NASA Counterfeit Parts Awareness and Inspection

MARK LEBLANC AND CARLO ABESAMIS

JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government or the Jet Propulsion Laboratory, California Institute of Technology.

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Training Course Objectives

- **This course provides a high level overview of counterfeit concepts related to government and industry best practices.**
  - Gain an understanding of the electronics parts counterfeit issue
  - Gain knowledge of the supply chain environment for EEE parts
  - Develop a familiarity with some of the methods used in counterfeiting
  - Learn the steps within a risk mitigation plan
  - Become familiar with government and industry policy, standards, and regulation
  - Learn hands-on verification and inspection processes for the detection of suspect parts

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The Counterfeit Problem

- Independent distributor
  - Clearwater, FL
  - Nine employees
  - Distributor sold ICs for over a five year period
  - Imported chips from China through various U.S. ports
    - 3263 shipments (59k parts) often changing the name of what the were importing
  - ICs sold as “military grade” from Germany but were counterfeits from China
  - Sold large amount of semiconductor chips to 1,100 customers
    - Sold to every sector, most of devices have not been recovered

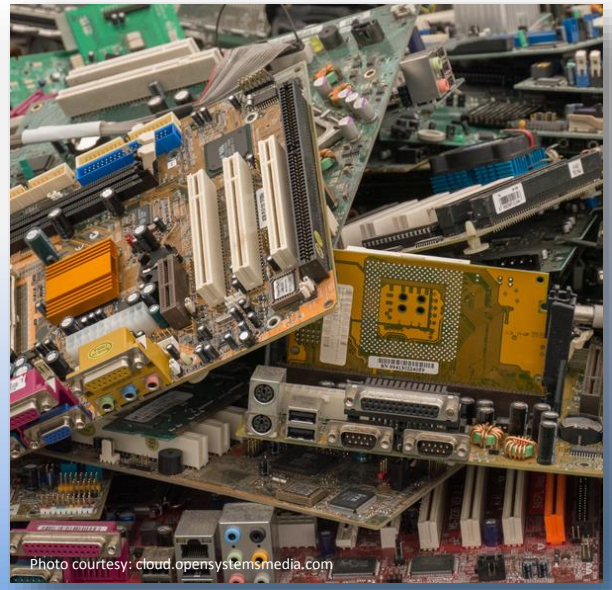


Photo courtesy: cloud.opensystemsmedia.com

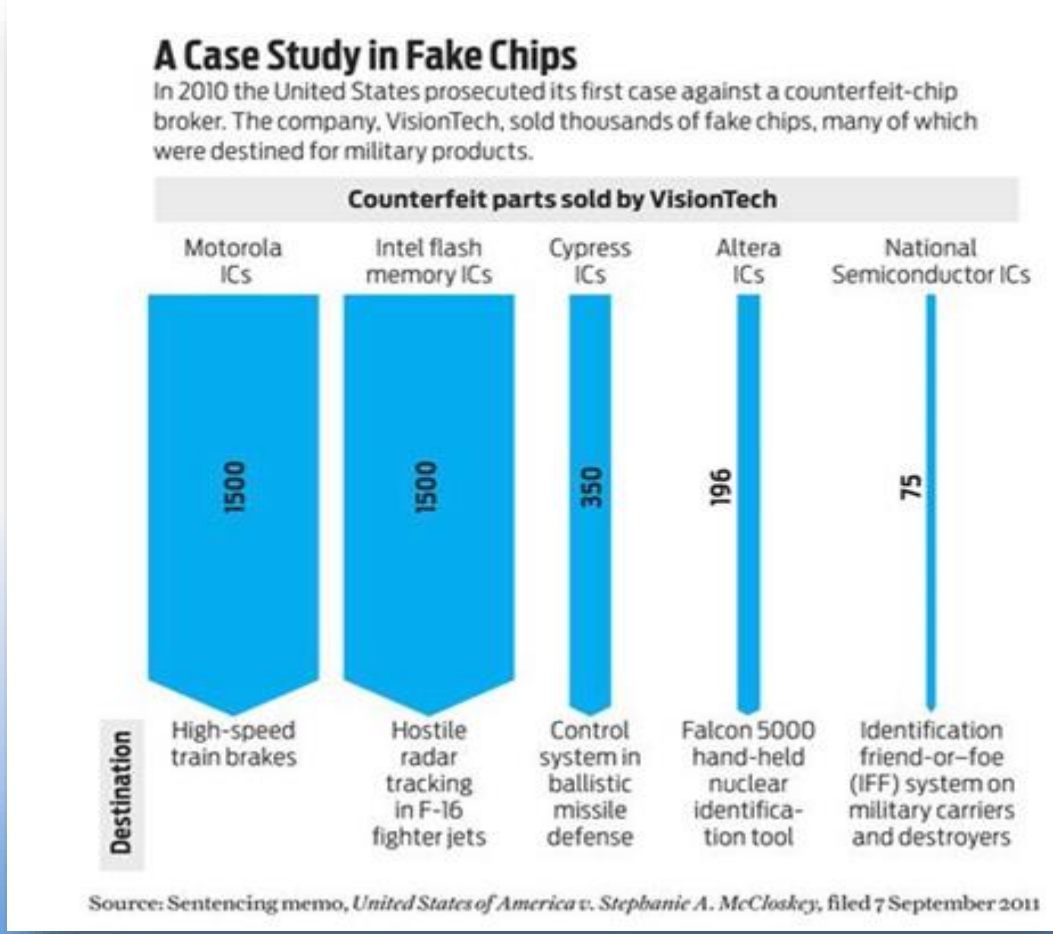
Source: Criminal Case 10-245-PLF

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The Counterfeit Problem

Where did those fake parts end up?

- Hostile radar tracking in F-16 fighter jets
- High speed train brakes
- Control system in ballistic missile defense
- Falcon hand-held nuclear identification tool
- IFF system on military carriers and destroyers



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The Counterfeit Problem

- $16 million counterfeiting operation
  - $7.5 million for purchase of goods
  - $14, 742 testing
- Bait and switched good samples for companies to test
  - Returned chips returned and sold to another customer
- Chips showed signs of black topping, incorrect P/Ns and date codes
  - Used Armor all to make parts appear shiny
  - Forged CofCs
- Employees were both arrested in Florida.
  - Police seized luxury vehicles, motorcycles, motor home, beach home and four other properties

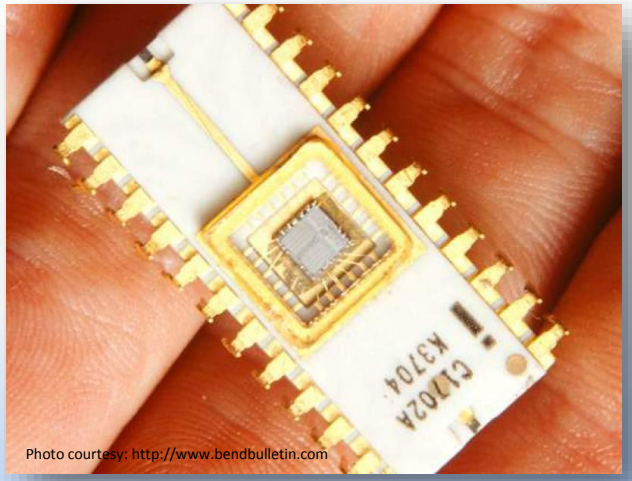


Photo courtesy: http://www.bendbulletin.com

Source: Criminal Case 10-245-PLF

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Reality of Counterfeiting

Photo courtesy of:
http://static.progressivemediagroup.com/uploads/imagelibrary/dfg.jpg

Photo courtesy of: www.nissgroup.com

Photo courtesy of: www.dreamstimes.com

Photo courtesy of: www.theguardian.com

Massachusetts Man Sentenced to 37 Months in Prison for Trafficking Counterfeit Military Goods

http://www.justice.gov/opa/pr/massachusetts-man-sentenced-37-months-prison-trafficking-counterfeit-military-goods-0

New Jersey Man Admits Smuggling $65 Million in Sensitive Electronic Components to Russia's Ministry of Defense

http://www.justice.gov/opa/pr/new-jersey-man-admits-smuggling-65-million-sensitive-electronic-components-russia-s-ministry

Texan gets 10 years in U.S. prison for Russian tech export scheme

http://www.reuters.com/article/us-usa-russia-fishenko-idUSKCN1012ML?il=0

Counterfeiters Will Become 'Virtual Criminal Underground:' Europol

http://www.ebnonline.com/author.asp?section_id=3788&doc_id=278060

History of Pre-Infected Electronics Will Block China's Bid to Purchase Micron Technology

http://www.theepochtimes.com/n3/1463955-history-of-pre-infected-electronics-will-block-chinas-bid-to-purchase-micron-technology/

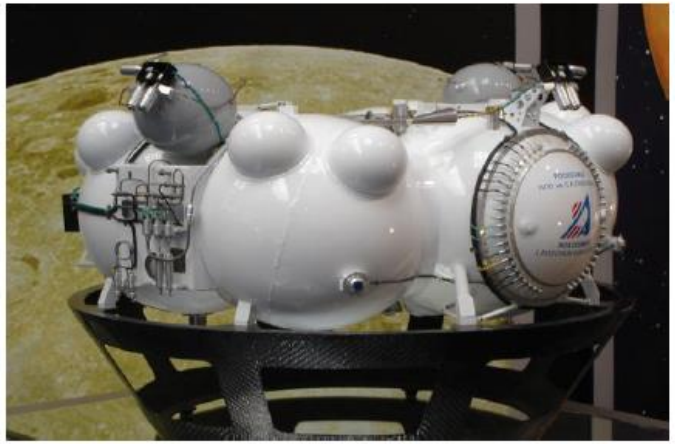
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

IN THE NEWS:

IEEE Spectrum Tech Alert **Did Bad Memory Chips Down Russia's Mars Probe?**

IEEE report blames the loss of Russia's ambitious Phobos-Grunt space mission on faulty memory chips ... **report suggests that the chips were counterfeits** that had been intentionally misrepresented as offering higher performance than they were actually capable of.

Report cites malfunctioning WS512K32 chip (a single-package assembly of *static random access memory (*SRAM) chips) suspected to be counterfeit

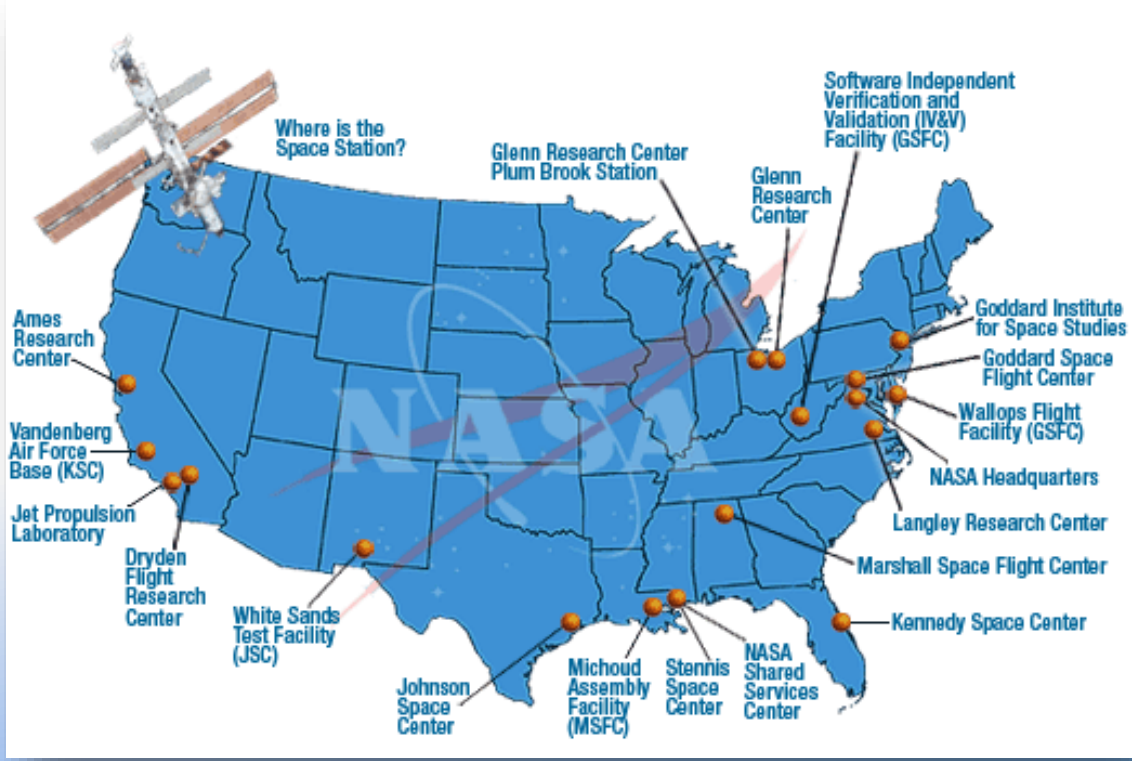


Mockup of Phobus-Grunt main propulsion unit

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Training Overview

- 1) Landscape of Counterfeiting
- 2) Identifying the Problem
- 3) The Extent of the Problem
- 4) Risk Mitigation
- 5) Government/ Industry Flow downs
- 6) Counterfeit Part Hands-On Training



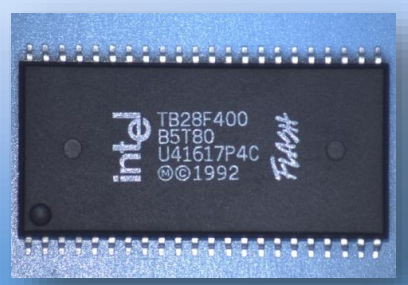
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Section 1 – the Landscape of the Counterfeiting Issue

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Integrated Circuit (IC)

- Complex electronic part that “controls” the flow of electricity
- Basis of all modern electronics
- Used in aerospace, military, industrial, computers, and many other industries
- Also found in numerous consumer electronics
  - Personal computers, phones, home appliances

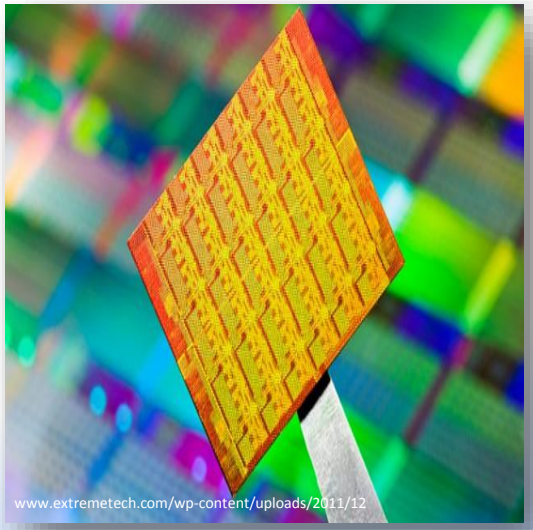


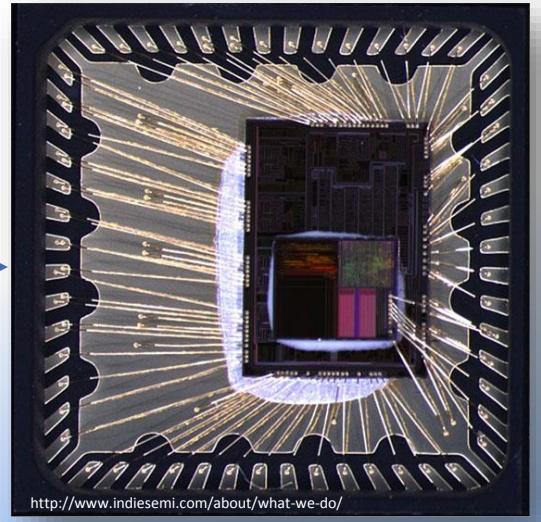
Honeywell: NASA Round Robin Testing Results

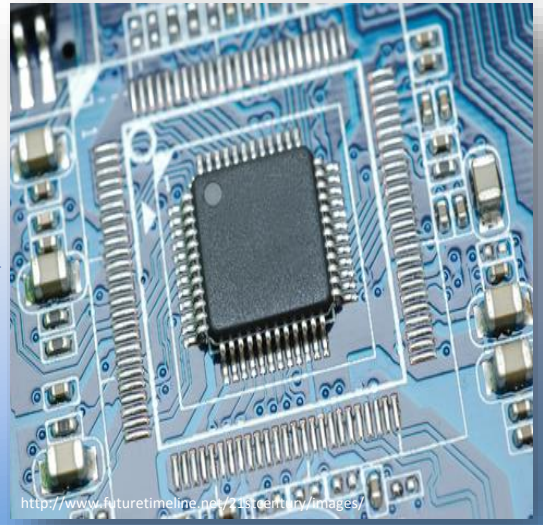
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Integrated Circuit (IC)

- Component packaged in plastic or ceramic package containing a semiconductor chip
  - Package serves to protect and preserve performance of the chip
- Semiconductor material from silicon and contains many transistors







Source: Criminal Case 10-245-PLF

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Which term to use?

