Counterfeit Component Detection Utilizing Silicon Biometrics Techniques

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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**

Counterfeit Detection

The Need for Better Counterfeit Detection Technologies

1. **Why do some manufacturers employ a "See if it works, first" Counterfeit Mitigation Philosophy?**
2. **Why does that matter to us?**

Counterfeit Detection

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**

Counterfeit Detection

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**

Counterfeit Detection

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

Counterfeit Detection

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**

Counterfeit Detection

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

Counterfeit Detection

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**

Counterfeit Detection

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.

Counterfeit Detection

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!**

Counterfeit Detection

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

Counterfeit Detection

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?

Counterfeit Detection

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

Counterfeit Detection

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

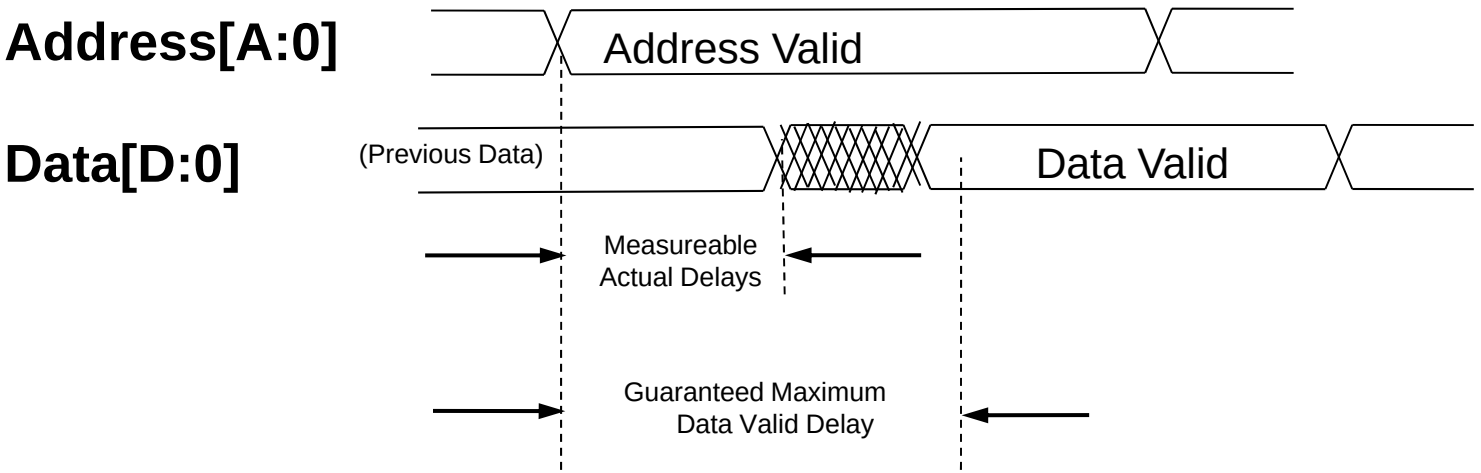
Counterfeit Detection

Silicon Biometrics

Examples

Relative Data Valid Delay in SRAM

(Data Valid Delay - Time from Address Valid to Data Valid)



