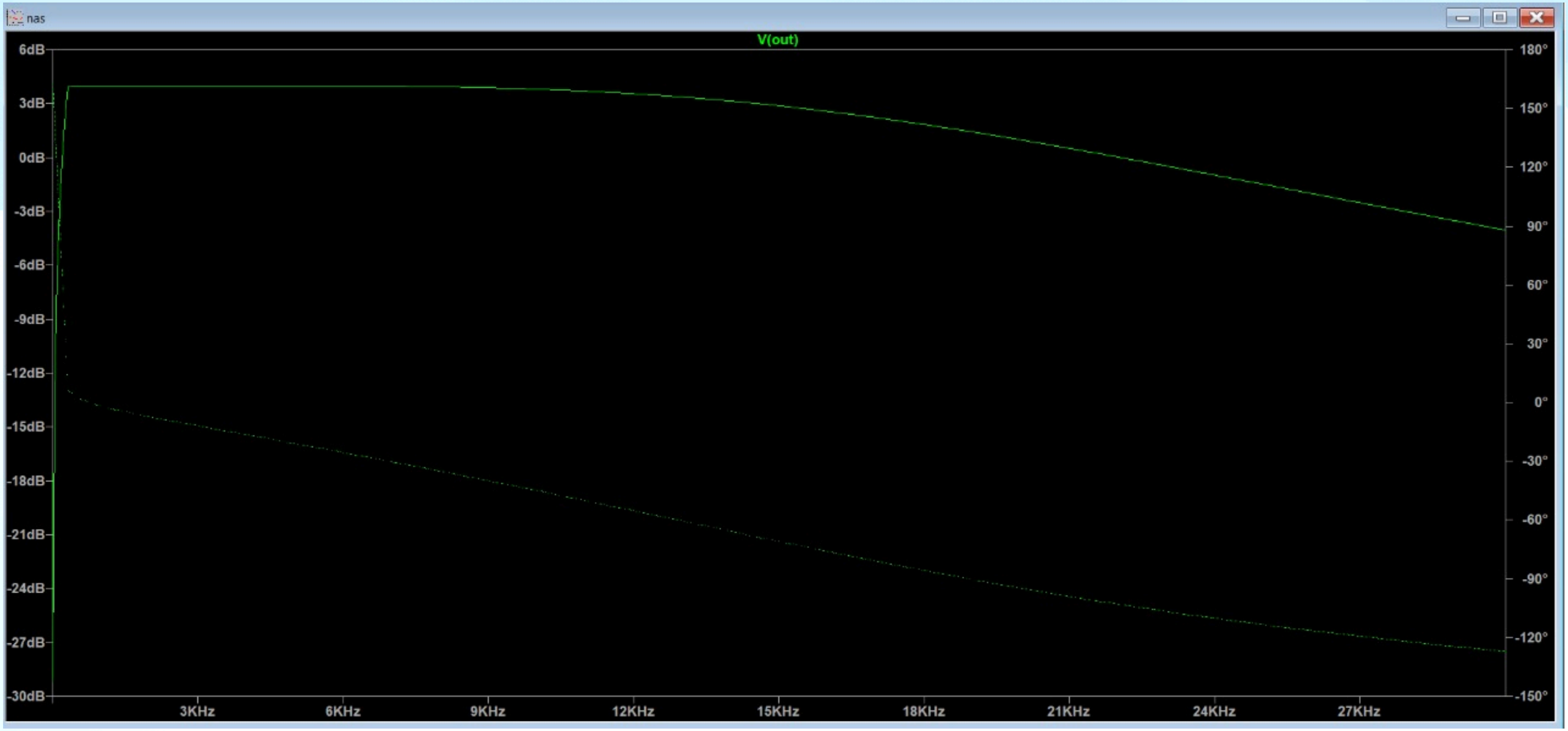
