Best Detection Methods for Counterfeit Components

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Mark Marshall
Vice President of Engineering
Integra Technologies LLC
3450 N Rock Road Building 100
Wichita, Kansas 67226

Ph 316-630-6812
Email: Mark.Marshall@Integra-tech.com
Web: www.integra-tech.com

Presentation Links

• Business Week – Dangerous Fakes
  http://www.businessweek.com/magazine/content/08_41/b4103034193886.htm

• Tom Sharpe of SMT – Visit to China
  http://www.slideshare.net/cyanarella/Linkedin-Defense-and-Aerospace-procurement
Key Industry Specifications

- **AS5553**
  - Industry Standard on dealing with the risk of counterfeit devices
  - Additional Standards in process
  - For Buyers AS5553 (released)
  - For Distributers AS6081 (Near release)
  - For Laboratories AS6171 (In development)
    http://standards.sae.org/as5553/

- **IDEA-1010**
  - Methods to detect counterfeit devices
  - Great color photos and guidance
  - In a major update (announcement in April)
    http://www.idofea.org/products

- **CCAP-101**
  - Procedure / program to inspect and test for counterfeit parts

Outline

- Overview of Counterfeiting
- Methods of Counterfeit Detection and Costs
- Integra Experience
- Counterfeit Testing Plan
- Counterfeit Testing of Counterfeit Parts
- Summary
Where Who and Why

- **Generation of the counterfeit**
  - Estimates are 80 to 90% is “Made in China.”
  - China has minimal IP protection
  - Other reported sources: Russia, Malaysia, India, and Latin America and even USA
  - Counterfeit products typically circulate in Asia then move into the U.S. and Europe
  - Possibly 10-20% of the non-franchised broker material is counterfeit
  - Counterfeits from China and elsewhere are increasing

- **Recycling of E-waste**

- **Manufacturing in China**
  - As manufacturing moves to China so does the components supply
  - Chinese government wants China to use Chinese suppliers

- **Creation of Suppliers in China**
  - China is rapidly building up its semiconductor infrastructure
  - Near state-of-the-art semiconductor fabs and assembly plants
  - Transplanted companies: Japanese, Taiwanese, Korean and U.S.
  - Flood of experienced engineers and managers
  - Improved capacity to produce complex counterfeits of greater value
  - Counterfeiter’s abilities will continue to improve
  - Detection has never been more important in the electronics industry
  - Other developing economies (technology transfer for low cost production)

- **Counterfeits are expected to increase**
  - Problem will continue growing as long as it’s profitable
  - Distributors & retailers often sell counterfeit goods unknowingly
  - Forged parts stopped often continue to persist in the supply chain for years

Not so Easy Ways to Avoid Counterfeit Parts

- **Purchasing don’t buy from Brokers**
  - Just can’t be done with the fast changing market needs

- **Redesign when products go obsolete**
  - Too much cost for legacy products
  - Device lifecycles to fast

- **Trust your Brokers to test and evaluate devices**
  - Brokers don’t understand test
  - Focus on the lowest cost!

- **OEMs take control of your device purchases**
  - Reintroduce strong incoming quality assurance on all parts
  - Need to do some testing and physical inspection
  - Implement a process for analysis devices of questionable origin
    - More on this later
Non-Functional Counterfeits

- Marking Quality can be excellent even better than the original
  - Generally done with ink mark
  - Can use the same ink as the manufacturer
  - Include: logos date codes and lot codes
    Vendor part marking information available on the WEB
- What’s inside
  - Derived from scrap parts or be made from scratch
  - Wrong DIE
    Counterfeiter finds the package
    Removes the marking
    Re-marks to the device in demand
  - No DIE inside
    Counterfeiter acquires blank packages from an assembler
    Marks to the desired device
- Removing the Marking
  - Blacktopping is too easy to spot
  - Laser marking is very shallow (shave, sand or polish off a layer)
  - Chemically wash off or etch the ink
- Re-Marking
  - Simulated laser mark is impact-printed with laser colored epoxy ink
  - Some have true laser marking
  - Ink mark can be easily duplicated (many manufacturers use ink on some of their products)
- These parts are usually easily duplicated