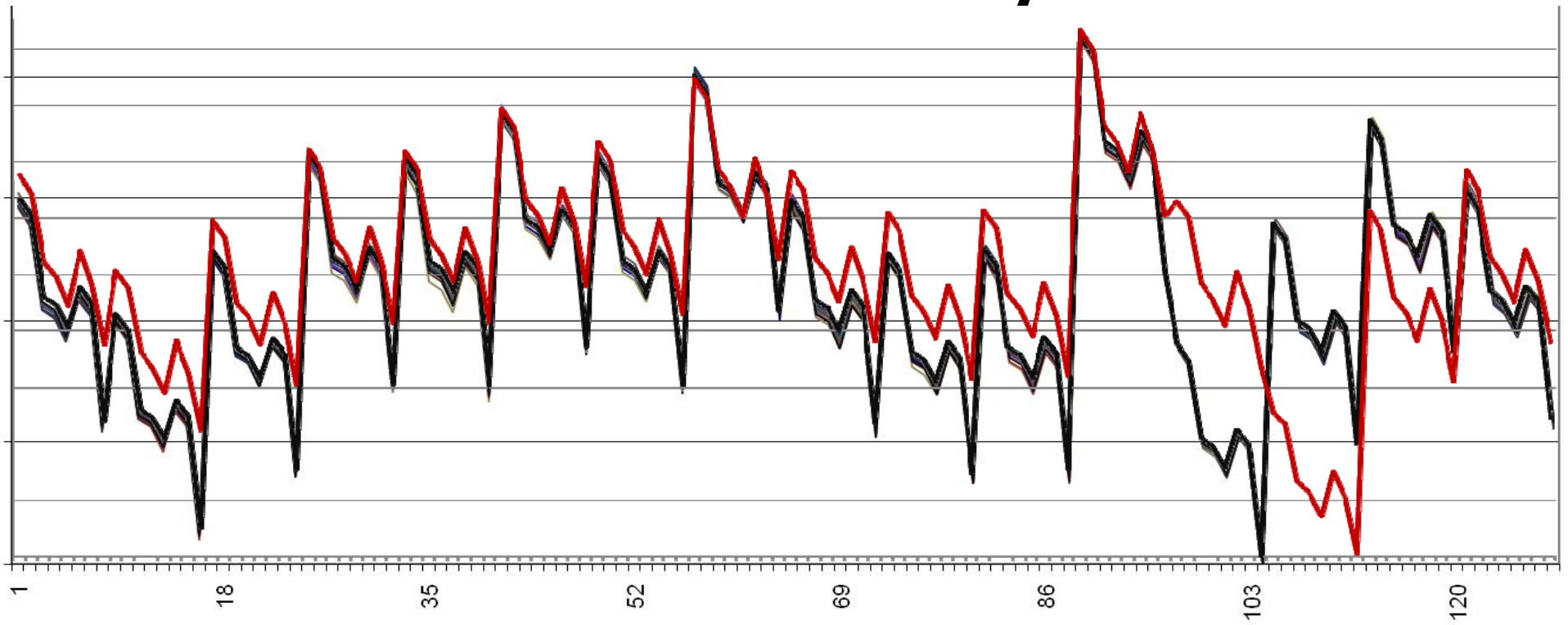
- SRAM are Characterized by Maximum Delay
- Unique Measureable Differences Exist in each Data Bit delay