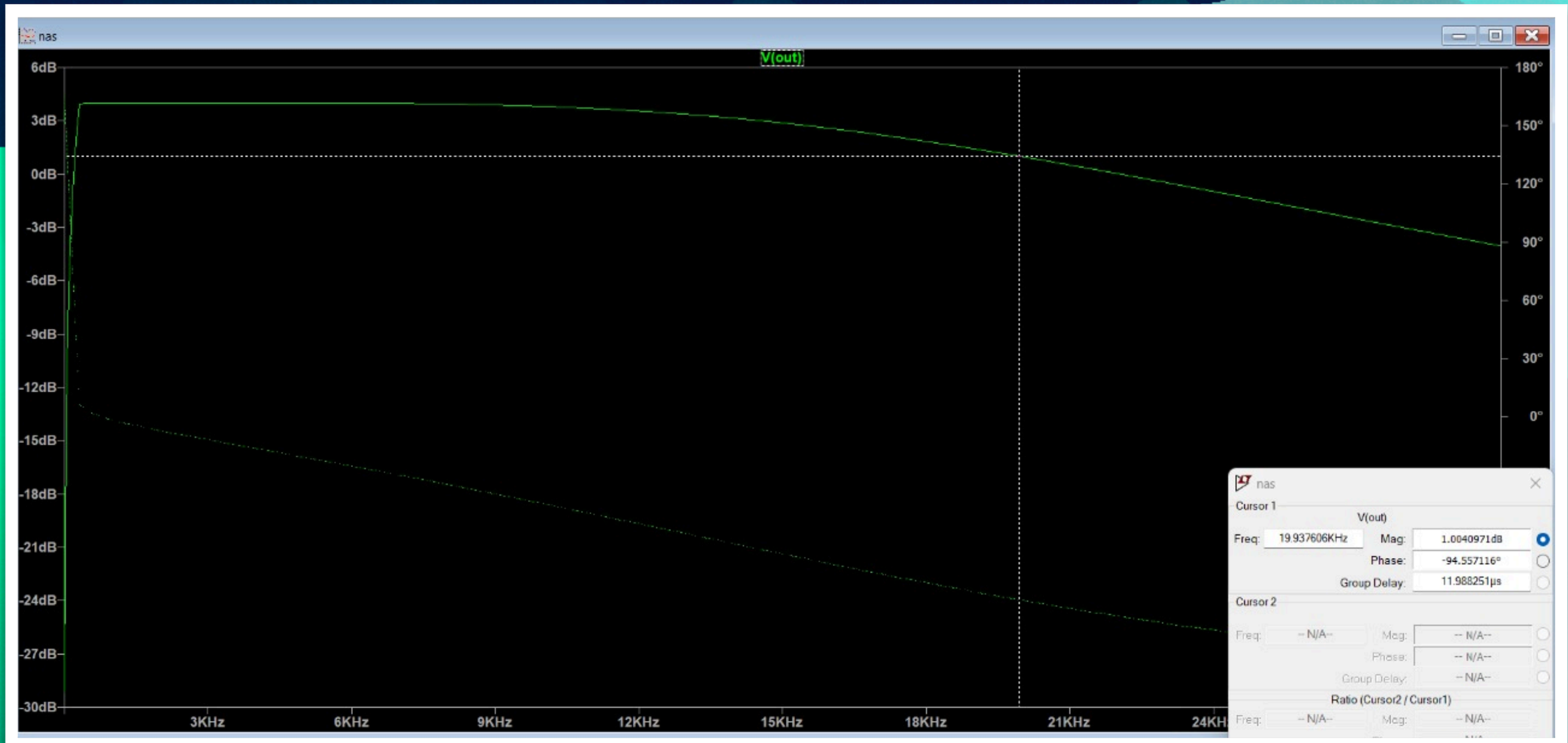
SIMULATIONS:



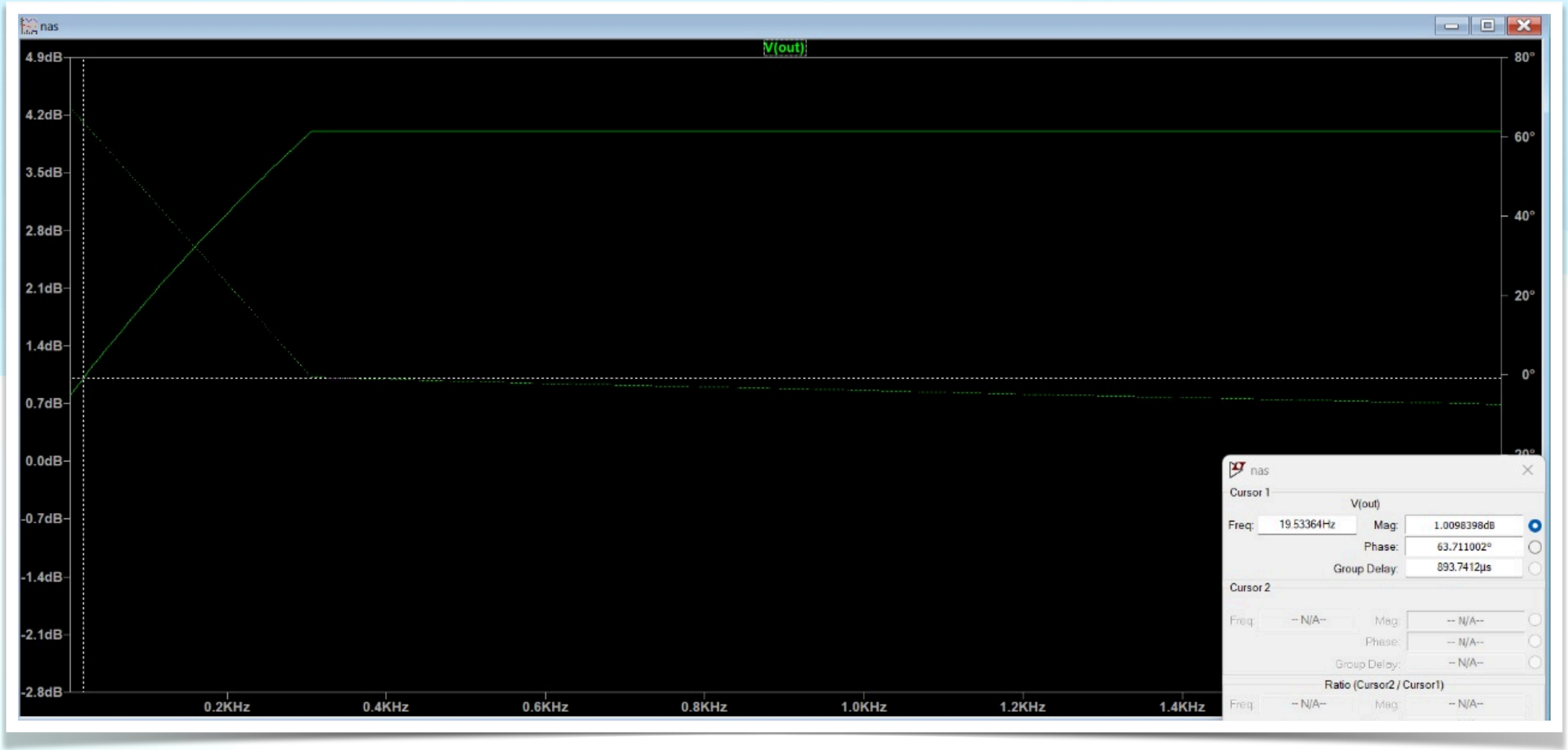
OUTPUT- >


nas
V(out)
6dB
3dB
0dB
-3dB
-6dB
-9dB
-12dB
-15dB
-18dB
-21dB
-24dB
-27dB
-30dB
180°
150°
120°
90°
60°
30°
0°
-30°
-60°
-90°
-120°
-150°
3KHz
6KHz
9KHz
12KHz
15KHz
18KHz
21KHz
24KHz
27KHz