COUNTERFEIT ELECTRONIC PART

An unlawful or unauthorized reproduction, substitution, or alteration that has been **knowingly** mismarked, misidentified, or otherwise misrepresented to be an authentic, unmodified electronic part from the original manufacturer, or a source with the express written authority of the original manufacturer or current design activity, including an authorized aftermarket manufacturer.

SUSPECT COUNTERFEIT ELECTRONIC PART

An electronic part for which credible evidence (including, but not limited to, visual inspection or testing) provides **reasonable doubt** that the electronic part is authentic.

DFARS 252.246-7007

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

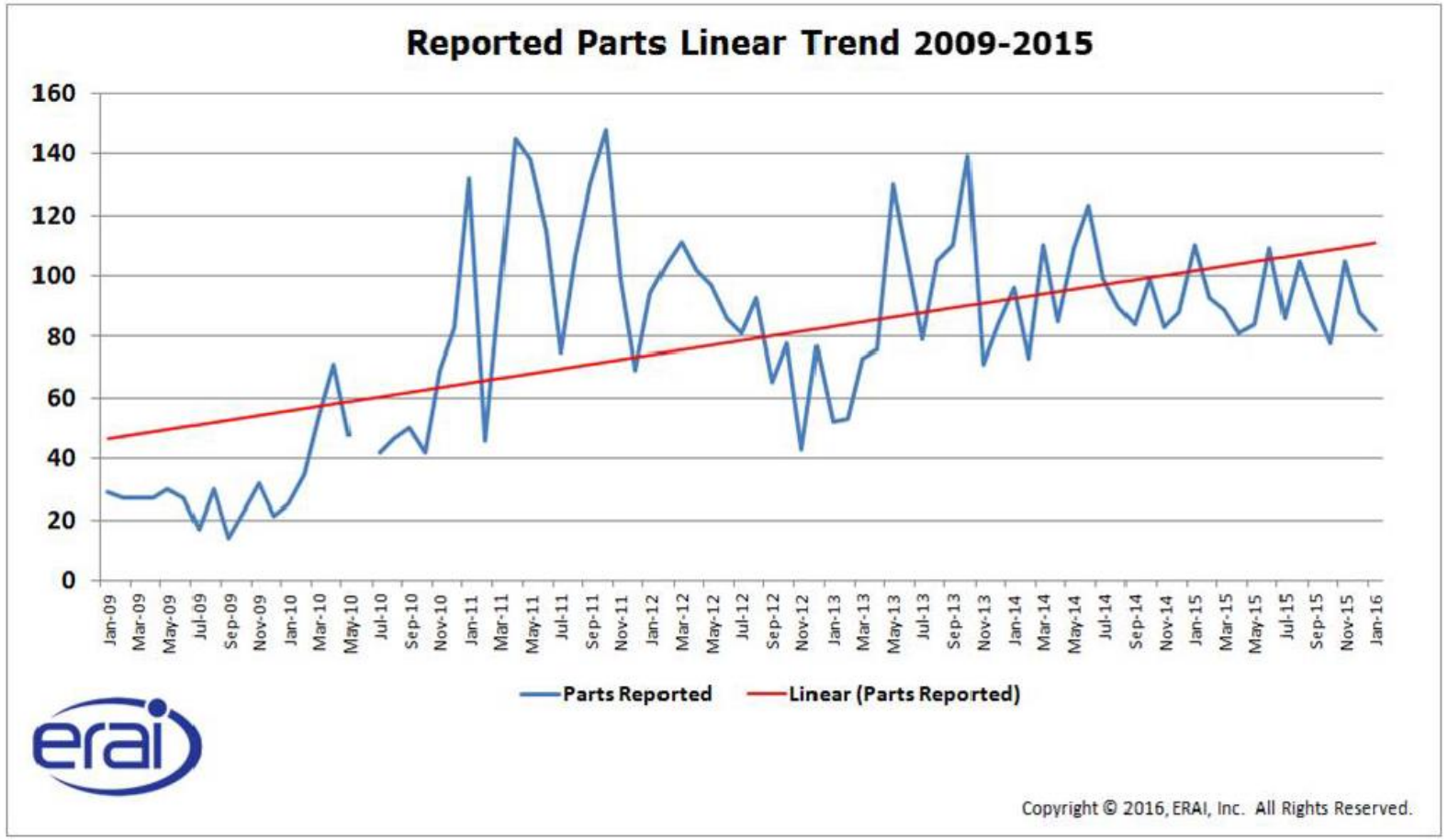
Examples of Counterfeit Parts

- Parts which do not contain the proper internal construction (die, manufacturer, wire bonding, etc.) consistent with the ordered part.
- Parts which have been used, refurbished or reclaimed, but represented as new product.
- Parts which have different package style or surface plating/finish than the ordered parts.
- Parts which have not successfully completed the Original Component Manufacturer's (OCM)'s full production and test flow, but are represented as completed product.
- Parts sold as upscreened parts, which have not successfully completed upscreening.
- Parts sold with modified labeling or markings intended to misrepresent the part's form, fit, function, or grade.

SAE AS5553 standard

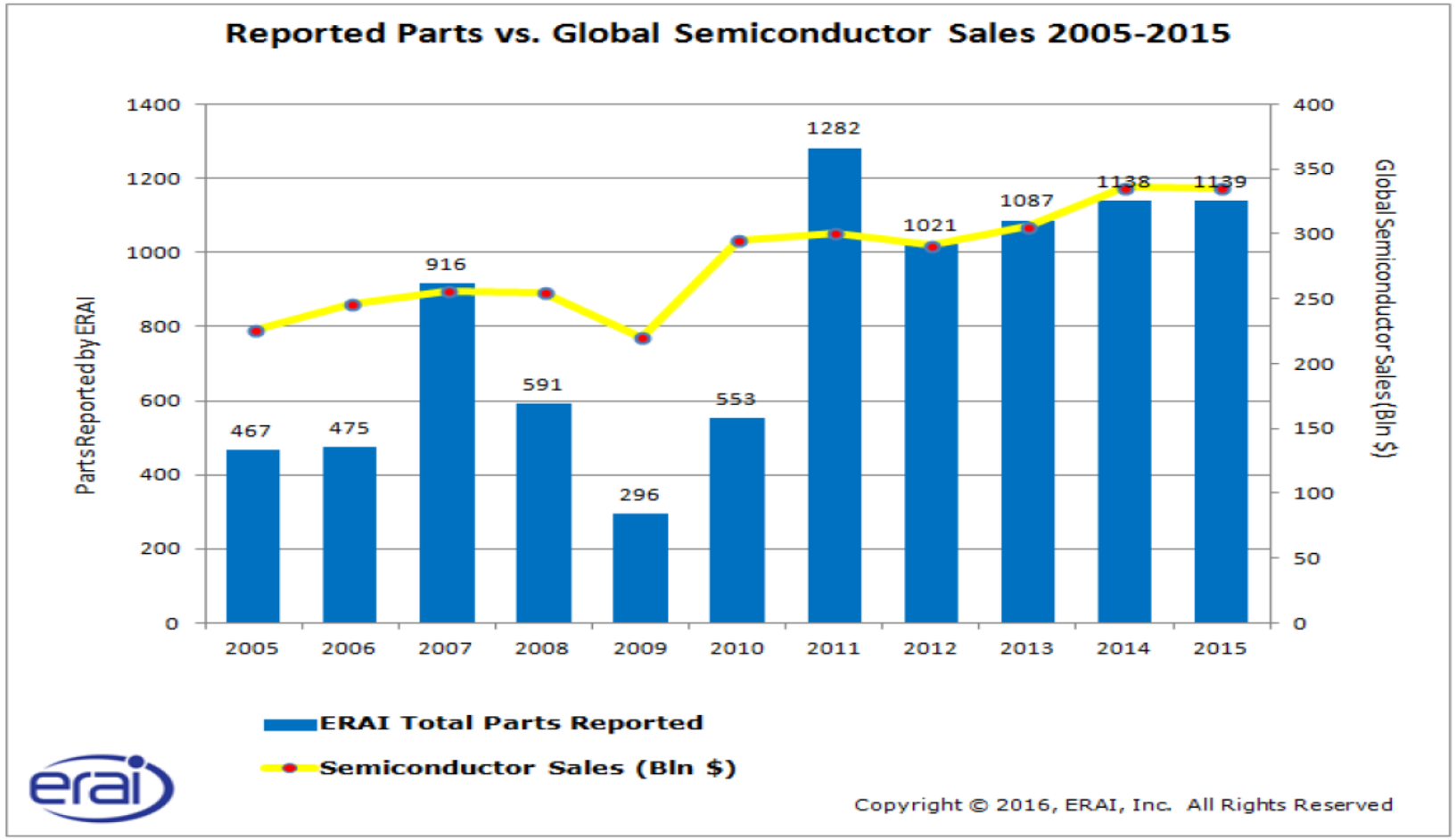
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

An Increasing Threat



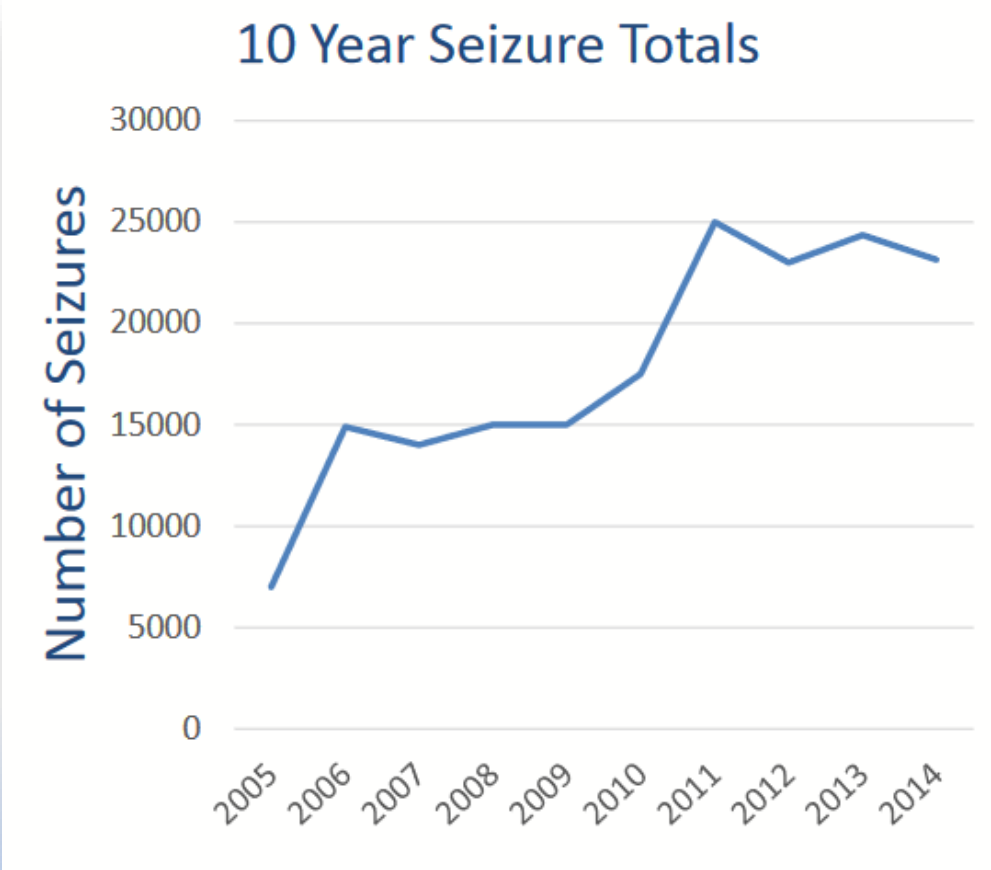
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Semiconductor sales continue to increase



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Total # of counterfeit seizures



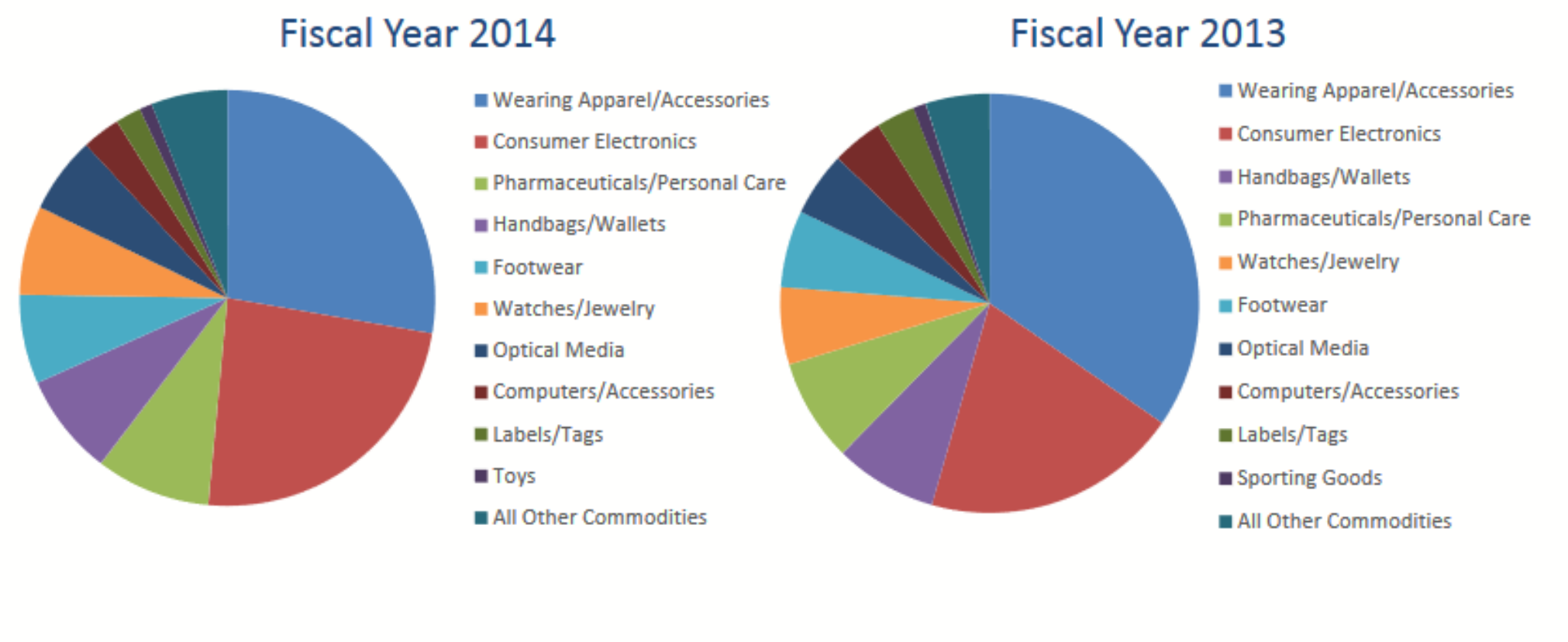
Courtesy: Homeland Security: IPR Seizures FY 2014

- Since 2009, counterfeit seizures have increased 40%
- Semiconductor enforcement focus led to 5% increase in seizures
- 23,140 seizures in FY2014
  - seaports, land borders, air, cargo, mail,