Functional Counterfeits

- Up-Marking
  - Processor or memory speed markings are stepped up to add premium value
  - Similar function changed to high spec parts (standard op-Amp to high performance)
  - Transform standard parts to more valuable industrial, military or space rated parts
  - These parts function correctly but may fail at temperature extremes
  - Testing may be the only way to know
- Date Code update
  - Old parts remarked with a current date codes
- Lead-free remarking
  - Pb-free parts marked as the Pb types
- Knock-off Parts
  - True counterfeit devices
  - Functional and carry the labels of well-known component manufacturers
  - "Third rate makers" built product and label with a reputable manufacturer
  - Some devices can't possibly work at the rated power levels
  - Parts are flawed and may fail immediately or in the field
  - Can be functional, but will have quality and reliability issues
- Failed Real Parts
  - Parts are already marked by the manufacturer
  - Parts that failed manufacturer testing, were rejected and scrapped
  - Retrived from dumpster, smuggled by employees, etc
  - Destruction of rejects in ASIA test houses is hard to guarantee
  - Show up on market may be sold as new
  - Often high percentages of failed parts may appear to work in applications
  - Leakage failures, elevated power supply currents, speed failures, single bit/gate failures, etc
  - Difficult to detect without full testing and pose a major quality and reliability risk
- Salvaged Parts
  - These are the most dangerous type of counterfeits since they may escape detection even in the system
## Detection Methods

### Visual Inspection

- **Good low cost way to find blatant counterfeits**
- **Should always be performed on questionable purchases**

**Typical Cost:** $250

**External Visual**
- 100% count & external visual
- Low power magnification
- Compare to known good device (if possible)
- Check the paperwork and labels on containers
- Check all marking to be consistent with manufacturers' specifications, including logos
- Look for obvious re-marking, scratches, sanding, incorrect part number, etc
- Counterfeiter marking removal process often makes edges and corners rounded and a matte surface
- Look at leads for solder build up, bent leads, etc

**Sample Tests**
- If devices in TnR, select sample from beginning & middle of reel
- 40x External Visual
  - Look for more subtle re-marking, scratches, sanding, crude lettering, etc
  - Laser mark may really be ink
- Physical Dimensions
  - Measure pkg body dimensions against pkg spec
  - Weigh the parts, measure dimensions them with a caliper
- Resistance to Solvents
  - Acetone test or mil spec marking permanency
External Visual (Example)

- SOT in tape & reel
- Crude inconsistent laser mark
  - See burn holes on marking
  - Alignment on package varied
- Obvious signs of sanding
  - Non flat surface
- Part failed
  - Visual inspect
  - Solderability test
  - Package thickness test
- Part passed DC transistor test

FLASH Memory

- All parts are laser marked with the same date code and manufacturer on the topside
- Multiple sources on the backside
Tape and Reel (Example)

- Few genuine parts hidden on the ends of reel

Tape and Reel (Example)

- Parts look reasonably good on tape side of reel

Fake Parts  Good Parts
Tape and Reel (Example)

- Parts are obvious counterfeit on pocket side of reel

**Internal Visual Detection Methods**

- **Industry Terms**
  - DPA (Destructive Physical Analysis)
  - De-Lid / De-Cap (De-capsulation)
  - Mil Std 883 Method 2010 (Internal Visual) (Typically is not a complete to spec DPA)

- **Typical Counterfeit Analysis Method**
  - Remove or Open Lid for Cavity Type packages
  - Use of Acid to expose die on Plastic type device (Equipment available to Aid in the process)
  - Basic Visual inspection using an optical Microscope
    - Look for gross manufacturing defects
    - Identify Die Manufacturer and part number
    - Typically not performed (cross section, Bond Pull, SEM analysis, workmanship analysis)
  - Compare the exposed die to the die indicated by device
  - Contact the manufacturer to help in the identification

- **Issues**
  - Destructive Test (only perform on a small sample of devices)
  - Known good die information often not available
  - Manufacturer may not include a part number or even a manufacturer identifier
  - Device part numbers may be in a different form on the die
  - Die design date typically much different than the device date code
  - Often die manufacturer is out of existence (die designs change hands)
  - Die identifiers are not often not changed when manufacturers change names
  - Reasonable cost to find blatant counterfeits and some quality concerns.

- **Advantage: Fast Affordable Authenticity Evaluation**
Internal Visual Detection Methods
BASIC DPA

- Reasonable cost to find blatant counterfeits and some quality concerns.
- Should be considered on questionable purchases
- Parts are destroyed in the sample evaluation
- Can inspect each date code or part variance

- Typical Cost: $150-200

- Extended tests (Quality Assessment not typically performed)
  - Die workmanship inspection
  - Glassification Integrity Testing
  - Cross-section
  - Bond pull

- Other non-destructive options
  - XRAY (see if samples match internally or even have DIE)
  - CSAM (check for plastic package integrity issues)

Some Detection Examples of Counterfeits Seen by Integra

- Intel Logo inside an AMD Package
  - Fake! ... Real! ... NO Fake!