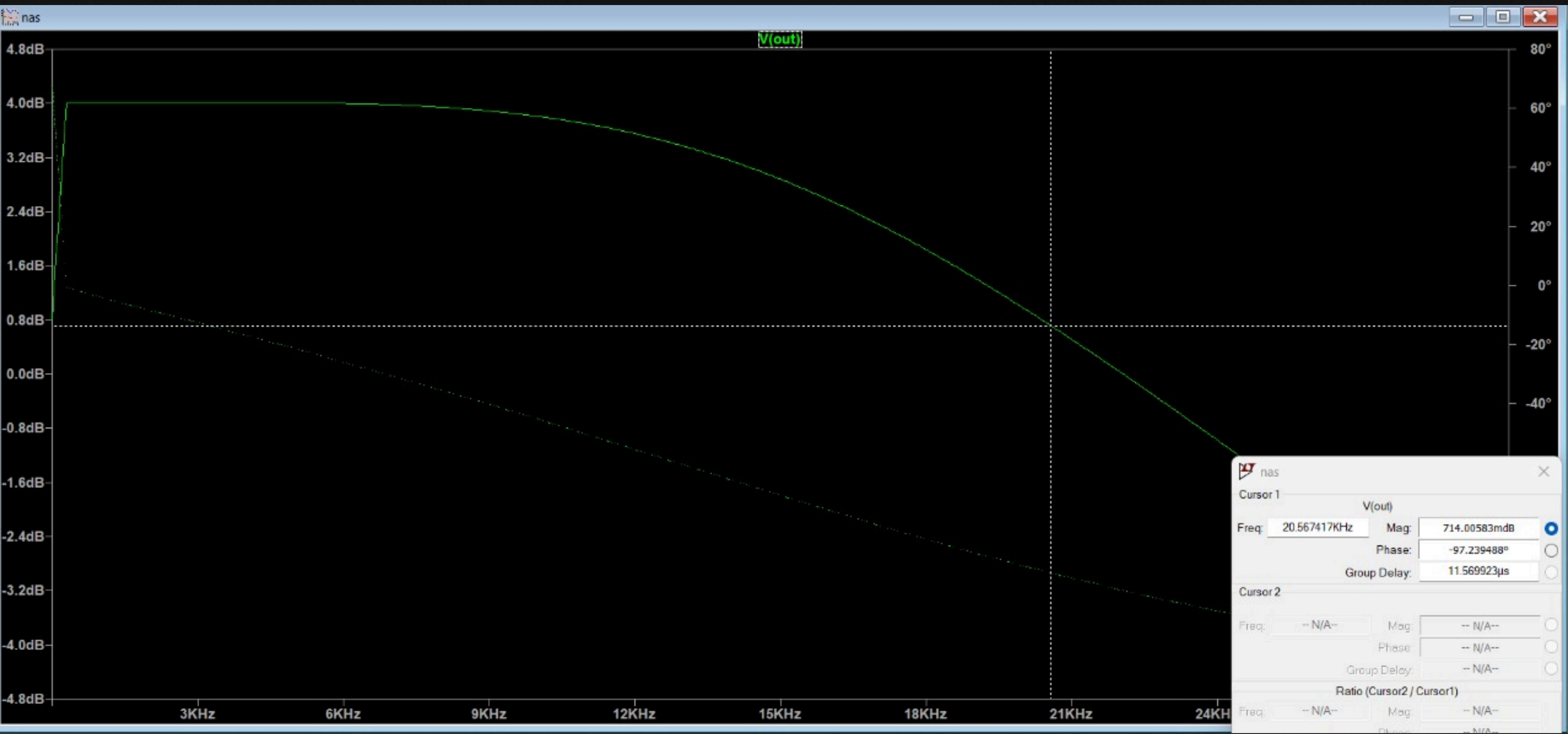
AT 20KHZ


nas
V(out)
6dB
3dB
0dB
-3dB
-6dB
-9dB
-12dB
-15dB
-18dB
-21dB
-24dB
-27dB
-30dB
180°
150°
120°
90°
60°
30°
0°
3KHz
6KHz
9KHz
12KHz
15KHz
18KHz
21KHz
24KH
nas
Cursor 1
V(out)
Freq: 19.937606KHz
Mag: 1.0040971dB
Phase: -94.557116°
Group Delay: 11.988251µs
Cursor 2
Freq: -- N/A--
Mag: -- N/A--
Phase: -- N/A--
Group Delay: -- N/A--
Ratio (Cursor2 / Cursor1)
Freq: -- N/A--
Mag: -- N/A--

