ECEN 3714--------Network Analysis
Cover Sheet for Lab 3 to 11

Spring 2022

Lab #__4__

Topic:___RL Circuit__

Final Report (Pre-lab + Post-lab)

Name of Group Members:	
Name (Print): Roger Bennett	Name (Print): Thomas Kidd
Signature: Roger M. Bennett	Signature: Thomas Kidd
TA Signature:	

1. Introduction

1.1. This RL circuit lab covers the time constant calculations for such a circuit as well as the mathematical voltage characteristics of the R and the L in the given circuit. We calculate this using primarily Pspice and Matlab. After calculating mathematically and graphing these changes over time, we experimentally prove the results and find that some of our results have unexpectedly related qualities to different circuits that have to do with side effects of our physical components. We do this by comparing them to pre-lab work done mathematically.

2. Pre Lab Assignment

2.1. Find τ Circuit 1

$$\tau = L/R = 150mH / 20K\Omega = 7.5 * 10^{-6}s = 7.5\mu s$$

Circuit 2 $\tau = L/R = 4707\mu H / 500\Omega = 9.4 * 10^{-7}s = .94\mu s$

2.2. Plot of Circuit 1 with a 5V square wave with a DC offset of 2.5V at 10kHz frequency.

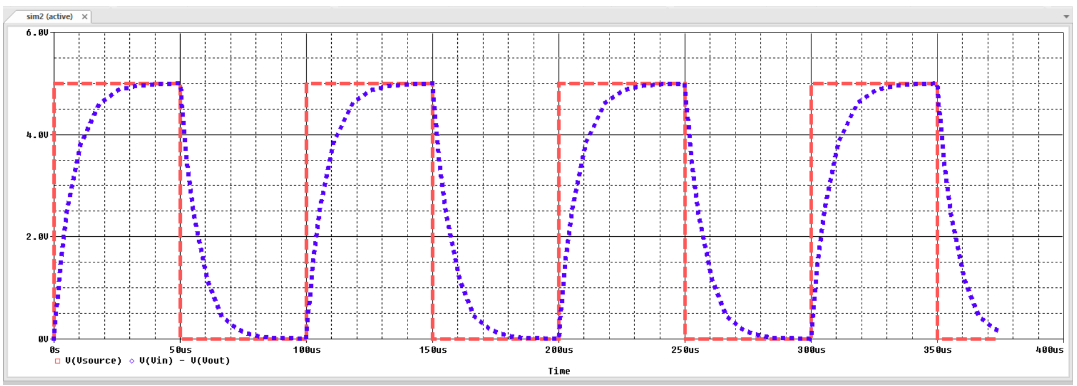

Figure1: V_{out} *for Circuit 1 over resistor-* $V_{source} = RED$, $V_{in} - V_{out} = PURPLE\ DASHED\ LINE$

