Counterfeit Prevention & Detection Strategies: Cost versus Risk Assessment

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DfR Solutions; June 9th, 2010
The State of Counterfeits

- Increasing concern across industries
- Department of Commerce measured 141% increase over past three years
- Recent DfR activities
  - Military Communications
  - Internet Routers
  - Air Traffic Control
  - Consumer
EIA/G-12 Committee Strategy

- TB-0003-2009 Counterfeit Parts & Materials Risk Mitigation: Prevention, Detection and Mitigation

Immigration and Customs Enforcement (ICE) Top Commodities Seized 2004 – 2006

<table>
<thead>
<tr>
<th>Commodity</th>
<th>M $</th>
<th>Commodity</th>
<th>M $</th>
<th>Commodity</th>
<th>M $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wearing Apparel</td>
<td>$61.7</td>
<td>Wearing Apparel</td>
<td>$16.0</td>
<td>Footwear</td>
<td>$34.7</td>
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<tr>
<td>Cigarettes</td>
<td>$24.2</td>
<td>Handbags/Wallets/Backpacks</td>
<td>$14.9</td>
<td>Handbags/Wallets/Backpacks</td>
<td>$14.7</td>
</tr>
<tr>
<td>Handbags/Wallets/Backpacks</td>
<td>$23.2</td>
<td>Cigarettes</td>
<td>$9.6</td>
<td>Computers/Hardware</td>
<td>$14.2</td>
</tr>
<tr>
<td>Consumer Electronics</td>
<td>$8.8</td>
<td>Footwear</td>
<td>$8.9</td>
<td>Consumer Electronics</td>
<td>$7.0</td>
</tr>
<tr>
<td>Media</td>
<td>$6.0</td>
<td>Consumer Electronics</td>
<td>$8.7</td>
<td>Footwear</td>
<td>$7.0</td>
</tr>
<tr>
<td>Toys/Electronic games</td>
<td>$3.9</td>
<td>Toys/Electronic games</td>
<td>$8.5</td>
<td>Computers/Hardware</td>
<td>$7.0</td>
</tr>
<tr>
<td>Watches/Parts</td>
<td>$2.5</td>
<td>Computers/Hardware</td>
<td>$4.7</td>
<td>Medical Supplies</td>
<td>$6.9</td>
</tr>
<tr>
<td>Batteries</td>
<td>$2.3</td>
<td>Watches/Parts</td>
<td>$3.0</td>
<td>Medical Supplies</td>
<td>$6.9</td>
</tr>
<tr>
<td>Footwear</td>
<td>$2.0</td>
<td>Perfumes</td>
<td>$2.7</td>
<td>Medical Supplies</td>
<td>$6.9</td>
</tr>
<tr>
<td>Computers/Hardware</td>
<td>$1.5</td>
<td>Pharmaceuticals</td>
<td>$2.0</td>
<td>Medical Supplies</td>
<td>$6.9</td>
</tr>
<tr>
<td>All Other Commodities</td>
<td>$13.2</td>
<td>All Other Commodities</td>
<td>$13.5</td>
<td>All Other Commodities</td>
<td>$13.0</td>
</tr>
</tbody>
</table>

Total FY 04 Domestic Value $138 Total FY 05 Domestic Value $92.5 Total FY 06 Domestic Value $154.7
Prevention

- EIA/G-12 Recommendation
  - “…only procure from the Original Component Manufacturer (OCM) that makes and warranties the part or material or their designated franchisees.”

- Procuring from OCM’s
  - Unrealistic for Military / Government programs
  - Volumes too low

- Procuring from designated franchisees
  - Component availability from designated franchisees is often similar to that of OCM
Designated Franchisees

Military / Government contractors standardizing sourcing plans

- Lists of approved sources (Authorized Source Directory)
- Other sources by exception and with specific approvals

- Approval process
  - Audit based on quality system
  - Risk assessment to the program
  - Development of an inspection / test plan

Use of Authorized Franchisees does not eliminate risk
Complex Supply Chains

- Multiple points of entry
- Porous return policies

NEDAs targets counterfeit components with return guidelines

NEDA has released its guidelines on returns, aiming to reduce the number of counterfeit electronic parts entering the electronics supply chain.

By Suzanne Daffron, Managing Editor, News -- EDN, 2/4/2010

The NEDA (National Electronic Distributors Association) has released its guidelines on product returns, aiming to provide a clear-cut process to ensure the legitimacy of products customers purchase through an authorized distribution channel. According to NEDA, the primary entry of counterfeit electronic parts into the electronics supply chain is purchasing from unauthorized sources, such as brokers and unauthorized distributors. The group's goal is to strengthen the integrity of the electronics supply chain when customers purchase through authorized distribution.
Decision Process

- If prevention is not realistic, when to detect? How to mitigate?
- Entry for counterfeit components is cost
  - Cost to procure < cost of redesign (+ requal)
  - If cost to mitigate is too high, then simply redesign
- How to determine the appropriate cost to detect and mitigate?
  - Driven by probability of counterfeit / mission risk / volume matrix
Decision Matrix

Mission Risk

- Lives lost or Millions of Dollars
- Original Manufacturer
- Tens of Thousands of Parts
- Volume of Purchase
- Tens of parts
- Unknown Broker Probability of Counterfeit
- Separation from Manufacturer
- Little or no Impact
Counterfeit Probability

