

# *Counterfeit Parts Inspection and Detection*

PRESENTED BY

CARLO ABESAMIS

NASA/JPL WESTERN REGION  
TRAINING CENTER



# Agenda/Purpose

Western Region Manufacturing Technology Transfer Center

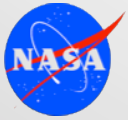
- Awareness/Introduction to the following:
  - Electronic Components Counterfeit Issue
  - Steps in Conducting a Basic Visual Inspection
  - A glimpse on a few Inspection Tools/Equipment
- View counterfeit parts in greater detail
- Examine different kinds of packaging, labels and documentation
- Discuss Electrostatic Discharge issues/implementation

AUTHENTIC

SUSPECT



NOTE: NASA/JPL provides a more in depth Awareness Training class and an Inspection Training class.



# Introduction

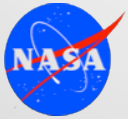
## Counterfeiting Process Example

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- Sand-off markings, resurface (“blacktop”), remark



NOTE: There are also more sophisticated methods of counterfeiting that are difficult to detect just by visual inspection.

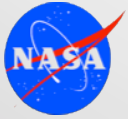


# Counterfeit Parts Definition

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- Broad Industry Definition per AS6741: Materiel misrepresented as meeting the customer's requirements and has been confirmed to be a copy, imitation or substitute that has been represented, identified, or marked as genuine, and/or altered by a source without legal right with intent to mislead, deceive or defraud.
- For Law Enforcement: Counterfeit means counterfeit trademark.
  - Customs and Border Patrol (CBP) and Immigration and Customs Enforcement (ICE) conduct civil enforcement under 19 U.S.C. § 1526(e) and criminal enforcement under 18 U.S.C. § 2320 against semiconductor devices and traffickers of devices that are affixed with counterfeit trademarks.





# Impact of Counterfeit Parts

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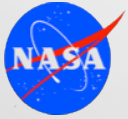
- SYSTEMS DO NOT FUNCTION AS DESIGNED
  - Immediate failure, Latent failure
- LOSS OF LIFE
- MISSION FAILURE
- COST AND SCHEDULE DELAYS



“The failure of a single electronic part can leave a soldier, sailor, airman, or Marine vulnerable at the worst possible time,”

-US Senate Committee Report

<http://abcnews.go.com/Blotter/counterfeit-chinese-parts-slipping-us-military-aircraft-senate/story?id=16403599#.UCA-zsie6uw>

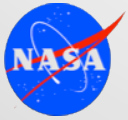


# Minimizing Counterfeit Risk

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- PROCUREMENT PRACTICES and SUPPLIER SELECTION PROCESS
- INSPECTION, MEASURING AND TEST EQUIPMENT (IMT&E)
  - Calipers
  - Microscope
  - X-Ray Fluorescence (XRF)
  - Real Time X-Ray
  - DTEK
  - Acoustic Microscopy
- VISUAL INSPECTION





# Risks Associated with Inspection

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- Physical Damage to Hardware
- Mishandling
- Loss of Traceability

[Link to Handling Guideline document](#)



## Guidelines for Handling J-Lead, QFP, BGA, FBGA, and Lidless FBGA Devices

AN-071-5.0

Application Note

This application note provides guidelines for handling J-Lead, Quad Flat Pack (QFP), and Ball-Grid Array (BGA, including FineLine BGA [FBGA] and lidless FBGA packaging) devices to preserve the quality of these devices during storage, shipment, and transfer and to ensure easier soldering.

Devices that use surface-mount J-Lead, QFP, BGA, FBGA, and lidless BGA are now common on boards because they provide density, size, and cost benefits. However, a few precautions are necessary to protect these devices from mechanical damage during transportation and storage.

This application note describes the following topics:

- "Handling J-Lead and QFP Devices" on page 1
- "Transferring Devices Between Tubes" on page 13
- "Transferring QFP, BGA, FBGA, and Lidless FBGA Devices Without Carriers Between Trays" on page 13
- "Dry Packing J-Lead, QFP, BGA, FBGA, and Lidless BGA Devices" on page 14
- "Shipping J-Lead, QFP, BGA, FBGA, and Lidless FBGA Devices in Boxes" on page 19

### Handling J-Lead and QFP Devices

To protect device leads and ensure proper operation, you must handle J-Lead and QFP devices carefully when they are stored, shipped, and transferred. You must store and ship J-Lead devices in tubes sealed with stoppers. Add foam inside the tubes for cushioning if necessary.

You must ship QFP devices in carriers only inside tubes sealed with stoppers and with foam (if necessary). Carriers are static-dissipative, molded plastic shells that hold QFP devices in a secure frame to prevent mechanical damage to device leads. You can program and erase these QFP devices inside carriers and they can tolerate the 125°C baking required for dry packing. When handling QFP devices in carriers, do not touch the QFP device; only use fingers cots to touch the carrier.

- If you are required to insert a QFP device into a carrier, contact Altera® Customer Marketing. For more information on QFP carriers, refer to the [QFP Carrier and Development Socket Datasheet](#).



