Circuits Lab 1

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1 Experiment 1: Resistance Measurement

We acquired a resistor with a labeled as 422 Ohm 5 PCS, 1/4 Watt, 1% metal Film resistor.
The Keithley 2400 SourceMeter measured a resistance of 419.34 ohm.
Next we measured it with the SMU and generated the current-voltage plot show in Figure 1 on the following page. From it we were able to extract a measured resistance value of 416.6666 ohm.
These values three are all different, but they are relatively close. The SMU measured resistance does fall outside of the 1% tolerance specified on the package, but it is very close. Possible reasons for these differences could include differences caused by measuring with a sweeping voltage versus a steady voltage.
We believe that both ways of measuring are useful in their own way. The Keithley 2400 SourceMeter is likely more uniquely precise but the SMU is useful for looking at the behavior across a swept range of voltages similar to what might be seen during operation of some circuits.

2 Experiment 2: Resistive Voltage Division

We measured the two chips for their 8 resistance values, shown below:

409.9684	409.9646	409.9684	409.9675	409.9726	409.9671	409.9651	409.9699
409.9685	409.9711	409.9708	409.9660	409.9637	409.9705	409.9761	409.9651

All the resistance values in both chips are extremely close to one another, the max difference between any two being only .06 kOhm or 0.00001463414% difference. This similarity is also present between the chips.
We constructed the voltage divider with a voltage divider ratio of 5/8=0.625. We measured the voltage at the Vout of our divider while sweeping an input voltage between -5v and 5v. The plot generated is shown in Figure 2 on the next page. The plot fitted with linear regression produces a slope of 0.6272, different from the theoretical by only .0022 or 0.35%. This incredibly low difference is consistent with the very low differences seen between resistor values in the chips.