- Identified as a Fake by parametric testing
Board Removals (Elevated Risk)

- Removal process can be very damaging
  - Poor Controls in China
  - Extreme heating of device
  - May induce failures
  - Increased long term reliability risk
  - Lead condition (solderability)
  - Chemical contamination
- Failure Modes
  - Delamination “popcorn effect”
- Reliability concerns

XRF Analysis

- Part was claimed to be Pb Free
  - Analyses clearly shows presence of Pb
- Counterfeit can be both ways
  - Pb free
  - Pb product

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<tr>
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<tr>
<td>Pb</td>
<td>12.08</td>
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<tr>
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<td>2.30</td>
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<tr>
<td>Sn</td>
<td>24.22</td>
<td>4.23</td>
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**Broker Directed Electrical Test**

- Typical Test Request from a Broker: (Often confusing & No spec’s provided)
  - Group A Test
  - Pin Verification Test
  - Functional Test
  - Datasheet Test

- Unclear direction (Parameters & methodology are not defined)
  - Group A = Electrical Test (Subgroup? Temp?)
  - Pin Verification Test = Check to see if the pins are connected
  - Functional Test = Provides some definition but unclear parameters
  - Datasheet Test = Open for interpretation to the parameters tested

- Labs typically have various interpretations of the tests to be performed
  - One lab may quote – minimal testing
  - Another lab may quote - comprehensive as speed testing

- Typical decision process is to go with the lowest price
  - Minimal consideration for test quality
  - Drives test labs to go for less and less test coverage

- Result is a minimally tested component
- Warning not all test labs will be upfront with the test coverage provided.
- Who and how you choose to test is important!

**Take Control of the Test Lab Selection**

- Most Brokers and Distributors will only consider cost in the selection
- Direct the Lab selection
  - Identify, qualify and select test and evaluation labs
- Define the process
  - Develop a risk mitigation process document
  - Define the Testing Flow
    - Test Temps (25C only or Temps: 85C, -55 …)
    - Sample sizes
    - Environmental Stresses (burn-in, temp-cycle …)
    - Special Tests (de-cap, marking, solderability …)
  - Identify the parameters to test if possible
    - Write a testing spec ... or
    - Circle or mark the critical parameters on the Manufacturer’s datasheet
  - Define the Type of test coverage
    - Basic DC Validation
    - Minimal Functional Testing
    - Parametric Testing
- Get Feedback from your test lab
  - Request Tester used
  - Listing of the Parameters Tested
  - Datalogs (after test is complete)
  - Have a conference call with the lab
    - To clarify the requirements
Three Levels of Electrical Test

- **Basic DC Validation**  
  (Most often provided, the lowest cost)  
  - Minimal Test

- **Basic Functional Test**  
  - Little more test

- **Functional Test to Specification with Parametric Testing**  
  (What is desired)  
  - Comprehensive Test

Detection Methods

**Minimum Cost Sample Test**

- **Basic DC test**  
  - Normally a sample test of 5 to 10 units from lot  
  - Sample should be pulled from beginning, middle and end of reels  
  - Test is developed from a datasheet  
  - A know good device would be helpful but not required  
  - Typical costs sample test of 5 units: $150 to $800.

- **IC Device**  
  - DC test of all pins  
  - Check Continuity and Shorts on all pins  
  - Make sure input/outputs and power/ground pins are in the right places  
  - Check leakage currents on input and output pins  
  - Linear pins check basic pin characteristics  
  - Static power supply current measurement is also possible  
  - Does not typically include a functional test  
  - Will find wrong die and some electrically failing parts

- **Transistor and Diodes**  
  - Test Basic DC device parametric values

- **Capacitors and Resistors**  
  - Measure component value
Detection Methods
Basic Functional ATE Test

• Basic Electrical test
  – Production test of the entire lot
  – Add NRE costs if fixtures are not available

• Simple Device
  – Functionally test the device
  – Limited parameter measurements are performed
  – Tested at 25C

• Complex Device
  – Power up the device
  – Validate some limited DC measurements
    • Minimal functional test
  – Tested at 25C

• Will find wrong die and empty parts
  – As well as non-functional parts

• Typical costs: NRE $1-2K and $1/unit @25C
  – Cost dependent on unit volume and complexity