101 Innovation Drive  
San Jose, CA 95134  
[www.altera.com](http://www.altera.com)

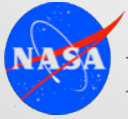
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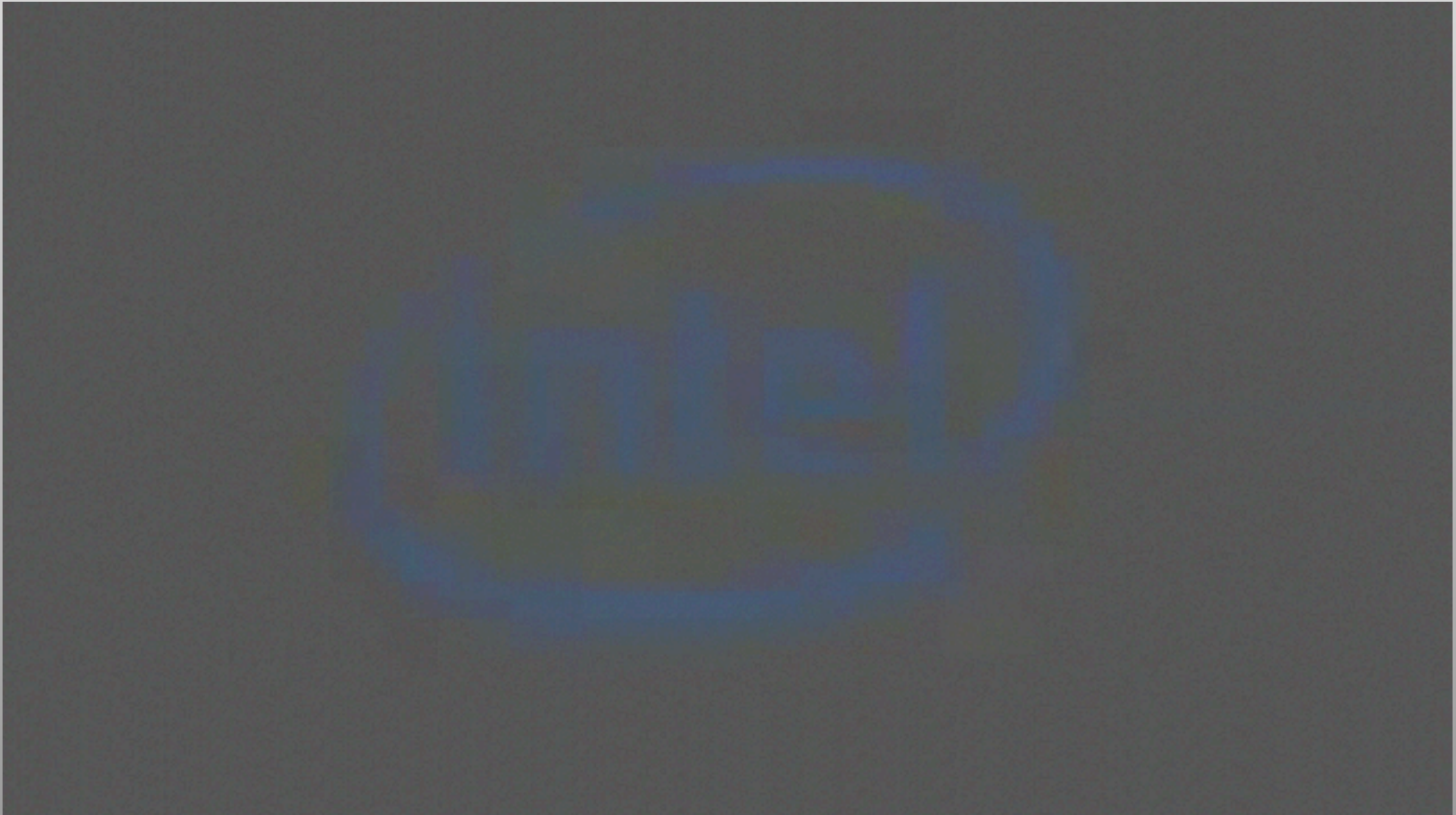


# Risks Associated with Inspection

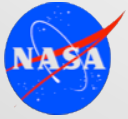
Electrostatic Discharge Damage (ESD) due to lack of ESD precautions

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- REF ANSI/ESD S20.20 – Std of the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment







# Risks Associated with Inspection

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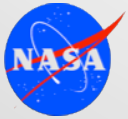
- Electrostatic Discharge (ESD) Summary
  - May occur undetected
  - Damage can be immediate or latent – part can fail at a later date
  - Precautions can be taken to minimize ESD damage risk
    - Observe handling and packaging requirements
    - Properly grounded workstation
    - Electrostatic dissipative surfaces
    - Grounded wrist strap
    - ESD smock



# Visual Inspection Checklist

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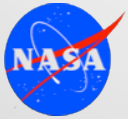
- Documentation
  - Inconsistencies between shipping documents
    - Certificate of Conformance, shipper, purchase order
- Packaging
  - General:
    - Inspect shipping boxes for authenticity and possible prior use.
    - Evidence of tampering and/or seals are intact.
    - Complies with applicable ESD and humidity control requirements
  - Trays/Chip Carrier:
    - Verify labeling information matches supplier documentation (e.g. part number, date code/lot number, quantity).
    - Verify carrier is not damaged.
    - Verify carrier matches lid (e.g. discoloration differences, over or undersized lid compared to carrier).



# Visual Inspection Checklist

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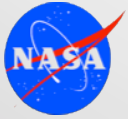
- Packaging
  - Reels:
    - Tape is consistent and appropriate in type and color and conforms to the norm for the manufacturer.
    - Inspect for missing parts within the tape.
    - Parts are facing the same direction within the carrier tape.
  - Packaging-Tubes:
    - Parts are facing the same direction inside the tubes.
    - Tube size and configuration is appropriate for the part.
- Part Traceability:
  - Inconsistencies in date code(s)/lot code(s) (i.e. dates that are not possible, mixed date codes within a shipment, etc.).
  - Inspect for multiple countries of origin with the same lot code.
  - Authenticity of labels (parts and packaging material), logos and manufacturing markings, verify barcode information



