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Studentzone—ADALM2000 Activity: Stabilized Current Source

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This article will concentrate on stabilized current sources using a bipolar junction transistor (BJT) and an NMOS transistor.

Stabilized Current Source (BJT)

Objective

The objective of this activity is to investigate the use of the zero-gain concept to produce an output current that is stabilized (less sensitive) to variations of the input current level.

Materials

- ADALM2000 Active Learning Module
- Solderless breadboard
- One 2.2 kΩ resistor (or any similar value)
- One 100 Ω resistor
- One 4.7 kΩ resistor
- Two small signal NPN transistors (2N3904 or SSM2212)

Directions

The circuit corresponding to the BJT stabilized current source is presented in Figure 1.

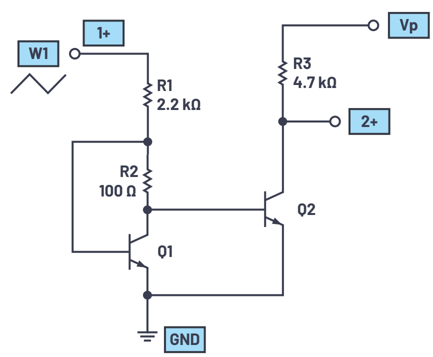


Figure 1. Stabilized current source.

Hardware Setup

The breadboard connections are shown in Figure 2. The output of the W1 drives one end of resistor R1. Resistors R1 and R2, as well as transistor Q1, are connected as shown in the November 2020 StudentZone article. Since the V_{BE} of Q2 is always smaller than the V_{BE} of Q1, you should, if possible, select Q1 and Q2 from your inventory of devices such that (at the same collector current) Q2's V_{BE} is less than Q1's V_{BE}. The base of transistor Q2 is connected to the zero-gain output at the collector of Q1. R3, connected between the Vp supply and the collector of Q2, is used along with the 2+ scope input to measure the collector current.

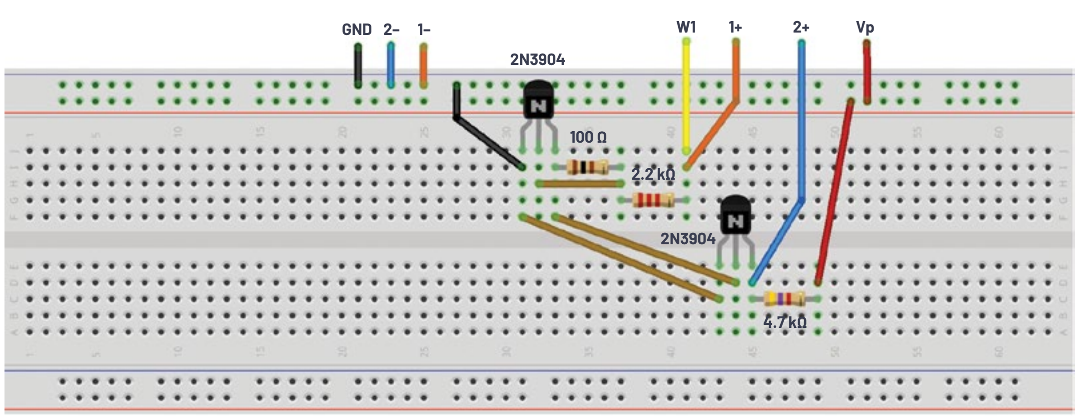


Figure 2. NMOS zero-gain amplifier breadboard circuit.

Procedure

The zero-gain amplifier can be used to create a stabilized current source. Because the voltage seen at the collector of transistor Q1 is now more constant with the changes in the input supply voltage represented by W1, it can be used as the base voltage of Q2 to produce more constant current in transistor Q2.

The waveform generator should be configured for a 1 kHz triangle wave with 3 V peak-to-peak amplitude and 1.5 V offset. The input of Scope Channel 2 (2+) is used to measure the stabilized output current at the collector of Q2.

Configure the oscilloscope instrument to capture several periods of the two signals being measured. Make sure to enable the XY feature.

Plot examples using the oscilloscope are provided in Figure 3 and Figure 4.

