

Measured results from commercial OTA ICs and a discrete OTA

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Below is measured data from a discrete OTA, an LM13700 purchased from Digi-Key, a CA3080E purchased from a seller out East and a CA3280E sent to me by a friend. The LM13700 is the only part in production as both the CA3080E and CA3280E are obsolete.

Figure 1 shows the test setup used to measure the data in Figure 2 and Figure 3. Figure 2 compares the measured results of the current mirrors in the OTA. Figure 3 gives an indication of how well the +/- (p/n) mirrors match. Figure 5 shows the effect of the output impedance of the CA3280E and a discrete OTA.

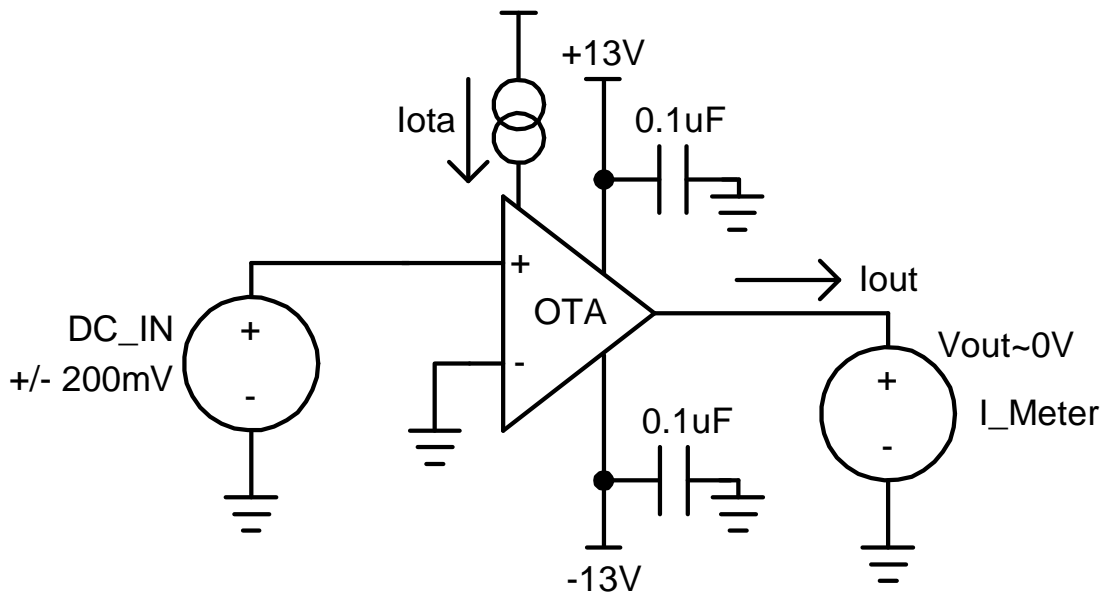


Figure 1: Test setup used for measuring data in this report.

The discrete OTA performs very well versus the commercial OTA ICs. The LM13700 is the only IC still in production. The discrete OTA could be built in production as well. All of the commercial OTA ICs start to deviate in performance at currents above 200 μ A. This is largely due to thermals at the higher currents. The discrete OTA was tested out to 3mA and could be tested to even higher currents. There are significant problems starting to occur in the commercial ICs at 1mA and above even. (Spec gives 2mA max)

The next step is to measure the offset voltage of the various OTAs versus I_{ota} . Figure 5 gives one source of error that will generate an input referred offset error. The input pair will also be another source of V_{os} .

LM13700, CA3080E, CA3280E, Discrete, I_{out}/I_{ota} vs. I_{ota} , $V_{in} = \pm 200mV$, $V_{out} = 0V$,
 $V_{supply} = \pm 13V$