- Probability of counterfeit (per shipment) tends to display order of magnitude dependence on component source

  - May vary based on supply chain and component

<table>
<thead>
<tr>
<th>Source of Components</th>
<th>Probability of Counterfeit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component Manufacturer</td>
<td>0.02%</td>
</tr>
<tr>
<td>Licensed Distributor</td>
<td>0.2%</td>
</tr>
<tr>
<td>Broker (Known)</td>
<td>2.0%</td>
</tr>
<tr>
<td>Broker (Unknown)</td>
<td>20.0%</td>
</tr>
</tbody>
</table>

Known: Existing business relationship
Unknown: No existing business relationship (e.g., eBay)
Case Study

- Telecom OEM procures one reel of capacitors from known broker
  - End-of-life (EOL) product
- Decision Matrix
  
<table>
<thead>
<tr>
<th>Probability is 2%</th>
<th>Volume is 4000 parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Risk is $5M</td>
<td></td>
</tr>
</tbody>
</table>

* Eight capacitors per CCA (500 CCAs)

- DfR recommended that $10K to $100K should be spent on counterfeit detection and mitigation
  - Industry ROI can be 1:1 to 10:1
Detection of Counterfeits

- Counterfeiters are increasingly sophisticated
- Use of actual parts at the start and end of a reel
  - Challenges sampling techniques
- Inspection and comparison of known-good to possible counterfeits
  - Markings
  - Internal structure
  - Performance measurement
Detection Cost vs. Requirements

- Add material check / seal test / radio-graphic or do basic electrical testing
- Add full ambient electrical tests
- Add burn-in
- Add post burn-in full electrical tests over temperature
- Add QCI and other lot acceptance testing
- Add full electrical tests over temperature
- Add DPA
- Add C of C Only Check Alerts
- Add Visual Inspection

Item End-Use Requirements:
- Low cost / repairable / redundant systems
- Moderate cost / repairable-replaceable / non-mission critical
- High cost / non-repairable / mission critical

T. Apple 610-531-5484
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Case Study – Visual Inspection

- Capacitor Group 1, Fluorescent Light - Dark Brown
- Capacitor Group 2, Fluorescent Light - Pink
- Capacitor Group 3, Fluorescent Light - Greenish Gray
- Capacitor Group 4, Fluorescent Light - Bluish Gray
- Capacitor Group 5, Fluorescent Light - Light Brown

- Five different capacitor types in one reel
Case Study – Visual Inspection (2)

- Which is counterfeit?
  - The one with markings? Or the two that seem to have none?
- Two samples are non-functional and one functions
- Customer experienced two failures
- Left: known good part; center and right: bad parts
- Center part: no die; right part: cracked die
Case Study – Visual Inspection (3)

L01, remarked date code, VC36 changed to GC33
Just under top surface

L011, hynix part
date code mismatch
Visual Inspection Cost vs. Benefit

- $1K to $3K
- Identify color differences in parts
- Ascertain marking imperfections/changes/blacktopping
- Lead finish and variability
- Co-planarity of leads – reused parts
Case Study: X-Ray

- Customer has an issue with DC to DC converter failures
- Simulation models did not predict the failures
- X-ray inspection of the failed units

Parallel FETS
Loose Parts

Z536

Z536

Z436, Z536

Z536

EZ609
X-Ray Cost vs Benefit

- $1K to $3K
- Verification of die and wire bonding pattern
- Internal construction of component
  - Size/orientation
  - Interconnection
  - Die attach voiding
Case Study – Electrical

This is not an STS25NH3LL Part, does not meet resistance specifications.

Its higher drain to source resistance will cause its parallel FET partner to carry all the current. This part is present in the failed KT Master module.

FETs with large die have similar resistances and electrical performance, regardless of lead frame style.
Electrical Characterization of Counterfeit Diodes

Breakdown:
- 280V
- 250V

Breakdown:
- 50V
- 420V
Electrical Characterization of Counterfeit Diodes

Acceptable Waveform

Counterfeit Waveform

Recovery measurements
Electrical Characterization Cost vs. Benefit

- $3K to $6K – passives, simple actives
- One temperature for evaluation
- $15K to $80K – characterization of complex IC, fixturing, test equipment
- Potential for circuit board design, layout and fabrication costs to enable testing
Case Study – Mechanical Robustness

- Thermal Cycling Test inducing cracks
  - 35% of counterfeit caps had unacceptable chip-outs (EIA-595 allows for 5 mil depth)

Pictures of chip-outs of counterfeit capacitors (left) and OCM capacitors (right)
Mechanical Robustness—Cost vs. Benefit

- $2K to $5K
- Thermal cycling or other testing to verify component is not counterfeit
DPA - Cost vs. Benefit

- $7 to $10K passives
- $8 to $12K actives
- Step by Step analytical approach to identifying whether a device is counterfeit using all tools available.
Conclusions:

- Counterfeits are a real threat and growing
  - Complex supply chain provides multiple entry points
- Risk needs to be managed through a decision matrix
  - Probability / Mission Risk / Volumes
  - Helps provide clear boundaries and guidelines for mitigation practices
- Costs are not prohibitive and should be chosen as a function of risk mitigation
Thank You!