AUTO-ZERO (CHOPPER-STABILIZED) OP AMPS

Auto-zero amplifiers, also known as chopper-stabilized amplifiers, have been around for decades and continue to evolve. In a modern version, as shown in Figure 10-23, two amplifiers are used to check up on each other.

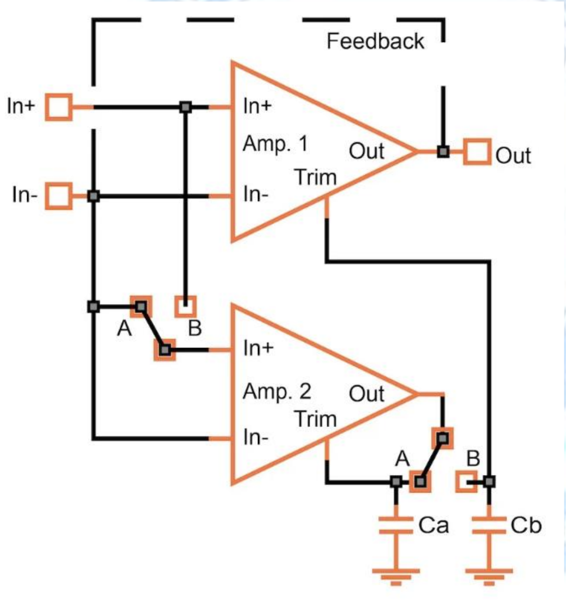

Figure 10-23. Auto-zero op amp.

Each amplifier has a "trim" input—a single node that changes its offset voltage in both directions. A built-in oscillator flips the two switches periodically at a rate of a few hundred to a few thousand Hz.

With the switches set to position A, the inputs of Amplifier 2 are shorted together. Its offset voltage is amplified by the open-loop gain and corrected by feeding the output to the trim input. The required trim voltage is stored in capacitor C_a.

With the switches set to position B, the inputs of Amplifier 2 are connected in parallel to those of Amplifier 1. Its output now feeds Amplifier 1's trim input. With the charge remaining across C_a, Amplifier 2 continues to be nulled. In this way, it corrects the offset of Amplifier 1.

As the oscillator switches back to phase A, this correction voltage remains across capacitor C_b. Due to the high open-loop gains of both amplifiers, the offset voltage is now reduced to microvolts. Because the correction is done repeatedly, temperature drift is also considerably reduced.

There's an additional benefit: anything sensed by Amplifier 2 *below the switching frequency* is treated as an offset. This includes flicker (1/*f*) noise, which is completely eliminated. Above the switching frequency, the behavior of the auto-zero amplifier is identical to a regular op amp.

Apart from higher current consumption from the additional circuitry, the main drawback of an auto-zero op amp is switching noise. At the switching frequency, there's a noise peak that also causes (intermodulation) distortion. This effect can be ameliorated by changing the switching frequency at random—in other words, creating a spread spectrum.

Applications

- Bridge sensor conditioning (e.g., strain gauges, pressure sensors).
- Medical instrumentation (e.g., EKG/ECG machines).
- High-resolution data acquisition systems (24-bit ADCs).
- Thermocouple and RTD amplifiers.