

Task 10

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Research the reliability and robustness requirements for ASICs used in medical devices

Reliability Requirements

1. **Longevity:** ASICs must have a long operational life, often exceeding 10-15 years, depending on the application.
2. **Environmental Tolerance:** ASICs should withstand variations in temperature, humidity, and electromagnetic interference (EMI) typical in medical environments.
3. **Fault Tolerance:** Design must incorporate error detection and correction mechanisms to handle soft errors, particularly from radiation exposure in certain medical applications.
4. **Low Failure Rate:** Adhere to standards like the Reliability Prediction Methodologies (e.g., MIL-HDBK-217) to estimate and minimize failure rates.
5. **Redundancy:** Implement redundant circuits or paths to ensure continued operation in the event of a component failure.

Robustness Requirements

1. **Power Integrity:** Ensure stable power supply with low noise levels, as fluctuations can lead to malfunction.

2. **EMC Compliance:** Meet Electromagnetic Compatibility (EMC) standards to prevent interference with other devices and to minimize susceptibility to external electromagnetic fields.
3. **Signal Integrity:** Maintain high signal integrity to prevent data corruption, using techniques such as proper layout, shielding, and differential signaling.
4. **Stress Testing:** Subject the ASIC to various stress tests (thermal cycling, vibration, etc.) to validate performance under extreme conditions.
5. **Manufacturing Variability:** Design for tolerance against manufacturing variances by using robust design techniques (DFT - Design for Testability).

common challenges in ensuring reliability in healthcare ASICs

1. Environmental Variability

- **Temperature Fluctuations:** Medical devices often operate in varied environments, requiring ASICs to perform reliably across a wide temperature range.
- **Humidity and Contaminants:** Exposure to moisture and biological contaminants can affect performance and reliability.

2. Electromagnetic Interference (EMI)

- **Interference from Other Devices:** Medical environments often have multiple electronic devices, increasing the risk of EMI affecting ASIC performance.
- **Regulatory Compliance:** Meeting EMC standards can be challenging due to stringent requirements.

3. Power Supply Variability

- **Voltage Fluctuations:** ASICs must operate reliably under varying power conditions, including transient spikes or drops.
- **Low Power Requirements:** Many medical devices need low-power ASICs, which can complicate reliability.

4. Manufacturing Variability

- **Process Variability:** Inconsistencies in semiconductor manufacturing can lead to variations in performance and reliability.

- **Material Quality:** The choice of materials affects long-term reliability, requiring careful selection and testing.

5. Aging and Wear-Out Mechanisms

- **Electromigration:** Over time, current flow can cause degradation of interconnects, impacting long-term reliability.
- **Thermal Stress:** Repeated thermal cycling can lead to failures, necessitating robust thermal management strategies.

6. Complex Design Requirements

- **Integration of Multiple Functions:** As more functions are integrated into a single ASIC, the complexity increases, making it harder to ensure reliability.
- **Error Handling:** Implementing effective error detection and correction mechanisms can complicate design.