Counterfeit Detection

Silicon Biometrics

Examples

Relative Data Valid Delay in SRAM



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**

Applying Silicon Biometrics to Counterfeit Detection

Research Process – Investigate Biometric Characteristics

A. Pin Impedance

B. Delay

C. Parasitic Characteristics

D. Looking for More

Applying Silicon Biometrics to Counterfeit Detection

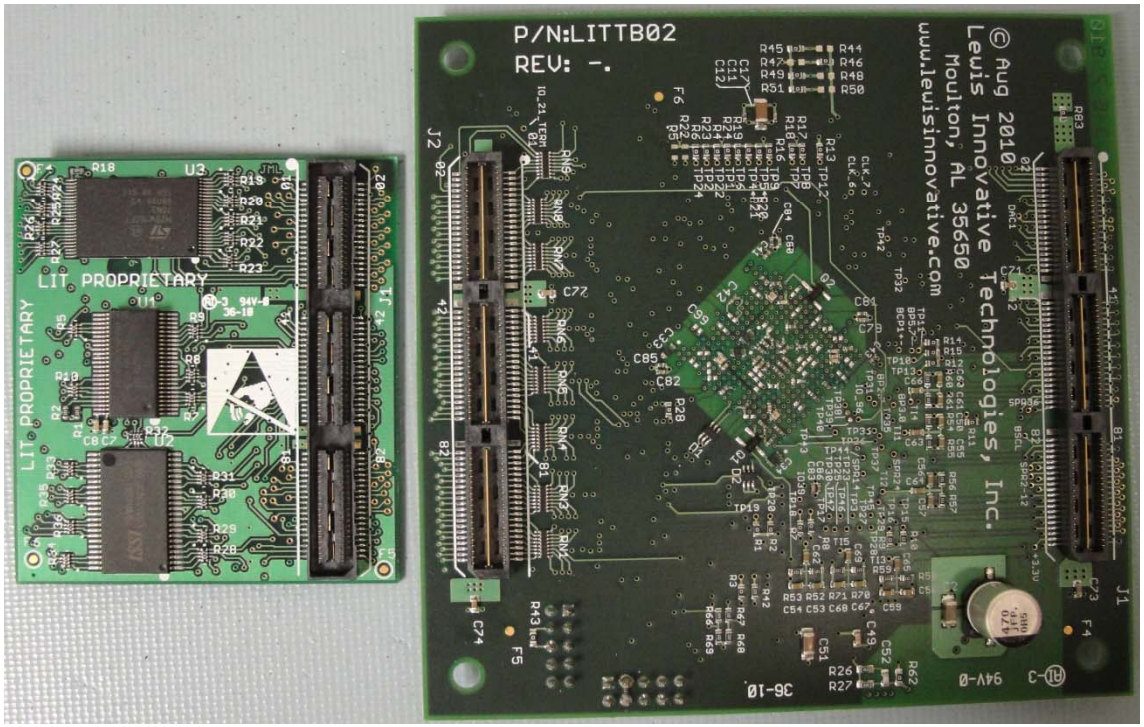
Research Process – Develop Tests

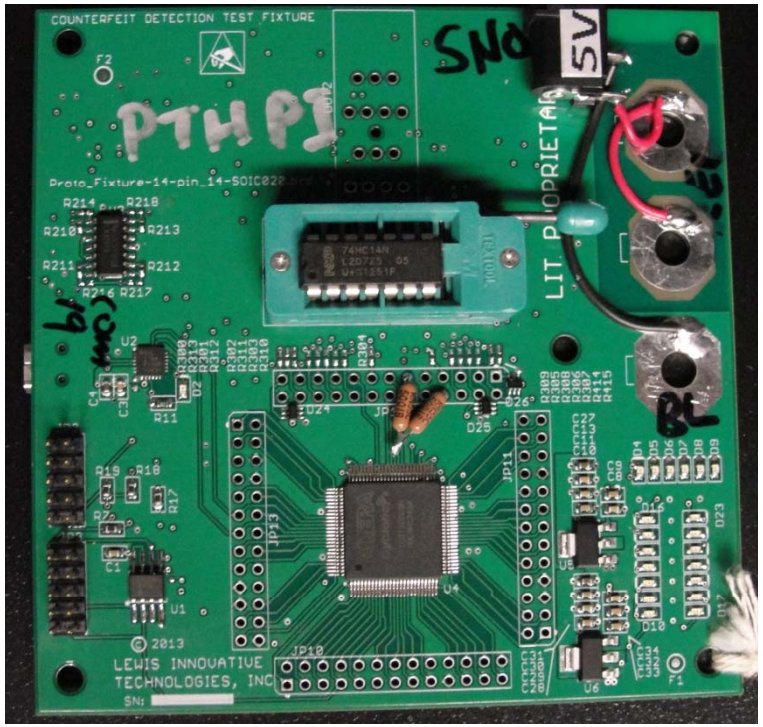
1. **FPGA – Self Testing Capabilities**
   - Asymmetric Unclonable Functions
2. **Low Cost Test Fixtures**
   - A. Delay Tests
   - B. Impedance Tests
   - C. Parasitic

