

INTEGRATED PATCH CLAMP AMPLIFIER

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Abstract— The patch clamp technique is the central method in modern electrophysiology. It allows single ion-channel currents to be recorded, or alternatively currents from entire small cells. It traditionally uses a glass pipette as an "electrode" which is gently applied to a cell membrane through control by a skilled operator. There is much room for improvement in the technique, especially in view of its difficulty and the large electrical capacitance introduced by the glass pipette. We have designed and fabricated a potentiometer chip in a 0.5um process that can be used to measure patch and whole-cell membrane currents.

INTRODUCTION

The need for fast and sensitive drug testing in the pharmaceutical industry requires the implementation of rapid, highly parallel screening techniques [1, 2, 3]. Ion channels are excellent drug targets as they play a major role in many common diseases [4]. The most sensitive technique available for screening ion channel active drugs (ICADs) is patch clamp recording from cell membranes, which allows even single ion channels to be probed with great accuracy [5, 6]. The major drawbacks of this technique for industrial applications are the low throughput and the high personnel costs due to the labor intensive evaluation of individual drugs. Given the large number of drugs generated by combinatorial chemistry and the high degree of selectivity required, a rapid and efficient screening method is particularly important. Recently, different instruments for the automated analysis of ion channel function have been developed for ion channels expressed in *Xenopus Oocytes* [7] as well as mammalian cells [8, 9].

We have developed an integrated approach to patch-clamp that can measure the pA current levels of single patch measurement and provide a converted digital output using the sigma-delta technique. This prototype is a first step in integration and automation of the patch measurements. The integrated system is a single channel potentiometer fabricated in a 0.5um process available via MOSIS, CA.

We report here some of the main features of the integrated patch clamp system:

- Die Size: 1.5 x 1.5mm
- Technology: 0.5um CMOS
- Supply: 3.3V
- ADC: 12b Sigma-Delta
- Output Data: Serial
- Range: 1pA to 100nA
- Noise: 0.1pA RMS
- Bandwidth: 10kHz

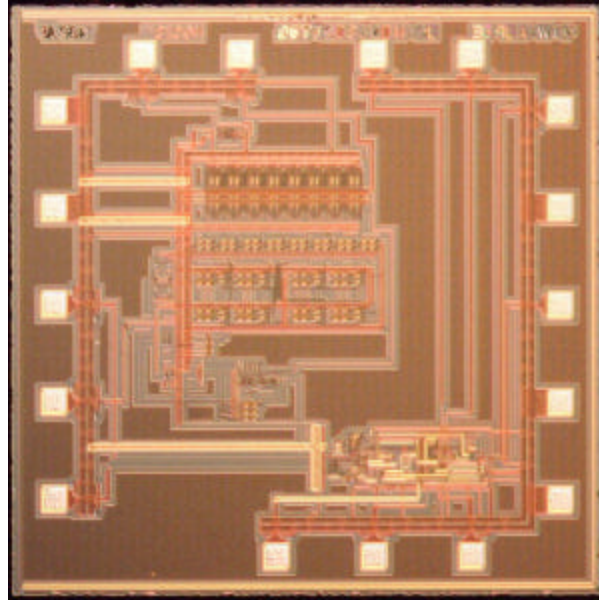


Figure 1. System Die micrograph.

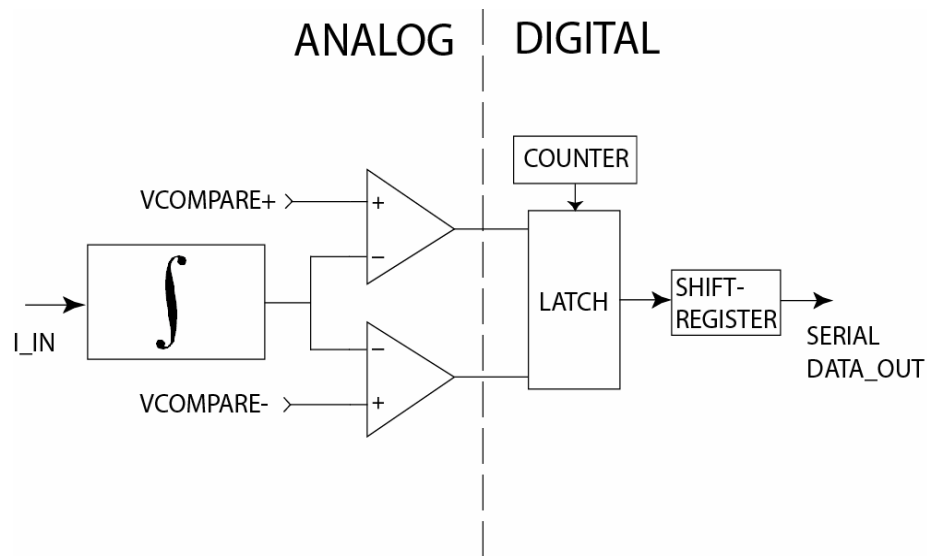


Figure 2. Integrated Patch Clamp Block Diagram

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