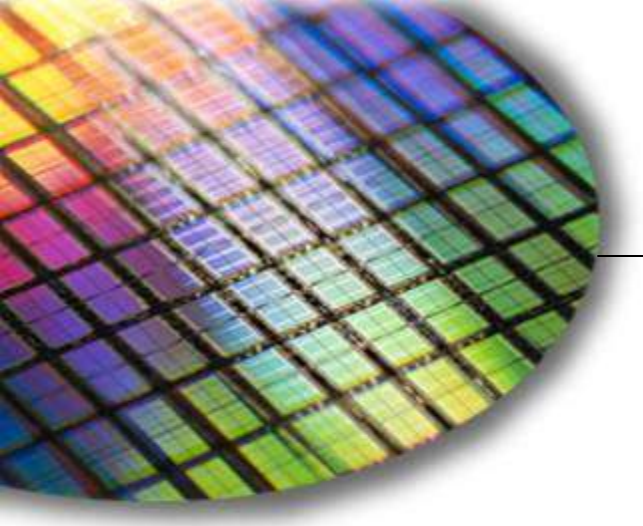

The World Leader in High-Performance Signal Processing Solutions

Counterfeit Microcircuits: The #1 Threat to Electronics Reliability

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Outline

- Categories of Counterfeit ICs
- Increasing Sophistication of Counterfeiters
- Why Counterfeit ICs Have Poor Reliability
- Summary

Categories of Counterfeit ICs

1. **Recycled / Used ICs**
   - Parts pulled from boards; leads straightened/cleaned; original markings removed or “blacktopped”; new markings added
2. **Lower Grade / Inferior “Second-Source” ICs**
   - Parts may be new or used; original markings removed or “blacktopped”; new markings added
   - Parts typically are functional but out-of-spec
3. **New or Used IC Die Assembled in New Packages**
   - Die may be removed from “old” packages and assembled in new packages; extremely difficult to detect these counterfeits!
4. **Useless ICs**
   - Parts are non-functional: no die, bad die, wrong die, wrong package, etc.

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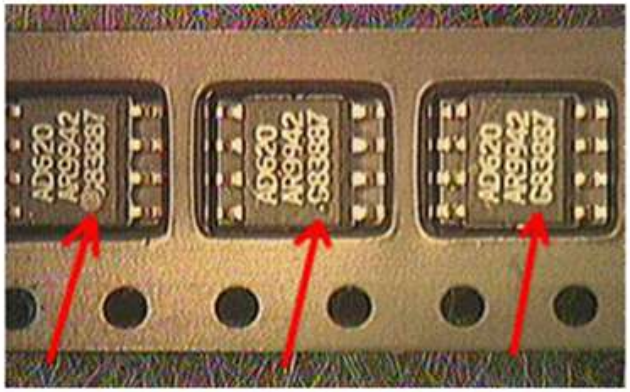
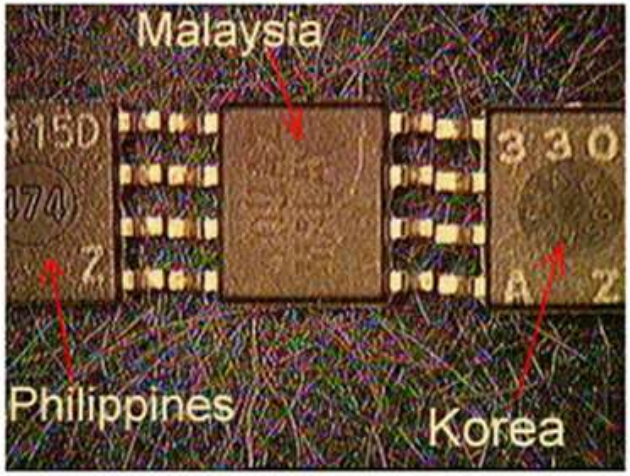
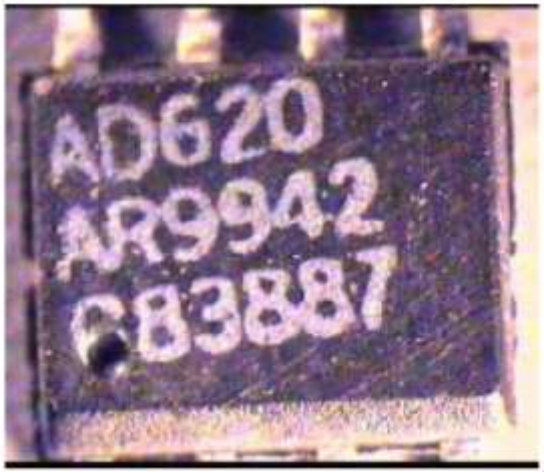
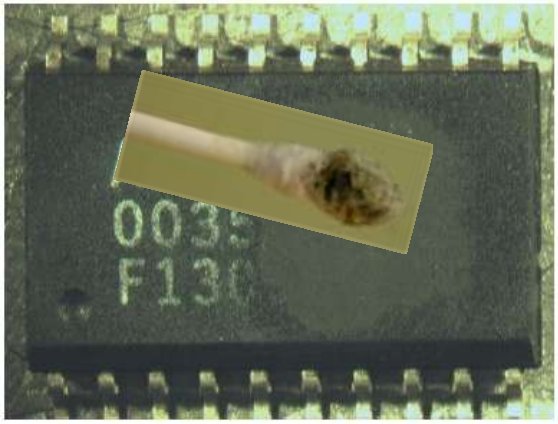
Counterfeits Easy to Detect Years Ago





