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Transimpedance Amplifiers Shenanigans

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README

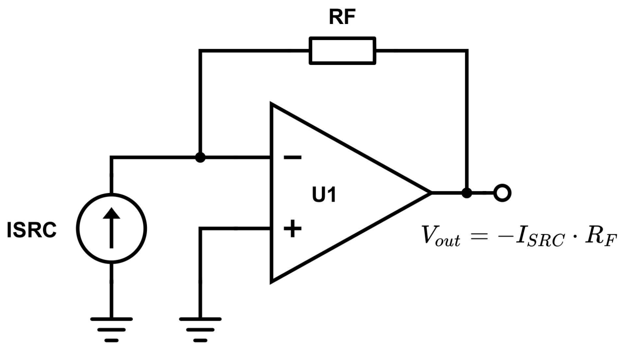
Transimpedence Amplifiers for Sensors

Purpose

I have taken a great liking to optoelectronics and optical sensors. A very important part to sensor use and integration is the transition from sensor current output to DMM-friendly voltage outputs. This is done by means of a transimpedance amplifier, or a shunt-shunt amplifier.

Part One: Transimpedance Amplifier

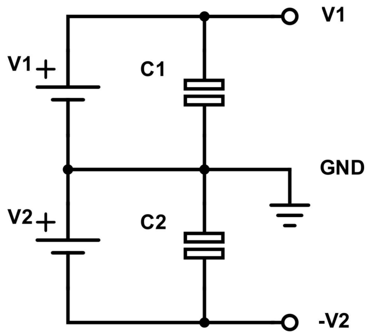
Transimpedance amplifier converts the source current to a voltage. Below is presented the typical configuration of a TIA, where the operational amplifier and current source are taken to be ideal.



Transimpedance Amplifier basic circuit

The circuit presented above does not compensate for any parasitic capacitance of the current source. This is most important for use in photodiode amplifier circuits, where the junction capacitance of the diode cannot be neglected.

The output voltage of the op amp circuit will always be negative, this means that we must employ a dual rail approach with negative and positive voltage rails. The method I found the easiest to use is from this TI technical page, whihc uses the following circuit schematic:

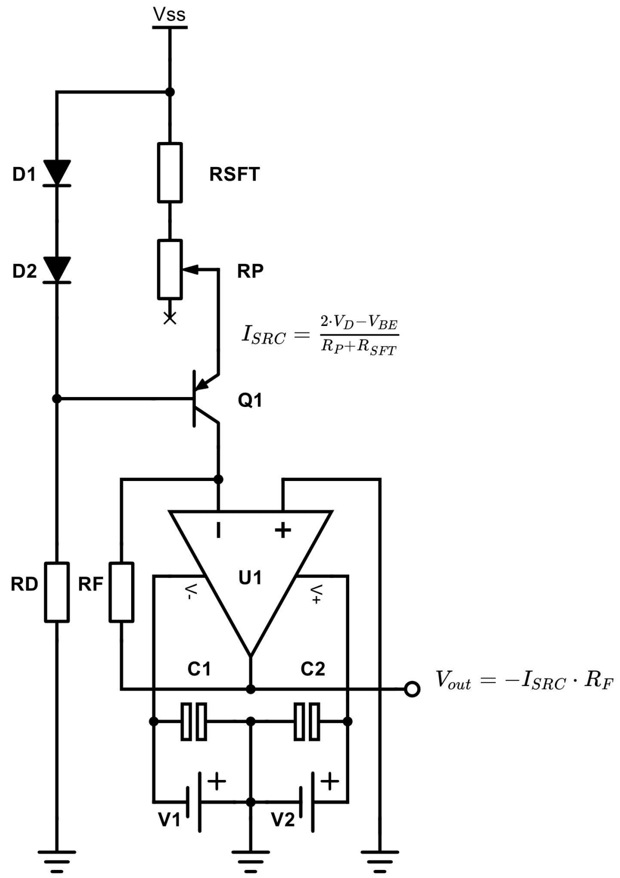


Negative and Positive Voltage Rails for Op Amp Biasing

The voltage sources used were two 9V batteries, the capacitor were each 100 nF ceramic capacitors.

The final part of the puzzle is the current source, which for our humble circuit is a generic PNP current source repurposed from other projects.

Combining the current source, the op amp bias network and the TIA itself we obtain this final breadboard-friendly circuit:



TIA complete circuit

The breadboarded version of this circuit used a feedback resistor R_F = 67 $K\Omega$ and has a narrow range of approximatively 10 to 110 microamperes source currents.