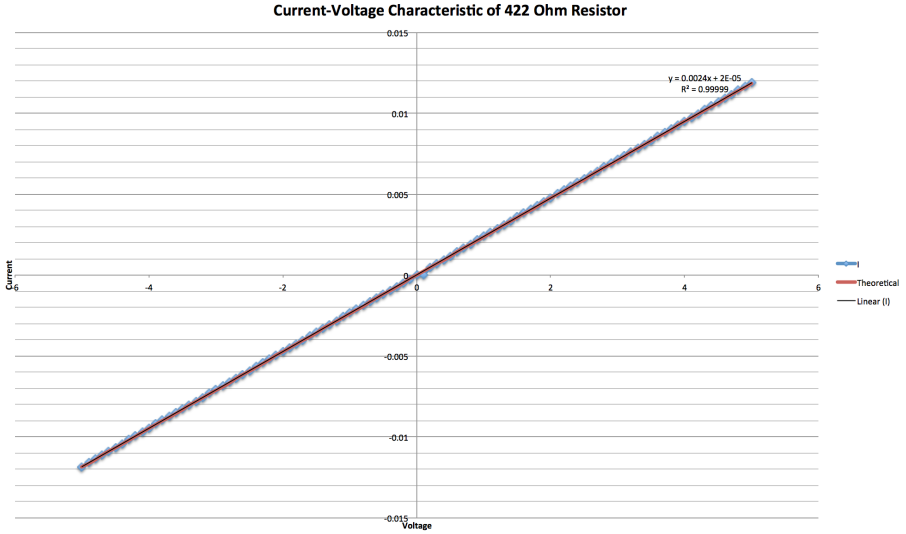

Figure 1: Current-voltage characteristic for a 422 ohm resistor across -5v to 5v

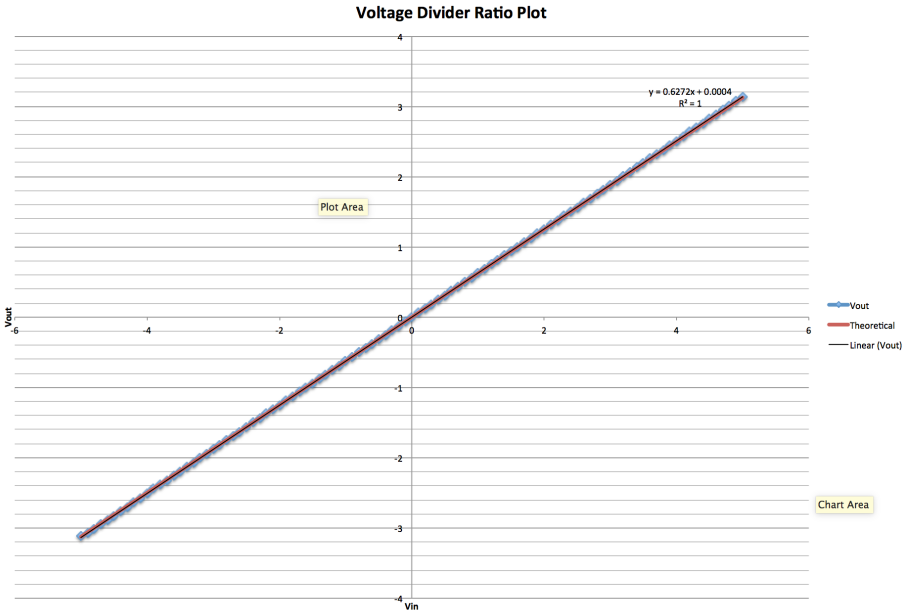

Figure 2: Plot of voltage divider with ratio of 5/8

3 Experiment 3: Resistive Current Division

For this experiment we also aimed to produce a divider ratio of 5/8=.625 in our current divider. We constructed the circuit and measured the current at Iout

while sweeping Iin between -.0001 and 0001. The plot is shown in Figure 3. The experimentally derived value from our chart .6224. Compared to the supposed .625, it is off by only .0026, which is again extremely low. This low difference is consistent with the low difference seen in the chips.

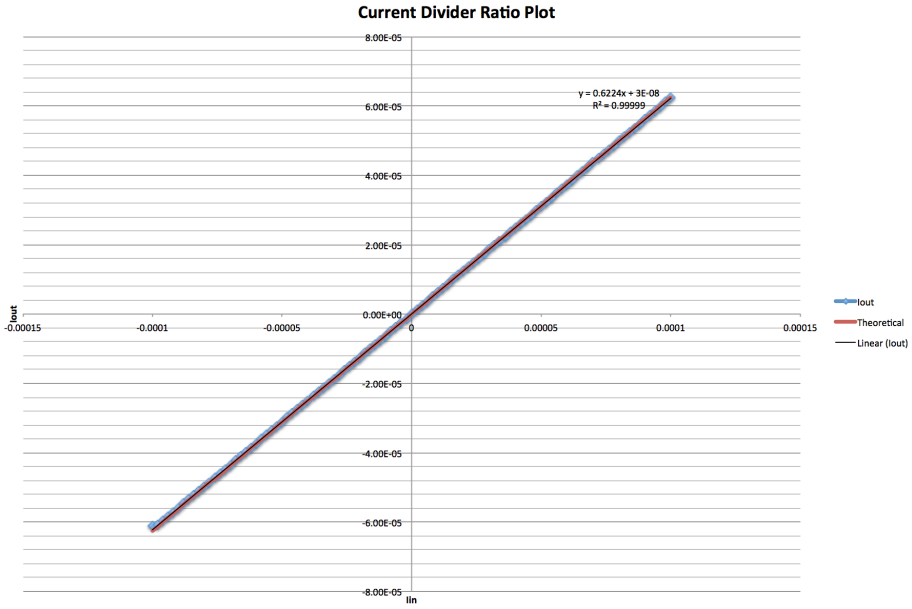

Figure 3: Plot of current divider with ratio of 5/8

4 Experiment 4: R-2R Ladder Network

For this experiment, we constructed an R-2R ladder out of the two Bourns 10k resistor arrays. We used Channel 1 of the SMU to sweep voltage (form -5V to 5V, as before) across the ladder 4 times, measuring current through a different branch each time by connecting Channel 2 between each set of series resistors. The results are illustrated in Figure 4 on the next page.

We looked at the currents for 1V, 2V, 3V, 4V and 5V and graphed them versus branch number on a semilog plot (Figure 5 on the following page). The slope of the line was accurate (the exponent coefficient was about -.715 across the board, compared to the expected ln(1/2)=-.693) and the data-points were well-aligned ($R^2 \approx .9997$), which indicates they followed the exponential R2-R curve closely. The graphs were also accurately related to each other, keeping the same proportions as their corresponding voltages. However, the overall current was higher than expected theoretically, yielding an effective resistance of $6.1k\Omega$ per resistor in the 2R branch.

