OP-AMP DC PARAMETERS DETERMINATION
Linear Integrated Circuits

Equipment Required
- Triple Output DC power supply
- Digital Multimeter

Introduction:
The DC characteristics of input offset voltage (Vio), input bias current (IB), input offset current (Ilo), output voltage swing, supply currents and output short circuit currents are important characteristics of an op-amp, since they must be known to analyze or design a circuit using that op-amp. In this lab experience, you will measure some of the DC parameters of a BJT-input operational amplifier (a 741). Also, you will measure input bias currents and input offset voltage for a FET-input op-amp, and compare these values with those of the 741. The techniques used in this experiment are universally applicable to most op-amps; the specific parts values used in the tests, however, may have to be varied (by you) depending on the type of IC (BJT, JFET, MOSFET, precision) under test.

I. Measuring Vio and IB
Be sure to apply power to circuits for enough time (about 5 minutes from a cold start), to allow chip temperature to stabilize before taking data.
1. Construct the circuit below:

\[ V_{\text{supply}} = \pm 15 \text{ VDC}. \]

Pick \( R_A \) and \( R_B \) somewhere between 2M and 10M \( \Omega \). They need NOT be matched, or even equal.

Use jumper wires for switches A & B.
MEASUREMENT OF INPUT OFFSET VOLTAGE (Vio)

2. With both switches closed, record V0. This voltage is V_{o tot} (total output offset voltage), which is the sum of V_{o oo} (output offset voltage due solely to input offset voltage) and V_{o ib} (the output offset voltage due to input bias currents). However, V_{o ib} is zero since there is no resistance in the circuit through which input bias currents flow, so no voltage is created by the input bias currents.

It is possible (but not likely) that your op-amp had such a small Vio that either you could not measure it, or could not measure it with any precision. For example, a reading of 0.2 mV, as with any digital reading, is + or - 1 least significant digit. This means that the actual voltage could have been 0.1 mV or 0.3 mV, and the DVM could have displayed the same 0.2 mV value. This is a huge possibility for error. A more precise measurement of Vio will be done in step 7 below.

MEASUREMENT OF INPUT BIAS CURRENTS, USING RESISTORS

3. Open switch A and record V0. This voltage is V_{o tot} which includes V_{o oo}. Subtract the value of V_{o oo} obtained in step 2, and the difference is V_{o ib}. Now calculate I_{b1} by using:

\[ \text{I}_{b1} = \frac{(V_{o tot} - V_{o oo})}{R_A} \]

4. Close switch A, open switch B and record V0. This voltage is V_{o tot} which includes V_{o oo}. Subtract the value of V_{o oo} obtained in step 2, and the difference is V_{o ib}. Now calculate I_{b2} by using:

\[ \text{I}_{b2} = \frac{(V_{o tot} - V_{o oo})}{R_B} \]

MEASUREMENT OF INPUT BIAS CURRENTS, USING A PICOAMMETER

5. A picoammeter is a DC current meter designed to measure currents with a resolution of 1 pA (1E-12 ampere). Remove R_A and R_B from the circuit above. Use a picoammeter to measure I_{b1} by putting its common lead to ground, and its “hot” lead to the non-inverting terminal, and removing the switch A jumper. Replace the switch A jumper after measurement.

6. Use the picoammeter to measure I_{b2} by putting its common lead to the op-amp output terminal, and its “hot” lead to the inverting terminal, and removing the switch B jumper.

PRECISE MEASUREMENT OF INPUT OFFSET VOLTAGE

7. N.A.

MEASUREMENT OF TOTAL OUTPUT OFFSET VOLTAGE

8. Build the circuit below:

9. Record V_{o tot} which is V_{o tot}. There are significant contributions to this total output offset voltage from both V_{o ib} and V_{o oo}.

10. Outside of lab, using the measured values of V_{o tot} and I_{b2} from parts 2 and 6, respectively, calculate the expected V_{o tot} for the circuit.

11. Compare the calculated V_{o tot} with the measured V_{o tot} from step 9.

12. N.A.
II. Measuring Saturation Voltages, Supply Currents & Output Short Circuit Currents, 741:

1. Build: Record:

\[ V_o = -V_{sat} = \ldots \]

2. Build: Record:

\[ V_o = +V_{sat} = \ldots \]

NOTE: in procedures 3 and 4 below, make sure you are measuring the short circuit current limit value of your IC, not the current limit setting of your power supply!

3. Build: Record:

\[ I_{O(s.c.)} = \ldots \]

4. Build: Record:

\[ I_{O(s.c.)} = \ldots \]

5. Build: Record the +/- 15 V power supply currents

\[ I_{CC} = \ldots \]
\[ I_{EE} = \ldots \]