Experimental Results

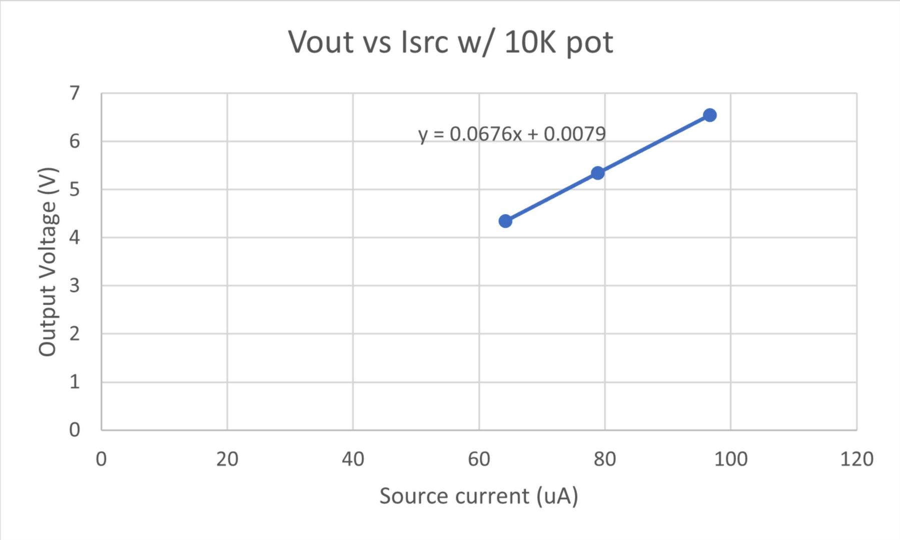
The circuit was tested with different current ranges and the output voltage was noted. Only the output voltage's numerical values is given, without the negative sign. The numerical results and curves are presented below:

- first experiment, with 10K pot as a current set resistor for PNP current source:

Numerical Results:

Current [uA]	Output Voltage [V]
96.7	6.543
78.9	5.338
64.2	4.347
62.8	4.247

Graphical Representation:



10K pot curve

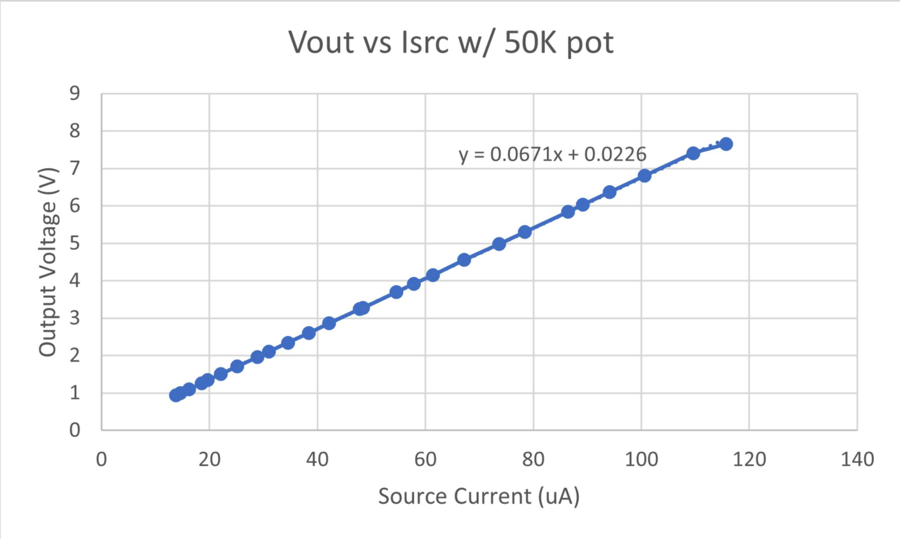
- second experiment, with 50K pot as a current set resistor for PNP current source:

Numerical Results:

Current [uA]	Output Voltage [V]
13.8	0.9404
14.6	0.9941
16.2	1.1001
18.5	1.2552
19.7	1.3395
22.1	1.5
25.1	1.7034
28.9	1.9616
31	2.1
34.6	2.344
38.4	2.595
42.2	2.857
47.8	3.238
48.4	3.276
54.6	3.698
57.8	3.915
61.4	4.152
67.2	4.55
73.7	4.986
78.4	5.304
86.4	5.844

Current [uA]	Output Voltage [V]
89.2	6.032
94.1	6.365
100.6	6.806
109.6	7.41
115.7	7.656

Graphical Representation:



50K pot curve

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