ANALYSIS OF DIODES DISTORTION FOR DIFFERENTIAL INPUT VOLTAGE TO OFFSET SIGNIFICANT AMOUNT OF INPUT STAGE NON LINEARITY AT HIGHER DIFFERENTIAL INPUT VOLTAGES

Jyoti Dadwal* & Bhubneshwar Sharma**
* M.Tech Student, Department of Electronics and Communication Engineering, S.S.C.E.T, Under Punjab Technical University, India
** Assistant Professor, Department of Electronics and Communication Engineering, S.S.C.E.T, Under Punjab Technical University, India

Abstract:

Differential amplifiers are found in many circuits that utilize series negative feedback (op-amp follower, non-inverting amplifier, etc.), where one input is used for the input signal, the other for the feedback signal (usually implemented by operational amplifiers). For comparison, the old-fashioned inverting single-ended op-amps from the early 1940s could realize only parallel negative feedback by connecting additional resistor networks (an op-amp inverting amplifier is the most popular example). A common application is for the control of motors or servos, as well as for signal amplification applications. In discrete electronics, a common arrangement for implementing a differential amplifier is the long-tailed pair, which is also usually found as the differential element in most op-amp integrated circuits.

Keywords: Differential Amplifier & Amplification.

1. Introduction

The amplifier's differential inputs consist of a non-inverting input (+) with voltage V_+ and an inverting input (−) with voltage V_-; ideally the op-amp amplifies only the difference in voltage between the two, which is called the differential input voltage.

- The magnitude of A_{OL} is typically very large—100,000 or more for integrated circuit op-amps—and therefore even a quite small difference between V_+ and V_- drives the amplifier output nearly to the supply voltage.
- Situations in which the output voltage is equal to or greater than the supply voltage are referred to as saturation of the amplifier. The magnitude of A_{OL} is not well controlled by the manufacturing process, and so it is impractical to use an open loop amplifier as a stand-alone differential.

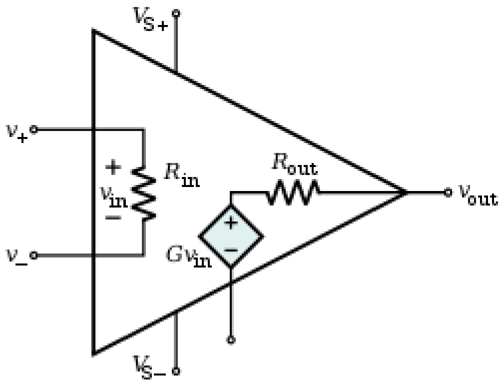

Figure (1): Equivalent Circuit of Operational Amplifier for Resistive Non-Ideal Parameters.

- Without negative feedback, and perhaps with positive feedback for regeneration, an op-amp acts as a comparator.
- If the inverting input is held at ground (0 V) directly or by a resistor R_g, and the input voltage V_{in} applied to the non-inverting input is positive, the output will be maximum positive; if V_{in} is negative, the output will be maximum negative.
- Since there is no feedback from the output to either input, this is an open loop circuit acting as a comparator.

2. Input stage non linearity at higher differential input voltages:

Variations in the quiescent current with temperature, or between parts with the same type number, are common, so crossover distortion and quiescent current may be subject to significant variation.

- The output range of the amplifier is about one volt less than the supply voltage, owing in part to V_{BE} of the output transistors Q14 and Q20.
- The 25 Ω resistor at the Q14 emitter, along with Q17, acts to limit Q14 current to about 25 mA; otherwise, Q17 conducts no current.
- Current limiting for Q20 is performed in the voltage gain stage: Q22 senses the voltage across Q19's emitter resistor (50Ω); as it turns on, it diminishes the drive current to Q15 base.
- Later versions of this amplifier schematic may show a somewhat different method of output current limiting.

Conclusion:

First, when used with input resistors, the diodes distort the differential input voltage to offset a significant amount of input stage non linearity at higher differential input voltages. According to National Semiconductor, the addition of these diodes increases the linearity of the input stage by a factor of 4. A second improvement is the integration of an optional-use output buffer amplifier to the chip on which the OTA resides. This is actually a convenience to a circuit designer rather than an improvement to the OTA itself; dispensing with the need to employ a separate buffer. It also allows the OTA to be used as a traditional op-amp, if desired, by converting its output current to a voltage.

References:

1. Jung, W.G., IC Op-Amp Cookbook (Howard W. Sams -Bobs Merrill First Ed. 1974) p. 440 et seq.
2. Jung, W.G., IC Array Cookbook (Hayden, 1980) p. 40-41.
3. Data Sheet for LM 13700 – Graph of Distortion v. Differential Input Voltage (National Semiconductor, June 2004) p. 6.
4. http://cache.national.com/ds/LM/LM13700.pdf