Some Detection Examples of Counterfeits Seen by Integra

• Linear Tech Mil-Std OpAmp in metal can
  – High performance OpAmp
  – Broker requested testing before completing sale transaction
  – One week turnaround time
  – Very high cost obsolete device
  – High quality Ink Mark on can, no scratches
  – Testing showed device was a functional OpAmp
  – DC OpAmp parameters passed
  – AC OpAmp parameters failed at 25C
    • Device failed slew rate testing by 10x
  – 100 % failure rate
  – Parts were likely Linear Tech OpAmps remarked to a higher grade
  – Only a comprehensive test including AC’s could identify the fakes
Detection Methods
Full Specification Test

• Test the device as it is used
  – Functional at-speed
  – Comprehensive functional testing
  – All reasonably possible patterns with memories
  – AC go-no-go of key parameters
  – Selected AC characterization measurements
  – DC measurements to the full specified limits and accuracies
  – Test all pins even with high pin count devices

• Match the right tester to each device
  – Tester should match the testing needs of the device
  – Use specialized engineers with test expertise in each technology commodity
    (Digital, RF, Mixed-signal, Analog, Memory, Discrete)
  – Tester optimized to the needs of each device technology

• Testing will be similar to the original manufacturers test

• Full testing will find most types of counterfeit devices

• Add extended temp testing to assure operation over the operating range
  – Existing test software will have minimal NRE costs
  – Typical costs (simple): NRE $3K-$5K @ hot/cold $2-$5 each device
  – Typical costs (complex) NRE $5K-$20K+ @ hot/cold $3-$10 each device

Some Detection Examples of Counterfeits Seen by Integra

• Xilinx FPGA device
  – Obsolete device in a PQFP package
  – Parts were purchased from a broker
  – Customer requested a functional test 25C
  – Parts passed basic continuity and shorts testing
  – Parts would not program and all failed
  – Real Xilinx parts that had been previously electrically damaged
  – Only a full functional test could identify the junk parts
Some Detection Examples of Counterfeits Seen by Integra

• Cypress complex digital device
  – Expensive obsolete device
  – Purchased from a broker
  – Ceramic Mil Temp range part
  – Many parts passed functionally at room
  – Only 3 out of 200 passed testing at 125C temp
  – Were original Cypress parts but failures
  – 3 passing parts were probably marginal or contact related failures
  – Only a full extended temp test could find these failed devices

Substitution of Same Functionality of Device

• Visual Inspection (no clear issues)
• Marking testing passed
• Die inspection found the correct generic but wrong manufacturer
  – Catalyst acquired by On Semi
• Testing Results
  – All units passed functionally
  – Only failure was one parameter
  – Slower TWC (write cycle) then the Atmel data sheet
Substitution of Same Older Generation of Device

- Visual Inspection (no clear issues)
- Marking testing passed
- Die inspection found the correct generic and manufacturer
  - However die architecture was wrong
- Testing Results
  - Units passed functionally
  - Only failure power supply current differences
  - Die were older generation of the correct device

Substitution of very similar DIE

Very Close Substitution
- Similar function
- Same 8 bit and A/D
- Same Manufacturer
- Slight pinout variation
False Detections

- Vendor’s easy answer is to say the marking does not look exactly right.
  - Several times we have been fairly certain that the vendor is wrong and the parts are legitimate
  - Parts are often old and factory practices have changed.
  - Vendors often don’t have records or knowledge of how processing was done
  - National Response: “does not match National’s date code format for mil products”

<table>
<thead>
<tr>
<th>Correct Die</th>
<th>Rejected but is Valid Part</th>
<th>Real Counterfeit Same Device Type</th>
</tr>
</thead>
</table>

Ghost Marking OK – Aeroflex Remarking

Ghost markings
IDT logo and part number
IDT Manufacturer
Parts Clearly Remarked – However Most units Pass

- Marking Permanency Passed
- Correct Cypress Die
- Clear Indication of Blacktopping
- >50% Units Passing Electrical Testing
- Fails were typically Dead Parts

- Likely Board pulls
- Parts Damage
  - Handling
  - Storage
  - Board Removal
- Recommended scrap all parts
- Passing Parts were used

New Blacktop Materials

- Resistant to marking permanency and acetone
- Similar appearance to plastic
- Material composition similar
  - Likely resin mixed with shavings from sanding
- Detection Methods
  - Careful visual inspection for defects in the top coat
  - Honeywell developed technique
    - High temp dangerous chemical soak process
  - Scratching or scribing also effective
  - CSAM can typically see the overcoat
  - Material analysis can identify small chemical differences
Only Failed Dynasolve Black Top Test

Results:
Visual (some concerns)
Marking Permanency (pass)
Acetone Test (pass)
Mixed Die (OK per OCM)
Mixed Assembly sites (OK per OCM)
Same Date Code (OK per OCM)
Laser Mark (OK per OCM)
Electrical Test (pass)

Dynasolve (**FAIL**)  
Counterfeit Parts!

