Task-11

Team No.4

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Design for a mixed signal ASIC for medical applications, focusing on power efficiency and functionality.

**Report:**

Power Efficiency in ASIC Design:

To ensure power efficiency in medical ASIC design, it is crucial to focus on minimizing power consumption to extend the device's battery life.

Utilizing a programmable stimulator with a low-voltage DAC and a triple-mode voltage multiplier can significantly reduce dynamic power consumption by lowering the charge pump clock frequency.

Implementing a low-power control strategy in the sensing channel, such as turning off the op-amp when not in use, helps reduce average power consumption in the ASIC.

Functionality Considerations:

Incorporating features like contact resistance measurement in the ASIC design is essential to reflect the connection status and pathological conditions of the patient's heart.

Challenges in the sensing channel, such as low-frequency heart signals and potential interferences, can be addressed by utilizing architectures like capacitive feedback and gm-C filters while avoiding external passive components.

Front-End Amplifier and Filter Design:

The front-end amplifier in the sensing channel should adopt a fully differential active-RC topology with external passive components to ensure accurate gain and bandwidth .

While capacitive feedback and gm-C architectures offer advantages, the classical active-RC topology with external components provides low power consumption and stable performance across variations in technology and supply voltage.

Pacing Circuit Efficiency:

Improving power efficiency in pacing circuits, especially the high-voltage pulse generator, is crucial for achieving long battery life in pacemakers.

Enhancing the efficiency of the charge pump connected to the pacing capacitor by reducing the clock frequency can lead to substantial power savings and prolonged device operation.

By adhering to these design principles focusing on power efficiency and functionality, designers can create effective mixed-signal ASICs for medical applications that meet the stringent requirements of implantable devices while ensuring optimal performance and longevity.

**Applications:**

**Neurostimulators:**

ASICs in neurostimulators interface with neural signals, requiring high-resolution analog-to-digital conversion (ADC), digital processing for stimulation control algorithms, and wireless communication for programming and data telemetry.

These ASICs allow for targeted electrical stimulation of nerves or the brain, aiding in the treatment of conditions like chronic pain, Parkinson's disease, or epilepsy.

**Continuous Glucose Monitors (CGMs):**

ASICs in CGMs integrate sensors for glucose monitoring with analog front ends for signal conditioning, low-power ADCs for accurate glucose level measurement, and digital processing for real-time data analysis and trend prediction.

They enable continuous monitoring of glucose levels in diabetic patients, providing timely alerts and insights for better disease management without the need for frequent blood sampling.

**Medical Imaging Systems (MRI and Ultrasound):**

ASICs in medical imaging systems handle signal acquisition from imaging sensors (e.g., MRI coils, ultrasound transducers), analog-to-digital conversion of received signals, and digital processing for image reconstruction and enhancement.

ASICs optimize signal quality, speed up image processing, and reduce noise, enhancing diagnostic accuracy and efficiency in medical imaging diagnostics.

**Portable Diagnostic Devices (Handheld ECG Monitors and Pulse Oximeters):**

ASICs integrate analog front ends for acquiring physiological signals (ECG or SpO2), digital signal processing for real-time analysis, and display interfaces for user feedback.

These ASICs enable compact, battery-operated devices for point-of-care diagnostics, facilitating early detection and monitoring of cardiac or respiratory conditions in clinical or home settings.