Counterfeit Detection

Counterfeit Component Detection Utilizing Silicon Biometrics Techniques

Lewis Innovative Technologies, Inc
110 Johnston Street, SE
Decatur, AL 35601
www.lewisinnovative.com

Presenter – James Lewis
James.lewis@lewisinnovative.com
Counterfeit Detection

Outline

1. The Need for Better Counterfeit Detection Technologies
2. What are Silicon Biometrics and How do They Work
3. Applying Silicon Biometrics to Counterfeit Detection
4. Current State of the Research
5. Moving Forward
1. Why do some manufacturers employ a “See if it works, first” Counterfeit Mitigation Philosophy?

2. Why does that matter to us?
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The Need for Better Counterfeit Detection Technologies

Manufacturing Practices

1. Modern Pick and Place Machines
   Place >100,000 components/Hr
   (>4,000 IC/Hr)

2. Components are Purchased “Just in Time” to Manage Inventory Costs
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The Need for Better Counterfeit Detection Technologies

Counterfeit Detection Realities

1. Counterfeit Detection Tests Require Hours or Days per Device

2. Subjective Results
   (Qualitative vs Quantitative Results)

3. Cost
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The Need for Better Counterfeit Detection Technologies

“How does the attitude of other manufacturers affect my product?”

“My organization addresses Supply Chain Risk and Counterfeit Component Issues. Why do we care about organizations that do Not?”

Viral Problems
Counterfeit Detection

The Need for Better Counterfeit Detection Technologies

Viral Problems

All Sectors of the Market must be Sanitized

Eliminate the Environmental Factors that Nurture the Counterfeit Epidemic
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The Need for Better Counterfeit Detection Technologies

Viral Problems

Counterfeit Eradication Concept

Environmental Factors that Nurture the Counterfeit Epidemic

- Unattractive Mitigation Processes
- Profit Motives
- Counterfeiter Immunity Issues
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The Need for Better Counterfeit Detection Technologies

Specific Needs:
1. Fast, Effective, Low-Cost Detection
2. Integrated and Automated Processes

Attractive Counterfeit Detection Options:
- Fast and Automated
- Reliable
- Integrated (into existing equipment and systems)
- Quantitative
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What are Silicon Biometrics and How Do They Work?

• Unintended Characteristics that result from:
  (1) Manufacturing Variation
  (2) Design

• No Impact on IC performance
  effect is much less than component safety margins

• Unique Test and Evaluation Technologies

• Comparable to Evaluating Genetic Markers in Biological Organisms
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What are Silicon Biometrics and How Do They Work?

1. **Peripheral** – Component Characteristics that are not critical to Product Operation, Integrity, or Design.

2. **Physics Based** – Due to the Physics of the Device.

3. **Measurable** – Some Method must exist of Consistently measuring these characteristics.
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Silicon Biometrics

Background

1. Every transistor ever manufactured is Unique!
   
   A. Unique by Design
   
   B. Unique Due to Manufacturing Variation

2. ICs, constructed of numerous transistors, are also Unique!
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What are Silicon Biometrics and How Do They Work?

Peripheral

• Not the Characteristics That Were Evaluated When the Component was Selected

• **Surprise!** – Peripheral Characteristics May be Unknown, Unreported in the Data Sheet, Not Understood by the Typical Designer or Engineer

• Result from Material Physics or Tradeoffs Necessary to Design Components that Meet Requirements
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What are Silicon Biometrics and How Do They Work?

Peripheral Examples

- Delay – Maximum versus Relative
- Impedance – Acceptable versus Characteristic
- Parasitic Characteristics

Why don’t Peripheral Characteristics Affect Design?

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What are Silicon Biometrics and How Do They Work?

Physics Based

- **Silicon Biometrics** are Founded in the Physics of the Device
- **Forgery Resistant** – Difficult to Emulate or Fake
- **Family Characteristics** – based on Design and Manufacturing Methods
- **Individual Characteristics** – based on Manufacturing Variation
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What are Silicon Biometrics and How Do They Work?