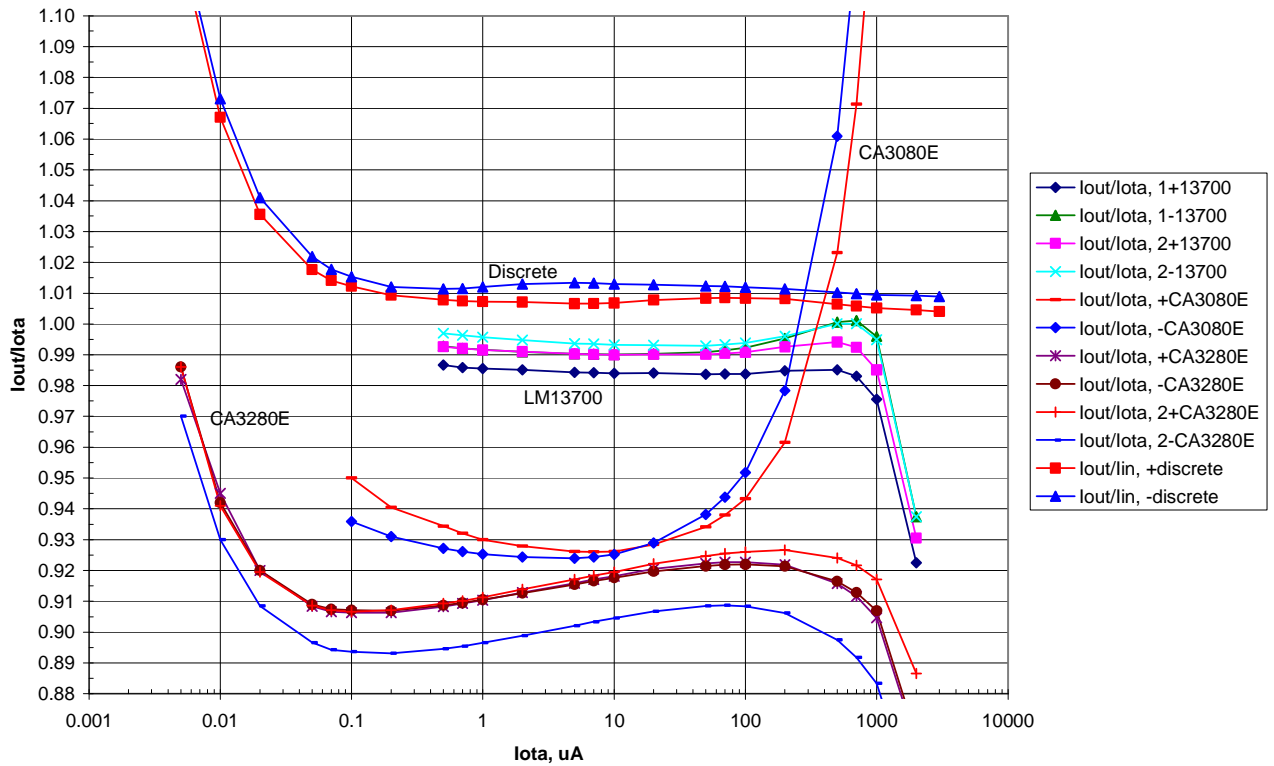


Figure 2: Effect of OTA's bias current through its current mirrors – various OTAs.