Customs

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

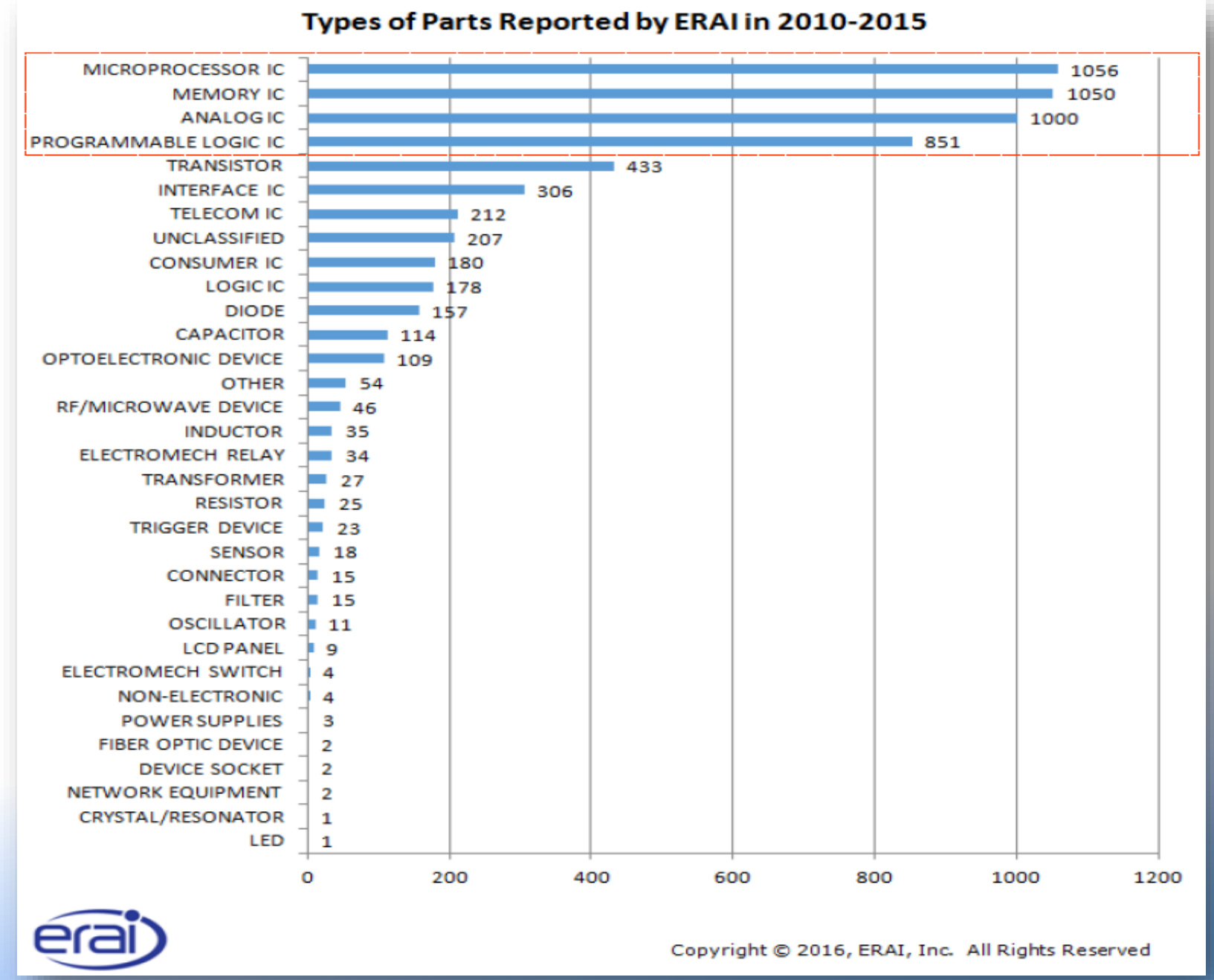
Types of counterfeit commodities



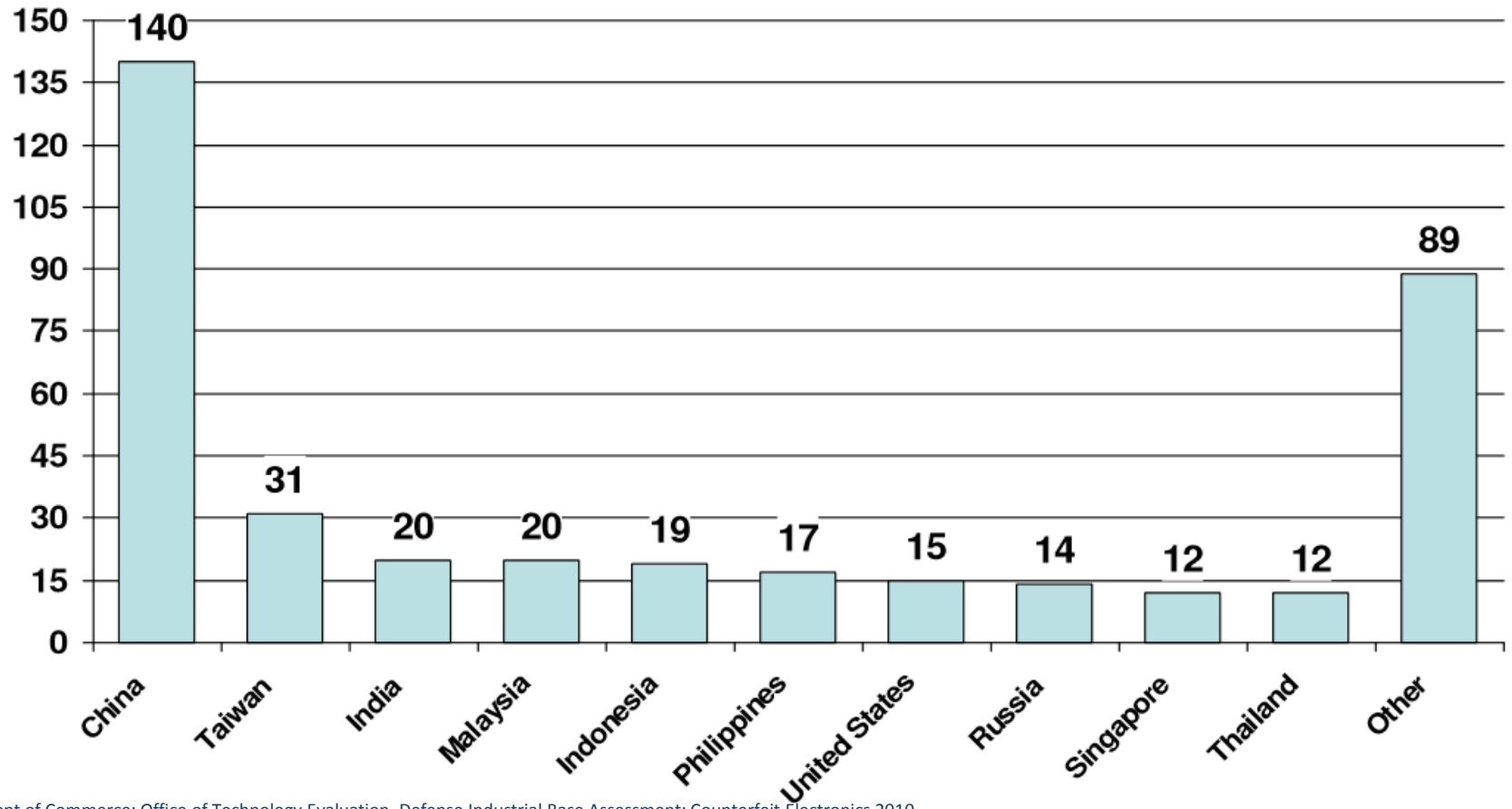
Courtesy: Homeland Security: IPR Seizures FY 2014

Customs

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED


Types of Parts Reported by ERAI in 2010-2015
MICROPROCESSOR IC 1056
MEMORY IC 1050
ANALOG IC 1000
PROGRAMMABLE LOGIC IC 851
TRANSISTOR 433
INTERFACE IC 306
TELECOM IC 212
UNCLASSIFIED 207
CONSUMER IC 180
LOGIC IC 178
DIODE 157
CAPACITOR 114
OPTOELECTRONIC DEVICE 109
OTHER 54
RF/MICROWAVE DEVICE 46
INDUCTOR 35
ELECTROMECH RELAY 34
TRANSFORMER 27
RESISTOR 25
TRIGGER DEVICE 23
SENSOR 18
CONNECTOR 15
FILTER 15
OSCILLATOR 11
LCD PANEL 9
ELECTROMECH SWITCH 4
NON-ELECTRONIC 4
POWER SUPPLIES 3
FIBER OPTIC DEVICE 2
DEVICE SOCKET 2
NETWORK EQUIPMENT 2
CRYSTAL/RESONATOR 1
LED 1
0
200
400
600
800
1000
1200
erai
Copyright © 2016, ERAI, Inc. All Rights Reserved

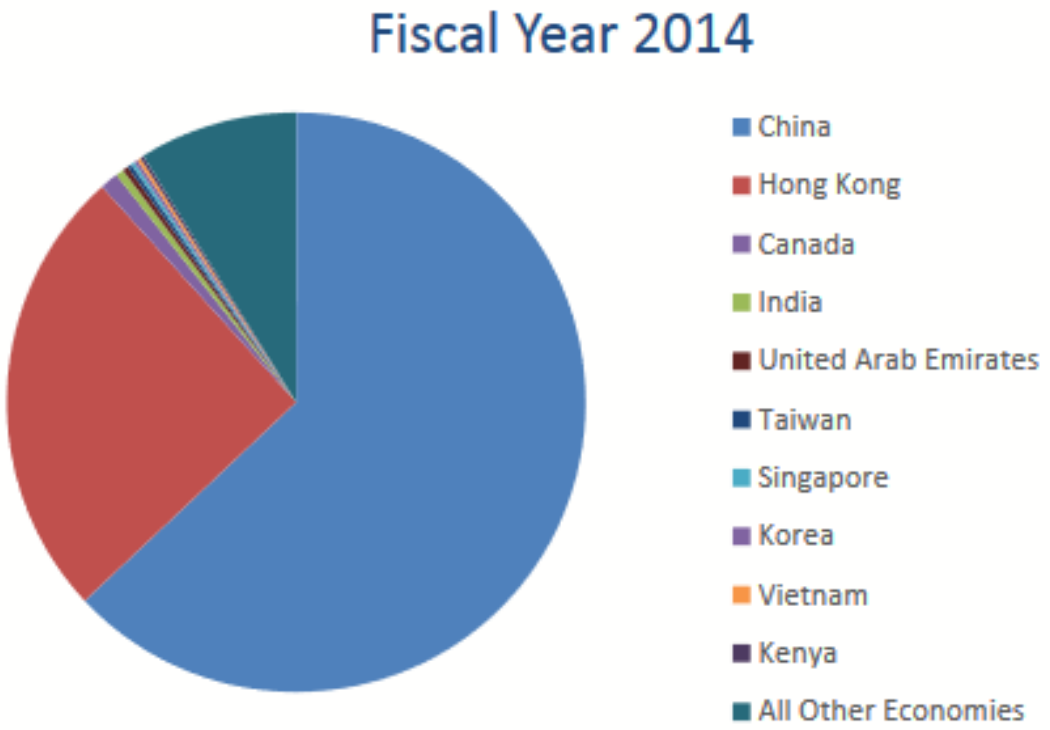
Top countries suspected/ confirmed to be Sources of Counterfeits

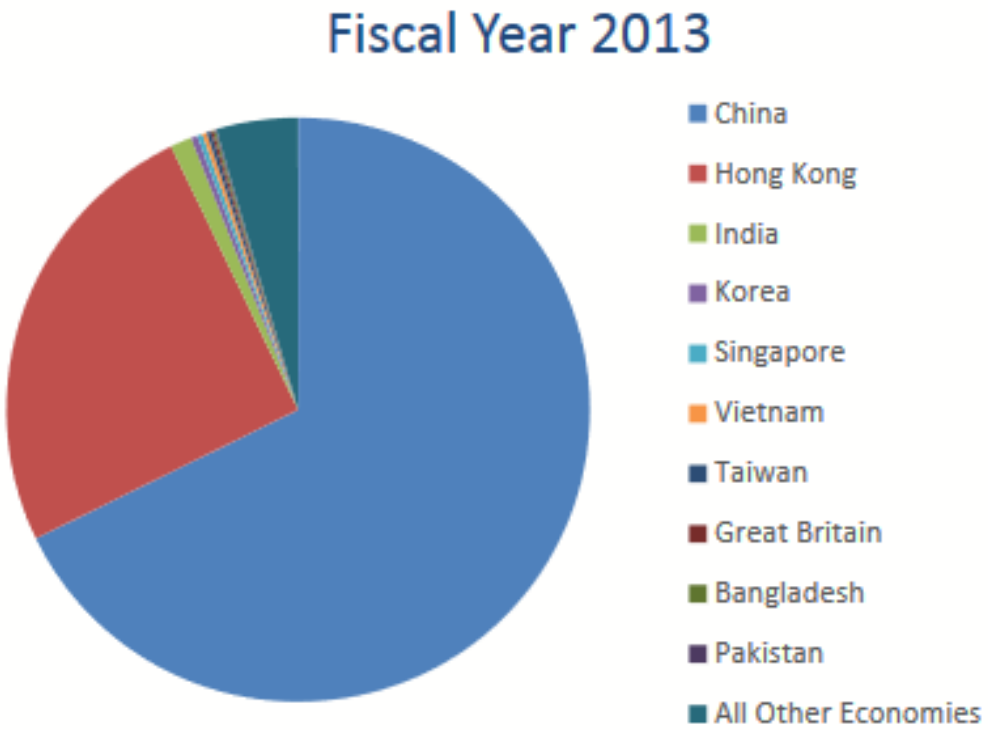


U.S. Dept of Commerce: Office of Technology Evaluation. Defense Industrial Base Assessment: Counterfeit Electronics 2010

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Top Countries with Homeland Seizures





Courtesy: Homeland Security: IPR Seizures FY 2014

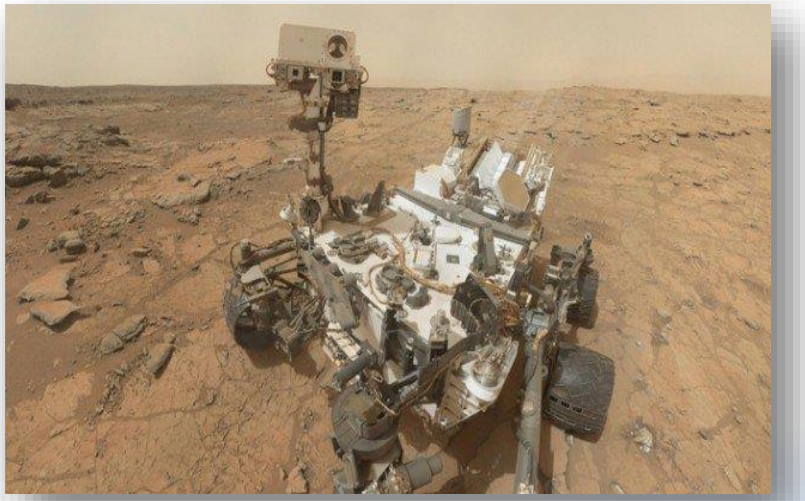
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Section 2-Identifying the Problem

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Which product is more likely to encounter counterfeit parts?

Military-design life of product outlives design of electronic parts. Components in jet fighters have short life time compared to use of aging systems.



Space-different risk profile compared to military, often build only 1 flight model. Projects primarily based on new design

Commercial-cellphone, computers, video game system products mirror part lifetime.

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Part obsolescence dilemma

- Semiconductor industry has grown 3x that of US economy overall last 10 years
- Increases in technology led to better speed and smaller size
- Parts cycle life have become significantly shorter than the life cycle of the product
- Projected lifecycles of electronic parts and components produced by industry can be as brief as two years.
  - The life cycle differences during design, requires designers be aware which parts will be available and which parts may be obsolete.
  - Systems may contain obsolescence problems before product is fielded and during field life
  - Led to a decline in military parts
- Obsolescence occurs when:
  - 1) Demand has dropped to low, mfg is no longer practical (discontinuance)
  - 2) Materials/ technologies no longer available

Electronic Part Life Cycle Concepts and Obsolescence Forecasting-IEEE Trans.

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Part Obsolescence

- Demand for critical systems designs with 20+ year life cycles > commercial ICs with 2-3 year product life cycles
  - Systems such as the F-15, which was put into service in 1975 and is scheduled to be in service till 2025, are used far after their original end-of-life projections.
  - The B-52, has an expected service life of 90 years and the F-16, which has been flying since the late 1970's, has no service termination date.

- It is typically less expensive to find part substitutions and aftermarket manufacturing for needed electronic parts than reengineering and redesign.

Photo courtesy: desertjet.com

Courtesy: SAE; Military Aerospace

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Who has the purchasing power?

									Totals
Segment	**Computer**	**Consumer**	**Telecom Subscriber**	**Telecom Infrastructure**	**Automotive**	**Industrial General**	**Industrial HiRel**	**Military**	
1999 Market	70,917	20,975	21,361	5,259	8,184	9,845	3,199	1,082	140,822
2000 Market	10,400	28,000	33,000	8,000	13,000	14,000	4,000	880	111,280
2001 Market	72,000	19,000	22,000	5,470	8,900	9,000	2,800	830	140,000
2002 Market	66,603	23,090	23,125	5,781	11,429	7,598	2,400	790	140,816
2003 Market	78,050	29,050	30,800	6,770	13,370	5,000	2,800	740	166,580
2004 Market	95,000	37,000	42,000	12,000	14,300	6,100	6,946	701	214,047
2005 Market	101,215	39,421	44,748	12,785	15,411	6,499	7,400	696	228,175
2006 Market	108,680	41,990	49,400	13,478	17,798	7,000	8,000	654	247,000
Percent of Market	**43.41**	**17.18**	**19.19**	**5.01**	**7.37**	**4.68**	**2.70**	**0.46**	1,388,720

Rochester Electronics: The Impact of Uncertified Parts in Military Applications

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Do you know where your parts come from?

