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# A picture containing clock  Description automatically generatedLow-Pass Filter – Design for -3dB Gain

First, let’s revisit the low-pass filter. In this section you will work with the circuit shown to the right using a fixed resistor of $R=1kΩ$, input signals of different shapes but always at a frequency of 25-kHz, and different capacitors to vary the behavior of the circuit.

## Oscilloscope trace showing -3dB gain.

Choose a capacitor so the gain of the circuit will be approximately -3dB when the input is a 25-kHz *sine* wave. Capture an oscilloscope trace that shows both the input and output traces.

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## Justification and explanation of -3dB gain circuit.

State the value of the capacitor that you chose, justify why you chose it, and explain how your oscilloscope image above verifies that the gain is -3dB.

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# Low Pass Filter – Design for Unity Gain.

Continue to work with the same circuit with the same $1kΩ$ resistor, but now choose a capacitor that will create a unity gain (0 dB) situation when the input is a 25-kHz *square* wave.

## Choose $C$ for unity gain circuit.

Capture an oscilloscope trace that shows both the input and output signals and upload it below.

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## Justification and explanations of unity gain circuit.

State the value of the capacitor that you chose, justify why you chose it, and explain how your oscilloscope image above verifies that the gain is unity.

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# Low-Pass Filter – Design for Integrator

Continue to work with the same low-pass filter with a $1kΩ$ resistor, but now choose a capacitor that will cause the circuit to act as an integrator for a 25-kHz input signal.

## Choose $C$ for integrator circuit.

Capture an oscilloscope trace that shows the input as a 25-kHz square wave and the output signal that is proportional to the integral of this input.

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## Justification and explanations of integrator for square wave.

State the value of the capacitor that you chose, justify why you chose it, and explain how your oscilloscope image above verifies output is proportional to the integral of the input.

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## Integral of a sine wave input.

Change the input to a sine wave, still at 25-kHz. Capture an oscilloscope trace that shows both the input signal and the output signal that is proportional to the integral of this input.

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## Explanations of integrator for sine wave.

Explain how your oscilloscope image above verifies output is proportional to the integral of the input.

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## Integral of a triangle wave input.

Change the input to a triangular wave, still at 25-kHz. Capture an oscilloscope trace that shows both the input signal and the output signal that is proportional to the integral of this input.

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## Explanations of integrator for triangle wave.

Explain how your oscilloscope image above verifies output is proportional to the integral of the input.

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# A picture containing clock  Description automatically generated High-Pass Filter – Design for -3dB Gain

Now, let’s move to a high-pass filter. In this section you will work with the circuit shown to the right using a fixed capacitor of $C=10$nF, input signals of different shapes but always at a frequency of 25-kHz, and different resistors to vary the behavior of the circuit.

## Oscilloscope trace showing -3dB gain.

Choose a resistor so the gain of the circuit will be approximately -3dB when the input is a 25-kHz *sine* wave. Capture an oscilloscope trace that shows both the input and output traces.

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## Justification and explanation of -3dB gain circuit.

State the value of the resistor that you chose, justify why you chose it, and explain how your oscilloscope image above verifies that the gain is -3dB.

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# High-Pass Filter – Design for Unity Gain.

Continue to work with the same circuit with the same $10$nF capacitor, but now choose a resistor that will create a unity gain (0 dB) situation when the input is a 25-kHz *square* wave.

## Choose $R$ for unity gain circuit.

Capture an oscilloscope trace that shows both the input and output signals and upload it below.

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## Justification and explanations of unity gain circuit.

State the value of the resistor that you chose, justify why you chose it, and explain how your oscilloscope image above verifies that the gain is unity.

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# High-Pass Filter – Design for Differentiator

Continue to work with the same high-pass filter with a $10$nF capacitor, but now choose a resistor that will cause the circuit to act as a differentiator for a 25-kHz input signal.

## Choose $R$ for integrator circuit.

Capture an oscilloscope trace that shows the input as a 25-kHz square wave and the output signal that is proportional to the derivative of this input.

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## Justification and explanations of integrator for square wave.

State the value of the resistor that you chose, justify why you chose it, and explain how your oscilloscope image above verifies output is proportional to the derivative of the input.

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## Derivative of a sine wave input.

Change the input to a sine wave, still at 25-kHz. Capture an oscilloscope trace that shows both the input signal and the output signal that is proportional to the derivative of this input.

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## Explanations of differentiator for sine wave.

Explain how your oscilloscope image above verifies output is proportional to the derivative of the input.

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## Derivative of a triangle wave input.

Change the input to a triangular wave, still at 25-kHz. Capture an oscilloscope trace that shows both the input signal and the output signal that is proportional to the derivative of this input.

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## Explanations of differentiator for triangle wave.

Explain how your oscilloscope image above verifies output is proportional to the derivative of the input.

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