Ratio of +/- currents in mirrors vs Iota, Various OTAs, Vout=0V, Vsupply=+-13V

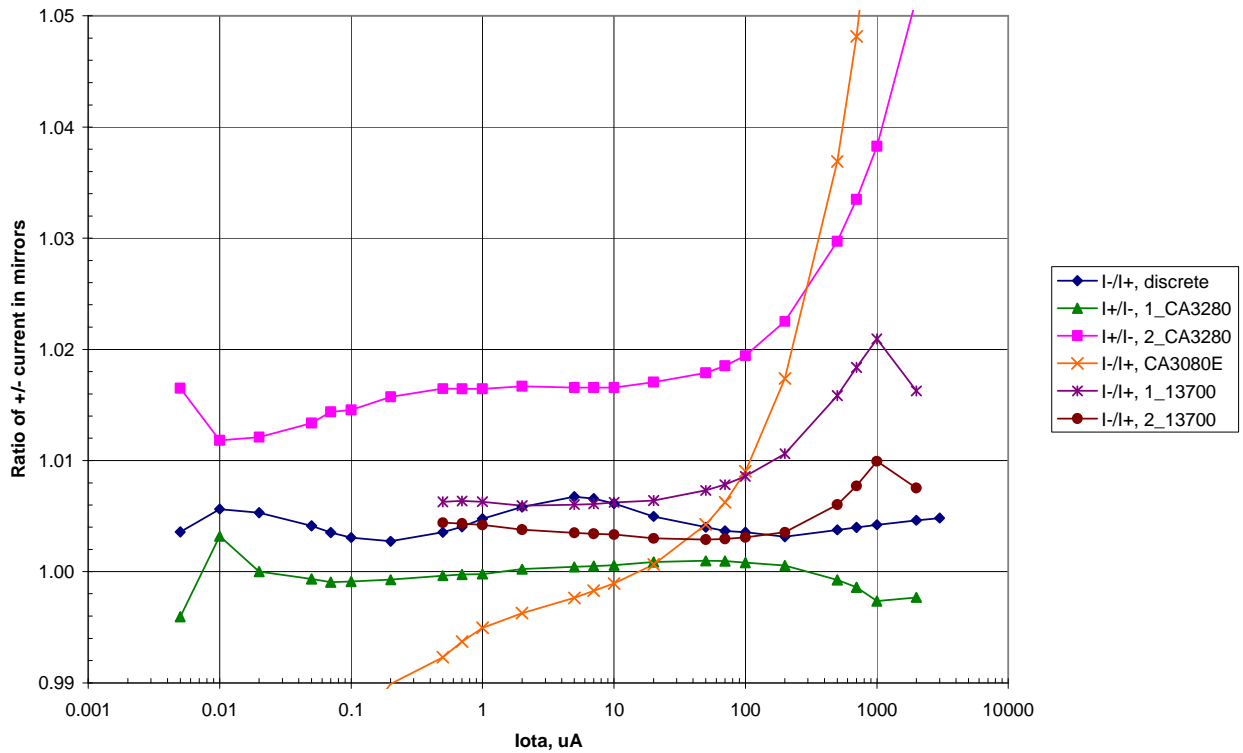


Figure 3: Ratio of mirror currents at the output. This is a good indication of how well the +/- (p/n) mirror's match and this mismatch will introduce a source of an input referred offset voltage.

Figure 3 has a couple of devices that don't fair well at all. The second device or B device of the CA3280 and the CA3080 doesn't do well either. Both of these devices will measure higher input referred offset voltages and will give greater variation versus Iota.

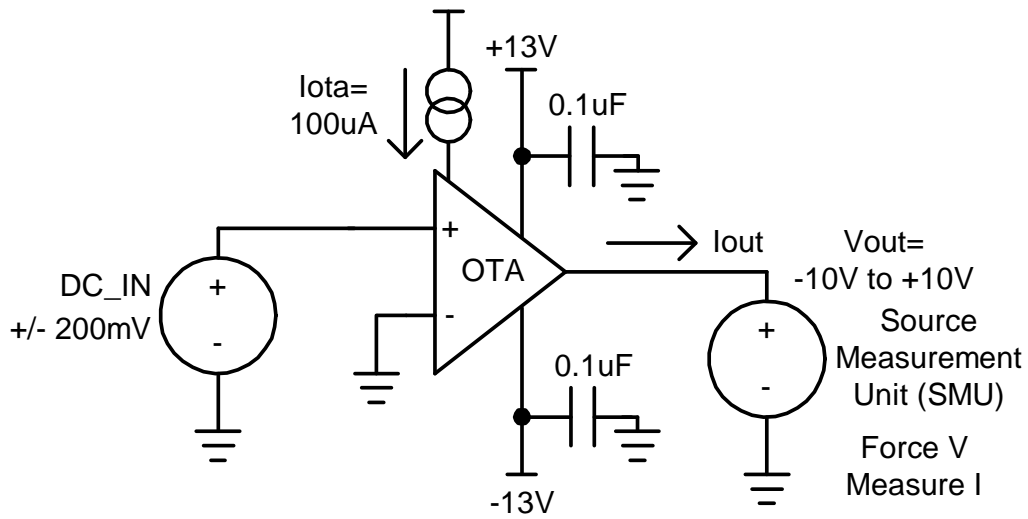


Figure 4: Measurement setup to measure output impedance. Data is in Figure 5.

