AAA Test Lab Inc.
AS9100 Certified

ABC's of Component Testing

(Everything you wanted to know about testing but were afraid to ask.)

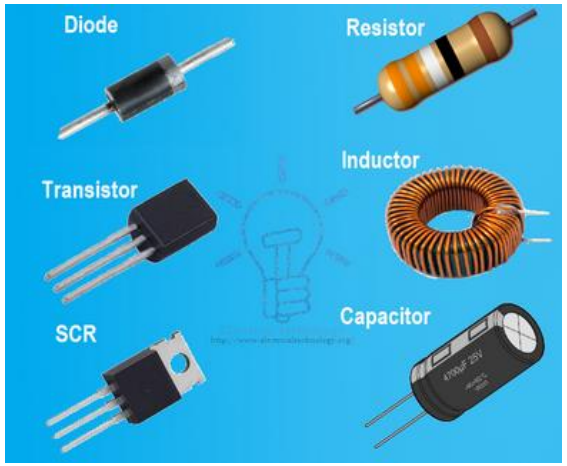
Component Basics

Two Main Type of Electronic Components: *Passive and Active*

- Passive Components include:
  - *Resistors, Capacitors, Inductors*
- Active Components include:
  - *Diodes, Transistors, Integrated Circuits, etc.*

Component Examples

Active **Passive**



AAA Test Lab Inc.
AS9100 Certified

Component Basics (Continued)

3 Main Types of Integrated Circuits: *Analog, Digital, Mixed Signal*

- Analog IC's include:
  - *Diodes, Transistors, Op-Amps, Line Drivers, Transceivers, etc.*
- Digital IC's include:
  - *Simple Logic (Flip-Flops, Adders, Timers), PLDs, Memory, etc.*
- Mixed Signal IC's include:
  - *D-A Converters, A-D Converters, DSPs, Processors, FPGAs, etc.*

Component Basics (Continued)

- Passives vs. Actives: What's the Difference?

Active Devices perform a *function* while

Passive Devices store or dissipate *energy*

- Reasons for Testing:
  - *Authenticate the Devices*
  - *Up-Screen to faster speed or higher temperature*
  - *Certify Compliance to MIL or Aerospace standards*
  - *Vendor Qualification*
  - *OEM Requirement*
  - *Parts have been in storage for >2 years*

Test Types

- **3 Primary types of testing (from cheapest to most expensive): Continuity, DC and AC**
  - Continuity Tests: Opens, Shorts, Structural Characteristics
  - DC Parameter Tests: Tests specified in Volts, Amps or Ohms
  - AC Parameter Tests: Tests specified in time or frequency (nS, MHz, etc.)
  - NOTE: PASS/FAIL Functional Testing (Memory, LED, etc.) is another common, cost effective test methodology
- **Continuity Tests (aka – Pin Correlation Testing)**
  - Most cost effective way to determine the probability a device is functional – 100% Lot Testing is economical and fast
  - Compares common pins looking for consistent I/V characteristics
  - Basic test that detects gross defects (like ESD damage) caused by improper handling or storage

Test Types (Continued)

- DC Testing
  - Insures Proper Device Operation - like power consumption and basic functionality
  - Verifies Data Sheet Parameters from Basic to Critical
  - Identifies Specific Family Members
  - DC Testing provides a reasonable Cost/Benefit trade-off when at least one data sheet parameter needs to be measured
- AC Testing
  - Measures speed and performance
  - Identifies the Speed Grade of Specific Family Members
  - AC & DC Testing combined, provide the most reliable test results

Which Tests Should I Pick?

- Choice is based on device complexity, comfort with the supplier, customer requirements, etc.
- Test Guidelines (Unless Otherwise Specified by Customer):
  - *Authenticate the Devices* (DC + AC if possible)
  - *Up-Screen to faster speed or higher temperature* (AC minimum)
  - *Certify Compliance to MIL or Aerospace standards* (DC + AC)
  - *Vendor Qualification* (DC + AC)
  - *OEM Requirement* (DC + AC)
  - *Parts have been in storage for >2 years* (Pin Correlation)
- Pin Correlation does not = a functional part, but is a cost effective way to reasonably predict one

Catch A Counterfeit: HA7-5137A

- Customer purchased 3 lots from different sources – 2 lots included lower performance, cheaper devices mixed in.
- All 3 lots passed visual inspection and RTS (Resistance to Solvents) Testing
- Pin Correlation Testing caught *some* of the nonconforming parts…