# Visual Inspection Checklist

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- Component Inspection
  - Proper pin arrangement and pin count, part dimensions
  - Part markings match information on the C of C
  - Inspect date code(s)/lot code(s) marked on parts for inconsistencies
  - Inspect part markings for multiple countries of origin with the same lot code
  - Inspect part markings for authenticity of logos and manufacturing markings
  - Inspect part markings for inconsistencies in font style, thickness, print color, and marking/identification placement
  - Inspect part markings for smeared, illegible, or poor quality
  - Verify that markings on top of the parts are consistent with bottom markings as applicable
  - [Resistance to Solvents Test](#)

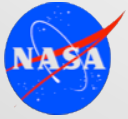


# Visual Inspection Checklist

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- Component Inspection
  - Inspect leads for possible prior use – bend and co-planarity outside allowable limits, oxidized or contaminated, tinning or solder, consistency of gloss/shine, color and texture
  - Inspect for signs of previous programming (i.e. colored dots or ink marks)
  - Inspect the surfaces of the parts for evidence of re-surfacing (for example: blacktopping, directional scratches, indents that are no longer clean and flat)
  - Inspect for stickers, underlying etching on packaging or any evidence of re-identification
  - Inspect for cracks on the surface of the parts and suspect laser burn marks
  - Inspect surface of parts for burn marks indicating exposure to excessive heat

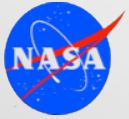




# Visual Inspection Checklist

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- Component Inspection
  - Inspect for evidence of tool / pull marks or heat-sink witness markings indicating prior use
  - Inspect for color or shading discrepancies on the top vs. bottom of part
  - Inspect for traces of glue or adhesive on the surface of the parts



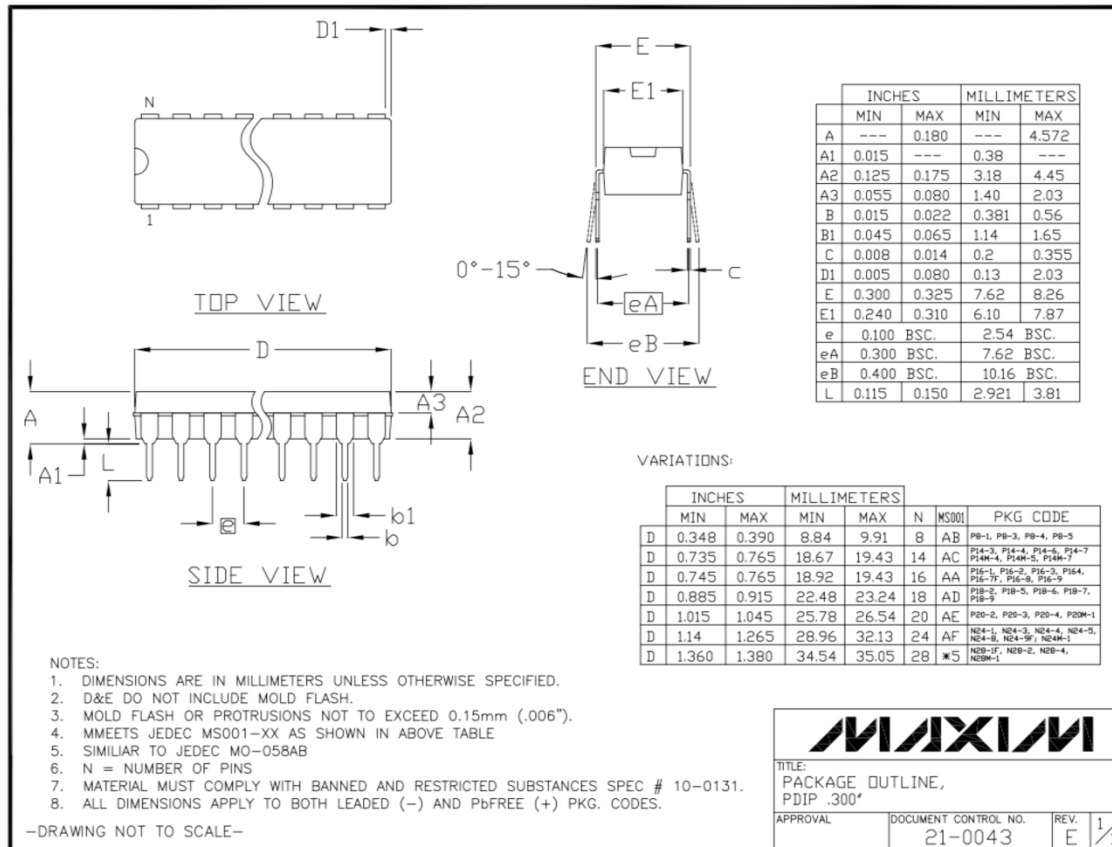
# APPENDIX

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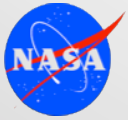


# Inspection Measurement and Test Hand Held Measurement Tools- Calipers

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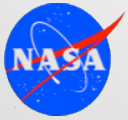
# Inspection Measurement and Test

## USB Microscope

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# Inspection Measurement and Test

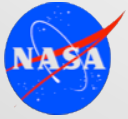
## X-Ray Fluorescence (XRF)

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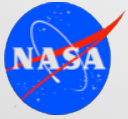


# Inspection Measurement and Test

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- X-Ray Fluorescence Example
  - Maxim MAX199ACNI
  - Manufacturer's website : 85% tin 15% lead
  - JPL Receiving Inspection XRF Machine Results: 88% tin, 12% lead
  - XRF readings from counterfeit parts may show traces of additional or different material composition from factory specifications.