X axis: time in (μs) *Y axis: Voltage in (volts)*

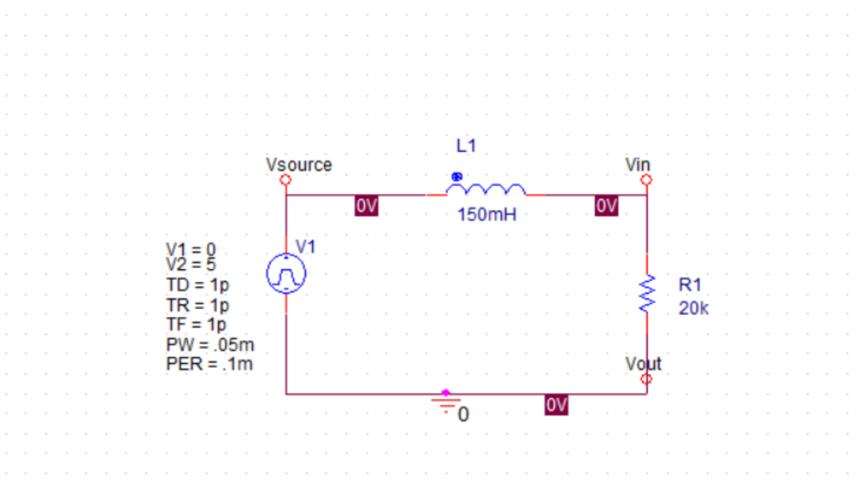

Figure2: Circuit 1 from question 2

2.3. Plot of Modified Circuit 1 with a 5V square wave with a DC offset of 2.5V at 10kHz frequency.

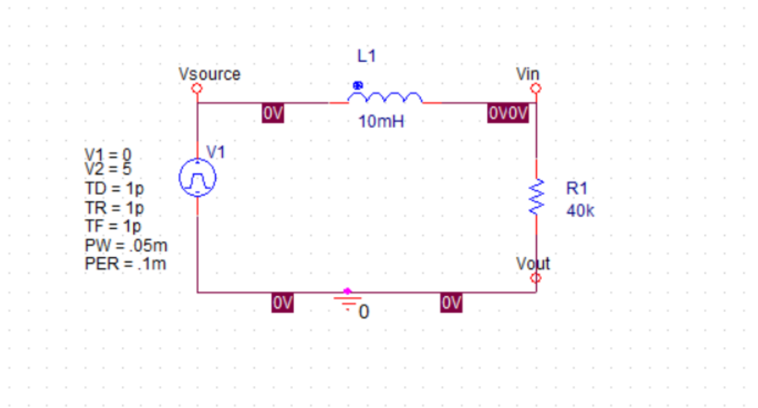

Figure3: Modified Circuit 1 for question 3

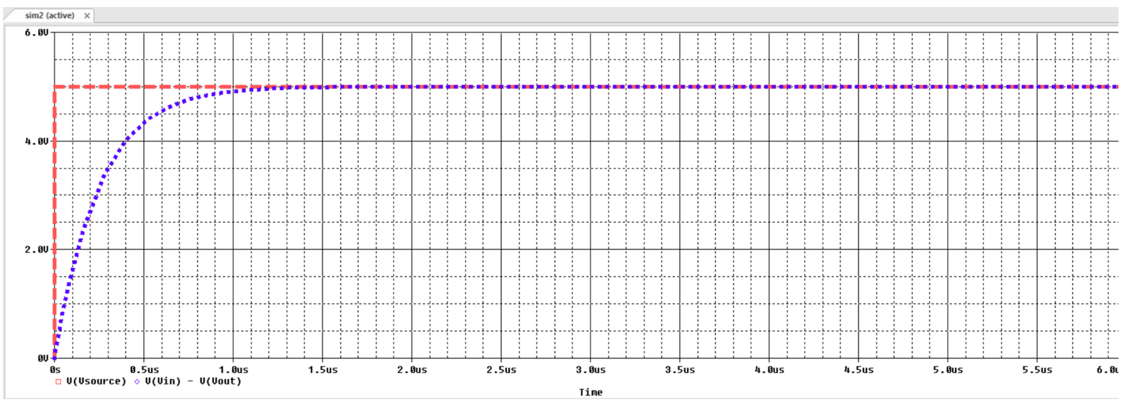

Figure4: V_{out} *for Modified Circuit 1 over resistor-* $V_{source} = RED$, $V_{in} - V_{out} = PURPLE\ DASHED\ LINE$

X axis: time in (µs) Y axis: Voltage in (volts)

R = 40kΩ, L = 10mH, total time = 6us

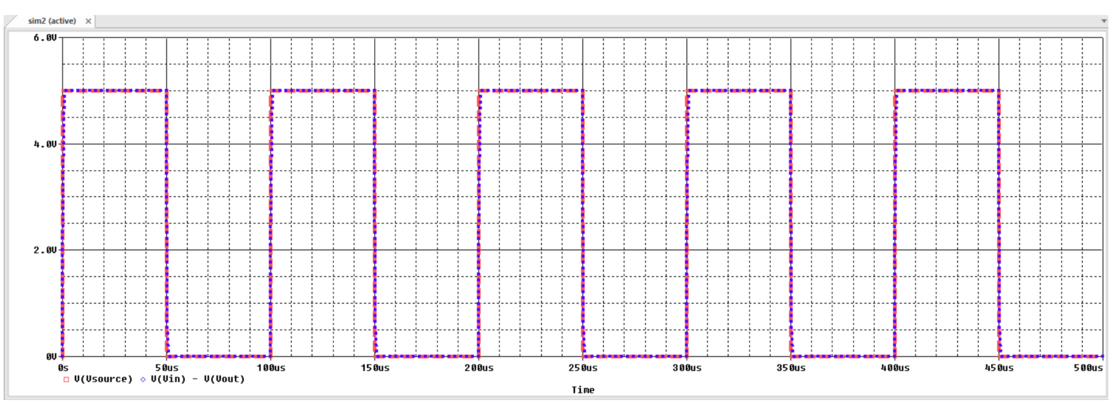

Figure5: V_{out} *for Modified Circuit 1 over resistor-* $V_{source} = RED$, $V_{in} - V_{out} = PURPLE\ DASHED\ LINE$

