

## 一种低电压、低噪声、低失真度的语音信号自动增益控制电路

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**摘要:** 提出了一种工作在低电压下的宽动态范围、低噪声、低失真度的可用于语音信号采集系统的自动增益控制电路(AGC)。该 AGC 环路采用反馈式结构, 数字式增益控制。设计指标为 1 V 工作电压, 0~40 dB 增益动态范围, 2 dB 增益步长, 8 kHz 带宽。采用  $\pi$  型电阻网络作为环路中可变增益放大器的无源反馈网络, 提高增益的准确性并实现增益在对数单位下的线性。采用滞回比较器来减弱当峰值检测器输出信号在阈值电压附近小幅度快速变化而引起的抖动。基于 UMC180 nm CMOS 工艺完成电路及版图设计, 芯片面积约为 0.45 mm<sup>2</sup>。提取版图寄生参数后的电路仿真结果显示, AGC 环路的功耗在 1 V 工作电压下约为 0.17 mW; AGC 的增益动态范围为 0~40.2 dB, 增益步长为 2 dB, 增益误差不大于 0.2 dB。总谐波失真在输出信号 1 kHz, 峰峰值为 0.4 V 时小于 -70 dB。AGC 中可变增益放大器单位增益时, 在音频(0.02~20 kHz)范围内的输出积分噪声小于 5  $\mu$  V RMS。

**关键词:** 自动增益控制; 语音信号采集; 数字式增益控制;  $\pi$  型电阻网络; 低噪声; 低失真

## A Low Noise Low Distortion Automatic Gain Control Circuit

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**Abstract:** This paper presents a kind of Automatic Gain Control (AGC) circuits which can be used in speech signal acquisition system, it has high gain range, low noise and high linearity. The proposed AGC is based on feedback topologies and the gain is digital controlled. The design indexes are 1 V supply voltage, 0~40 dB gain range, 2 dB gain step, 8 kHz bandwidth. A  $\pi$ -type resistors network is used in the Programmable Gain Amplifier (PGA) as the passive feedback device to realize gain linearity in decibels and increase the gain accuracy. The hysteresis comparator eliminate the chattering effects when the output signal of Peak Detector changes rapidly around the threshold. The design is implemented in 0.18  $\mu$  m CMOS and occupies an active area of 0.41 mm<sup>2</sup>. The power consumption of AGC is about 0.17 mW at 1 V supply voltage. The gain of AGC loop ranges from 0 dB to 40.2 dB in 2 dB step with gain error not more than 0.2 dB. The total harmonic distortion (THD) is below -70 dB over the audio frequencies at 1 kHz, 0.4-Vpp differential output. The integrated noise in the audio range (20 Hz~20 kHz) is less than 5  $\mu$  VRMS when the gain of PGA is set at 0 dB.

**Key words:** AGC; speech signal acquisition; digital control loop;  $\pi$ -type resistor network; low noise; low distortion

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