Passives

- Capacitors and Resistors are one of the most easily counterfeited device types
- A lower cost part with the same value can be substituted
- Markings not available, colors and mechanical dimensions not enough
- Test to rated currents and voltage levels
- Room temp test is not good enough
  - Must test over temp range for tolerance validation
- Burn-in or Qualification may be necessary to prove robust
  - High temp, max voltage burn-in (check for weak parts)
Case Study of a Counterfeit Manufacturer

- USA Company: MVP Micro
- Mass production of Counterfeit parts
- Recovery of die from packages
- Recovered die used in new packaging
- Revenue of just one part type $2 million/month
- Raid by Navy Counter Intelligence Services Oct 6, 2009
- Convictions and Jail time for owners
- Whistle Blower - Charles Irvin (turned them in)
- Charles Irvin now an employee of AERI
- Thanks to AERI for this presentation information.

Manufacturing a Counterfeit Device

- Acid decapsulation of plastic package
- Tweezers “plunk” removal of the bond wires
- Heating of package to loosen die from the leadframe
- Sanding of back side of the die
- Die sent to assembly house in China for new packaging
- Photos from
Stacked Bonding at Assembly

The new wire bond is placed on top of the old ball providing a signature showing what has transpired.

A bond on the original bond.

Photos courtesy Giga Connections & CTI/CCA

Problems

- Difficult to detect
  - Parts look new and have the correct die
  - Electrically would typically pass
    - Temperature Screening needed
    - May be out of spec
    - Burn-in and life test recommended
    - May have high fallout in testing
  - Double bond wire looks OK from top view

- Expect a low life expectancy
  - Reliability problems
  - Damage during the die recovery process
  - Bond pad degradation
  - Possible heating issues due to package integrity
  - High rate of Field failures

- Over 400K units still in the supply chain

- Are their copy cats in China??

Finished Product

Photos courtesy of ERIA
Labs failure to Detect Counterfeits

Seen by Integra

• Analog Devices digital video encoder
  – 44 pin TQFP
  – Customer had application failures after testing
  – Test lab used was selected strictly on price and not evaluated
  – Test lab results showed parts were good but failed in the application
  – Evaluation of the lab test information showed minimal if any testing was really performed
  – Integra assisted in the evaluation of the labs testing
  – Devices were likely counterfeits but not detected by the questionable lab
  – If the price of testing seems “too good to be true” it probably is.

Questionable Testing of Counterfeit Parts

• Some Test Labs are not performing the needed testing

• Problems are with broker/distributor directed component screening
  – Conflict of interest with provider responsible for test
  – Nonexistent lab oversight
    • No Audits/Reviews/Checks
  – Total focus on price
    • No consideration for test coverage or quality of test
  – Unreasonable expectations for testing costs
    • Typically looking for NRE and testing at $500 or less
  – Signs of questionable testing practices
    • Ridiculous test pricing
    • Turn-times beyond possible run-rates
    • Drastic price differences from reputable test labs
    • No documentation of testing coverage or test equipment

  – How do you ensure proper testing being performed?
Assurance of Test Quality

Basic steps that can help assure the quality of your test

- Take control of selecting your test lab
  - Ask for detailed quotes listing parameters tested
- Request a specification summary for the targeted tester
  - Does the tester have enough pins?
  - Does it have accurate enough DC and AC resources?
  - Can the tester run at the required device frequency?
- For linear and less complex devices request a full test datalog
  - The datalog should show all the DC test limits and measurements
  - Functional tests generally are not listed
  - Ask for an open-socket datalog since this will show that tests fail when no device is present
- For higher complexity devices
  - Ask for a test key that gives the details of the functional test
  - Request a list of device instructions executed in a program
- Visit your lab and perform a sample review of actual test programs
  - Run the program on the tester and have an engineer show how the tester and program operate
- Once you have confidence in your lab cut back the level of review