Counterfeit units with various pin 1 indicators and countries of origin.





Counterfeit units with poor and/or easily removed markings.

Counterfeit units with obvious sanding marks.

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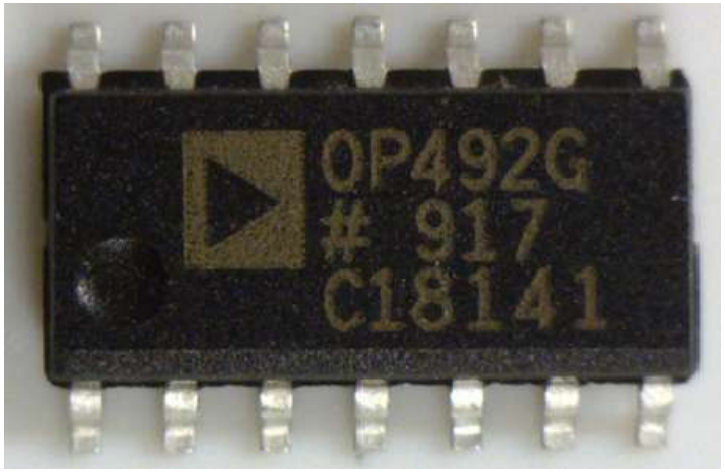
Counterfeits Now Tough to Detect



Excellent top marking quality (both ink and laser markings), but these products are all counterfeit.

