

Introduction to Electronic Instruments Low Pass Filter

Analysis Appendix

ENPH 253

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Appendix

Collected Data

Below in Table 1 are the measured values and errors on the resistor and capacitor used in the lab.

Table 1: Measured component values used in lab

Resistance (Ω)	Error (Ω)	Capacitance (μF)	Error (μF)
1192	6	0.033	1.66e-4

The data in Table 2 below was collected over the course of the lab.

Table 2: Measured voltage response for a range of frequencies across a low pass filter

Frequency (Hz)	Vin (divs) +/- 0.05	Vin Scale	Vout (divs) +/- 0.1	Vout Scale	Period (Divs) +/- 0.1	Time Scale (micro secs)
100	4	5	3.9	5	4	2500
300	3.95	5	3.9	5	6.33	500
1 000	4	5	3.75	5	2	500
3 000	4	5	3	5	3.33	100
10 000	4	5	1.4	5	4	25
30 000	4	5	0.5	5	3.3	10
100 000	4	5	1.75	0.5	3.9	2.5

Voltage Ratio Plot Data

The data in Table 3 below was calculated and used to plot the magnitudes and errors of each measured value for the ratio of Vout/Vin in units of dB.

Table 3: Values used to plot Vout/Vin in units of dB, along with the error associated with each point

Frequency (Hz)	Vout/Vin (Ratio)	Vout/Vin Error (Ratio)	Vout/Vin (dB)	V ratio Error (dB)
100	0.975	0.028	-0.220	0.244
300	0.987	0.028	-0.111	0.244
1 000	0.938	0.028	-0.561	0.252
3 000	0.750	0.027	-2.499	0.303
10 000	0.350	0.025	-9.119	0.608
30 000	0.125	0.025	-18.062	1.586
100 000	0.044	0.025	-27.180	3.927

Vout/Vin Error was determined by adding the measurement errors of in quadrature.

The conversion from voltage ratio to decibel was completed using the equation below:

$$dB = 20 * \log_{10}(\text{Voltage Ratio})$$

Error in dB was determined by first adding the ratio error to the measured value, then converted to dB. The difference was then taken between that value and measured value in dB to find the error in dB.

Phase Offset Plot Data

The data below in Table 4 was calculated to create the plot of phase shift between the output voltage and the input voltage in relation to the input frequency of the low pass filter.

Table 4: Data used to plot the expected and experimental phase offset between Vout and Vin

Frequency (Hz)	Period (Divs) +/- 0.1	Vin to Vout Phase Shift (Divs) +/- 0.1	Phase Shift (Rad)	Phase Shift Error (Rad)
100	4	0	0.000	0.157
300	6.7	-0.05	-0.047	0.094
1 000	2	-0.1	-0.314	0.315
3 000	3.4	-0.35	-0.647	0.186
10 000	4	-0.8	-1.257	0.160
30 000	3.275	-0.8	-1.535	0.197
100 000	4	-1	-1.571	0.162

Period (divs) and the phase shift (divs) were both measured quantities in the lab. To convert the phase shift to radians, the formula below was used:

$$Shift[Rad] = \frac{Shift[divs]}{Period[divs]} * 2\pi$$

Phase shift error was determined by adding the measurement error in the period and shift in divs in quadrature.