Lab 4: Translinear Circuits

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Experiment 1: Bipolar Transistor Matching

In this experiment we looked at the MMPQ3904 bipolar transistor array. There are four transistors in this chip. We measured the base and emitter currents as a function of the base voltage. The collector is connected to Vdd.

We were not able to complete the rest of this experiment due to the fact that amidst moving out of the dorms, we lost the data.

Experiment 2: Translinear Circuit 1

In this experiment, we constructed the circuit shown in figure 1. We tied the output voltage to Vdd. We measured Iz as a function of Ix for 3 different values of Iy and Ix as a function of Iy for 3 different values of Ix.

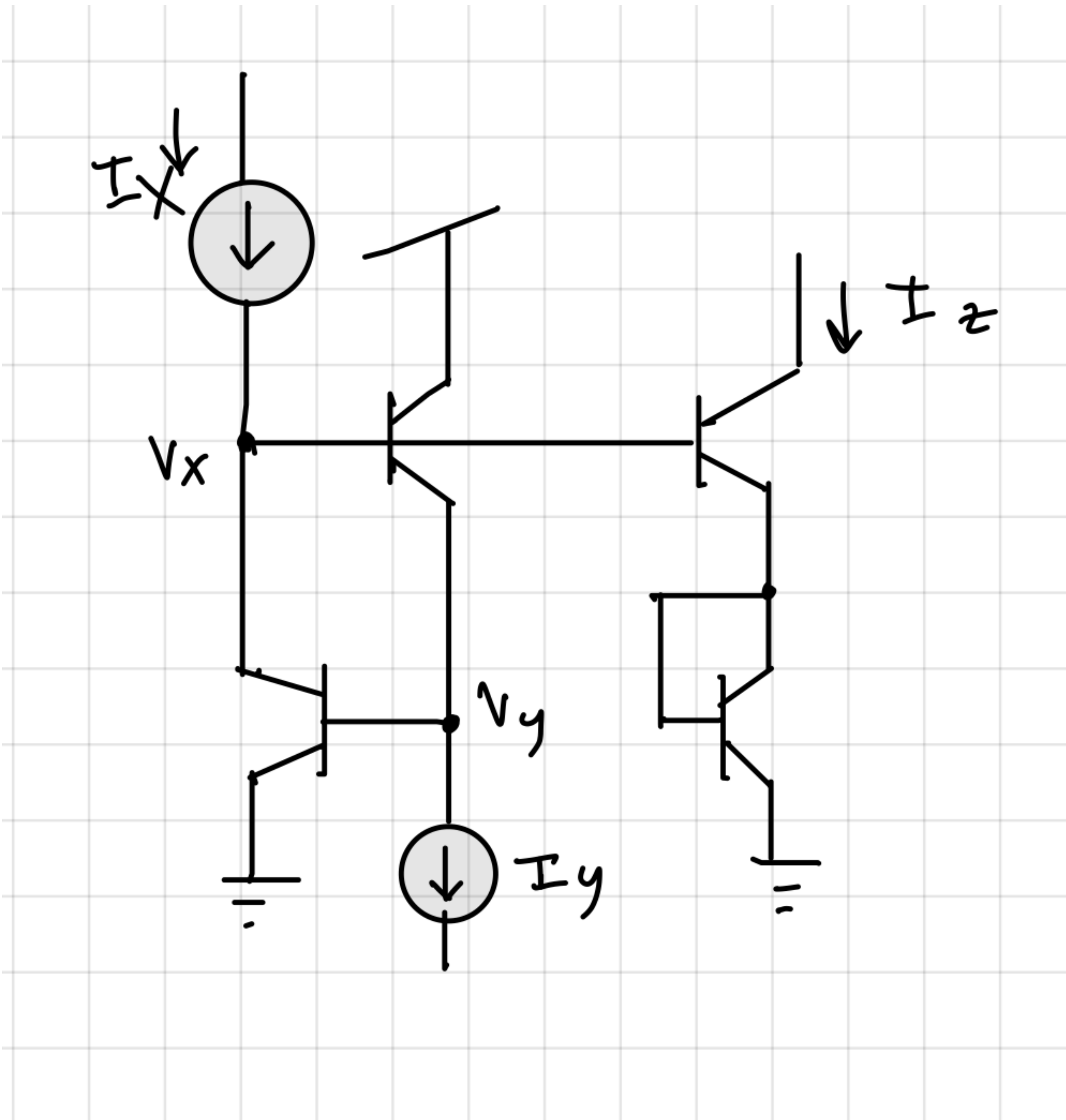


Figure 1: Circuit diagram of experiment 2

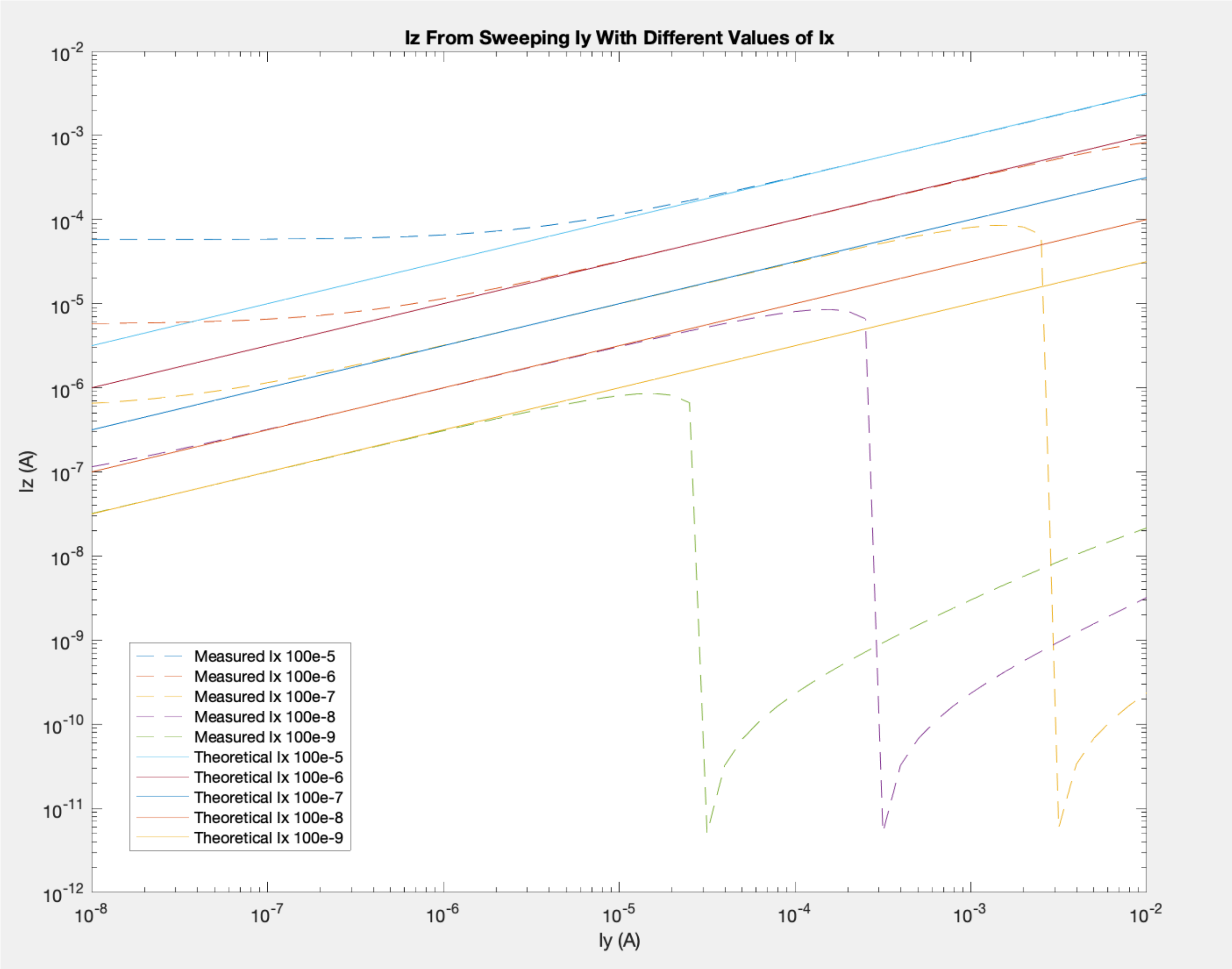


Figure 2: A plot of measured and theoretical Iz values at different Ix values with swept Iy values.