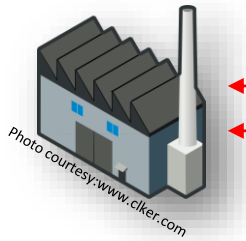
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Supply Chain Traceability

- Documented evidence of a part's supply chain history.
  - Supply chain intermediaries and significant handling transactions, such as from OCM to distributor, or from excess inventory to broker to distributor.
- Provides evidence where part was manufactured and who has "touched" the part before it is received into the hands of the customer.
  - Longer thread of intermediaries creates more risk
  - Harder to find traceability for >2nd tier subcontractor
  - Open market tends to provide limited traceability

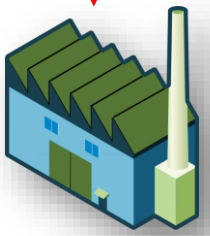
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Sources of Supply



Original Component Manufacturer (OCM)

Authorized/Franchised Supplier
-authorization contract
-controlled goods
-QMS certified
-warranty & manufacturer support, handling, traceability



Original Equipment Manufacturer (OEM)

Customer

Controlled Market

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Sources of Supply

- **ORIGINAL EQUIPMENT MANUFACTURER (OEM):** A company that manufactures products that it has designed from purchased components and sells those products under the company's brand name.

- **ORIGINAL COMPONENT MANUFACTURER (OCM):** An organization that designs and/or engineers a part and is pursuing or has obtained the intellectual property rights to that part.
  - The part and/or its packaging are typically identified with the OCM's trademark.
  - OCMs may contract out manufacturing and/or distribution of their product.
  - Different OCMs may supply product for the same application or to a common specification.

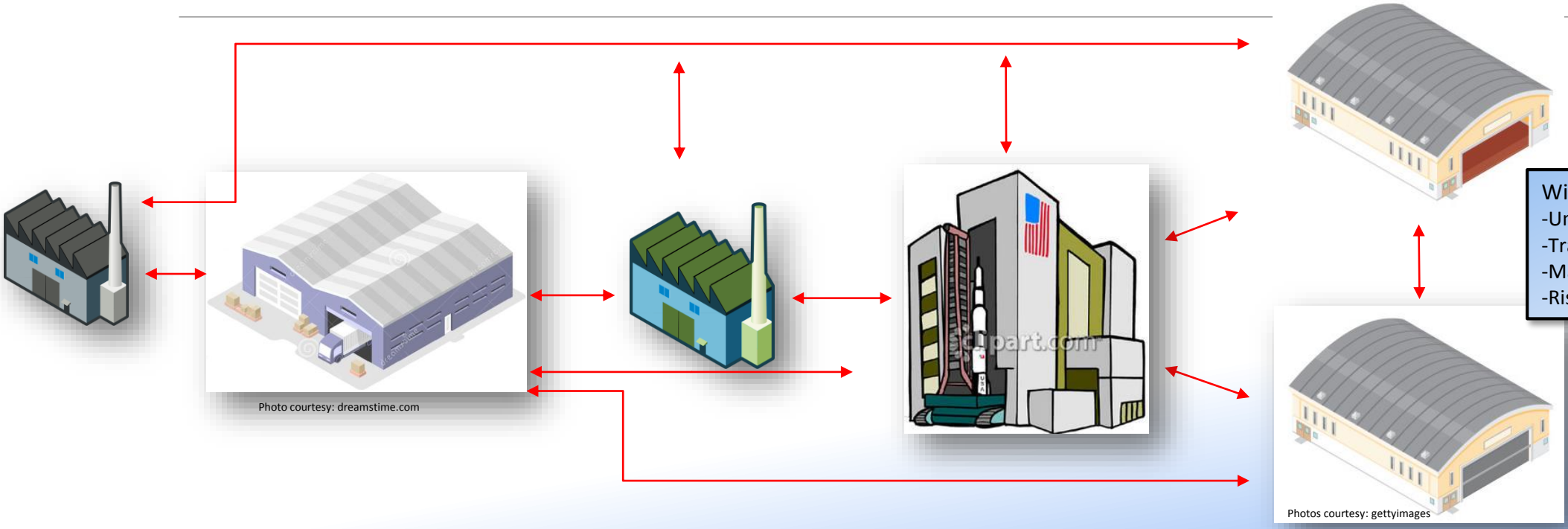
- **AUTHORIZED/FRANCHISED DISTRIBUTOR:** A distributor with which the OCM has a contractual agreement to buy, stock, re-package, sell and distribute its product lines. When a distributor does not provide products in this manner, then for the purpose of this document, the distributor is considered an independent distributor for those products. Franchised distributors normally offer the product for sale with full manufacturer flow-through warranty. Franchising contracts may include clauses that provide for the OCM's marketing and technical support inclusive of, but not limited to, failure analysis and corrective action, exclusivity of inventory, and competitive limiters.

- **AFTERMARKET MANUFACTURER**: Authorized by the OCM to produce and sell replacements parts, due to discontinuation of production of a part. Produces parts through emulation, reverse-engineering, or redesign, that match the OCM's specifications and satisfy customer needs without violating the OCM's intellectual property and intellectual property rights.

Courtesy: SAE AS6081

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Responsibility lies with the Purchaser



Wide Range of Suppliers
-Unknown handling
-Traceability may not exist
-Manufacturer Support unknown
-Risk-based Approach

Independent Distributors
(Stocking, Non-stocking, Brokers)

Controlled Market

Open Market

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

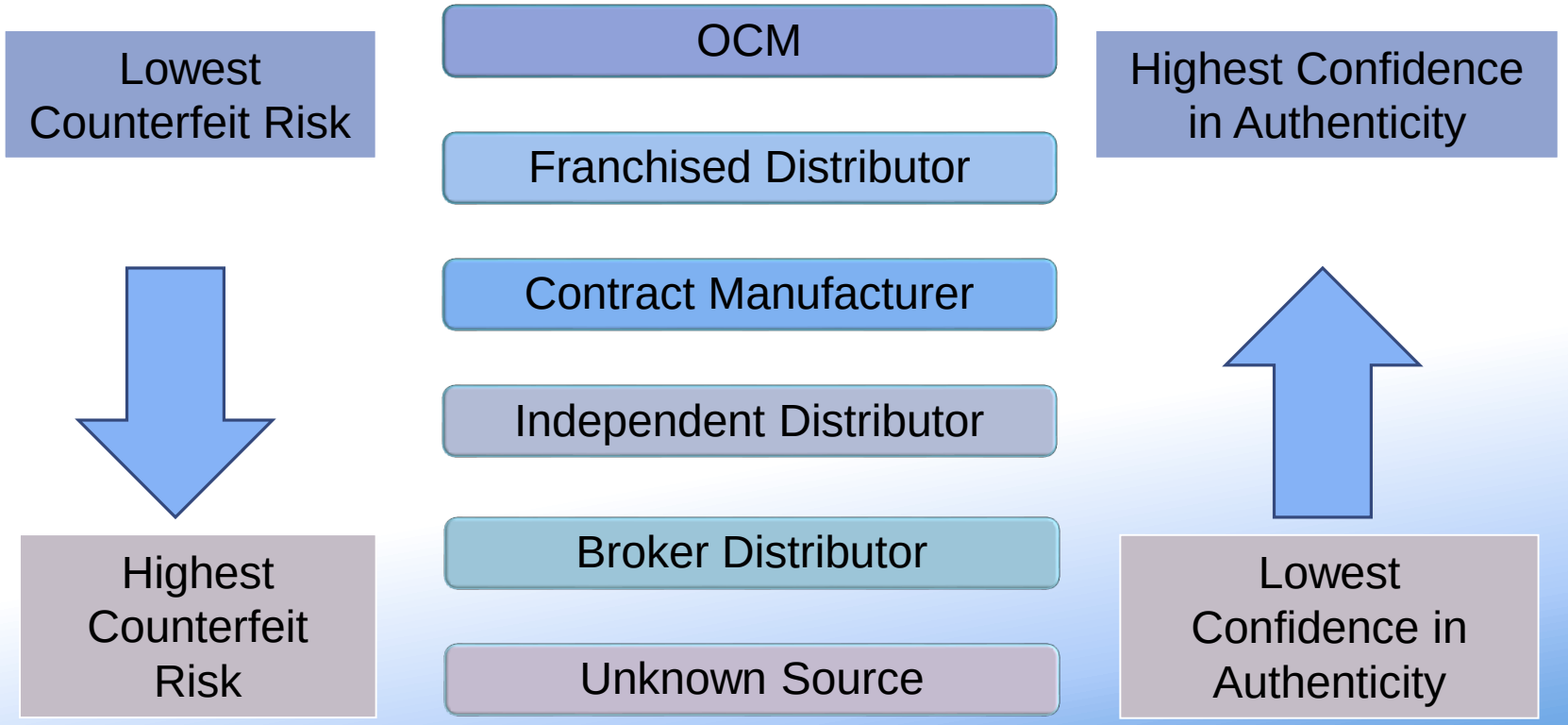
Sources of Supply

- **OPEN MARKET**: The trading market that buys or consigns primarily OEM and Contract Manufacturer's **excess** inventories of new electronic parts and subsequently utilizes these inventories to fulfill supply needs of other OEMs and contract manufacturers, often due to urgent or obsolete part demands.
- **INDEPENDENT DISTRIBUTOR**: A distributor that purchases parts with the intention to sell and redistribute them back into the market. Purchased parts may be obtained from Original Equipment Manufacturers (OEMs) or Contract Manufacturers (typically from excess inventories), or from other Distributors (Franchised, Authorized, or Independent). Resale of the purchased parts (redistribution) may be to OEMs, Contract Manufacturers, or other Distributors. Independent Distributors do not normally have contractual agreements or obligations with OCMs.
- **STOCKING DISTRIBUTOR**: A type of Independent Distributor that stocks large inventories typically purchased from OEMs and Contract Manufacturers. The handling, chain of custody, and environmental conditions for parts procured from Stocking Distributors are generally better known than for product bought and supplied by Broker Distributors.
- **BROKER DISTRIBUTOR**: A type of Independent Distributor that works in a "Just in Time" (JIT) environment. Customers contact the Broker Distributor with requirements identifying the part number, quantity, target price, and date required. The Broker Distributor searches the industry and locates parts that meet the target price and other Customer requirements.

Courtesy: SAE AS6081

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The “Procurement Decision”



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

SASC Investigation

- Investigation into counterfeit electronic parts in the DoDs supply chain, 2009-2011
- Many of the investigators pointed to China as a source for counterfeit electronics
- ASC staff were refused access to China
- Many of these parts came from resale points in the U.S., U.K., and Canada

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

SASC Investigation

- Investigation uncovered suspected counterfeit parts on mission computers for MDA missile, thermal weapons sights delivered to the Army and on military planes including C-17, C-130J, C-27J, and P-8A as well as on AH-64, SH-60B, and CH-46 helicopters.
- Identified 1,800 cases of counterfeiting
  - >1 million total suspected parts
  - Obsolete part numbers
  - Cost for replacement?
  - Parts sold by US companies originally from China!

Photo courtesy of: http://static.progressivemediagroup.com/uploads/imagelibrary/dfg.jpg

SASC Hearing

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

US Dept of Commerce Findings

- All orgs in supply chain have been directly impacted
- Record keeping on counterfeit findings is limited
- Incorrect assumption at others in supply chain are testing parts
- Most DOD orgs do not have counterfeit mitigation policies
- Lack of traceability is common
- Stricter testing and quality controls are required

Video

Courtesy: U.S. Department of Commerce, 2009

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Section 3 – the Extent of the Problem

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Electronics Waste

- E-waste is electronic products nearing the end of their "useful life."
  - Computers, televisions, VCRs, stereos, copiers, and fax machines are common electronic products.
  - Many of these products can be reused, refurbished, or recycled.
- Electronics Recycling is now the fastest growing solid waste stream in the world
  - EPA estimated 2012 E-waste at 3.4 million tons
    - Only 29.2% is recycled
  - EPA estimated 423k tons of computer disposed of in 2010
    - That's 51 million computers!

https://cdn2.sph.harvard.edu/wp-content/uploads/sites/59/2016/08/

http://www.calrecycle.ca.gov/Electronics/WhatisEwaste/

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The problem of E-waste

- Loopholes created in “loose” regulating policies and E-waste is shipped to other countries for cheap processing
- E-waste has “turned into an abundance of discrete electronic components and microcircuits for counterfeit parts” (Dept of Commerce)
- Refinished parts are slipped back into the supply chains which we have then procured

Photo courtesy of: http://discardstudies.files.wordpress.com/2012/03/ewaste-destinations.jpg

Source: EPA 530-R-11-002

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The problem of E-waste

- E-waste stream creates opportunities for counterfeiters
  - A rich material source of product at the end of service life
  - Counterfeiters re-mark recycled e-waste with different part numbers, recent date codes, uprated characteristics and return it to the supply chain
  - Multiple opportunities for the introduction of counterfeit parts into the supply chain
- the "Digital Dumping Ground"
  - http://www.pbs.org/frontlineworld/stories/ghana804/
  - E-waste

Source: the Basal Convention

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The problem of E-waste

Counterfeiting

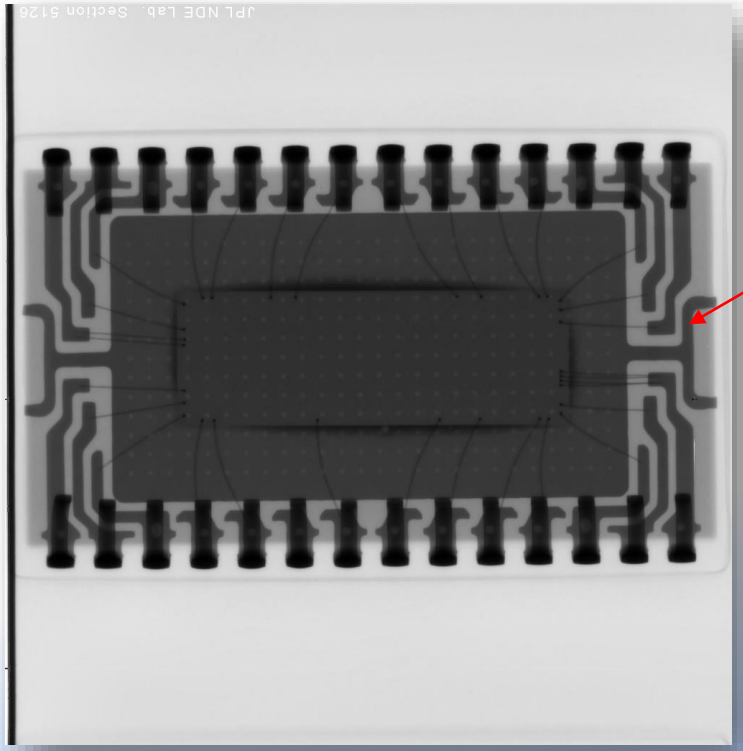
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

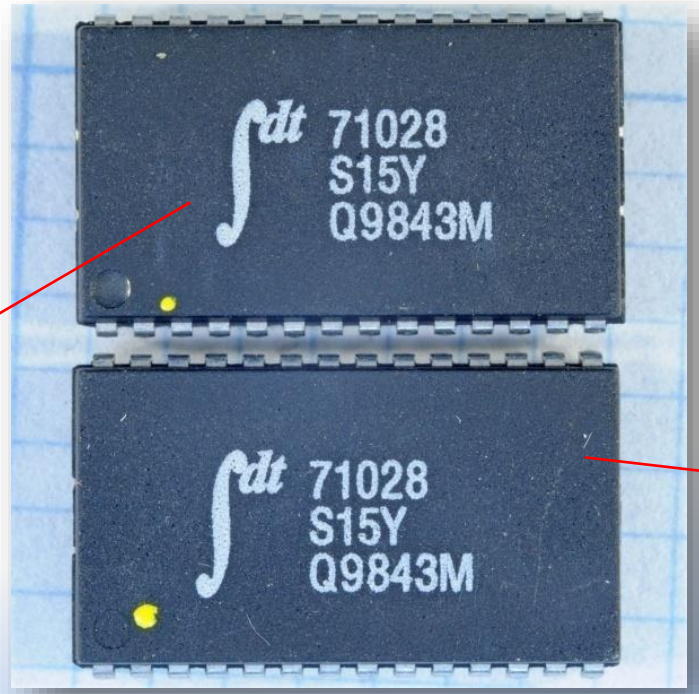
Stopping the flow of E-waste

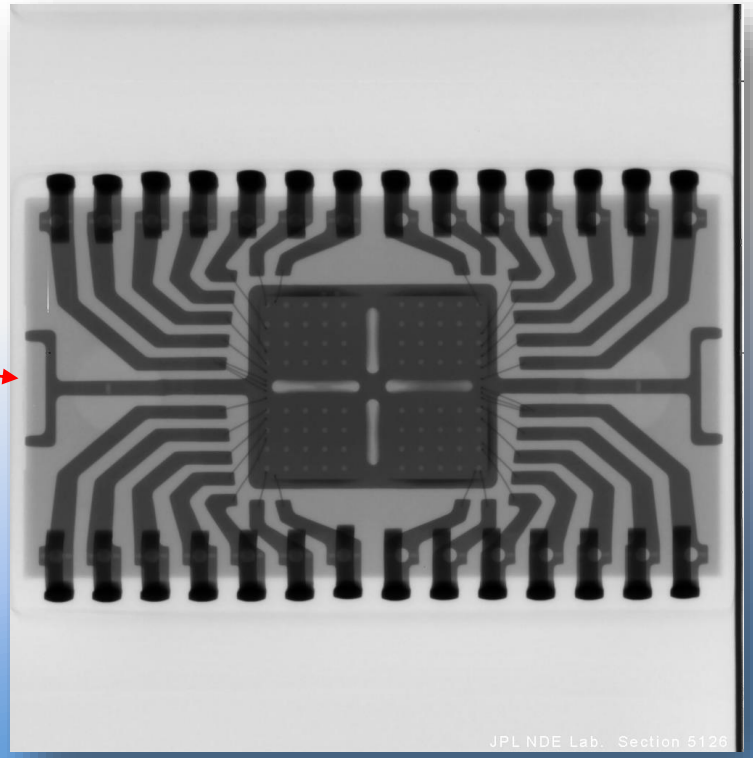
- Bills introduced requiring domestic recycling of all untested, nonworking electronics to countries that counterfeit electronics
  - Responsible Electronics Recycling Act- bill languishing in committee
  - Secure E-waste Export and Recycling Act (SEERA) – introduced June 2016

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

What's in the box?







COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Integrated Circuit Grade Markings and Testing

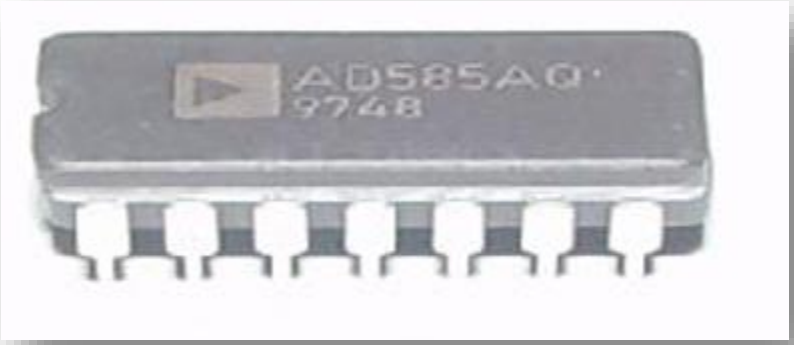
	Commercial	Industrial	Military
Temperature Testing (°F)	32 to 158	-40 to 221	-67 to 257
Vibration Testing	N	N	Y
ESD restrictions	Y	Y	Y
Additional Testing			Burn-In, Temperature Cycling, X-ray, additional testing dependent on MIL-STD requirements

Source: Criminal Case 10-245-PLF

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

False Advertising – Mil or Commercial

- Meets Requirements of DSCC specification 5962-87540
- Military Grade Quality Assurance Level
- Rated over a wider temperature range than commercial or industrial parts
- Costs more than industrial grade



- Industrial Grade IC
- Smaller temperature range
- Cost less money than the military grade

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

False Advertising – Mil or Commercial

1. SCOPE

1.1 Scope. This drawing describes device requirements for MIL-STD-883 compliant, non-JAN class level B microcircuits in ccordance with MIL-PRF-38535, appendix A.

1.2 Part or Identifying Number (PIN). The complete PIN is as shown in the following example:

5962-87540	01	C	X
Drawing number	Device type (see 1.2.1)	Case outline (see 1.2.2)	Lead finish (see 1.2.3)

1.2.1 Device type(s). The device type(s) identify the circuit function as follows:

Device type	Generic number	Circuit function
01	AD585	High speed, sample and hold amplifier

1.2.2 Case outline(s). The case outline(s) are as designated in MIL-STD-1835 and as follows:

Outline letter	Descriptive designator	Terminals	Package style
C	GDIP1-T14 or CDIP2-T14	14	Dual in line
2	CQCC1-N20	20	Square leadless chip carrier

1.2.3 Lead finish. The lead finish is as specified in MIL-PRF-38535, appendix A.

1.3 Absolute maximum ratings.

1.4 Recommended operating conditions.

Positive supply voltage ($+V_S$) ..... +5 V dc to +18 V dc
Negative supply voltage ($-V_S$) ..... -12 V dc to -18 V dc
Ambient operating temperature range (T_A) ..... -55°C to +125°C

ANALOG INPUT CHARACTERISTICS										
Offset Voltage			**5**			**2**			**2**	mV
Offset Voltage, T_{MIN} to T_{MAX}			6			3			**3**	mV
Bias Current			**2**			**2**			**2**	nA
Bias Current, T_{MIN} to T_{MAX}			5			5		20	**50**[2]	nA
Input Capacitance, f = 1 MHz		10			10			10		pF
Input Resistance, Sample or Hold 20 V p-p Input, A = +1		10^{12}			10^{12}			10^{12}		|
DIGITAL INPUT CHARACTERISTICS										
TTL Reference Output	**1.2**	1.4	**1.6**	**1.2**	1.4	**1.6**	**1.2**	1.4	**1.6**	V
Logic Input High Voltage T_{MIN} to T_{MAX}	2.0			2.0			**2.0**			V
Logic Input Low Voltage T_{MIN} to T_{MAX}			0.8			0.8			**0.7**	V
Logic Input Current (Either Input)			**50**			**50**			**50**	∝A
POWER SUPPLY CHARACTERISTICS										
Operating Voltage Range	+5, –10.8		±18	+5, –10.8		±18	+5, –10.8		±18	V
Supply Current, R_L = °	**6**		**10**	**6**		**10**	**6**		**10**	mA
Power Supply Rejection, Sample Mode	**70**			**70**			**70**			dB
TEMPERATURE RANGE										
Specified Performance	0		+70	–25		+85	–55		+125	℃
PACKAGE OPTIONS[3,4]										
Cerdip (Q-14)					AD585AQ			AD585SQ		
LCC (E-20A)								AD585SE		
PLCC (P-20A)		AD585JP								

NOTES
[1]Maximum input signal is the minimum supply minus a headroom voltage of 2.5 V.
[2]Not tested at –55℃.
[3]E = Leadless Ceramic Chip Carrier; P = Plastic Leaded Chip Carrier; Q = Cerdip.
[4]For AD585/883B specifications, refer to Analog Devices Military Products Databook.

Specifications subject to change without notice.
Specifications shown in **boldface** are tested on all production units at final electrical test. Results from those tests are used to calculate outgoing quality levels.
All min and max specifications are guaranteed, although only those shown in **boldface** are tested on all production units.

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

False Advertising – Mil or Commercial

- Pricing through Analog Devices site:
  - Military Grade >60 dollars more expensive
- Counterfeiters will falsify documents saying your purchasing a military grade when its actually commercial grade

SAMPLES & PURCHASE | PACKAGING

AD585 Model Options

Model	Status	Package	Pins	Temp. Range	Price* (100-499)	Price* (1000 pcs.)	Packing / Qty
5962-87540012A	Prodn	20 ld LCC	20	Mil	$79.75	$72.08	Tube, 54
5962-8754001CA	Prodn	14 ld CerDIP	14	Mil	$84.32	$76.21	Tube, 25
AD585ACHIPS	Prodn	CHIPS OR DIE	-	Ind	$10.35	$10.30	Tray, 100
AD585AQ	Not Rec**	14 ld CerDIP	14	Ind	$22.43	$20.30	Tube, 25
AD585JP	Not Rec**	20 ld PLCC	20	Comm.	$20.53	$18.55	Tube, 49
AD585JP-REEL	Not Rec**	20 ld PLCC	20	Comm.	-	$18.55	Reel, 1000
AD585JP-REEL7	Contact ADI	20 ld PLCC	20		-	-	Reel, 250
AD585JPZ	Not Rec**	20 ld PLCC	20	Comm.	$18.70	$16.91	Tube, 49
AD585JPZ-REEL7	Not Rec**	20 ld PLCC	20	Comm.	-	$16.91	Reel, 250
AD585SCHIPS	Prodn	CHIPS OR DIE	-	Mil	$36.77	$36.77	Tray, 100
AD585SE	Prodn	20 ld LCC	20	Mil	$59.81	$54.04	Tube, 54
AD585SE/883B	Prodn	20 ld LCC	20	Mil	$80.68	$72.92	Tube, 54
AD585SQ	Prodn	14 ld CerDIP	14	Mil	$62.04	$56.10	Tube, 25
AD585SQ/883B	Prodn	14 ld CerDIP	14	Mil	$80.65	$72.91	Tube, 25

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Clones

Cloned Part: The complete manufacture of a reverse engineered device to have the same form, fit, and function as the original. Devices are produced on low end equipment and will not meet the original reliability requirements. Devices are branded and sold as Original Component Manufacturer (OCM) parts

SMT-Cloning

Courtesy: iNEMI, “Development of a Methodology to Determine Risk of Counterfeit Use” by Mark Schaffer

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Returns

Authentic

- Properly marked
- Similar vintage and configuration as the fake part

Counterfeit

- Counterfeit logo
- Incorrect fonts & format
- Wrong ink

- At any moment parts leave hands, this creates risk
- Must have procedures in place, to verify your are receiving the same product back into stock
- Some suppliers are no longer selling previously returned items to aerospace/ space flight industry

Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Returns

Authentic

- Bottom markings in black validate configuration, serial number, and date code

Counterfeit

- Bottom markings removed

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Returns

- Supplier unknowingly returned bad parts switched out by customer.
- Parts then sent to new customers who caught the discrepancies
- Some suppliers are no longer selling previously returned items to aerospace/ space flight industry

GOVERNMENT - INDUSTRY DATA EXCHANGE PROGRAM

PROBLEM ADVISORY

1. TITLE *(Class, Function, Type, etc.)* Suspect Counterfeit, Microcircuit, +5V CMOS, RS-232 100KBPS, Transceiver with 2 Drivers/Receivers		2. DOCUMENT NUMBER 3. DATE *(DD-MMM-YY)*
4. MANUFACTURER AND ADDRESS	5. PART NUMBER ADM232LARZ	6. NATIONAL STOCK NUMBER Not Available
	7. SPECIFICATION Not Available	8. GOVERNMENT PART NUMBER Not Available
	9. LOT DATE CODE START 1108	10. LOT DATE CODE END 1108
11. MANUFACTURER'S POINT OF CONTACT	12. CAGE	13. MANUFACTURER'S FAX
14. MFR. POC PHONE	15. MANUFACTURER'S E-MAIL	
16. SUPPLIER	17. SUPPLIER ADDRESS San Diego, CA	18. SUPPLIER CAGE

19. PROBLEM DESCRIPTION / DISCUSSION / EFFECT

Supplier is an authorized distributor of OCMs products which were originally shipped to Customer . Supplier shipped ADM232LARZ parts acquired directly from OCMs to Customer . Based on this shipment and upon Customer request, Supplier later issued a Return Material Authorization (RMA) to Customer . Customer shipped 200 pieces of part number ADM232LARZ to Supplier on an RMA. These parts were received into inventory and subsequently re-shipped to two customers: 94 pieces to Customer A and 106 pieces to Customer B. Customer B advised Supplier that they had received non-conforming ADM232LARZ parts and sent a photo of the non-conforming parts. Customer B also contacted OCMs and submitted a photo for review and requested product change notices for the non-conforming parts. Supplier also contacted OCMs and in response to Supplier request, OCMs advised Supplier that the date code on the non-conforming parts indicated that these parts had never been shipped by OCMs to Supplier

Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Value added processes

- Any value added process sent out to another company creates risk
  - Such as further part level testing
  - MFG processes
- Some test house are soliciting cheaper test houses to do their contracted testing w/o notifying the customer
- Falsified Test Reports
  - 19% of companies contracting test houses had problems with counterfeit testing

Photo courtesy: engineeredtaxsolutions

Courtesy: U.S. Department of Commerce, 2009

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Commercial off the Shelf (COTS) items

- Goods and services bought and used under a federal contract available from the commercial marketplace

- Benefits of using COTS:
  - Reduced development time and delivery schedule
  - Reduction of cost, low cost alternative to full mil-spec parts
  - Alternative to custom-built parts
  - New generation of leading COTS IC technologies introduced every 3 years

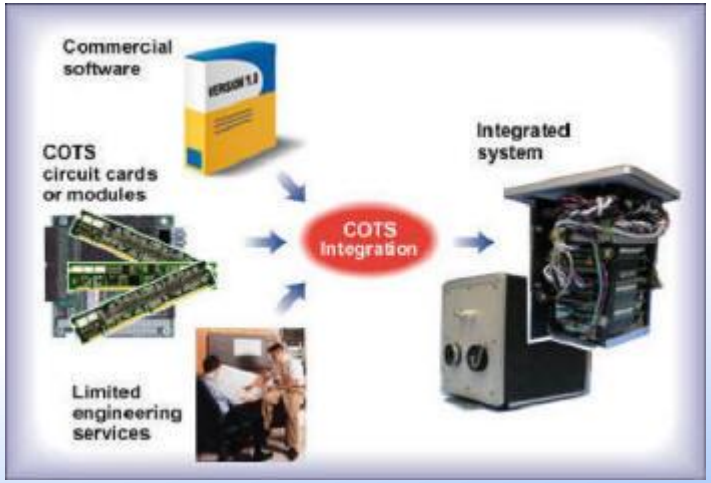


Photo courtesy: swri.org

Source: COTS: Reliability Concerns

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Commercial off the Shelf (COTS) items

- Risks of costs
  - Security vulnerabilities
  - Traceability may not exist
  - Vendor's business practices
    - Vendor may reject customers procurement requirements
    - At the mercy of commercial suppliers economic decisions
  - Little technical data provided
    - Not held to military specs
  - Not been designed or qualified for military market
    - Cannot upgrade to mil temperature range
  - Supplier selection can be risky
  - Obsolescence (Military v Space)

Photo courtesy: ginaabudi.com

Source: COTS: Reliability Concerns

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Section 4 – Risk Mitigation

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The importance of a risk mitigation plan

Created in response to significant and increasing risk of counterfeit electronic parts entering our supply chain

Risks posed:

- Performance/ Reliability
- Cost/ Schedule

Photo courtesy of: http://bayintegratedmarketing.files.wordpress.com/2012/07/parts.jpg?w=645

Photo courtesy of: http://static.progressivemediagroup.com/uploads/imagelibrary/dfg.jpg

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Key Counterfeit Part Mitigation Areas

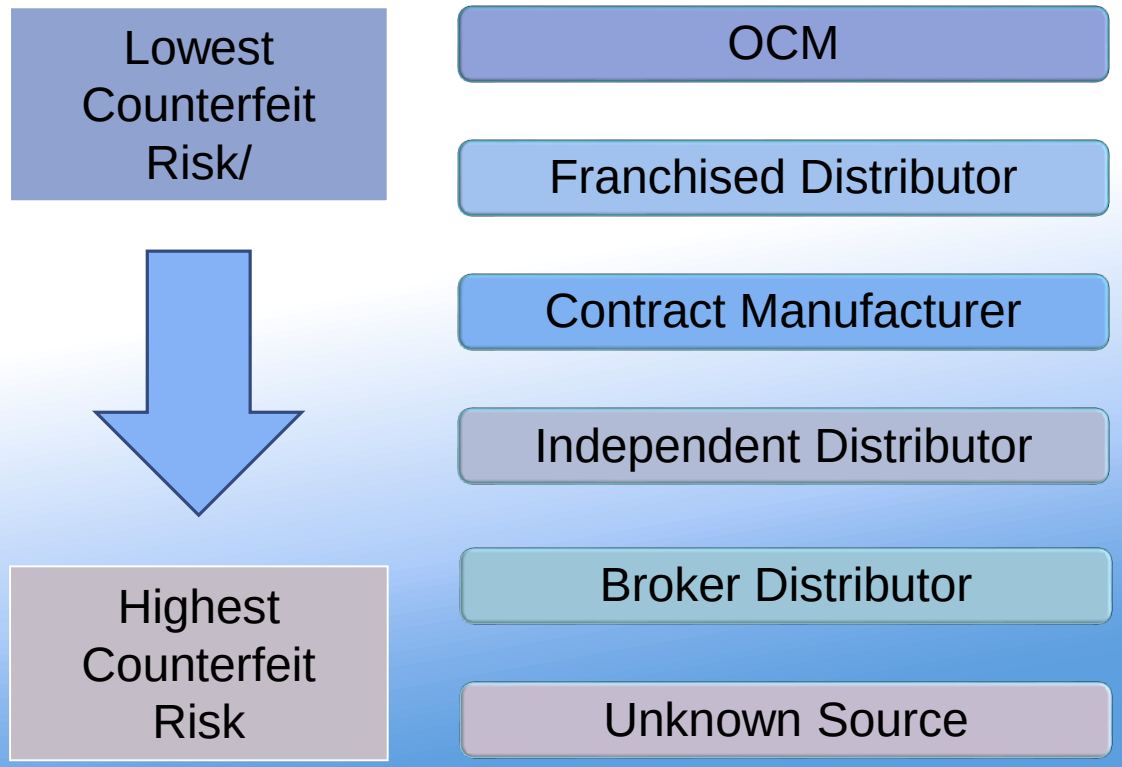
Develop standardized requirements, practices, and methods pertaining to:

Source: NPD 8730.2 NASA Parts Policy

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Supplier Management

- Assuring our approved suppliers are maintaining effective processes for mitigating the risks of supplying counterfeit electronic parts includes:
  - On-site audits (QMS, counterfeit)
  - Analysis of supplier data/ trends
  - Managing your supplier list
- Suppliers must demonstrate quality control, main source documentation history, and possess necessary certifications



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Know your Suppliers, and their Suppliers

- Audits can reduce the risk of:
  - Breaking the chain of traceability of parts
    - Returns process
    - Outsourcing of work
    - Weak supplier selection process
    - Procurement of counterfeit parts
  - Failure to detect and inspect counterfeit parts
  - Process in place is non-existent or inadequate in responding to counterfeit parts
  - Personnel unaware of counterfeit parts issue

- There is NO alternative to supply chain management and mitigation

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Assessing Independent Distributors

Supplier A

Supplier B

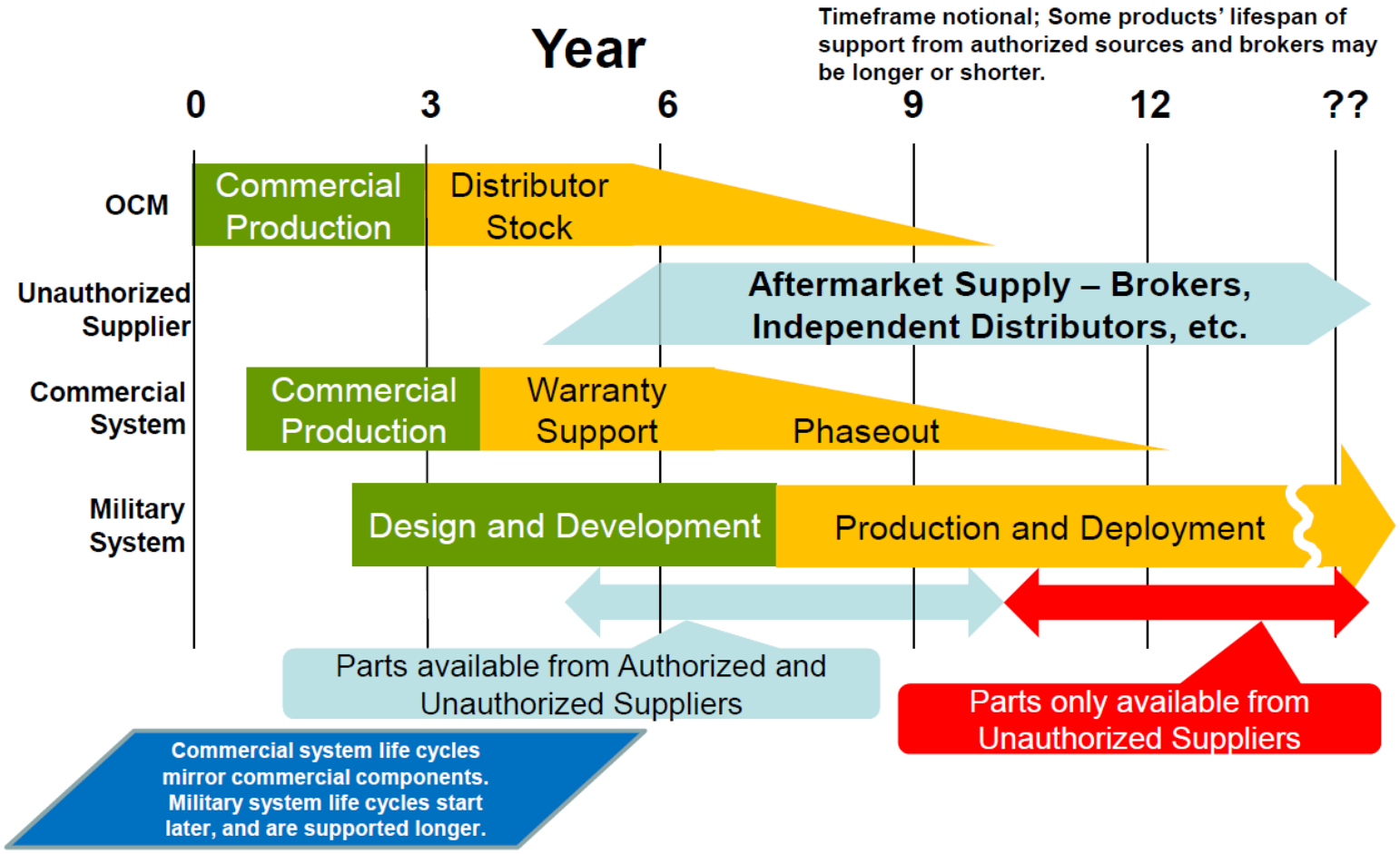
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Parts Availability Management

- Parts specialists review parts lists based upon part availability
  - OCM and authorized suppliers only
  - Identify multiple sources for parts
  - Schedule lead times
  - Track life cycle of parts
  - Product substitutions

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Parts Availability Management



Courtesy: MDA Counterfeit Part Training

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Parts Availability Management

- Many obsolescence mitigation approaches are being used:
  - Lifetime or last time purchase
  - Redesign (upgrading the system to make use of newer technology)
  - Aftermarket sources
  - Emulation (using newer technologies)
  - Reclaim
  - Uprating. Using parts outside of their manufacturer specified environmental range

- In the cases where obsolete electronic components are required, which are no longer in production and must be procured from non-authorized sources, there are significant requirements for both authentication and functional testing.

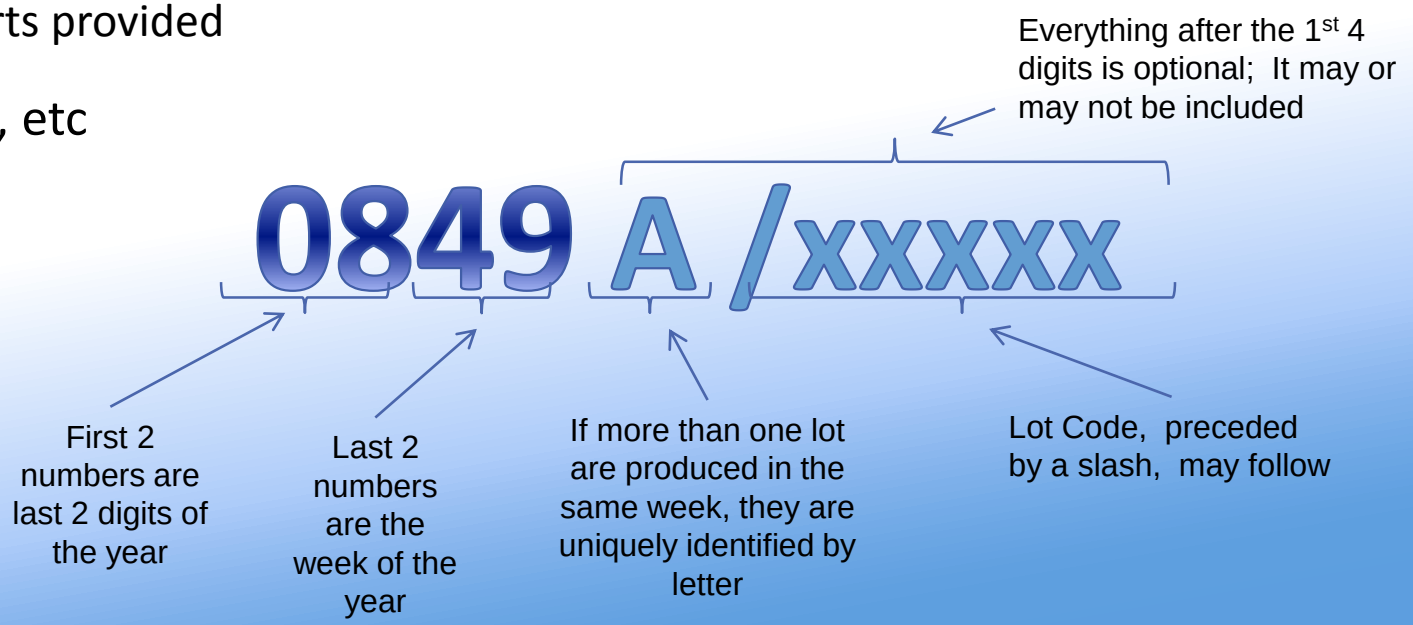
Electronic Part Life Cycle Concepts and Obsolescence Forecasting-IEEE Trans.

www.nationaldefensemagazine.org/archive/2016/Mar

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Product Assurance & Inspection

- Inspection for all received flight parts
- Verify receipt of documentation (i.e. CofC, purchase order, packing list) to confirm authentic conforming parts and traceability to MFG
  - Traceable to specific manufacturer, part number, date code, lot number, and/or serial #'s
  - Assure QC's met and test/ material certs provided
- Visual, dimensional, electrical testing, etc
- Failure Analysis Lab
- Trust buy verify



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

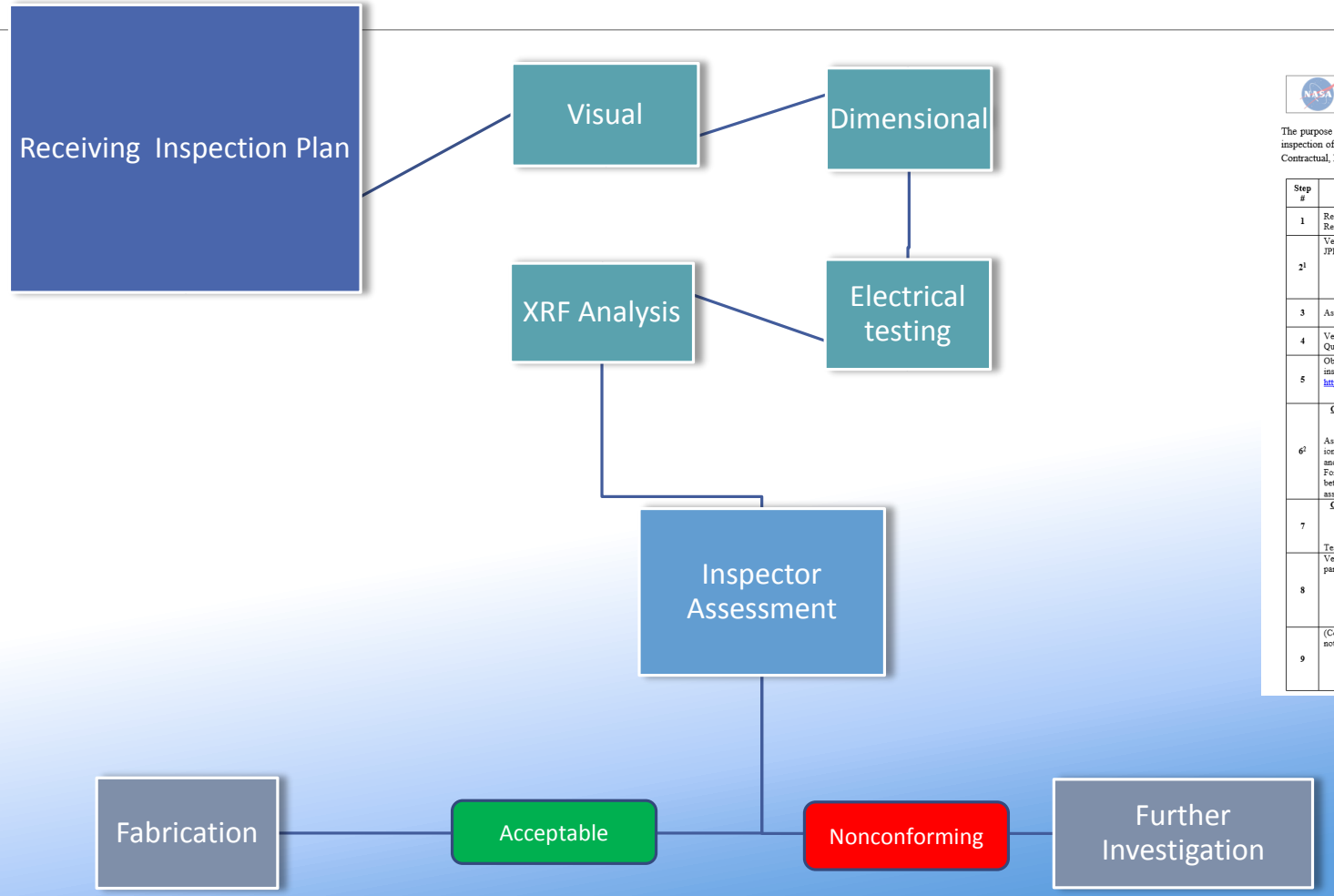
Product Assurance & Inspection

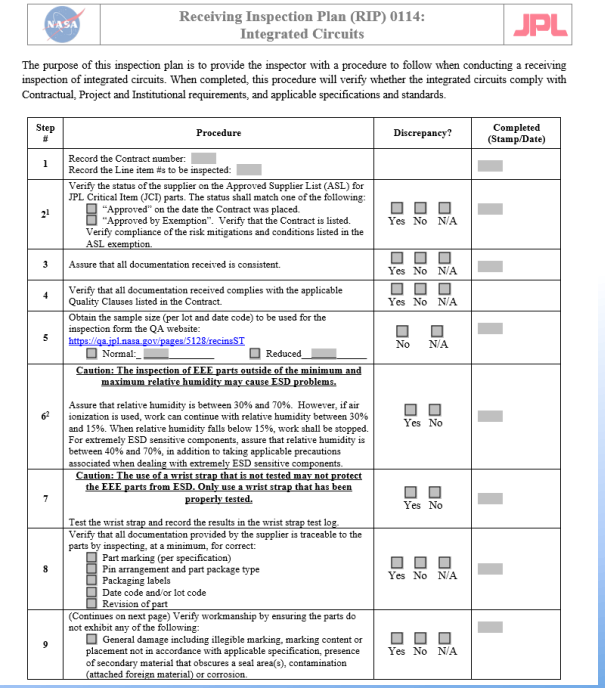
- The Magic Part
  - Date code indicates:
    - Part was made in November of 2003 (47th week of 2003)
  - Part was received on June 3, 2003

Part marked with a date code five months into the future compared to the date of the receipt

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Product Assurance & Inspection





Receiving Inspection Plan (RIP) 0114: Integrated Circuits

The purpose of this inspection plan is to provide the inspector with a procedure to follow when conducting a receiving inspection of integrated circuits. When completed, this procedure will verify whether the integrated circuits comply with Contractual, Project and Institutional requirements, and applicable specifications and standards.