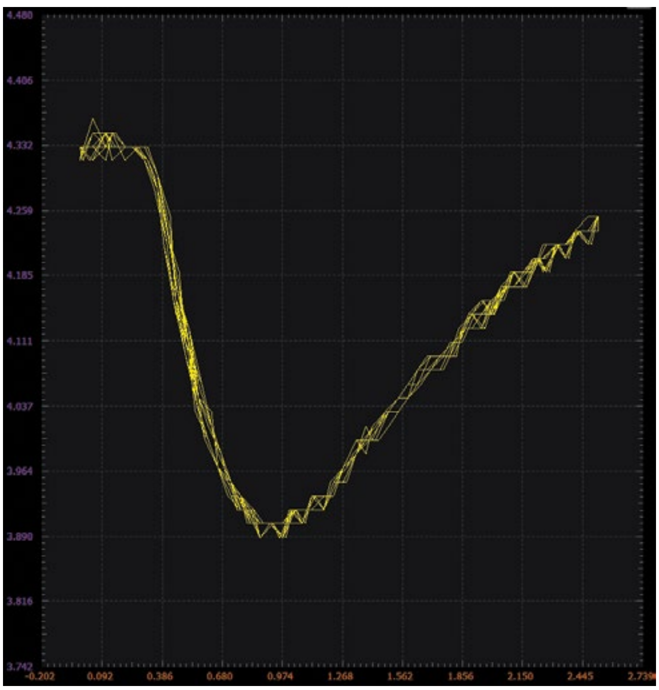


Figure 3. Q2 collector voltage vs. W1 voltage.

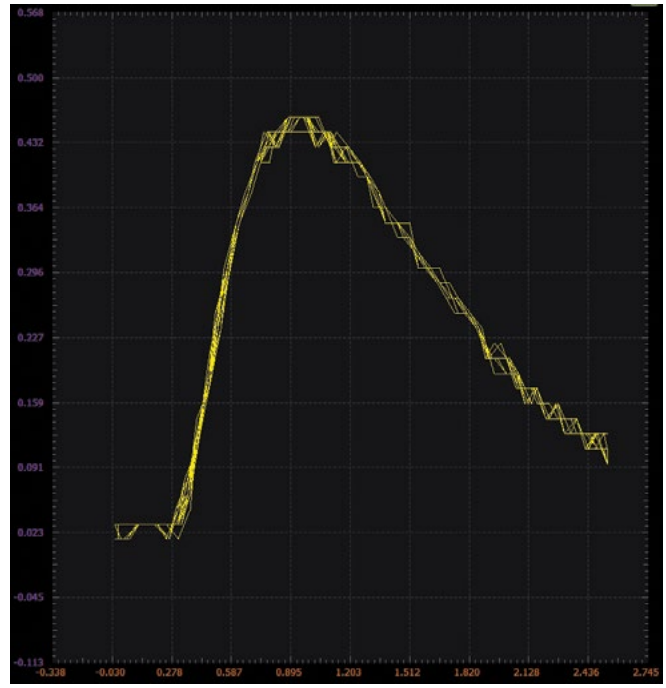


Figure 4. Q2 collector current vs. W1 voltage Scopy plot.

Stabilized Current Source (NMOS)

Materials

- ADALM2000 Active Learning Module
- Solderless breadboard
- One 2.2 kΩ resistor (or any similar value)
- One 168 Ω resistor (connect a 100 Ω in series with a 68 Ω)
- One 4.7 kΩ resistor
- Two small signal NMOS transistors (CD4007 or ZVN2110A)

Directions

The circuit corresponding to the MOS stabilized current source is presented in Figure 5.

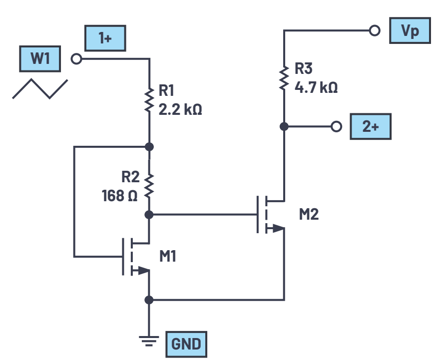


Figure 5. Stabilized current source.

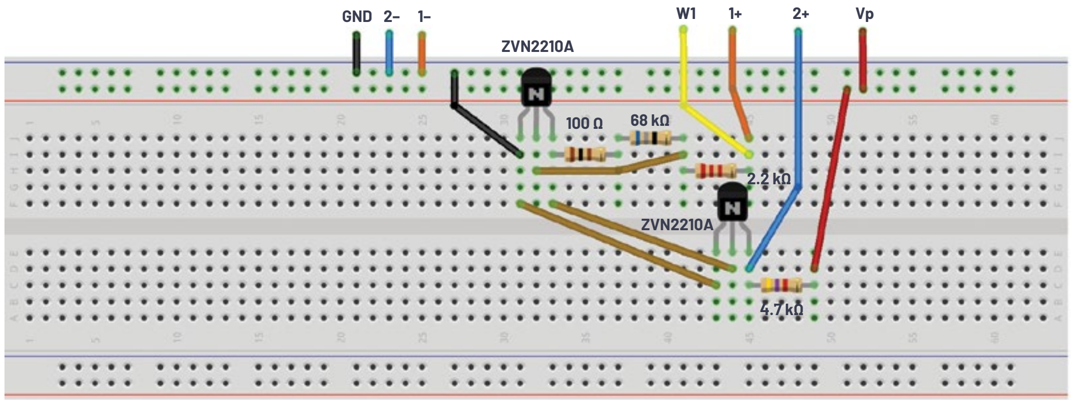


Figure 6. Stabilized current source breadboard circuit.