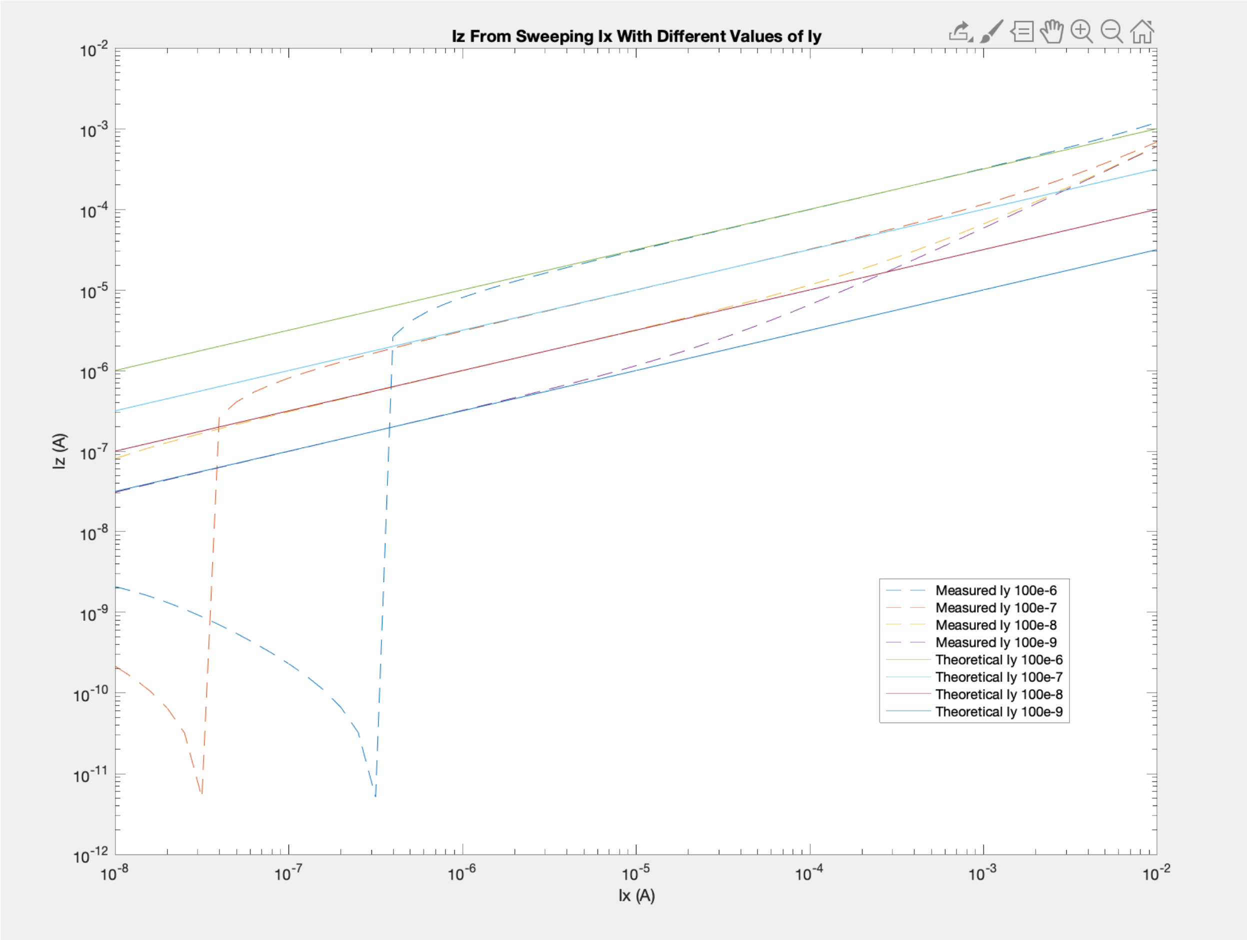


Figure 2: A plot of measured and theoretical Iz values at different Iy values with swept Ix values.

As found according to the prelab,

$$Iz = \sqrt{I_x \cdot I_y}$$

As seen in the figures above, the plots seem to follow the equation found in the prelab for some duration. They deviate from the duration at higher and lower swept values. When sweeping Iy, at higher Iy values the circuit enters saturation mode. When sweeping Ix, at lower Ix values the circuit enters saturation mode. This explains the deviations from the expected line.