I_{out} vs. V_{out} , CA3280E and discrete OTA, $V_{in} = \pm 200mV$, $I_{ota} = 100\mu A$, $V_{supply} = \pm 13V$

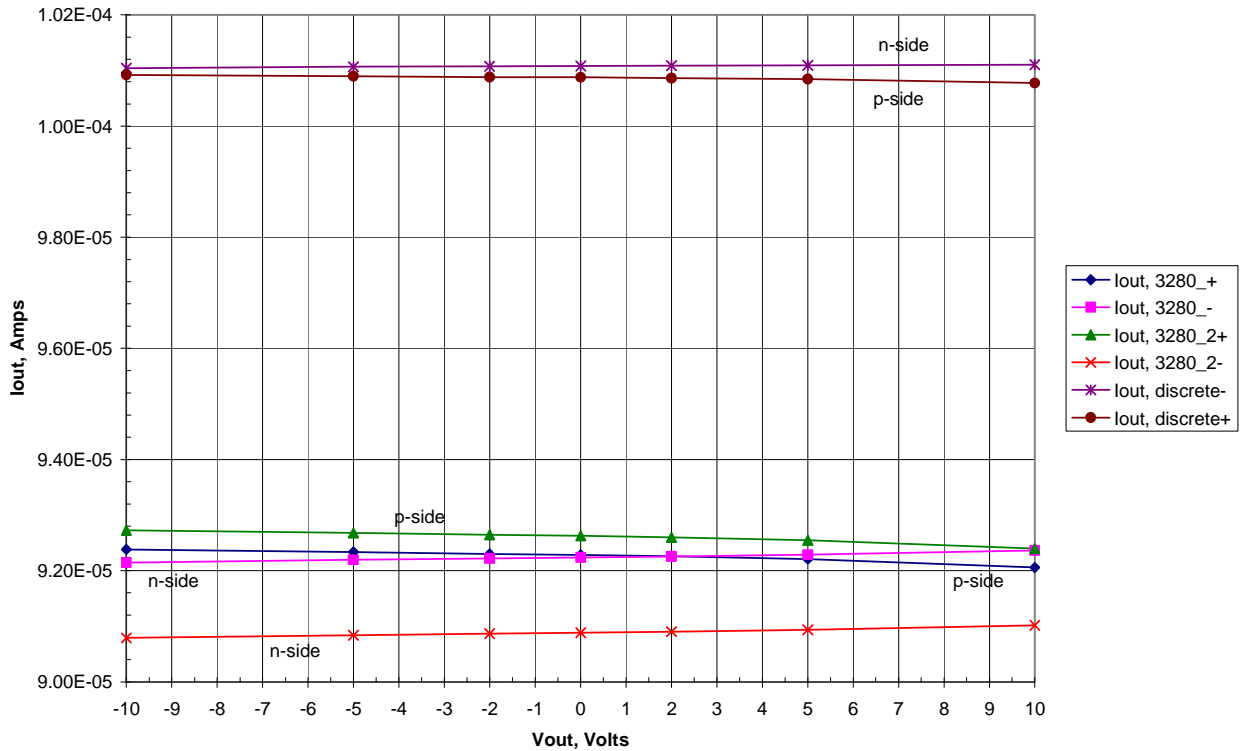


Figure 5: Effect of output impedance of CA3280E and discrete OTA. This wasn't measured yet on the other commercial OTA ICs. Discrete's data on upper two lines. The flatter the line, the better.

Figure 5 shows that the discrete OTA stacks up well against the CA3280 in comparison of output impedance. This isn't a big surprise as the discrete OTA can use transistors for both pnp and npn that have better VA (early voltage). This can be tougher to achieve for both bipolar polarities in an IC process.