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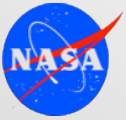


# Inspection Measurement and Test

## Real Time X Ray

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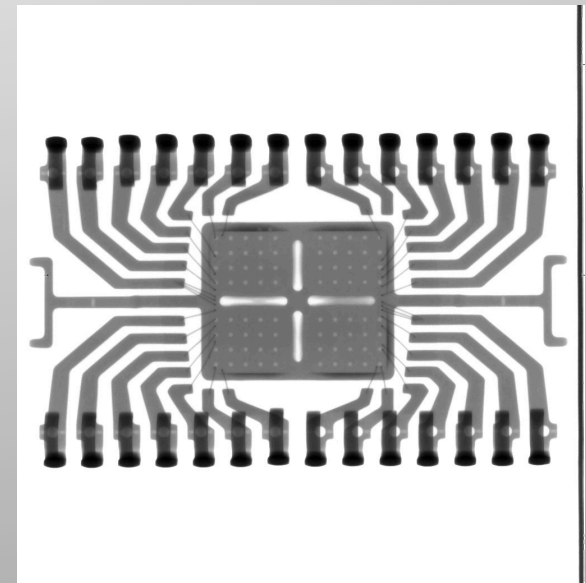
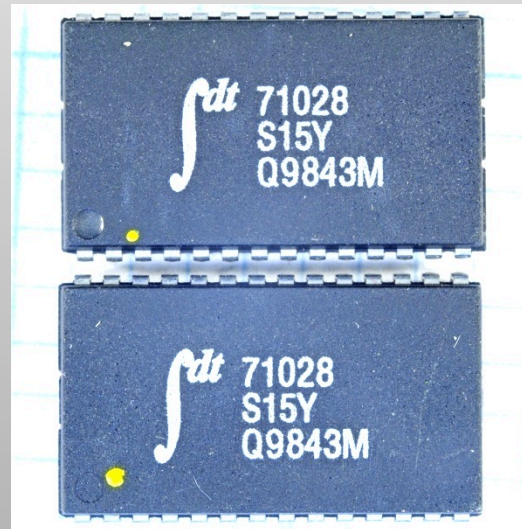
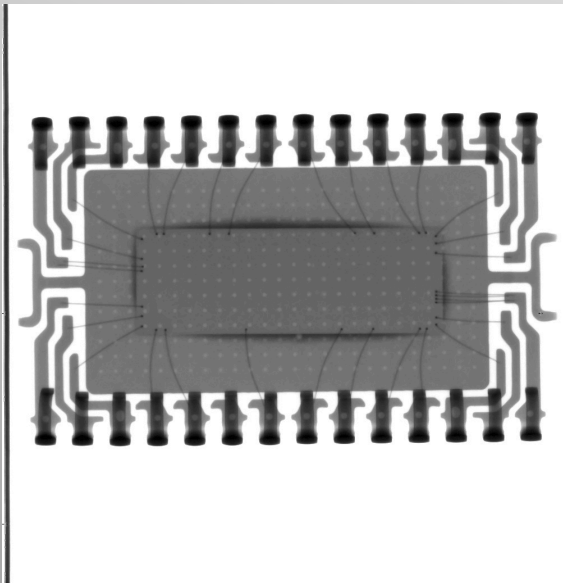


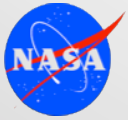


# Inspection Measurement and Test

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- Real Time X-Ray example
  - External markings indicate parts are the same BUT X-Ray shows the truth: they are completely different!





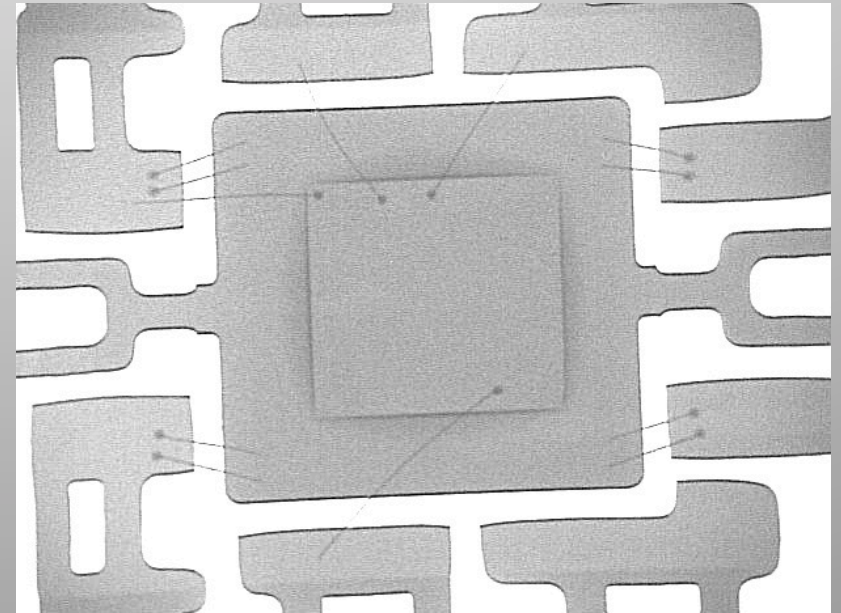
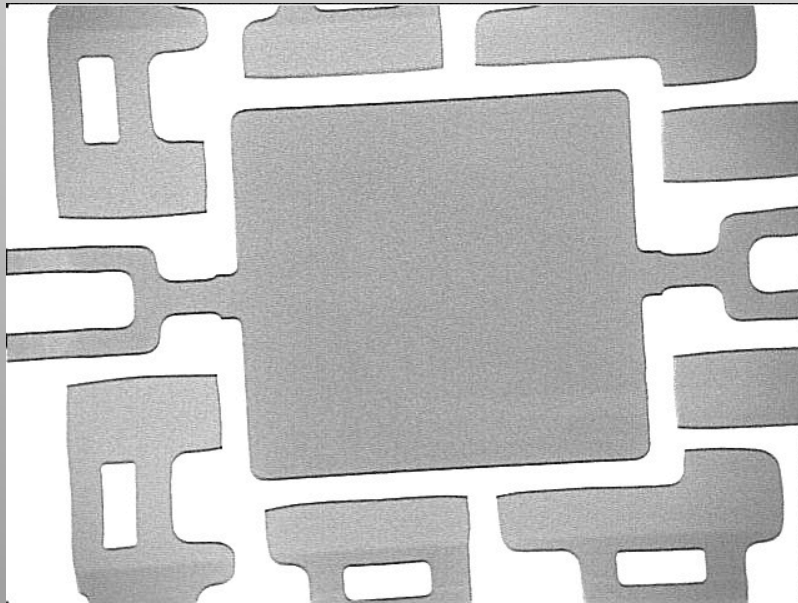
# Inspection Measurement and Test