X axis: time in (µs) Y axis: Voltage in (volts)

R = 40kΩ, L = 10mH, total time = 500us

2.4. Parallel capacitance of C = 100pF incorporated into circuit of pre-lab 3. Plot of Modified Circuit 1 with a 5V square wave with a DC offset of 2.5V at 10kHz frequency.

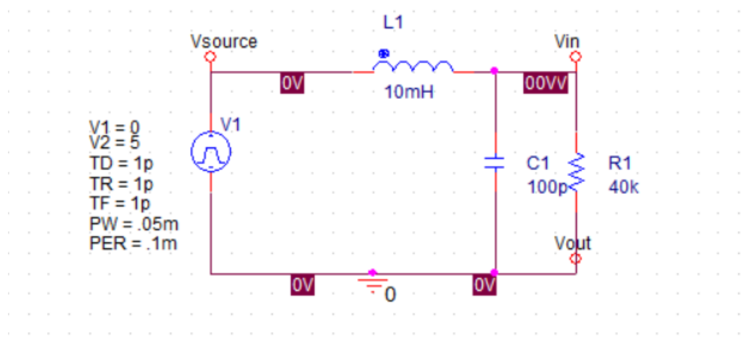

Figure6: Modified Circuit 1 for question 4

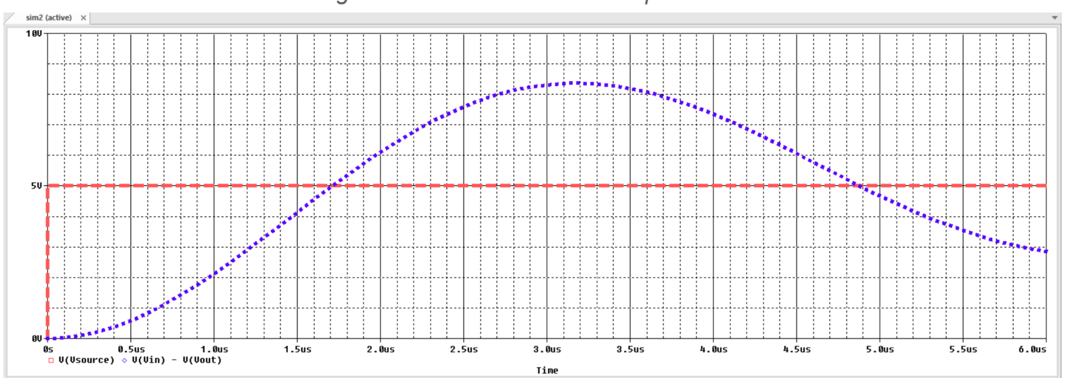

Figure7: V_{out} *for Modified Circuit 1 over resistor-* $V_{source} = RED$, $V_{in} - V_{out} = PURPLE\ DASHED\ LINE$