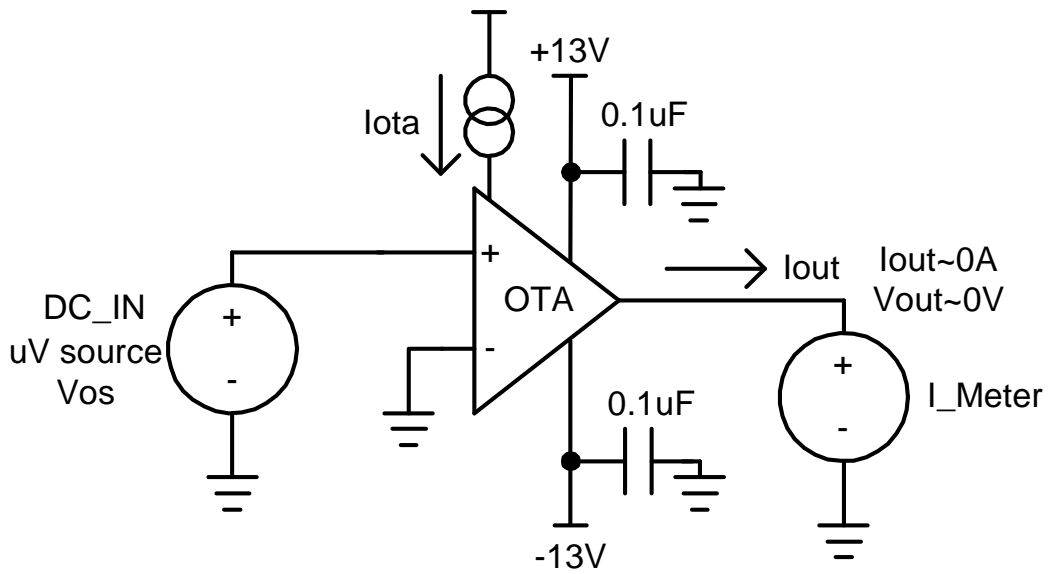


Figure 6: Circuit setup used to measure the data shown in Figure 7 to Figure 9.

Vos vs Iota, Discrete OTA, CA3280

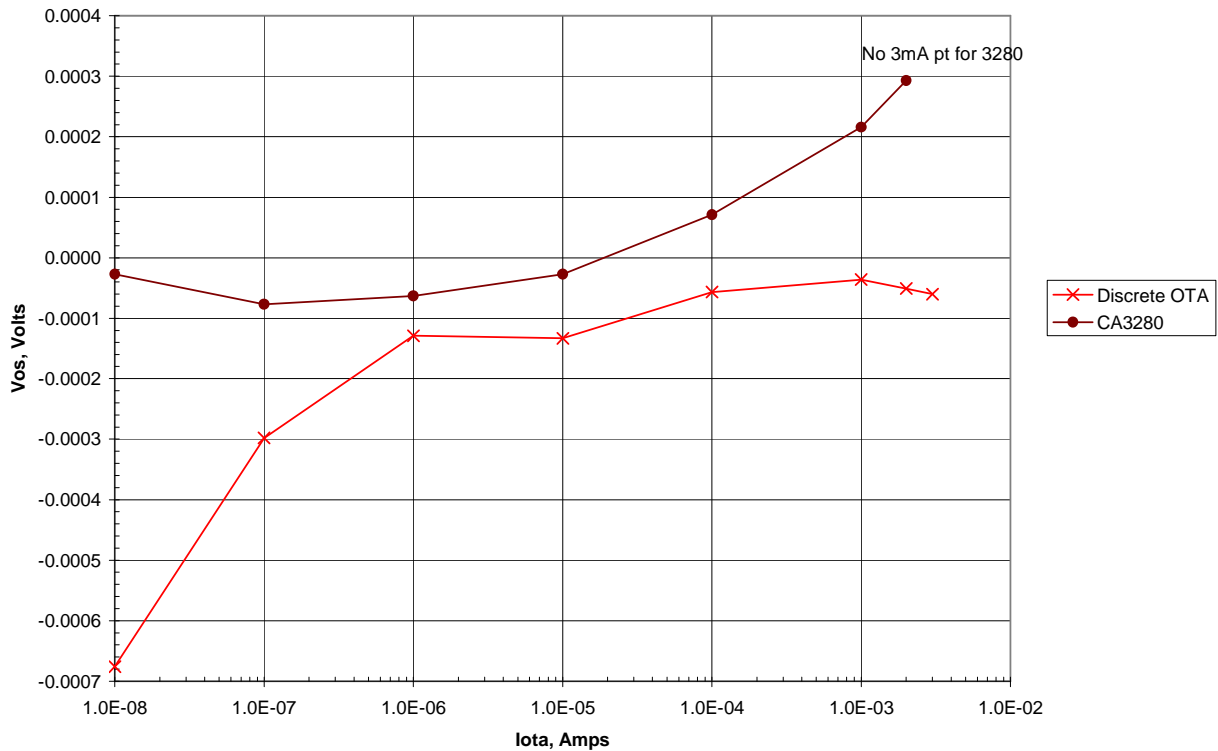


Figure 8: Offset voltage vs. Iota. Comparison of the best CA3280 I have measured to date versus the discrete OTA.