AT 20 HZ


nas
V(out)
4.9dB
4.2dB
3.5dB
2.8dB
2.1dB
1.4dB
0.7dB
0.0dB
-0.7dB
-1.4dB
-2.1dB
-2.8dB
80°
60°
40°
20°
0°
-20°
0.2KHz
0.4KHz
0.6KHz
0.8KHz
1.0KHz
1.2KHz
1.4KHz
nas
Cursor 1
V(out)
Freq: 19.53364Hz
Mag: 1.0098398dB
Phase: 63.711002°
Group Delay: 893.7412µs
Cursor 2
Freq: -- N/A--
Mag: -- N/A--
Phase: -- N/A--
Group Delay: -- N/A--
Ratio (Cursor2 / Cursor1)
Freq: -- N/A--
Mag: -- N/A--

ABOVE 20 KHZ


nas
V(out)
4.8dB
4.0dB
3.2dB
2.4dB
1.6dB
0.8dB
0.0dB
-0.8dB
-1.6dB
-2.4dB
-3.2dB
-4.0dB
-4.8dB
80°
60°
40°
20°
0°
-20°
-40°
3KHz
6KHz
9KHz
12KHz
15KHz
18KHz
21KHz
24KH
nas
Cursor 1
V(out)
Freq: 20.567417KHz
Mag: 714.00583mdB
Phase: -97.239488°
Group Delay: 11.569923µs
Cursor 2
Freq: -- N/A--
Mag: -- N/A--
Phase: -- N/A--
Group Delay: -- N/A--
Ratio (Cursor2 / Cursor1)
Freq: -- N/A--
Mag: -- N/A--

CALCULATIONS:

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage	±18 V
Internal Power Dissipation	500 mW
Input Voltage[1]	±18 V
Output Short-Circuit Duration	Indefinite
Differential Input Voltage	$+V_S$ and $-V_S$
Storage Temperature Range	−65°C to +125°C
Operating Temperature Range	
AD549J, AD549K, AD549L	0°C to +70°C
AD549S	−55°C to +125°C
Lead Temperature (Soldering, 60 sec)	300°C

[1] For supply voltages less than ±18 V, the absolute maximum input voltage is equal to the supply voltage.

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$$f_c = \frac{1}{2\pi RC}$$

$$Q = \frac{1}{3-K}$$

$Q = \frac{1}{\sqrt{2}}$ we will take general Q factor to consideration

$3 - K = \text{sqrt}(2)$

$K = 3 - \text{sqrt}(2)$

$K = 1.585$

$$K = 1 + \frac{R_4}{R_3}$$

$$\frac{R_4}{R_3} = 0.585$$

Let assume $R_3 = 10K$

$R_4 = 5850$ ohms

Audi

Audible frequency

20 Hz to 20 KHZ

F_c = 20KHZ

$F_c = 1/2\pi RC$

Let R = 10K

$$C = \frac{1}{2\pi R F_c}$$

$$C = \frac{1}{2\pi * 20k \times 10k}$$

C = 0.795 nF

Applications:

The applications include:

They are widely used in wireless transmitters and receivers in signal processing.
The main function of this filter is to restrict the bandwidth of the o/p signal that is allocated for transmission.
It evades the transmitter from meddling with other stations.
It decodes signals from a particular range of frequencies while stopping signals from unwanted frequencies to pass through. It also enhances the signal to noise ratio and sensitivity in a receiver environment.
They are deployed in all kinds of electronic and communication devices, biomedical devices like EEG's, electrocardiograms, seismology etc.
It is popularly used in optical field too, like Lasers, LIDARs, etc.
It is used in finding meteorological data to understand the weather forecasts during a particular range of time. For example, finding out weather report of specific area from a time range of 3-10 days time period.

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THANK YOU->