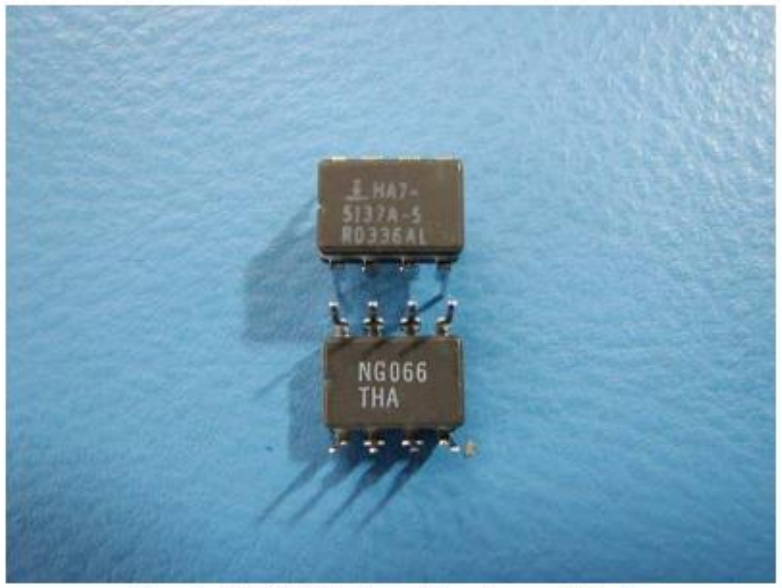


Figure 1. HA-5137A Purchased from Approved Vendor

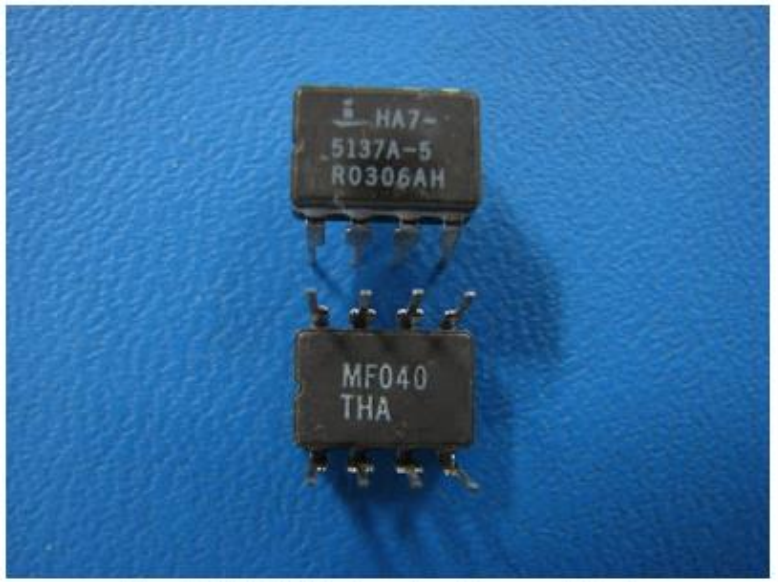


Figure 2. HA-5137A Purchased from Unapproved Vendor

AAA Test Lab Inc.
AS9100 Certified

Catch a Counterfeit (Continued)

De-Caps: Both Parts *Passed* Pin Correlation Testing

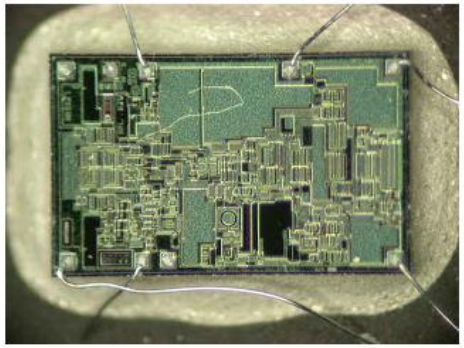


Figure 3. HA-5137A Device 1

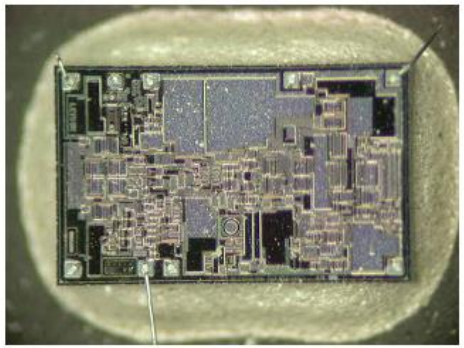


Figure 4. HA-5137A Device 2

Close-Up Reveals Different Markings from the Same Family

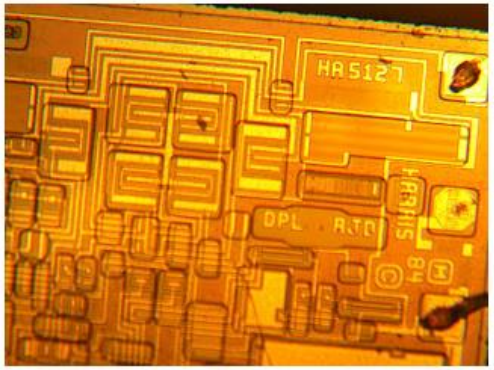


Figure 5. "HA-5137A" was actually a HA-5127 device.