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- Real Time X-Ray
  - X-Outside packaging made to appear authentic
  - ray image of dummy part = absence of a die and wire bonds

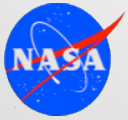
Dummy  
Part

Authentic  
Part



\* NASA Public Lesson Learned Entry: 1832

\* <http://www.celnav.de/hv/sn7490.jpg>

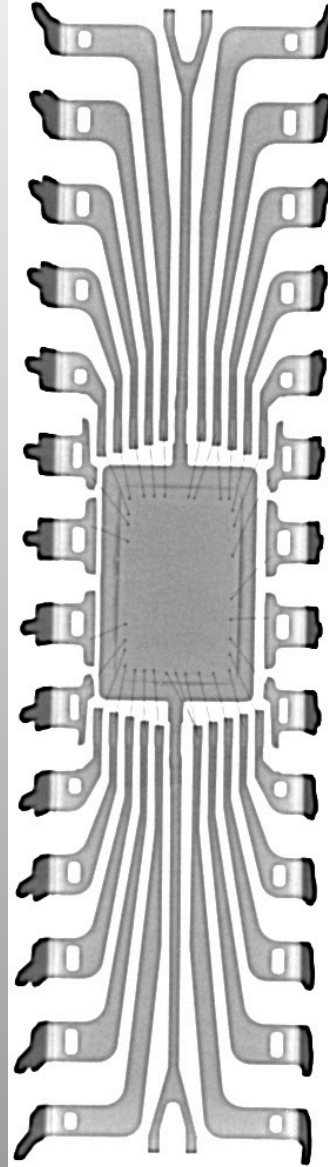
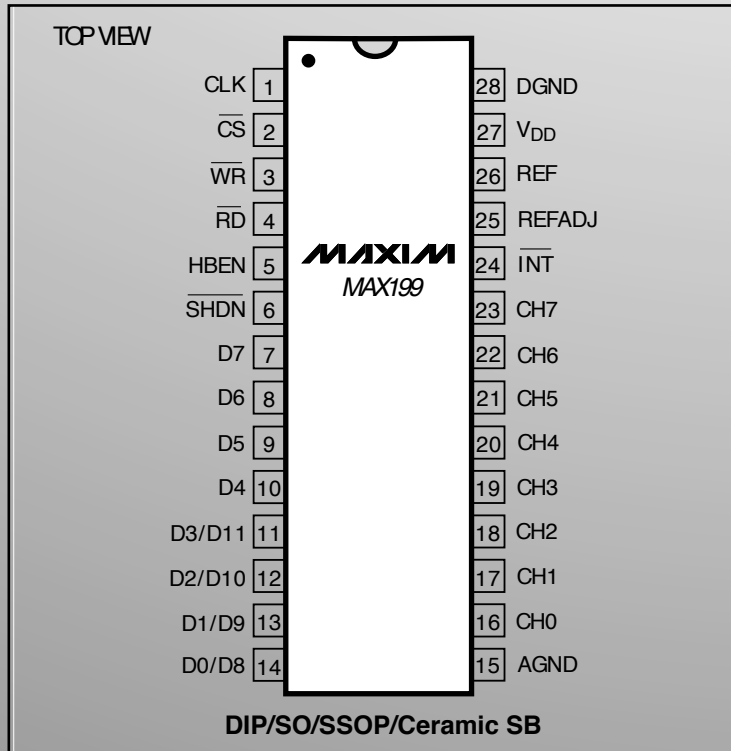


# Inspection Measurement and Test

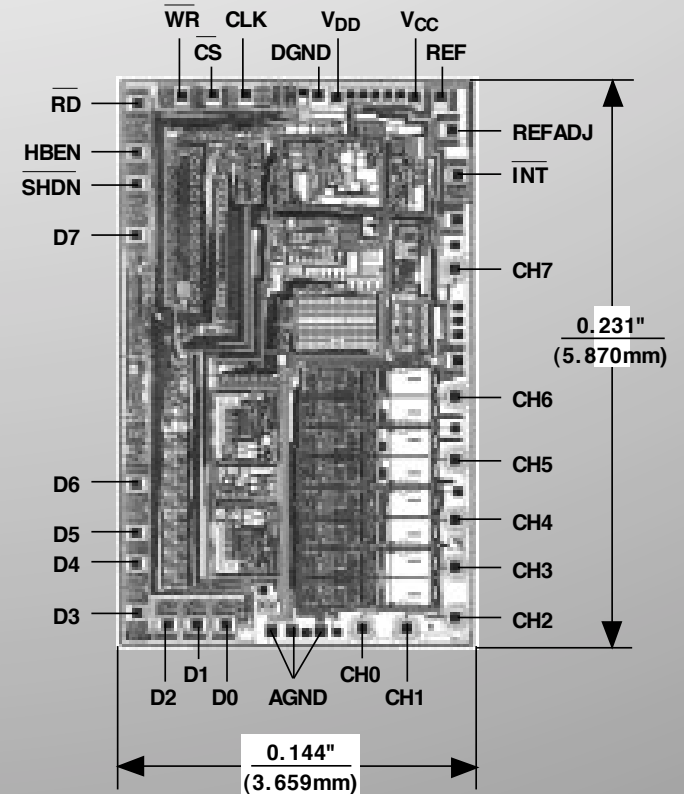
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- Real Time X-Ray example