Counterfeit Detection

Applying Silicon Biometrics to Counterfeit Detection

Low Cost Test Fixtures Examples





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

Counterfeit Detection

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

Counterfeit Detection

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

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**

Counterfeit Detection

Current State of Research

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**

Counterfeit Detection

Current State of Research

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**

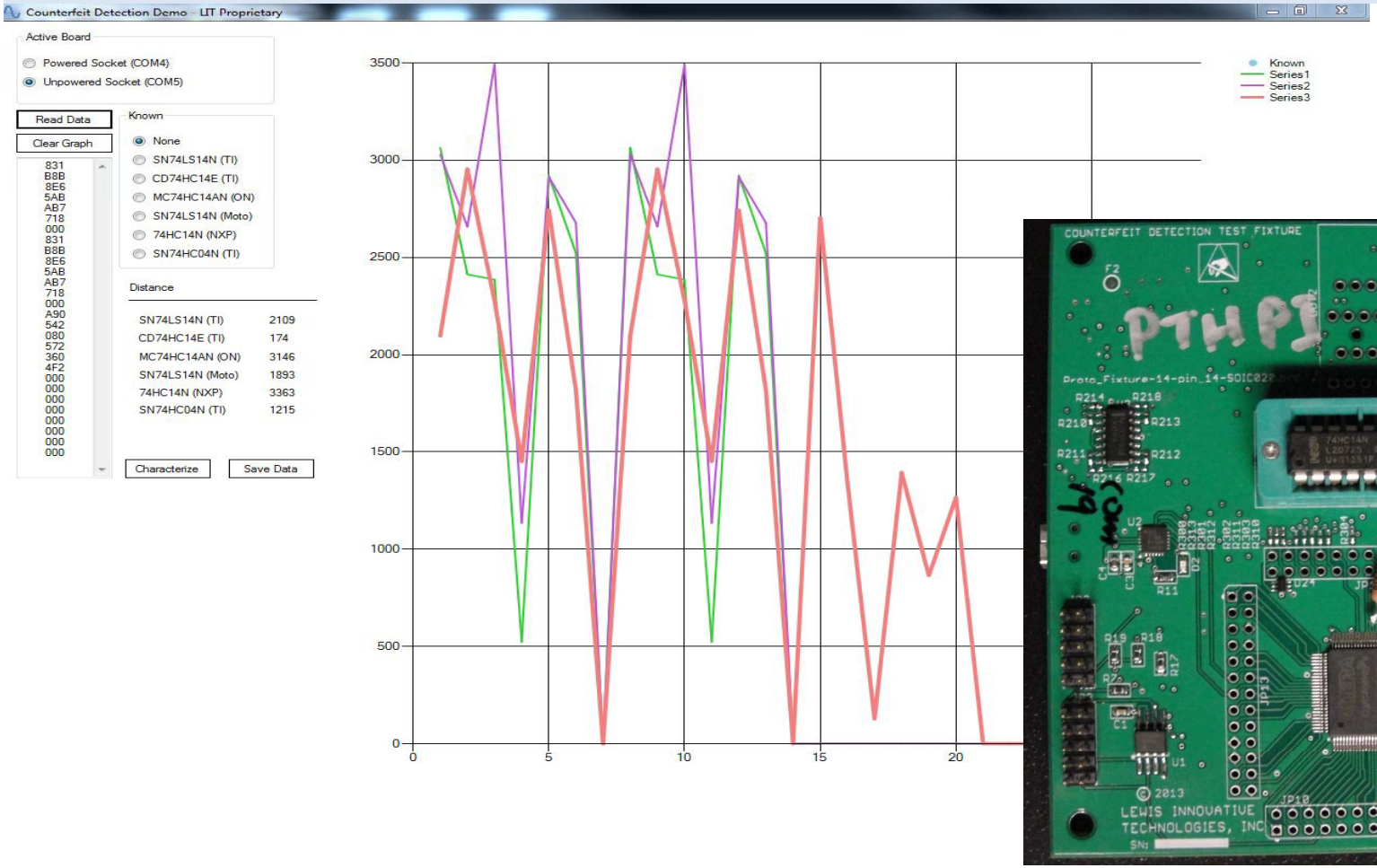
LIT Counterfeit Detection

Moving Forward 

1. **Looking for Partners**
2. **Looking for Target Components**
3. **Test Fixture Development**
4. **Component Testing**

LIT Counterfeit Detection

Demo



LIT Counterfeit Detection

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