Step #	Procedure	Discrepancy?	Completed (Stamp/Date)
1	Record the Contract number: ____ Record the Line item #s to be inspected: ____		____
2[1]	Verify the status of the supplier on the Approved Supplier List (ASL) for JPL Critical Item (JCI) parts. The status shall match one of the following: ☐ "Approved" on the date the Contract was placed. ☐ "Approved by Exemption". Verify that the Contract is listed. Verify compliance of the risk mitigations and conditions listed in the ASL exemption.	☐ Yes ☐ No ☐ N/A	____
3	Assure that all documentation received is consistent.	☐ Yes ☐ No ☐ N/A	____
4	Verify that all documentation received complies with the applicable Quality Clauses listed in the Contract.	☐ Yes ☐ No ☐ N/A	
5	Obtain the sample size (per lot and date code) to be used for the inspection form the QA website: https://qa.jpl.nasa.gov/pages/5128/recinsST ☐ Normal:_____ ☐ Reduced_____	☐ No ☐ N/A	____
6[2]	**Caution: The inspection of EEE parts outside of the minimum and maximum relative humidity may cause ESD problems.** Assure that relative humidity is between 30% and 70%. However, if air ionization is used, work can continue with relative humidity between 30% and 15%. When relative humidity falls below 15%, work shall be stopped. For extremely ESD sensitive components, assure that relative humidity is between 40% and 70%, in addition to taking applicable precautions associated when dealing with extremely ESD sensitive components.	☐ Yes ☐ No	____
7	**Caution: The use of a wrist strap that is not tested may not protect the EEE parts from ESD. Only use a wrist strap that has been properly tested.** Test the wrist strap and record the results in the wrist strap test log.	☐ Yes ☐ No	____
8	Verify that all documentation provided by the supplier is traceable to the parts by inspecting, at a minimum, for correct: ☐ Part marking (per specification) ☐ Pin arrangement and part package type ☐ Packaging labels ☐ Date code and/or lot code ☐ Revision of part	☐ Yes ☐ No ☐ N/A	____
9	(Continues on next page) Verify workmanship by ensuring the parts do not exhibit any of the following: ☐ General damage including illegible marking, marking content or placement not in accordance with applicable specification, presence of secondary material that obscures a seal area(s), contamination (attached foreign material) or corrosion.	☐ Yes ☐ No ☐ N/A	____

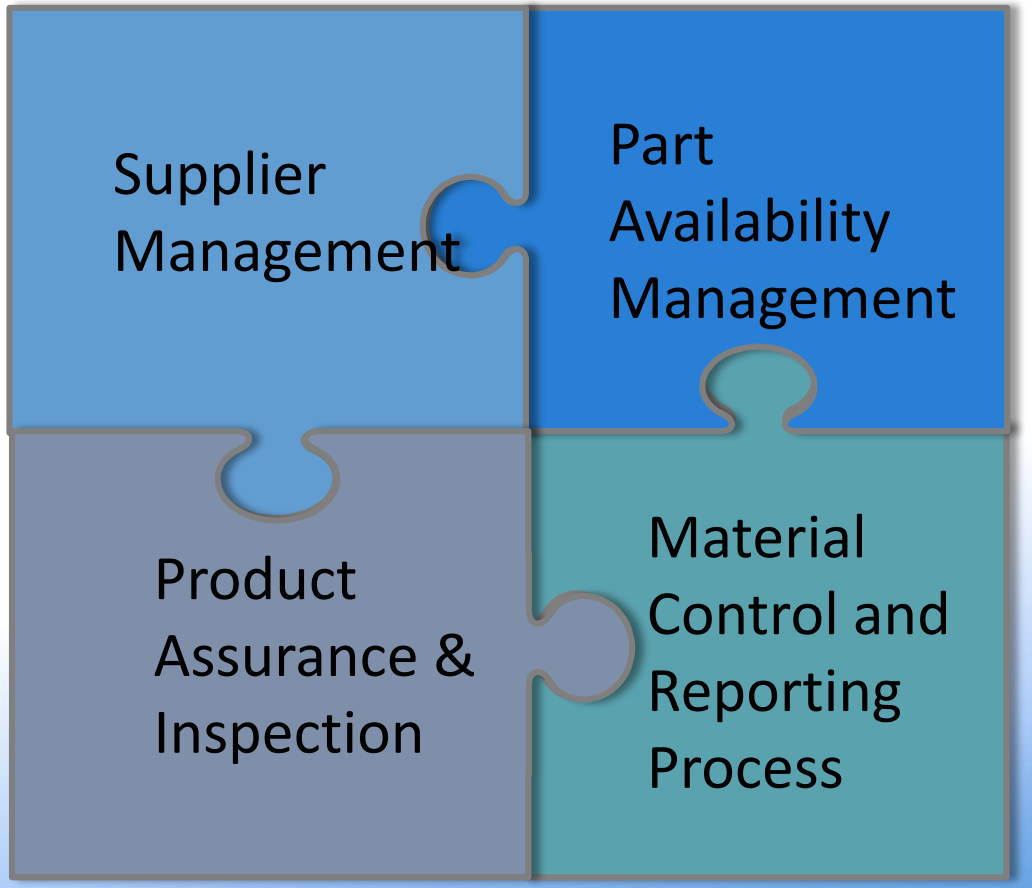
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Material Control and Reporting Process

- Parts identified as suspect are tagged and segregated
- Further work can include further part testing/ assessment and communication with the supplier or OCM
- Suspect or counterfeit parts place on “hold”
- Counterfeit parts are reported to the NASA Office of Inspector General and the NASA Director, Acquisition Integrity Program (AIP).
  - Reported in accordance with NASA GIDEP Advisory Program
  - Turn in counterfeit parts to investigative authorities

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Key Counterfeit Part Mitigation Areas



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Section 5 – Government/ Industry Flowdowns

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

NASA Flowdowns

- Administrator shall plan, develop and implement a program to detect, track, catalog, and reduce the number of counterfeit electronic parts
  - Counterfeit part identification:
    - Educate employees to identify counterfeit parts and procedures to follow if they suspect part is counterfeit
    - Update employees on new threats, identification techniques, and reporting requirements
  - Internal database to track all suspected and counterfeit parts
    - Supplier Assessment System (SAS) and GIDEP
  - Process to report counterfeit parts to law enforcement agencies and other databases
- NASA Part Policy 8730.2
  - Policy to control risk and enhance reliability in NASA flight and critical ground support/ test systems by managing selection, acquisition, traceability, testing, handling, packaging, storage.
    - Parts Availability Process, Procurement Process, Product Assurance Process, Material Control and Disposition Process, and Reporting Process

Courtesy: NASA Act 2010

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Defense Federal Acquisition Regulation Supplement (DFARS) Flowdowns

- Concerns over counterfeit part proliferation in U.S. government supply chain led to proposing of regulations through DFARS
  - the cost of counterfeit electronic parts and suspect counterfeit electronic parts and the cost of rework or corrective action that may be required to remedy the use or inclusion of such parts are not allowable costs under Department contracts
  - Requires CAS contractors to develop risk-based policies/ procedures that address 12 criteria
    - Training, inspection, part traceability, controlling obsolescence
  - Procure parts from OCMs or their authorized dealers
  - Contractors to notify government if parts procured from untrusted sources
  - RMA returns notifications to customers

Courtesy: NDAA 2013 Sec. 833, DFARS: 2012-D055

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

American Conspirators

- Supplier A
  - Operated for 3 years
  - Sold to DoD as “Wholesale Electronics Components” business
    - Falsely stated and knowing bought parts that were new and not from Asia, when in fact they were bought from companies located in Asia and were used
- Supplier B
  - Battery distributor sold near 3 million in fake batteries to DoD
  - For 7 years, sold more than 80k batteries for Navy purposes
    - First case prosecuted under 2011 Defense Authorization Act
    - Affixed counterfeit labels identifying them as originating from approved suppliers, used chemicals to remove “Made in China”, and prepared doctored documents
- Supplier C
  - Sold known Chinese counterfeit semiconductors to DoD contractors for use in nuclear submarines
    - Charged with conspiracy to traffic in counterfeit military goods, trafficking, wire fraud, money laundering.
    - Criminal conduct spanned Feb 07-April 12
    - Purchased millions of $$$ in counterfeit ICs bearing marks of 35 electronic MFGs
- Supplier D
  - Illegal incidents occurred during 2005-2008
    - Supplied customers with falsely remarked microprocessor chips manufactured in China
      - Many chips used in US military and commercial helicopters

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

American Conspirators

- Supplier E
  - Created fake companies and bid on Defense Supply contracts
    - Defrauded DOD for $11.2 million
  - Purchased ordinary band radio antennas instead of special military dome antennas
    - For just 3.77% amount he received back as payment
- "Serial Fraudster"
  - Schemed with other conspirators to form 18 separate companies to win nearly 1,000 contracts using a computer program
  - Tried to hide profits by turning it into gold bars and coins and smuggling it to Mexico
    - Hid in modified bumper of a 1979 Toyota Landcruiser
  - Former America's Most Wanted fugitive
    - Faked own death
  - Arrested in Cancun in a sting operation

Photo courtesy: toyotalandcruisers

Source: justice.gov

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

American Conspirators

- Supplier G
  - Irvine, CA
  - Scheme ran from for only two years
  - Imported counterfeit parts under various company names
  - Falsified test reports/ material certs
  - 302 domestic customers

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

The Takedown of a Supplier

- Employee hired by Suppler G as Quality Control Engineering Tech
  - Original job function to decap parts in order to detect counterfeits
  - Later started to extract die in large quantities from used parts to “refurbish”
  - Realized Supplier refurbishment process meant inserting used die in new packaging and selling as military grade
  - Secretly began informing customers and authorities about what was happening
  - In 2009, Supplier raided by NCIS (Navy Counter Intelligence Services)

Source: American Electronic Resource, Inc

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Potential parts in the supply chain

- The most popular part, ICM7170 IPG, was bought for $.02 and on average sold for $38.00 each as an ICM7170"A"IBG's equaling a potential gross profit of $2,000,000 per month.
  - 8 operators x 325 pieces per day = 2600 daily
  - 2600 parts x 5 days x 4 weeks = 52,000 monthly
  - Over 400k produced during MVP life cycle
    - Where are they now?

- ICM7170IPG:
  - 24-Lead Plastic Dual-In-Line Package (PDIP)
  - 20uA Maximum Standby Current at 32kHz

- ICM7170AIBG:
  - 24-Pin Small Outline Plastic Package (SOIC)
  - 5uA Maximum Standby Current at 32kHz

http://www.usbid.com/assets/partphotos/89/ICM7170AIBG_0014062.jpg

http://i.ebayimg.com/00/s/MTIwMFgxNjAw/z/thoAAOxy6-tR-OYe/$T2eC16FHJHgFFmDU0F7eBR-OYd03hw~~60_35.JPG

Source: American Electronic Resource, Inc

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Step 1 -Repackaging a die

- Decapsulation is the first step in the process to repackage the die.
- To harvest the quantities needed to make a profit, it can be a very dangerous and dirty process.
- The operators were put under pressure to perform which increases the chance for accidents with the toxic and oxidizing acids and their fumes.
- The chemicals used are very hard on the die and bonding pads.

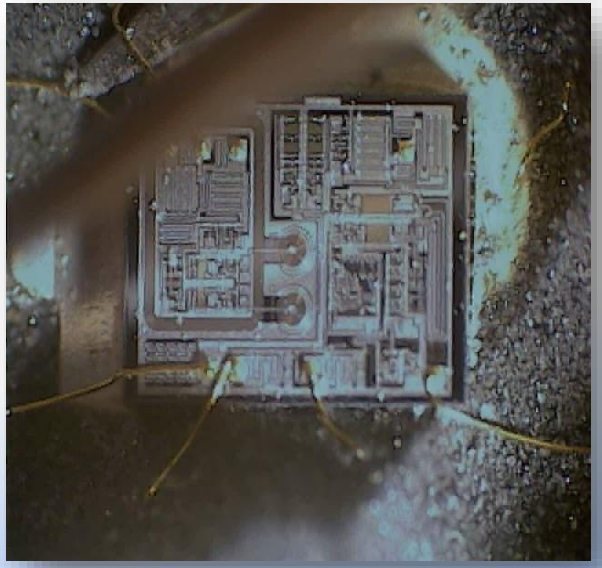
Source: American Electronic Resource

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

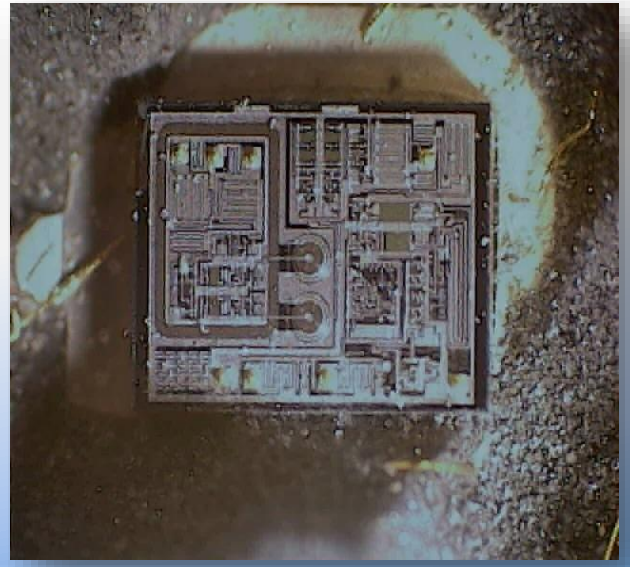
Step 2 – Bond wire removal

- With precision tweezers and steady hands the operator must get under the wire and pull the wires the opposite direction of the ball bond attached to the pad.
- Breaking the wire at the top of bonds of a decapped part is the most difficult part of the this process without damaging the original ball bond.

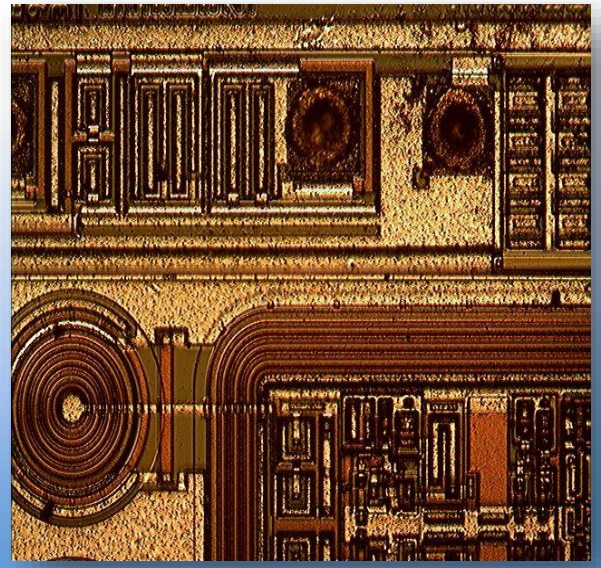
Plucking with tweezers



After plucking



Close up of bonding pad



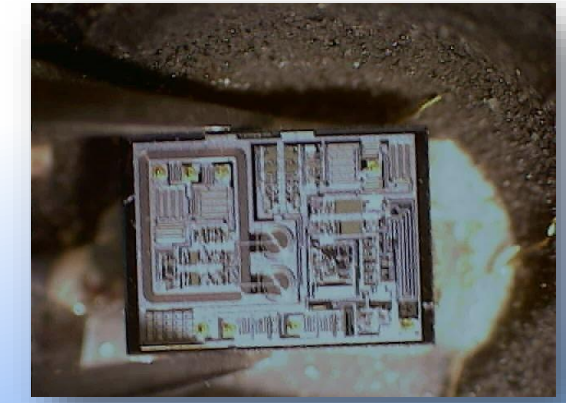
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Step 3 – Chip Removal

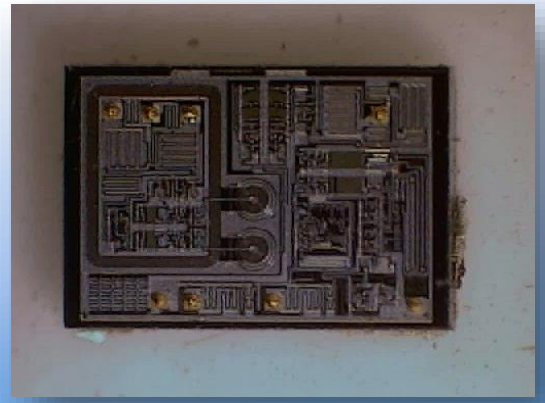
- To extract the die from the package and lead frame, the counterfeiter uses a hot plate not exceeding 100 degrees Centigrade to loosen the adhesive holding the die to the lead frame.
- The operator then uses an exacto knife and tweezers to pry the die gently off the lead frame or package mounting.

Loosening of adhesive

Extraction process



Extracted die



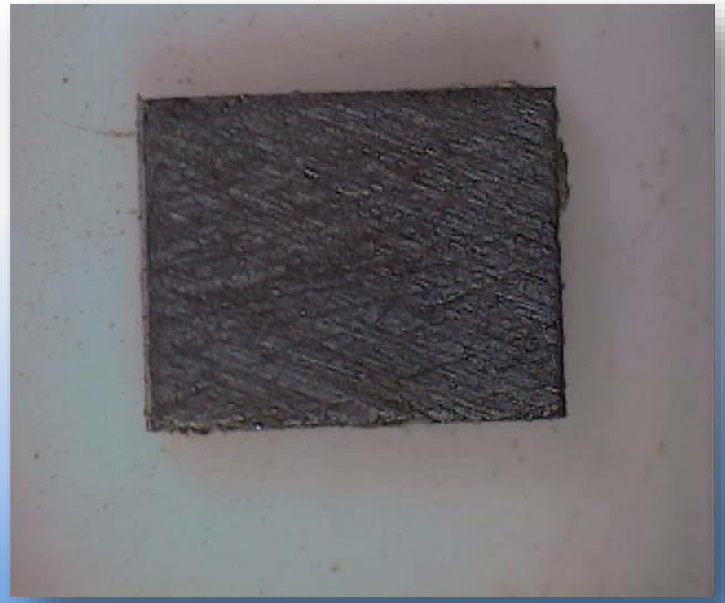
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Step 4 – Removing adhesive backing

- After the die is extracted the adhesive is left on the back of the die. The operator then sands the back to remove the adhesive leaving small abrasions that could later complicate the positioning of the die.