X axis: time in (μs) *Y axis: Voltage in (volts)*

R = 40kΩ, L = 10mH, C = 100pF total time = 6us

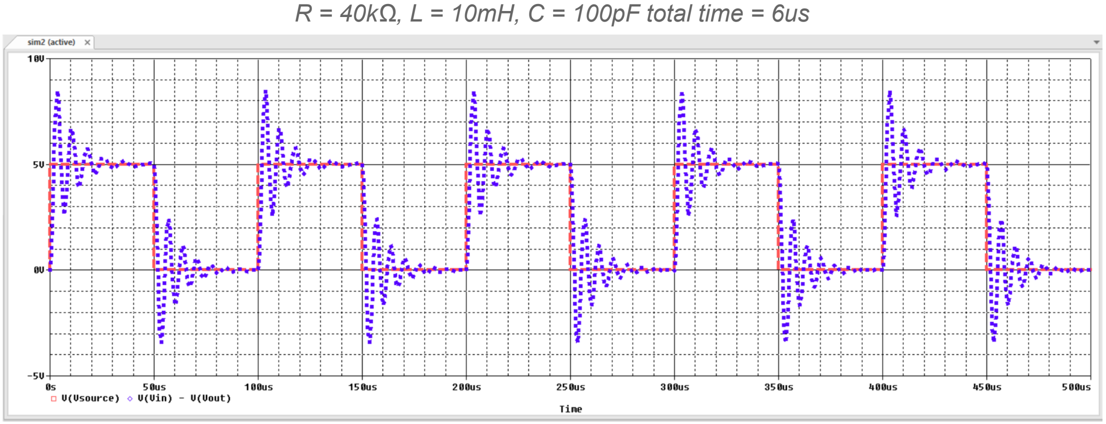

Figure8: V_{out} *for Modified Circuit 1 over resistor-* $V_{source} = RED$, $V_{in} - V_{out} = PURPLE\ DASHED\ LINE$

X axis: time in (μs) *Y axis: Voltage in (volts)*

R = 40kΩ, L = 10mH, C = 100pF total time = 500us

2.5. MATLAB assignment

2.5.1.

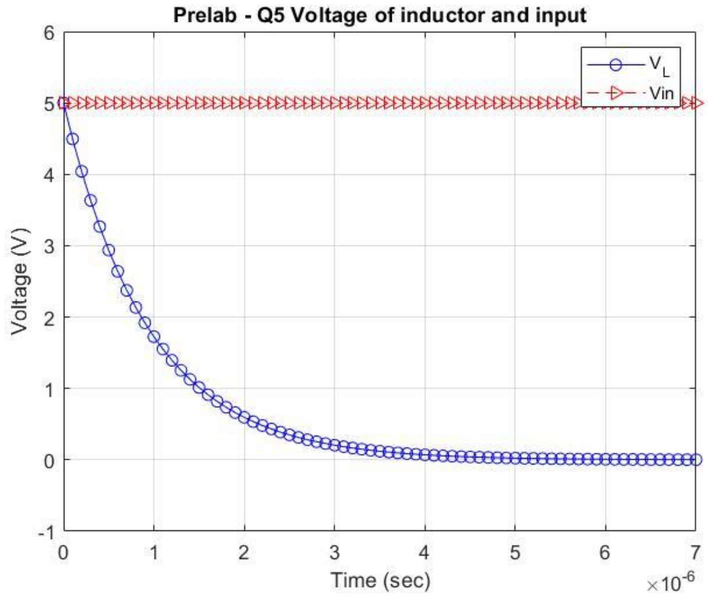

Figure9: V_{out} for Circuit 2 over inductor- $V_{source} = RED$, $V_{out} = BLUE$

X axis: time in (s) Y axis: Voltage in (volts)

R = 500Ω, L = 470μH, total time = 7μs

2.5.2.

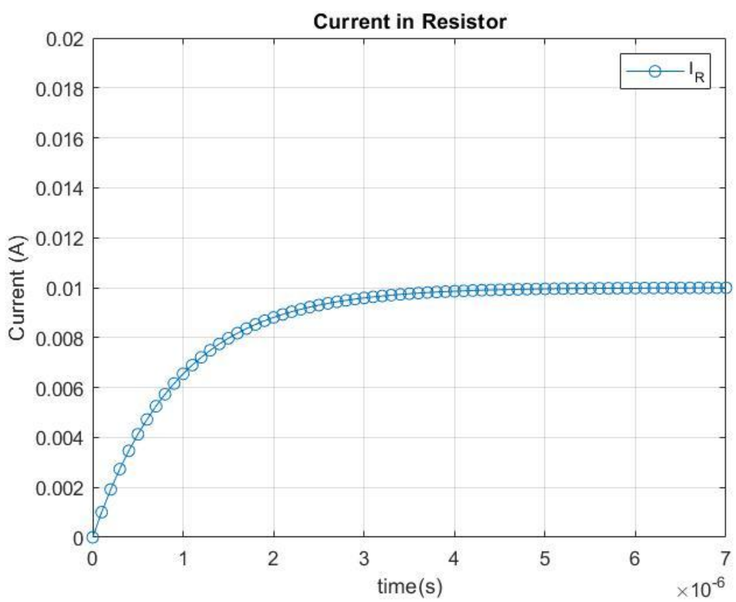

Figure10: I_R for Circuit 2 over resistor- $I_R = BLUE$

X axis: time in (s) Y axis: Current in (A)

R = 500Ω, L = 470μH, total time = 7μs

3. Lab Assignments

3.1.