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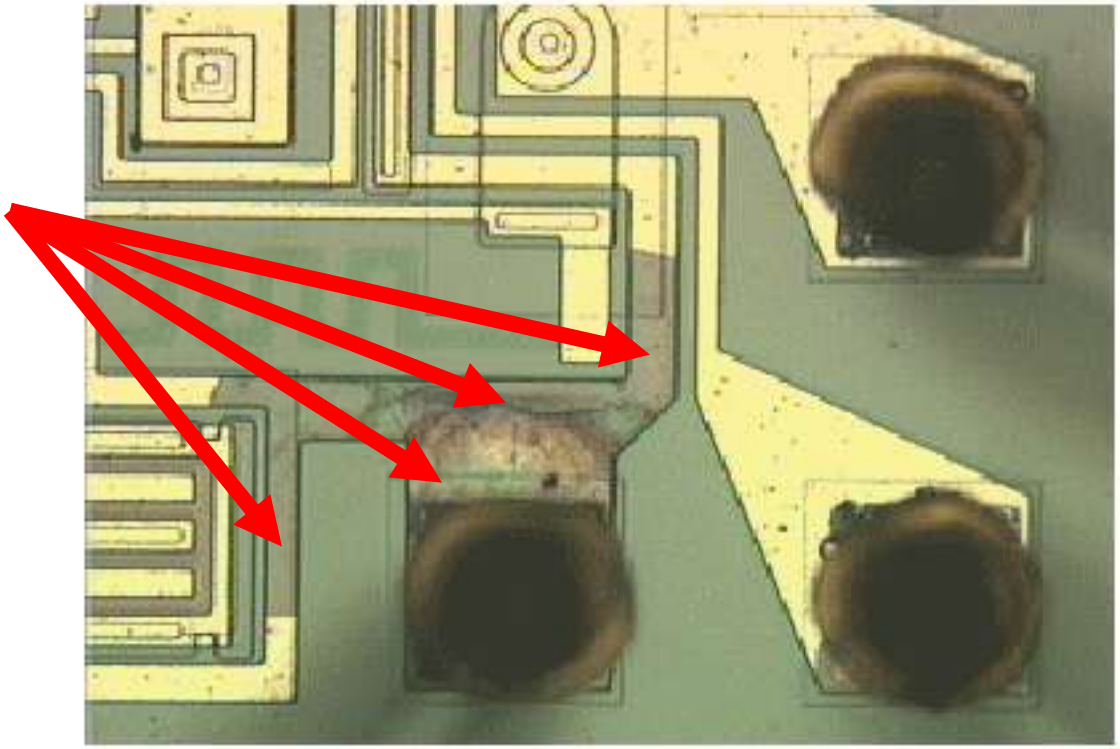
Counterfeit ICs Have Poor Reliability

- Package cracking, package delamination, and/or die cracking induced by IC removal from scrap boards
  - IC “recyclers” rarely take precautions against package damage
  - Package damage is not always detected immediately electrically
- Used ICs zapped by ESD during board removal; stripping markings; adding counterfeit markings; etc.
  - Counterfeiters rarely take precautions against ESD
  - Zapped ICs may fail during field use due to latent ESD damage
  - Especially CMOS gate oxide & Bipolar/BiCMOS capacitors

Counterfeit ICs Have Poor Reliability

- Moisture-sensitive parts not handled / stored properly, resulting in “popcorning” during board assembly
  - Counterfeiters are unlikely to dry pack moisture-sensitive parts
  - Brokers may dry pack parts without properly baking them first
- Chemicals used to strip the original markings and/or to clean the package pins result in corrosion
  - Counterfeiters may use harsh chemicals that can damage ICs
  - Such ICs may fail during field use due to the time it takes for chemicals to penetrate the package and corrode the die
  - Especially an issue with plastic-encapsulated microcircuits

Counterfeit ICs Have Poor Reliability



Used ICs were removed from PCBs and re-marked by counterfeiters. The pins were cleaned with acid. Over time, the acid migrated into the plastic packages and corroded away the metal on the die (see arrows), resulting in field failures and high OEM warranty costs.

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Counterfeit ICs Have Poor Reliability

- Counterfeits marked as having Pb-Sn solder may be Pb-free, or vice-versa
  - Parts may be unreliable after board mount at wrong temperature for the true solder composition
  - Parts that should not contain Sn may fail due to Sn whiskers
- Net result of all these potential failure mechanisms
  - Counterfeit ICs can initially work fine and then fail days, months, or years later in the field
  - Classic reliability models (such as MIL-HDBK-217 MTBF calculations) are completely meaningless if even one component in a system is counterfeit!

Summary

- Counterfeit ICs far more difficult to detect than in the past
  - Sometimes only OCMs can positively identify good from bad
- Counterfeits are the #1 threat to electronics reliability!
  - Packages or die may delaminate / crack during PCB removal
  - Parts may be ESD zapped & later fail due to latent ESD damage
  - Moisture-sensitive devices may “popcorn” during board assembly
  - Counterfeits marked as Pb-bearing may be Pb-free or vice-versa
  - Chemicals used to clean / re-mark ICs may result in corrosion
  - Net result is large warranty / monetary claims
- All traditional reliability models (MIL-HDBK-217, etc.) are meaningless if any component in a systems is counterfeit
- Best protection is to buy directly from component suppliers or directly from their authorized distributors