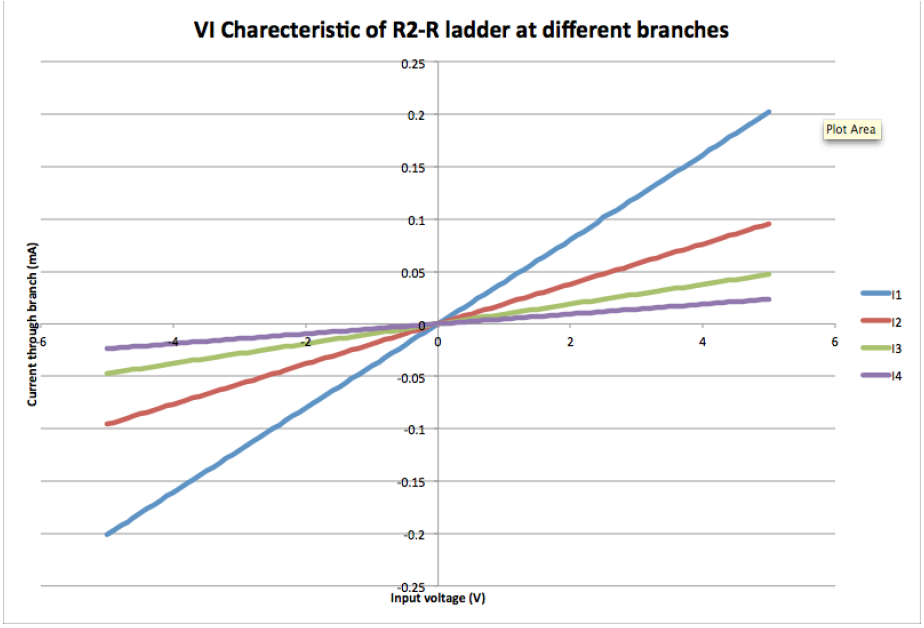

Figure 4: Raw Expiriment 4 data

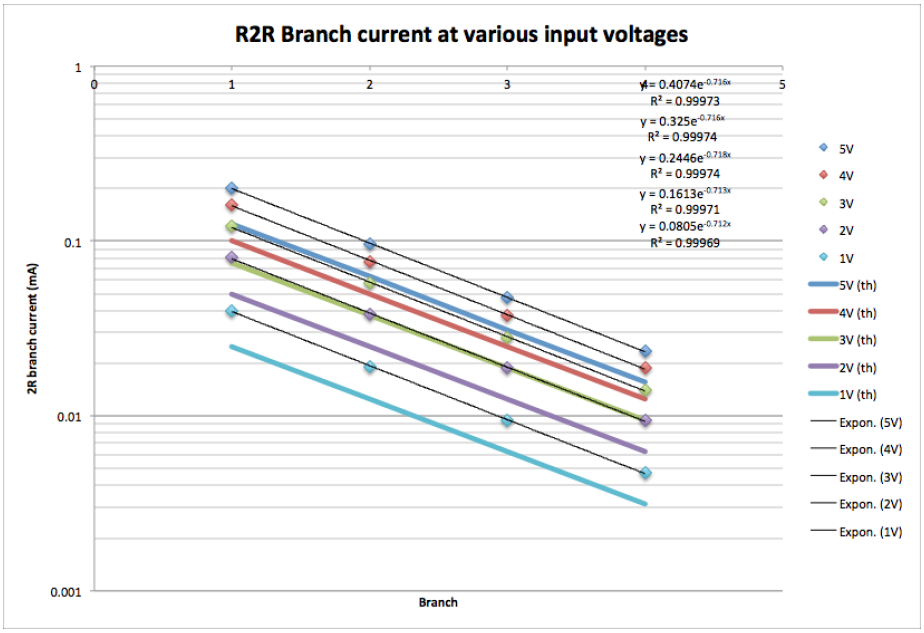

Figure 5: Plot of current through each 2R branch of R-2R ladder at 5 different voltages (Experimental, curve-fit and theoretical