	Circuit (i)
Time Constant - Estimated	7.5μs
Time Constant - Measured	8.4μs
Percentage of Error	12%

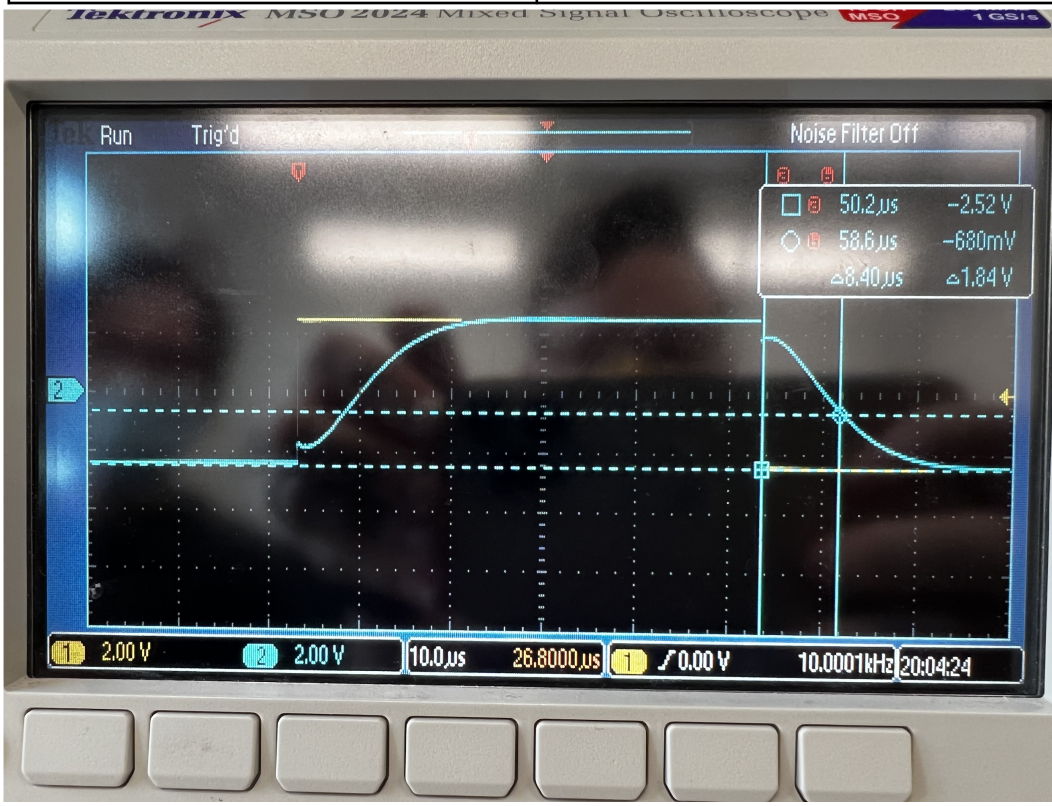

Figure11: V_{in} and V_{out} for Circuit 1 over resistor- $V_{source} = YELLOW, V_{out} = BLUE$

X axis: time in (μs) Y axis: Voltage in (volts)

R = 20kΩ, L = 150mH

3.2.

	Circuit (ii)
Time Constant - Estimated	0.94μs
Time Constant - Measured	0.96μs
Percentage of Error	2.08%