## Pin Configuration

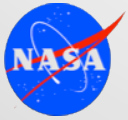


## Chip Topography



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# Inspection Measurement and Test

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## Benchtop System

### Contact:

Covisus Corporation  
180 N. Vinedo Ave.  
Pasadena, CA 91107  
[www.covisus.com](http://www.covisus.com)

Skylar Gauss  
[sgauss@covisus.com](mailto:sgauss@covisus.com)  
(805) 452-7025

### System Attributes:

- Non-Destructive
- Usable by Non-Expert
- Rapid, 5 Min Lot Time
- Safe (no solvents/radiation)

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### Information in Reports:

1. Results to 4 Tests
  - Pass-Fail-N/A
2. Component Images
  - JPG Exportable
3. Other Information at User's Discretion



# Inspection Measurement and Test

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- Acoustic Microscopy
  - Finds hidden defects such as internal cracks and delamination
  - Transmits and receives ultrasonic pulses that interacts within the sample.

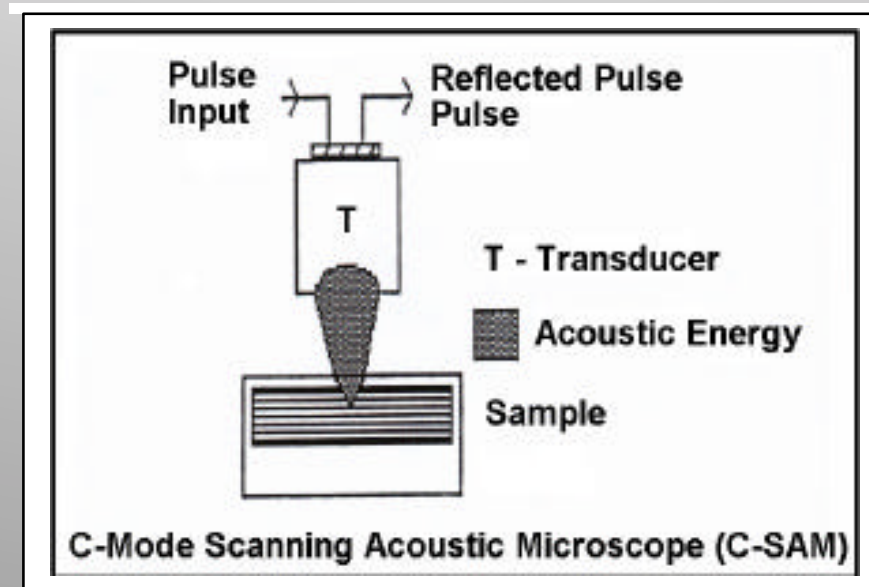
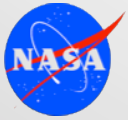


Figure 1. Representation of C-SAM acoustic imaging system (diagram courtesy Sonoscan, Inc.).



# Inspection Measurement and Test

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- This reflected energy is analyzed and is used to generate an image.



Figure 1 C-SAM image of a PEM, showing severe package cracking and delamination (red). This part was imaged while still on the board.

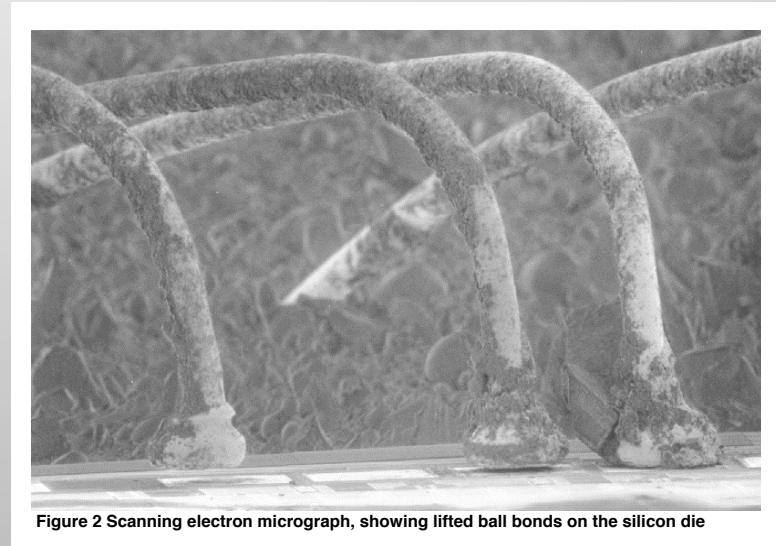


Figure 2 Scanning electron micrograph, showing lifted ball bonds on the silicon die

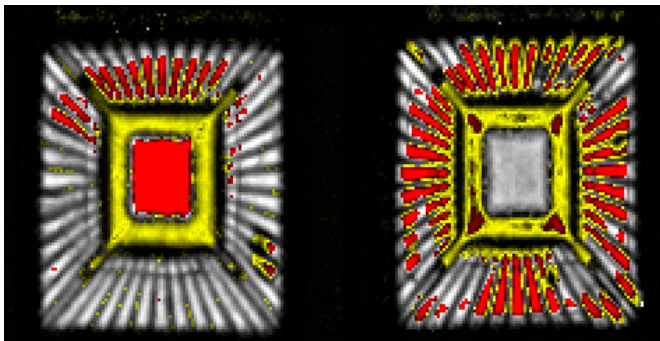
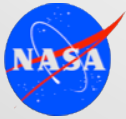


Figure 3 Part on left has 100% delamination of EMC to die surface (red rectangle in center). Die surface on right is well bonded. Both have delamination of other elements (red/yellow).