The CA3280 measured for this Vos data is the better of the two CA3280s that have been measured thus far. At this point, only one discrete OTA has been built and tested. At the time of this writing, a second one is almost complete.

Figure 8 shows that the offset voltage of the CA3280 is definitely better than the discrete OTA's at Iota currents less than 1uA. However, the offsets begin to become comparable above 1uA, and at currents of 100uA and greater, the discrete OTA performs better. Further circuit design has already occurred to make improvements at the lower Iota currents and the new OTA design will be measured and reported on soon. The output current of the discrete OTA is also more stable than that of the CA3280 under many operating conditions and that fact is attempted to be shown in Figure 9 and Figure 10.

If one has a good low offset voltage CA3280 and intends to design the tail current in the range around 10nA to 1uA, then a CA3280 is a better choice than this discrete OTA – given this data. Under the remaining biasing conditions however, the discrete OTA performs better. The next revision of the discrete OTA is making significant improvements at the lower Iota currents.

Minimum Iout including noise and drift while trimming offset at each Iota vs Iota, discrete OTA and CA3280

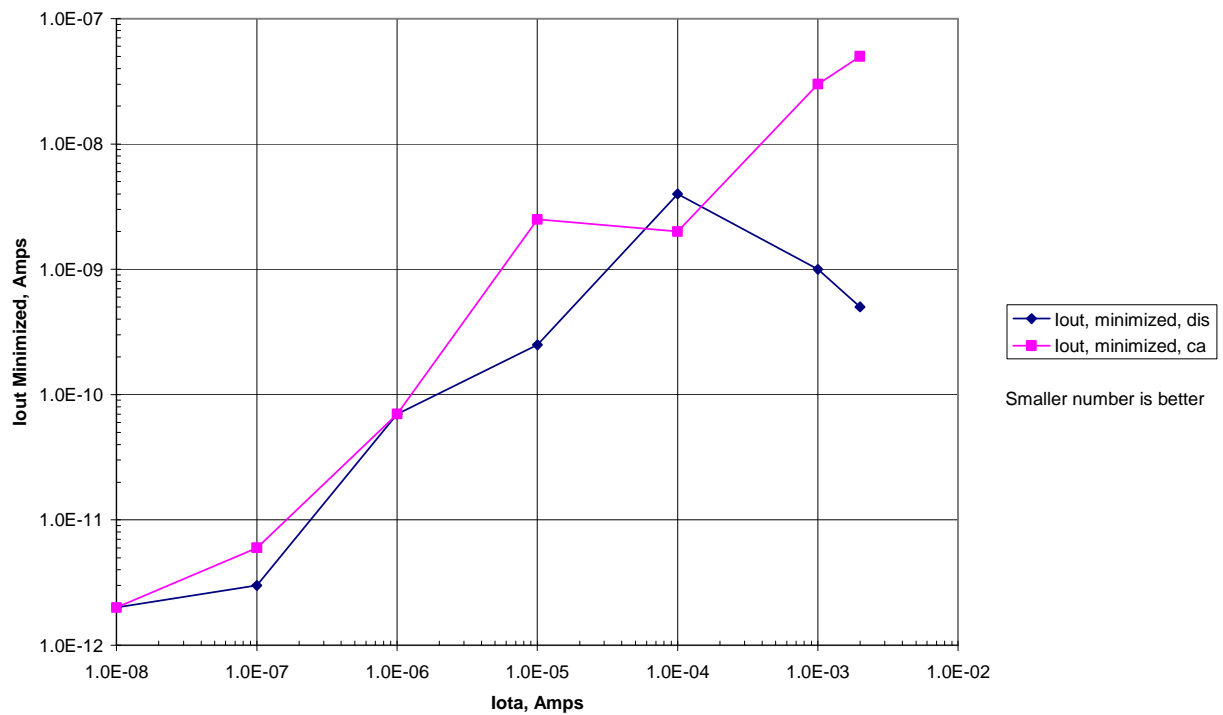


Figure 9: Minimum value of current including noise and drift while trimming Vos at each individual Iota. Discrete is blue, CA3280 is pink.