Recommended Test Methodology

- Test the device as it is used
  - Functional at-speed
    - Application speed not max spec
    - Test frequency is a major tester cost driver
  - Comprehensive functional testing
    - Test all device functionality
    - Fault grading is not possible since only the manufacturer has device modeling capability
  - Test key AC parameters
    - Key parameters are usually referenced to device clocks
      - Propagation delay
      - Setup and hold times
    - Extra parameters are often listed for designer reference
    - Use go-no-go testing to cover most AC parameters
      - Tested over the entire functional pattern
    - Selected AC characterization measurements can be made
  - DC measurements to the full specified limits
    - Attempt to test 25C parameters at extended temperatures
    - Limit adjustments may be required after testing
  - Select the appropriate tester
    - No one tester can effectively test all technologies
Developing a Plan Analysis Strategy

- **Define - when to implement**
  - Types of components and applications
  - Broker purchases
  - Parts without proper paperwork
  - Parts sourced from Asia or China

- **Determine your application risk tolerance**
  - Basic to high confidence of device genuineness
  - Higher confidence adds costs and time

- **Internal vs External (Equipment – Labor – Costs)**
  - Implementation expenses
  - Staffing for quick turn analysis
  - Identify, qualify and manage your labs

- **Develop and document a procedure**
  - Agreement between organizations
    - Purchasing – Engineering – Manufacturing
  - Force compliance to procedural methods

Evaluation Methodology – Questionable Origin Suggested Process

- **Basic Evaluation**
  - **All Units**
    - Part Count
    - Date code verification
    - External Visual
  - **Sample Qty**
    - 40x External Visual
    - Physical Dimensions
    - Marking Permanency
    - Solderability
    - Internal Visual (Destructive)
    - Minimum DC Sample Test
    - XRAY
    - CSAM

- **Electrical Testing Evaluation**
  - Minimum DC Sample Test
  - Basic Functional test screen
  - Full Spec Test Screen
    - Hot / Cold
  - Spec Test & Burn-In
  - Qualification Tests
Low Volume (<1,000 units)
Costs & Lead times

Detection Methods

<table>
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<tr>
<th></th>
<th>Count &amp; External Visual</th>
<th>10x - 40x External Visual</th>
<th>Resistance to Solvents</th>
<th>Internal Visual</th>
<th>Basic DC Sample Test</th>
<th>Solderability w/o Steamage</th>
<th>Physical Dimension</th>
<th>Date Code Count</th>
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<tr>
<td>Typical Cost</td>
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<td>$100</td>
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<td>$150-350</td>
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<td>+0-1 day</td>
<td>+0-1 day</td>
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Typical Costs

- **Minimal Functional Test**
  - Simple devices: $1k - 2.5k NRE + $1 each unit
  - Complex devices: $3k - 5k NRE + $2 each unit
  - Additional NRE costs will apply if test fixtures are not already in place
- **Full Functional Test at Temperature**
  - Simple devices: $2K - $5K NRE + $5 each unit
  - Complex devices: $5k - $20k NRE + 7.50 each unit
  - If test software is already in place, NRE costs will be reduced dramatically
- **Burn In**
  - $2k - $5k NRE + $2 each unit
- **Qualification**
  - $10k - $30k depending on types of stresses requested
Test Cost Drivers

- **Software Development NRE**
  - Complexity of device → Costs
  - Engineering rates
    - $100/hr to $200/hr
  - Tester charges
    - $50/hr to $300/hr
  - Loadboard & socket NRE
    - $300 to $10,000

- **Production Test**
  - Volume
    - >1000pc lots (automated handling)
  - Data Collection
    - Adder for data more for serialization
  - Test flow
    - Hot & Cold tests are more costly

Summary - Counterfeit Testing

- Inspection the first best way of detection
- Electrical Test: key element in counterfeit detection
- Many testing choices/options are available
  - Define what testing is needed
  - Ask for a list of parameters are tested
  - Evaluate the risks & costs with testing options
- Develop a plan to manage the risks
- Take control of your lab selection
Integra Test Engineering
Summary

- Test Facilities in Kansas and California
  - 41k sq ft (KS), 3k sq ft (CA)
- 27 Year History as a Testing Lab
- 24 Hours/Day x 7 Days/Week Operations
- 180 Employees, 26 Test Engineers & 38 Testers
- Broad tester and test technology capabilities
  - Memory, Digital, Linear, Mixed Signal, RF, FPGA
- Engineering expertise in every technology
  - Greater than 10,000 test programs developed locally
- >200 Active Customers Mil/Space & Semi-manufacturer
- Operations are ISO-9001, AS9100, ITAR, DSCC and Trusted
- On-Time Delivery Performance of 96%
- Customer Satisfaction Rating of 98%