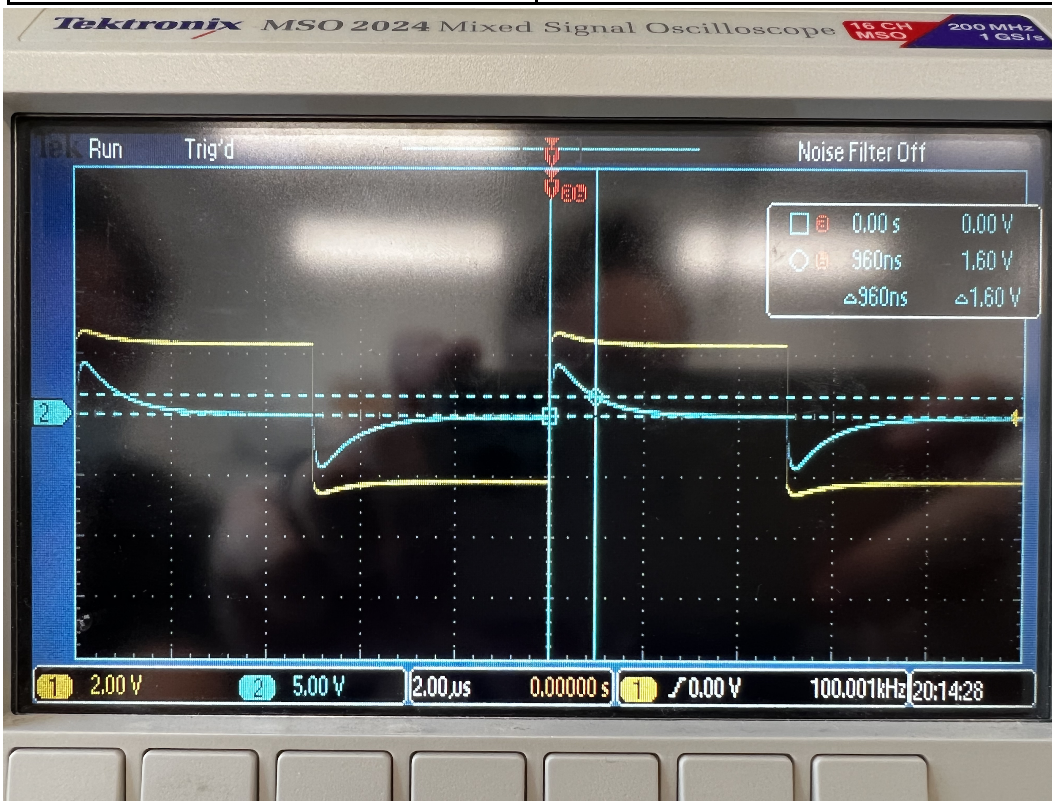

Figure12: V_{in} and V_{out} for Circuit 2 over inductor - $V_{source} = YELLOW$, $V_{out} = BLUE$

X axis: time in (μs) *Y axis: Voltage in (volts)*

R = 500Ω, L = 470μH

3.3.

Figure13: V_{in} and V_{out} for Circuit 1 over inductor - $V_{source} = YELLOW, V_{out} = BLUE$

X axis: time in (µs) Y axis: Voltage in (volts)

R = 20kΩ, L = 150mH

1X Cable

Figure14: V_{in} and V_{out} for Circuit 1 over inductor - $V_{source} = YELLOW, V_{out} = BLUE$

X axis: time in (µs) Y axis: Voltage in (volts)

R = 20kΩ, L = 150mH

10X Cable

4. Discussion

4.1. In this lab we mathematically and experimentally proved the time constant and graphical effects of three different circuits. We found experimentally that when we had a Vin = 5u(t) stimulating an RL circuit, we had a parasitic capacitance making the graph appear like an underdamped RLC circuit. This was because of the cable measuring the output voltage. The 1X cables give off a 100pF capacitance in the circuit, making the RL circuit behave like an RLC circuit. The 10X cables give off around 10pF or Capacitance, decreasing the time for the damping process. For optimal working, we would want to use a 100X cable to eliminate the internal capacitance created by the measuring wires.

4.2. In assignment 3 there was underdamped behavior in both graphs. It doesn’t match the theory of the RL circuit because it should just exponentially increase and decrease without the oscillations. The close proximity of the oscilloscope lines to each other creates a capacitance in series to the rest of the circuit.

4.3. The underdamping behavior of a real life RL circuit could be explained by the fact that we have multiple locations where capacitance can be parasitically located in our circuit. For example, the breadboard and the connections have capacitance, the lines from the oscilloscope have capacitance and the connections they have also have capacitance. The inductor itself has capacitance in the lines as well. We believe, based on our results, that the greatest culprit leading to the underdamped effects were the oscilloscope lines. We decided on this because of the massive change the graph underwent when we switched from 1x to 10x lines. This lowering in capacitance made the underdamped effects lessen and the same circuit oscillated less and for less time with the 10x cables versus the 1x. Some suggestions to suppress capacitance for the circuit can be to have a larger resistor, to limit current.