Experiment 3: Translinear Circuit 2

In this experiment we constructed the circuit shown below in figure 4.

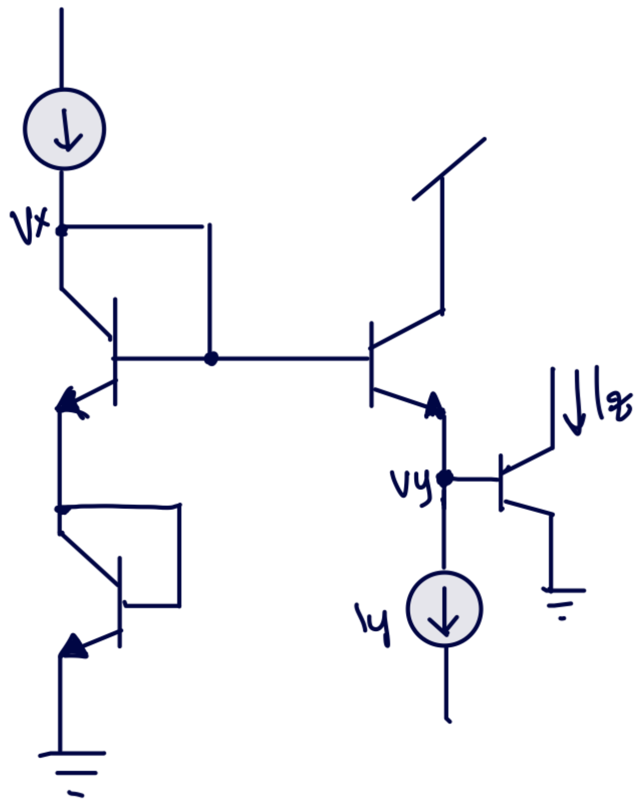


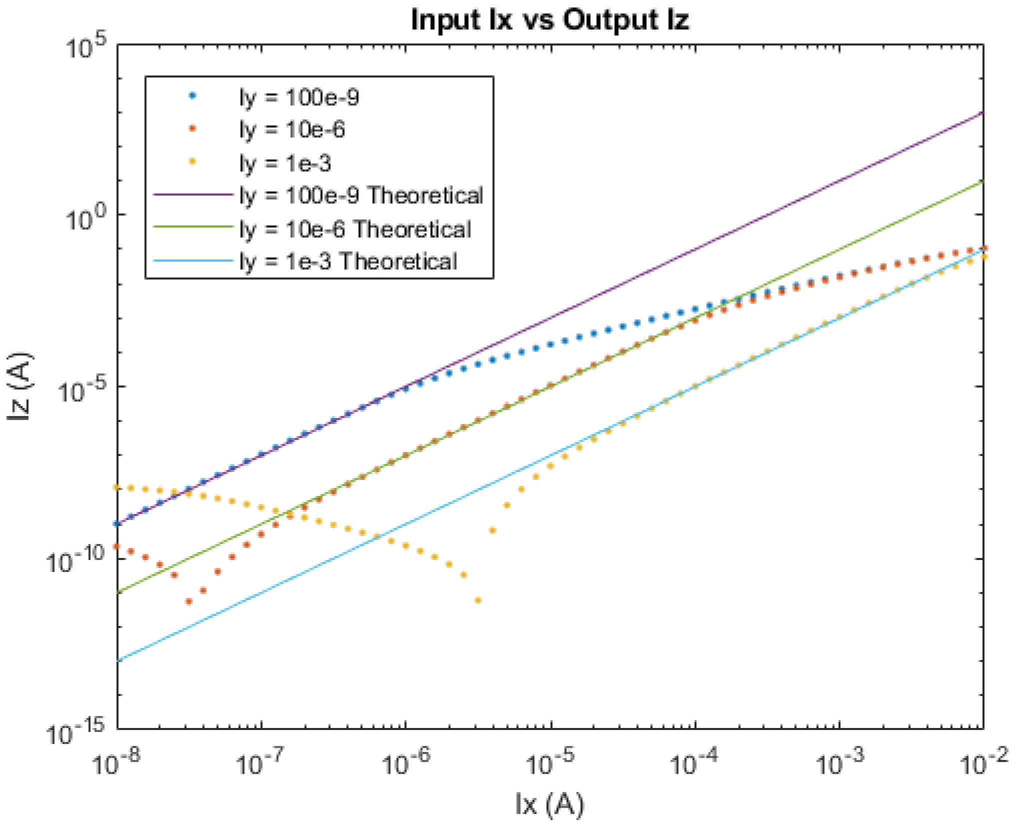
Figure 4: Circuit diagram for experiment 3

