An Operational Amplifier Architecture with a Single Gain Stage and Distortion Cancellation

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An Operational Amplifier Architecture with a Single Gain Stage and Distortion Cancellation

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Abstract

Amplifiers with a single high gain stage are attractive for their simplicity and excellent power/performance tradeoff, but their typically higher distortion has limited their use in the audio field. Presented here will be a low-power single -stage IC amplifier architecture that enables passive cancellation of distortion (THD <-120dB @ 20kHz, 7V rms, R_l = 600Ω). Classical output stage distortion as well as nonlinear capacitive effects are addressed.

Introduction

It is now more than 20 years since activity started in the field of integrated circuit (IC) op amps. Many of the basic circuit architectures and most of the theory remains useful to this day. The now ubiquitous 741 and its descendents fall in to the class of two-stage "pole-split" [1] amplifiers and still account for tens of millions of sockets every year. Their basic slew-rate and bandwidth limitations have been addressed in various ways [2,3,4], with the majority of high slew, wide band applications going to BiFET or simple degenerated bipolar designs. On the other hand, the requirements of high DC precision and low noise have been met by the three-stage op amp introduced around 1969 [5], refined in 1980 [6], and refined again in 1986 [7]. The now generic audio industry standard 5534 is descended from this line, adding an all NPN output stage to compensate for the poor PNP performance normal to a vintage 1975 bipolar process.

The original demand for the work presented here came from the automatic test equipment (ATE) industry ; after all, it is their burden to test the performance of today's high end systems. The requirements here are a combination of the DC precision of the three-stage op amp and the speed and dynamic characteristics of the single-stage amplifier. Current-feedback amplifiers offer excellent performance with respect to speed but the DC precision requirements eliminated them from consideration here. This combination of requirements also make this work of interest to the audio community.