Abstract—This paper introduces a tiny inner bladder pressure sensing system for long term ambulatory urodynamic monitoring. In order to realize this system, a small System-on-a Chip (SoC) called Medical Domain Specific SOC, Type-I (MeSOC-I) has been developed. MeSOC-I enables an inner bladder pressure sensing system to conduct more than 72 hours measurement with a small battery.

I. INTRODUCTION

Ambulatory Urodynamic Monitoring (AUM) has become an established diagnosing method for lower urinary tract symptoms (LUTS) [1]. AUM is expected to reduce the artifacts on pressure measurement because AUM releases patients from the stressful environment and investigates the natural activity of the urinary system in daily life.

II. SENSING SYSTEMS FOR AUM

Several pressure sensing systems have been proposed for AUM[2-4]. The system proposed in [3] implants catheters to measure bladder pressure. Although the system can be used in AUM, the results still contain the artifacts because the catheters adversely affect the test results. A balloon-type remote bladder pressure sensor reported in [2] can measure and transmit the bladder pressure every 5 minutes. However, the balloon is hard to be employed to AUM in terms of size, power, time resolution, and wireless functionality. Especially, the size of the balloon becomes a big obstacle for the less-invasive tests, and invasive incision is supposed to be necessary to implant the balloon. The system in [4] implants a capsule in the bladder and transmits data. Though the system assumes incision, it could be used in the less-invasive tests because the capsule is small enough. However, lack of functionality of multiple wireless communications, the system cannot insert multiple capsules in the body simultaneously.

III. DEVELOPED SOC AND PRESSURE SENSING CAPSULE

In order to satisfy the strict requirements for AUM, we developed a small and ultra low power System-on-a-Chip (MeSOC-I), and a less invasive pressure sensing capsule for AUM using MeSOC-I. MeSOC-I integrates a digital converter for the MEMS sensor, a wireless transceiver, and a digital system based on an Application Specific Instruction set Processor (ASIP), which is an embedded processor with a special Instruction Set Architecture (ISA). The SoC was fabricated as 2.5 x 2.5 mm² under 0.18µm mixed-signal CMOS technology [5].

To record pressure data, the tiny airtight capsules are inserted into the bladder and the rectum. The capsules communicate with a portable recorder attached on the body and transmit data in patient’s daily life. The capsule consists of four components: a communication coil, a battery, a MEMS capacitive pressure sensor, and the MeSoC-I. Diameter of this capsule is 6.5mm and the length is 18 mm. This is small enough to be inserted into bladder through urethra without incision. Developed pressure sensing capsule for AUM is shown in Figure 1. By analysis of the power consumption in this system, it can operate more than 72 hours with a 12mA small battery.

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REFERENCES