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# Certificate of Conformance

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- A formal statement by the supplier that certifies that the product meets all applicable requirements.



ArrowZeus Electronics  
2900 Westchester Avenue, Suite 401  
Purchase, NY 10577-2508

military distribution specialists

## Certificate of Conformance and Procurement Traceability for drop shipment

<b>Attention: Quality Assurance Department</b>				<b>Date: 3/15/11</b>	
<b>Customer Name and Address</b>		<b>Manufacturer</b>			<b>Assembly Code</b>
JPL - CENTRAL RECEIVING 4800 OAK GROVE DRIVE PASADENA CA 91109		Analog devices			24355
	<b>Part Number</b>	<b>Mil Spec</b>	<b>UM</b>	<b>Quantity</b>	<b>Mil-PRF- 19500</b>
	5962R0051701VDA	38535	ca	23	na
<b>Customer Purchase Order No.</b>		<b>Certification Type:</b>			
1425791		Per Mil PRF 38535 rev H Mil std 883 rev H			
<b>Date Code</b>					
1023A serial range 1216-1256					
<b>Retest</b>					
na					
<b>COMMENTS</b>					
Parts supplied on this order were drop shipped by Analog to JPL Reference Arrow invoice number 9468027					

The undersigned certifies that all articles included in each shipment under the above purchase order are in accordance with said purchase order; and with all requirements, specifications and drawings referenced therein, and that records of inspection and test providing objective evidence of the foregoing are on file at this facility, or at the manufacturer's plant, and are available upon request. Certification that this shipment is a part of the shipment covered by the manufacturer's documentation.

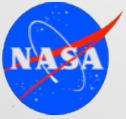
Authorized Quality Assurance Inspector

Bill Palladino / Director Quality

WHEN CHECKED MANUFACTURER'S  
CERTIFICATE ATTACHED



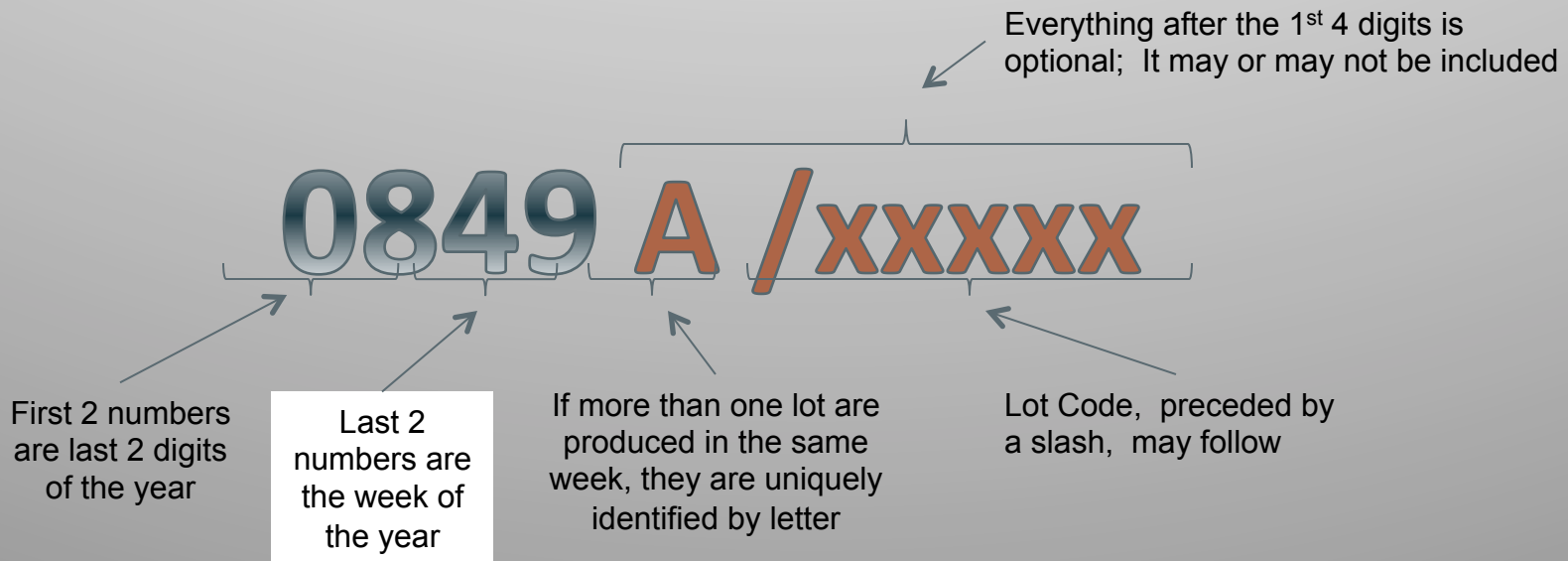
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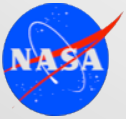
# Date Code Primer

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- Manufacturers use:
  - Date codes to identify the date of production (sealing) of a part
  - Lot codes to identify the production lot of a part
- MIL-PRF-38535 paragraph 3.6.6 specifies how date codes must be marked:







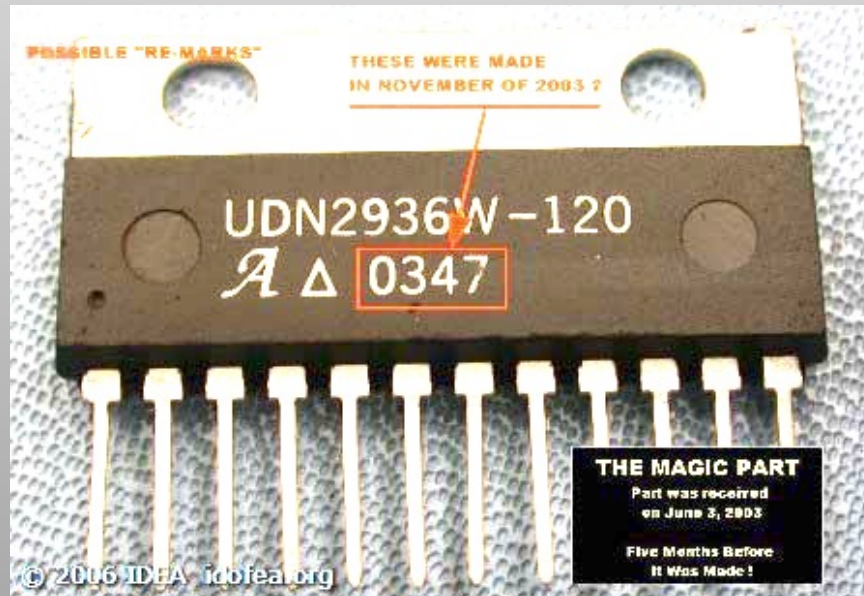
# Date Code Verification Exercise

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## THE MAGIC PART\*

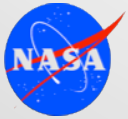
- Date code indicates:
  - part was made in November of 2003 (47<sup>th</sup> week of 2003)
- Part was received on June 3, 2003

This part was marked with a date code five months into the future compared to the date of receipt!!



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# Marking Permanency Test

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## ● Inspection for Re-marking or Re-surfacing

- Standard “resistance to solvents” test methods can be effective, but more aggressive methods may be necessary to remove coatings applied to disguise sanding marks, and to reveal other indications that the original device marking has been removed.
  - Scrape surface of part w/a razor blade
  - Dilute acetone 3:1 with water & swab with Q-Tip
  - 3:1 mineral spirits/alcohol
  - Pure/heated acetone
  - DynaSolve

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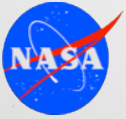
- ▶ If part has been re-marked, a grayish to black substance may be visible on the Q-Tip

**Warning! Will not detect re-packaged CF parts in molded (plastic) packages!**



- \*MIL Std 883 Method 2015

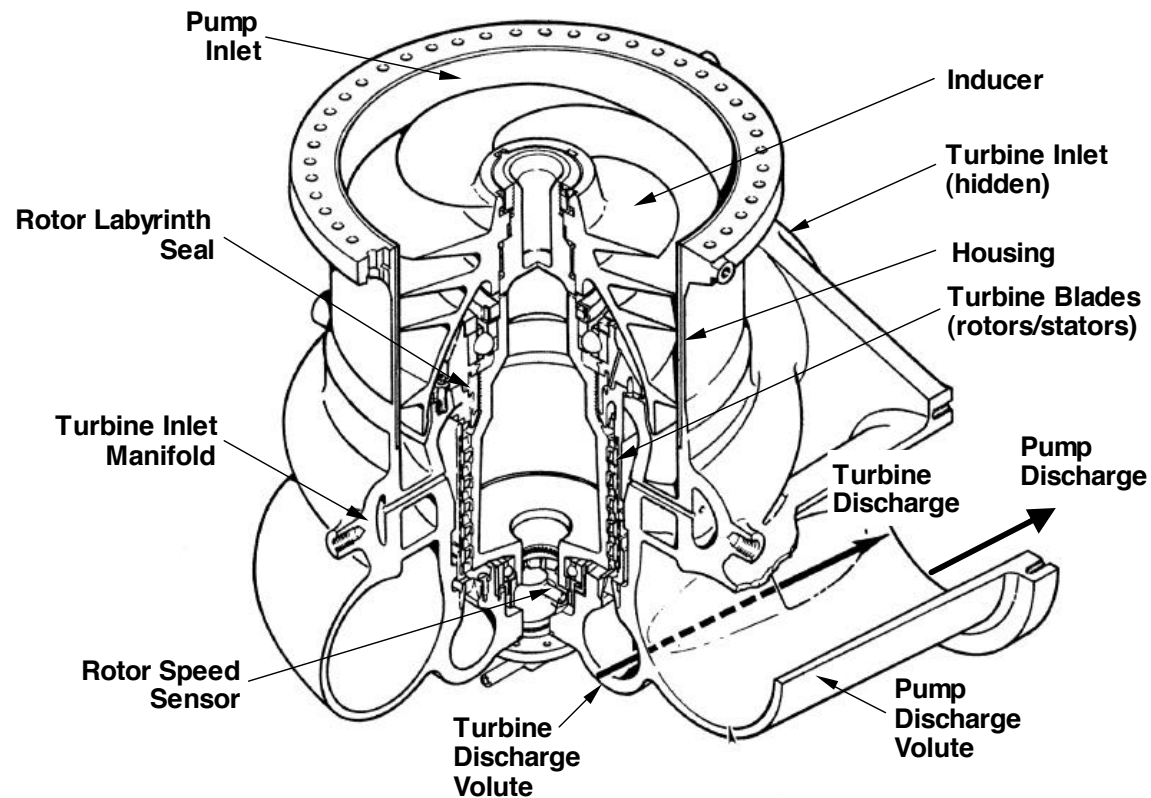
- SAE Aerospace Standard AS5553: Counterfeit Electronic Components; Avoidance, Detection, Mitigation, and Disposition

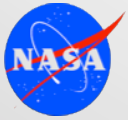


# Space Shuttle Main Engine

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## Low-Pressure Oxidizer Turbopump



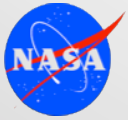


# Space Shuttle Main Engine

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