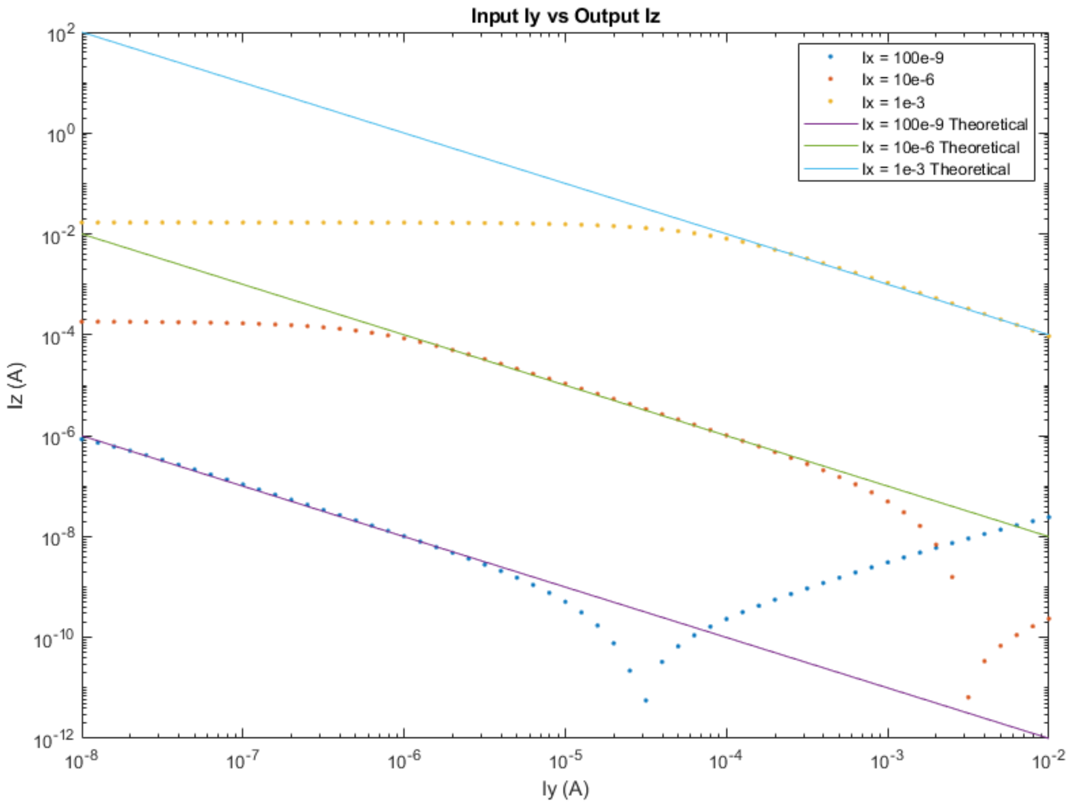
Because we have an even number of translinear elements with an equal number of clockwise and counterclockwise currents, we can evaluate the circuit using the TLP

$$\prod I_{CW} = \prod I_{CCW}$$

Applied to circuit 4.1c, we find the relationship of the currents to be

$$I_x{}^2 = I_y I_z$$


Input Ix vs Output Iz
Iy = 100e-9
Iy = 10e-6
Iy = 1e-3
Iy = 100e-9 Theoretical
Iy = 10e-6 Theoretical
Iy = 1e-3 Theoretical
Iz (A)
Ix (A)
10^5
10^0
10^-5
10^-10
10^-15
10^-8
10^-7
10^-6
10^-5
10^-4
10^-3
10^-2



As shown in the graphs, the outputs follow the calculated theoretical models for current values in the middle of the input range. There are current nonlinearities on the high and low ends of the input range. This is due to the breakdown of the assumption of infinite beta. Small values of Vbe lead to the -1 term having a non-negligible effect on forward current.