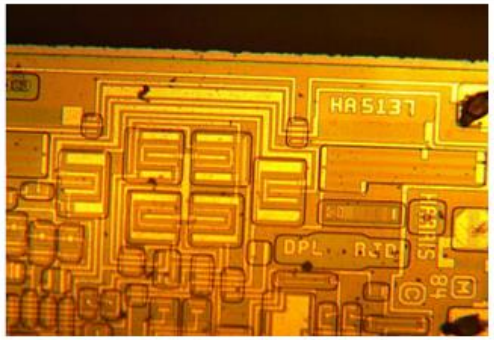


Figure 6. Failed HA-5137A Die Markings Up Close

AAA Test Lab Inc.
AS9100 Certified

Catch a Counterfeit: HA7-5137A

- Electrical Testing Detects Different Family Members
- HA7-5137A: Intersil, Low Noise, Op-Amp

	Parameter			
Device	Slew Rate (Volts/uSec)	Gain Bandwidth (MHz)	Offset Voltage (uVolts)	Noise (nV/Rt Hz)
HA-5127A	10	8.5	10	3.0
HA-5137A	20	63	10	3.0
HA-5147A	35	120	30	3.2

Catch a Counterfeit (Continued)

- Customer needed *all* good HA-5137A possible:
  - Counterfeit and Authentic Parts both passed pin correlation tests
  - Can't De-Cap all parts to find the counterfeits…
  - AC and DC Tests were selected that distinguished between HA-5137A and HA-5127A
  - Customer reported 0% incoming failures and 0% final product failures

- Conclusion
  - Pin Correlation Testing is a basic indicator of functional parts
  - Combined DC & AC Tested Parameters provide the highest assurance of device functionality

How Much Testing is Enough?

Any parameter on a data sheet can be tested….
(for enough $)

HOWEVER:

- **Genuine** Parts were precisely characterized over process and operating extremes by the manufacturer prior to release.
- **EACH** specification included on a data sheet is published based on conservative (*guard-banded)* characterization data
- All data sheet specifications are typically tested on each part by the manufacturer prior to release – retesting all parameters is costly and ultimately unnecessary.
- ESD, Handling, and Storage are the major causes for device failure after leaving the OCM ***(Pin Correlation Testing is highly effective and recommended on parts with D/C > 2 Years)***
- Unless customer requires a specific test protocol, 1-3 tested specifications is a good predictor of a functional device

What Should be in a Test Report?

- Test Procedure
  - *Test Plan Objectives, Techniques, and Expectations*
- Equipment Used
  - *List of Equipment Used including manufacturer and model number*
- Parameters Verified
  - *Data Sheet Specifications evaluated or what parameters were measured*
- Test Results
  - *# Pass, Fail, % Yield, Observations*

"What is Up-Screening and Why Should I Care?"

- Hard-to-find parts often have family members that are different speeds or temperature ranges (Commercial, Industrial, Automotive, Military, etc.)
- Up-Screening a device verifies data sheet performance at a given speed or temperature
  - Confirms that Commercial Grade Parts (0° to70°C) meet Industrial Grade (-40° to 85°C) Specifications
  - Validates a 15nS part operates at 10nS
- Up-Screening provides a reliable solution when the exact part isn't available

AAA Test Lab Inc.
AS9100 Certified

Up-Screening Equipment Requirements

- Thermal Forcing Unit (-65^{o} to 225^{o}C)
- OCM-Specific Test Tools & Software
- Test Equipment (LabVIEW, ATE, Benchtop, etc.)
- DUT (Device Under Test) Boards
  - >500 JEDEC Package Types from 2-pin to 2104-pin devices
  - Most Package Types Require a *Custom* DUT Board
  - Custom DUT Board Costs: $200 - $10,000 depending on complexity (find a test house that has the DUT board you need)

AAA Test Lab Inc.
AS9100 Certified

Conclusions

- Pin Correlation Testing is effective and highly recommended for all aftermarket components
- Unless required by the Customer, 1-3 DC Tests on 10% (20 pieces minimum) of each lot with 0 failures is sufficient confidence all parts are functional
- Device Characterization by the MFG makes Room Temp Test Results highly reliable (Don't waste $ on extended Temp Testing – unless Up-Screening is required)
- Performance of Up-Screened Parts = Performance of the Higher Grade Family Member

Workshop Quiz

(T or F?)

1) Parts that pass proper Pin Correlation Testing typically work in the end application

2) Passive Devices are usually only DC Tested to verify functionality

3) Digital ICs include speed (AC) and electronic (DC) parameters

4) Up-Screened parts only need AC Testing to prove the parts work over Temperature