Measurable

• Some Method must exist to Consistently Measure these Characteristics
• Measurement for Identification/Authentication
  • Reliable/Consistent
  • Timely
  • Cost Effective
  • Dimensionality
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Silicon Biometrics Examples

Relative Data Valid Delay in SRAM
(Data Valid Delay - Time from Address Valid to Data Valid)

- SRAM are Characterized by Maximum Delay
- Unique Measureable Differences Exist in each Data Bit delay
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Silicon Biometrics

Examples

Relative Data Valid Delay in SRAM
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Applying Silicon Biometrics to Counterfeit Detection

Research Process

1. Investigate Biometric Characteristics
2. Develop Tests
3. Test Target Components
4. Characterize
5. Analyze
6. Apply
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Applying Silicon Biometrics to Counterfeit Detection

Research Process – Investigate Biometric Characteristics

A. Pin Impedance
B. Delay
C. Parasitic Characteristics
D. Looking for More
Research Process – Develop Tests

1. FPGA – Self Testing Capabilities
   Asymmetric Unclonable Functions

2. Low Cost Test Fixtures
   A. Delay Tests
   B. Impedance Tests
   C. Parasitic
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Applying Silicon Biometrics to Counterfeit Detection

Low Cost Test Fixtures Examples
Counterfeit Detection

Applying Silicon Biometrics to Counterfeit Detection

Research Process – Test Target Components

A. Identify Test Opportunities
B. Develop Component Specific Tests
C. Components of Interest
   1) Programmable Logic
   2) Memory
   3) Logic
   4) Amplifiers
   5) Diodes & Transistors
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Applying Silicon Biometrics to Counterfeit Detection

Research Process – Characterize

1. Available Golden Units
   A. Database of Golden Unit Results
   B. Establish Acceptable Biometric Boundaries

2. No Golden Units
   A. Test Significant Component Population
   B. Compare Component Results
   C. Analyze Results
      1. Determine Population Homogeneity
      2. Determine the Number of Possible Families in Population
      3. Investigate Population Families
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Applying Silicon Biometrics to Counterfeit Detection

Research Process – Analysis

1. Evaluate Biometric Test Accuracy
   A. Population Stability
   B. Date Code Stability
   C. Population-Population Collisions/Separation

2. Evaluate Biometric Test/Fixture Sufficiency
   A. Environmental Stability
   B. Calibration
   C. Fixture Aging/Maintainability
   D. Gap Analysis
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Applying Silicon Biometrics to Counterfeit Detection

Research Process – Application

1. Apply Developed Biometric Tests and Hardware to Specific Component Acquisition Process
2. Develop Universal Test Node
3. Automation and Integration
4. Repeat Research and Development Process based on Lessons Learned
1. Investigate Biometric Characteristics
   - 5 Counterfeit Detection Appropriate Biometrics Identified
   - Investigating Analog Component Biometrics

2. Develop Tests
   - Mature Tests for 2 Biometrics
   - Developmental Tests for 3 Biometrics
   - Develop Universal Test Node (plans)

3. Test Target Components
   - Extensive Testing on PLD and Memory
   - Preliminary Testing on Logic and Diodes
   - Preparation for Amplifier and Transistor Testing
4. Characterize
   - Extensive Characterization of FPGAs
   - SRAM Memory Devices
   - FLASH Memory Devices
   - Calibration and Compensation Requirements

5. Analyze
   - Limited Analysis of FPGA Results (funded)

6. Apply
   - Investigating Partnerships
1. Looking for Partners
2. Looking for Target Components
3. Test Fixture Development
4. Component Testing
Contact Information

Lewis Innovative Technologies, Inc.

110 Johnston Street, SE
Decatur, AL 35601
www.lewisinnovative.com
256-905-0775

James Lewis, PE, Principal Engineer
james.lewis@lewisinnovative.com

Eddie McAbee, Chief Operating Officer
eddie.mcabee@lewisinnovative.com

Sarah Nelson, Marketing Director
sarah.nelson@lewisinnovative.com