Hardware Setup

The breadboard connections are shown in Figure 6. The output of waveform generator W1 drives one end of resistor R1. Resistors R1 and R2, as well as transistor M1, are connected as shown in [the November 2020 StudentZone article](). Since the V_{GS} of M2 is always smaller than the V_{GS} of M1, you should, if possible, select M1 and M2 from your inventory of devices such that (at the same drain current) M2's V_{GS} is less than M1's V_{GS}. The gate of transistor M2 is connected to the zero-gain output at the drain of M1. R3, connected between the Vp supply and the drain of M2, is used along with the 2+ scope input to measure the drain current.

Procedure

The waveform generator should be configured for a 1 kHz triangle wave with 4 V peak-to-peak amplitude and 2 V offset. The input of Scope Channel 2 (2+) is used to measure the stabilized output current at the drain of M2.

Configure the oscilloscope instrument to capture several periods of the two signals measured. Make sure to enable the XY feature.

A plot example using the oscilloscope is provided in Figure 7.

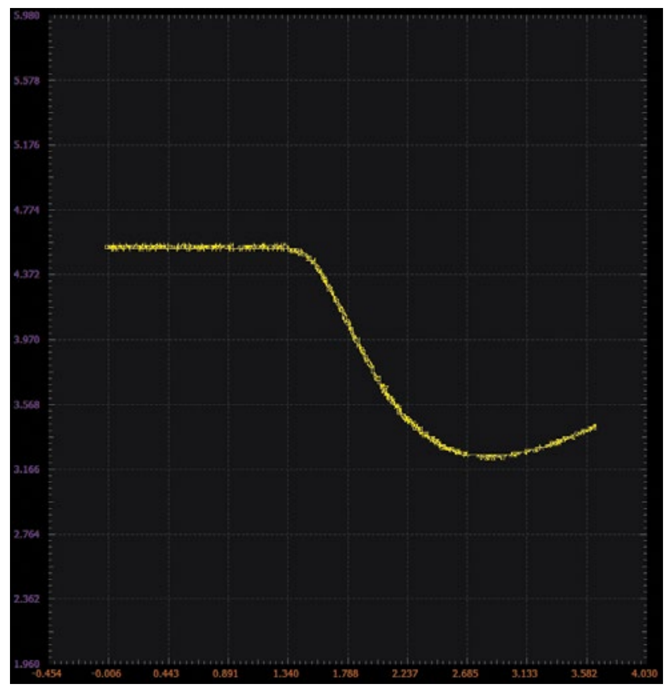
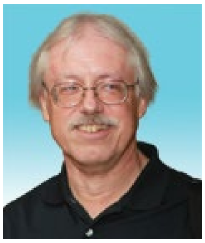


Figure 7. The M2 drain voltage vs. W1 voltage.

Questions about BJT and NMOS

- This circuit type is sometimes referred to as a peaking current source. Why do you think this naming convention is used?
- The output current has a narrow peak. How can you adjust the circuit to produce a much wider, flatter peak?

You can find the answer at the StudentZone blog.



About the Author

Doug Mercer received his B.S.E.E. degree from Rensselaer Polytechnic Institute (RPI) in 1977. Since joining Analog Devices in 1977, he has contributed directly or indirectly to more than 30 data converter products and he holds 13 patents. He was appointed to the position of ADI Fellow in 1995. In 2009, he transitioned from full-time work and has continued consulting at ADI as a Fellow Emeritus contributing to the Active Learning Program. In 2016 he was named Engineer in Residence within the ECSE department at RPI. He can be reached at doug.mercer@analog.com.

About the Author

Antoniu Miclaus is a system applications engineer at Analog Devices, where he works on ADI academic programs, as well as embedded software for Circuits from the Lab®, QA automation, and process management. He started working at Analog Devices in February 2017 in Cluj-Napoca, Romania. He is currently an M.Sc. student in the software engineering master's program at Babes-Bolyai University and he has a B.Eng. in electronics and telecommunications from Technical University of Cluj-Napoca. He can be reached at antoniu.miclaus@analog.com.