Figure 9 shows how low the output current can be trimmed by using Vos at each Iota current. Except for the 100uA current value, the discrete OTA is equal in performance or better at EVERY Iota current value. This is interesting because the discrete design seems to drift less and be less noisy than the CA3280.

I_{pico}ammeter, minimum includes noise and drift. Part trimmed at I_{ota}=1mA and then varying I_{ota} keeping V_{os} the same, Discrete OTA and CA3280

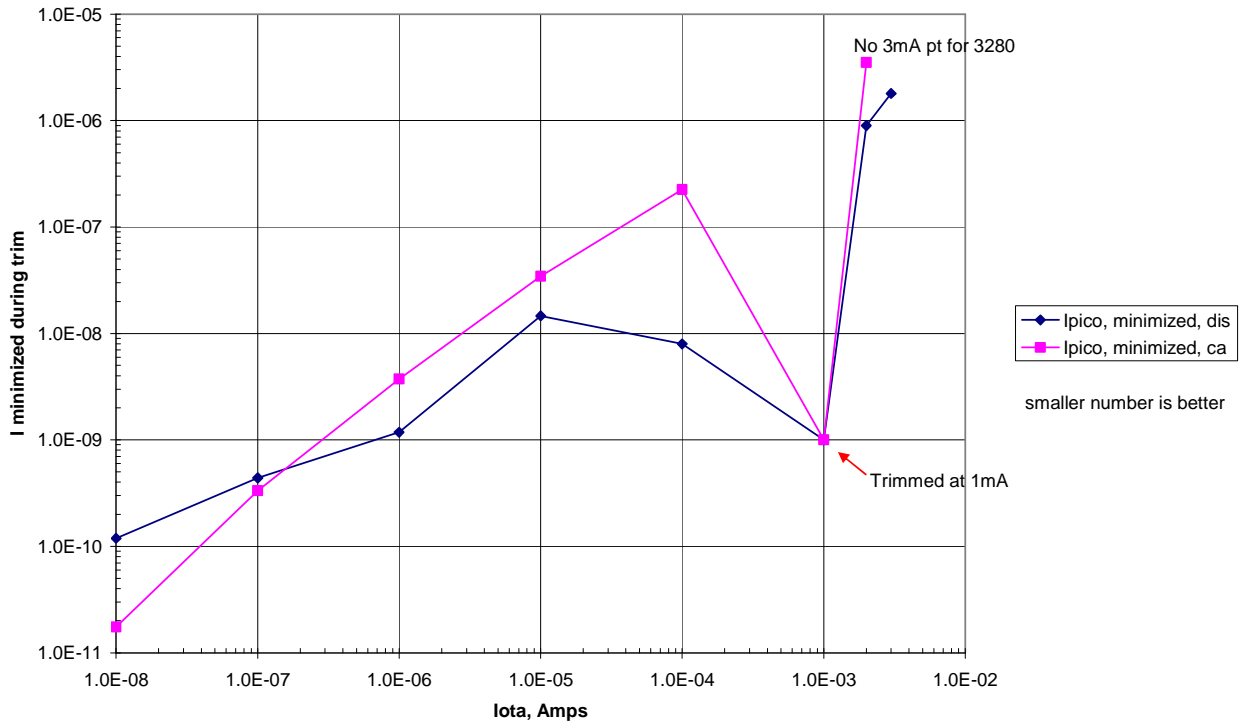


Figure 10: Trim V_{os} at 1mA I_{ota} and then measure the output current when varying I_{ota} and keeping V_{os} constant. Discrete is blue, CA3280 is pink.

In Figure 10, the discrete OTA performs equally well or better than the CA3280 at I_{ota} tail currents of 200nA and above. The CA3280 is thermally unstable at I_{ota} currents above 2mA. The discrete OTA was measured to I_{ota} currents of 3mA and should/could have been measured to higher current values yet. This graph also shows, and it was witnessed during test, that the discrete OTA doesn't drift and has more stable readings than the CA3280. The current shown on the y-axis in Figure 10 is taken to be the absolute value.