Die back with remaining adhesive

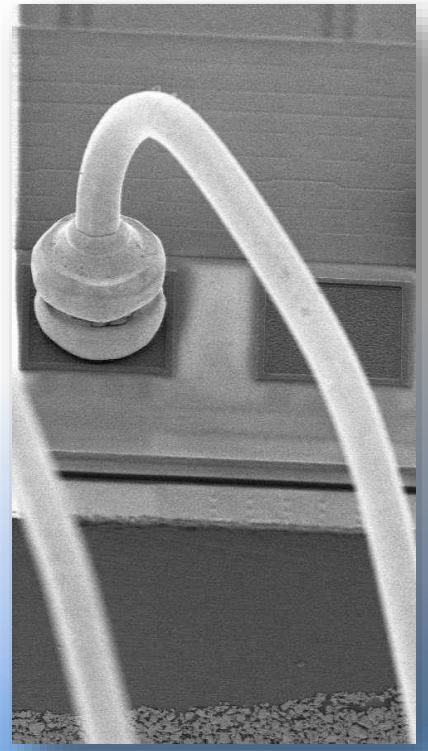
Die back after adhesive sanded off



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Step 5 – Bonding the New Package

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

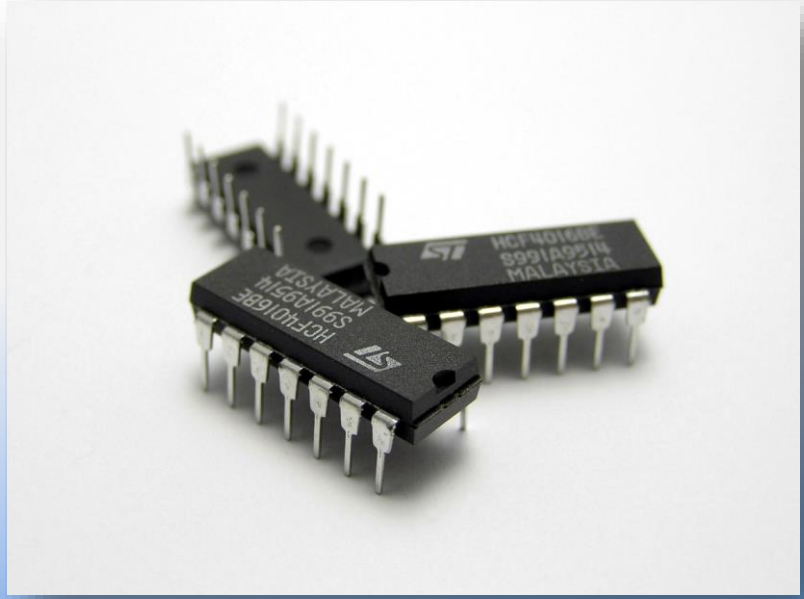


COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Step 5 – Finished product

- The finished product can look like the original. Once the components are complete they may undergo a simple electrical test, such as a curve trace, but the stresses from reclaiming and die harvesting can induce severe damage causing:

- Lower life expectancy
- Curve trace irregularities
- Out of specification
- Continuity failures
- Unknown reliability



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

SAE AS5553: Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition

- Created in response to a significant and increasing volume of counterfeit electronic parts entering the aerospace supply chain, posing significant performance, reliability, and safety risks
- Provides uniform requirements, practices and methods to mitigate the risks of receiving and installing counterfeit electronic parts for industry
- Highly recommended standard for use by all contracting organizations that procure and inspect electronic parts
- This standardizes practices to:
  - maximize availability of authentic parts,
  - procure parts from reliable sources,
  - assure authenticity and conformance of procured parts,
  - control parts identified as counterfeit,
  - and report counterfeit parts to other potential users and Government investigative authorities.

Courtesy: SAE AS5553

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

SAE AS5553: Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition

- Requirements: 4.1 Counterfeit Electronic Parts Control Plan
  - 4.1.1 Parts Availability
    - The processes shall maximize availability of authentic, originally designed and/or qualified parts throughout the product's life cycle, including management of parts obsolescence.
  - 4.1.2 Purchasing
    - Assess potential sources of supply (including electronic parts, assembly, and equipment suppliers) to determine the risk of receiving counterfeit parts. Assessment actions may include surveys, audits, review of product alerts (e.g., GIDEP, ERAI), and review of supplier quality data to determine past performance.
    - Maintain a register of approved suppliers including the scope of the approval, to minimize the risk of counterfeit parts supply. Specify a preference to procure directly from OCMs or authorized suppliers on the approved supplier list
    - Assure that approved/ongoing sources of supply are maintaining effective processes for mitigating the risks of supplying counterfeit electronic parts. Assurance actions may include surveys, audits, review of product alerts, and review of supplier quality data to determine past performance.
    - Assess and mitigate risks of procuring counterfeit parts from sources other than OCMs or authorized suppliers. This shall be accomplished and documented for every application when it is necessary to procure from other than the OCM or an authorized supplier.
    - Specify supply chain traceability to the OCM or aftermarket manufacturer that identifies the name and location of all of the supply chain intermediaries from the part manufacturer to the direct source of the product for the seller. If this traceability is unavailable or the documentation is suspected of being falsified, a documented risk assessment is required.
    - Specify flow down of applicable requirements of this document to applicable contractors and their sub-contractors. In the event that one or more supply chain intermediaries do not have a counterfeit part control plan compliant to this document, a risk analysis shall be required for every application of the part.

Courtesy: SAE AS5553

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

SAE AS5553: Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition

- 4.1.3 Purchasing Information
  - The documented process shall specify contract/purchase order quality requirements to minimize the risk of being provided counterfeit parts.
- 4.1.4 Verification of Purchased Product
  - The documented processes shall assure detection of counterfeit parts prior to formal product acceptance. The rigor of the verification process shall be commensurate with product risk. Product risk is determined by the criticality of the part and the assessed likelihood of receiving a counterfeit part. Examples of verification actions include: review of data deliverables, visual inspection, measurements, non-destructive evaluation and destructive testing (e.g., marking permanency, x-ray, destructive physical analysis, thermal cycling, hermeticity, burn-in).
- 4.1.5 In Process Investigation
  - The documented processes shall address the detection, verification, and control of in-process (post acceptance) and in- service suspect counterfeit parts.
- 4.1.6 Material Control
  - Control excess and nonconforming parts to prevent them from entering the supply chain under fraudulent circumstances.
  - Control suspect or confirmed counterfeit parts to preclude their use or reentry into the supply chain.
- 4.1.7 Reporting
  - The documented processes shall assure that all occurrences of counterfeit parts are reported, as appropriate, to internal organizations, customers, government reporting organizations (e.g., GIDEP), industry supported reporting programs (e.g., ERAI), and criminal investigative authorities.

Courtesy: SAE AS5553

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Useful SAE documents

- AS6496-Fraudulent/Counterfeit Electronic Parts: Avoidance, Detection, Mitigation, and Disposition - Authorized/Franchised Distribution
  - Requirements for mitigating counterfeiting products
- AS6081-Fraudulent/Counterfeit Electronic Parts: Avoidance, Detection, Mitigation, and Disposition – Distributors Counterfeit Electronic Parts; Avoidance Protocol, Distributors
  - Identify reliable sources, mitigate distribution risk, control and reporting procedures
- AS6171-Test Methods Standard; Counterfeit Electronic Parts
  - EVI-SEM techniques for Counterfeit detection

ARP6328-Guideline for Development of Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition Systems

- Supplements AS9100, guidance for implementing counterfeit mitigation program

Partair Video

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Section 6 – External Visual Inspection

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Assessing Incoming Parts

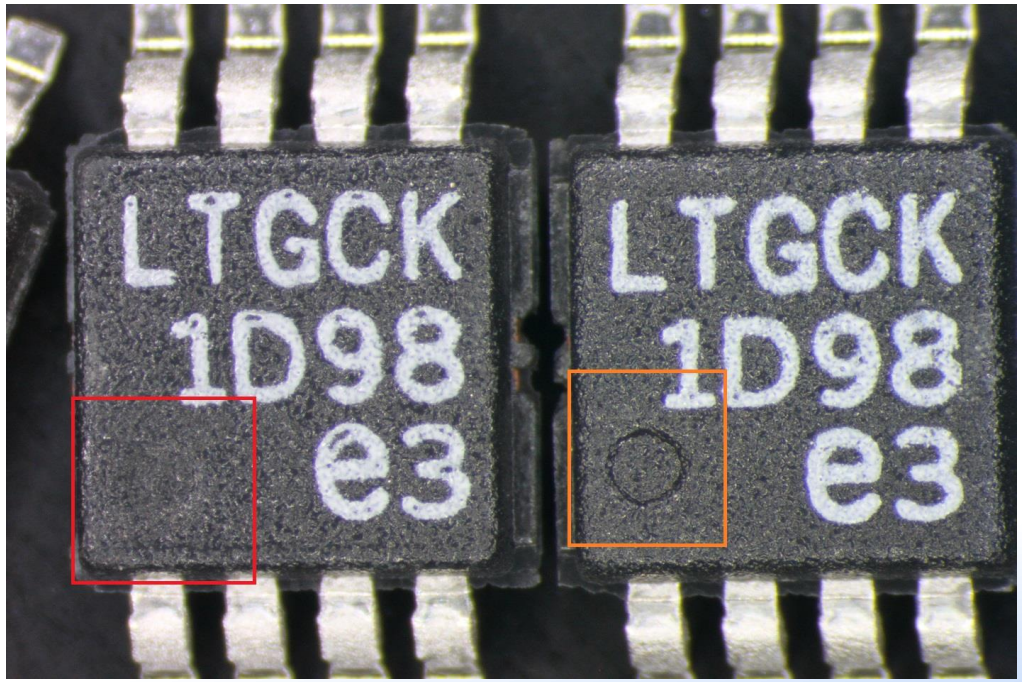
Trilateral Safety and Mission Assurance Conference," Brian Hughitt-NASA, April 2008

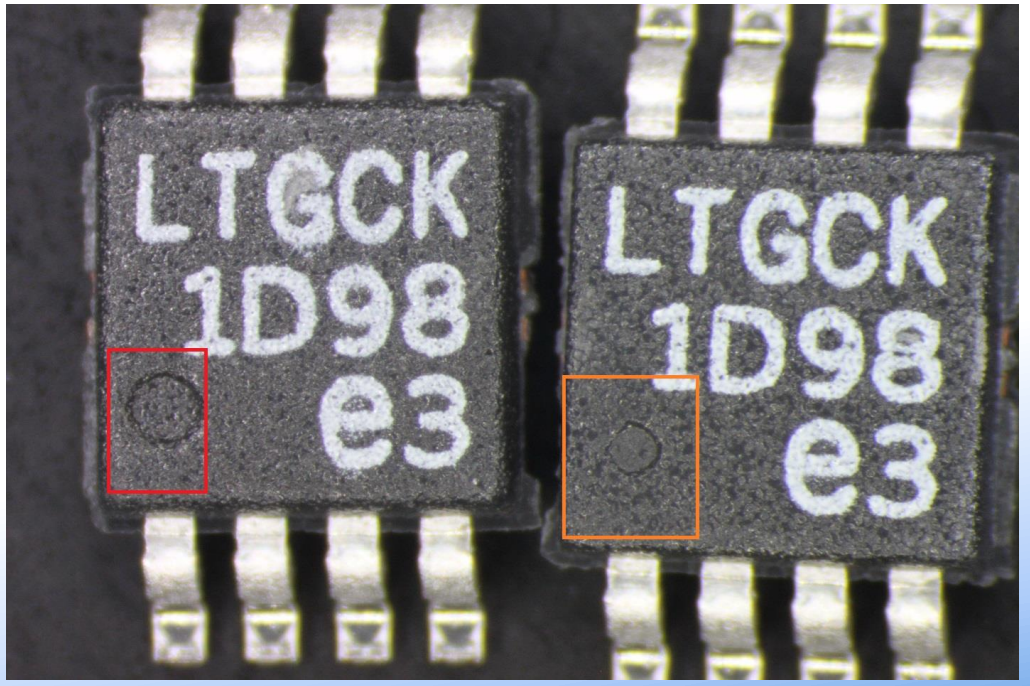
Is this part suspect of counterfeit?

- The part is suspect.
- Determining if a part is counterfeit depends upon the subsequent investigation.

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Assessing Incoming Parts





Parts are suspect, but are they counterfeit?

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Assessing Incoming Parts

1. Shipping/ Packaging
2. Documentation
   a) Traceability
3. External visual
   a) Physical mold features
   b) Part surface
   c) Part markings
   d) Indents
   e) Pins

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Shipping/ Packaging

- Verify packaging is correct and consistent
  - 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
  - Grammatical errors

'Q'TY' and 'SEALD' misspelled

Factory Label

Figure 10-4

Suspect Counterfeit Label

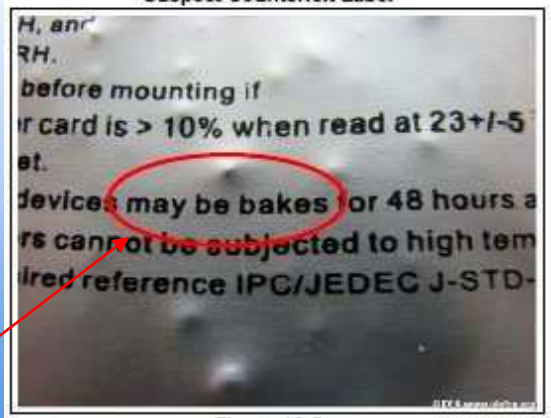


Figure 10-5

Incorrect grammar

Courtesy: IDEA.org

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Packaging

- 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).
- 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

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Assessing Incoming Parts

1. Shipping/ Packaging
2. Documentation
   a) Traceability
3. External visual
   a) Part markings
   b) Part surface
   c) Indents
   d) Physical mold features
   e) Pins

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

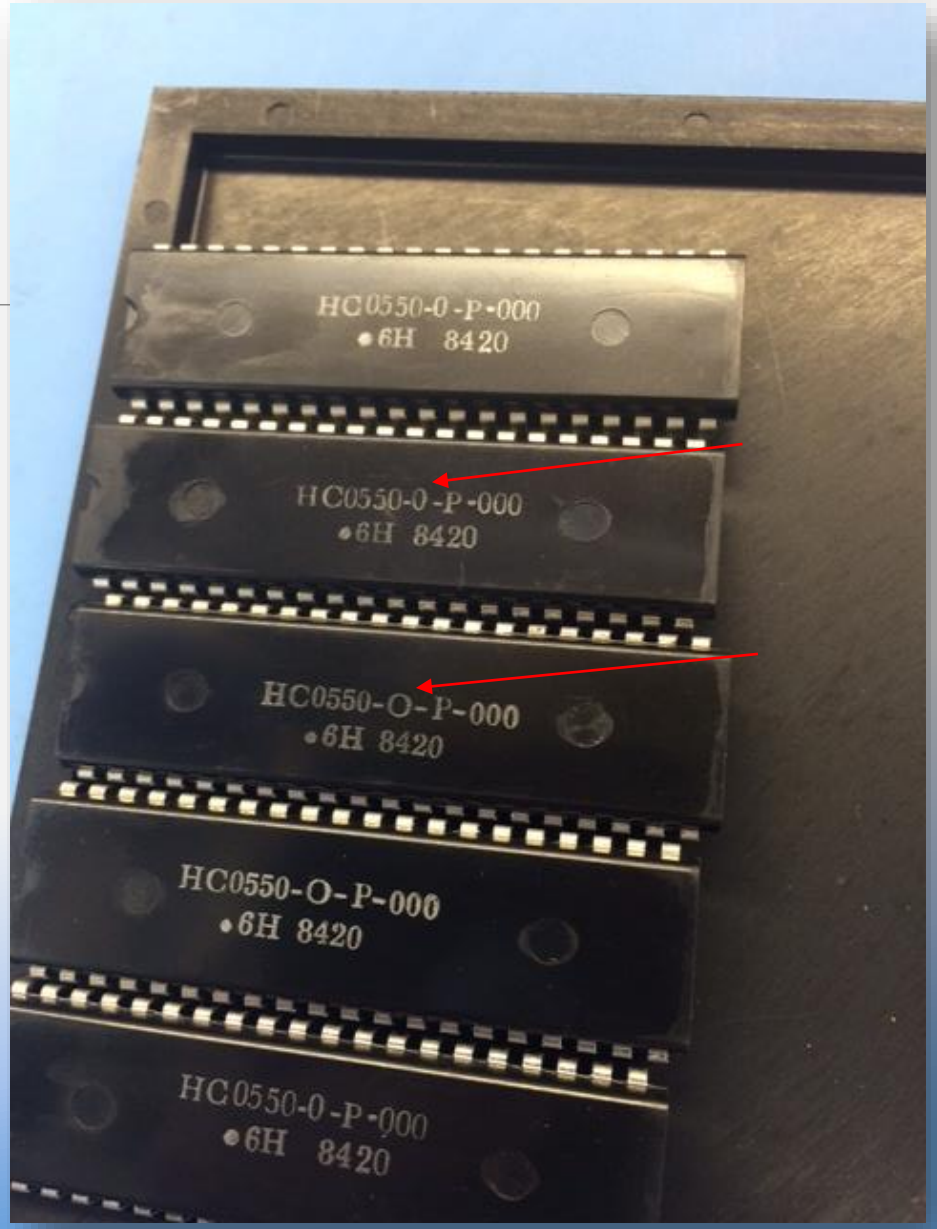
Suspect-Part markings

- OCMs follow quality standards and major imperfections are uncommon
  - P/N will be in a certain location on the part
  - P/N will not be misaligned, crooked or misspelled
  - MFG logos do not vary from part to part
  - Part markings designed to withstand rigors of testing

  - Part on right has laser burn markings
  - Markings missed the part on the left hand side
  - Part on right belongs to batch that had markings in a slightly different location on each part

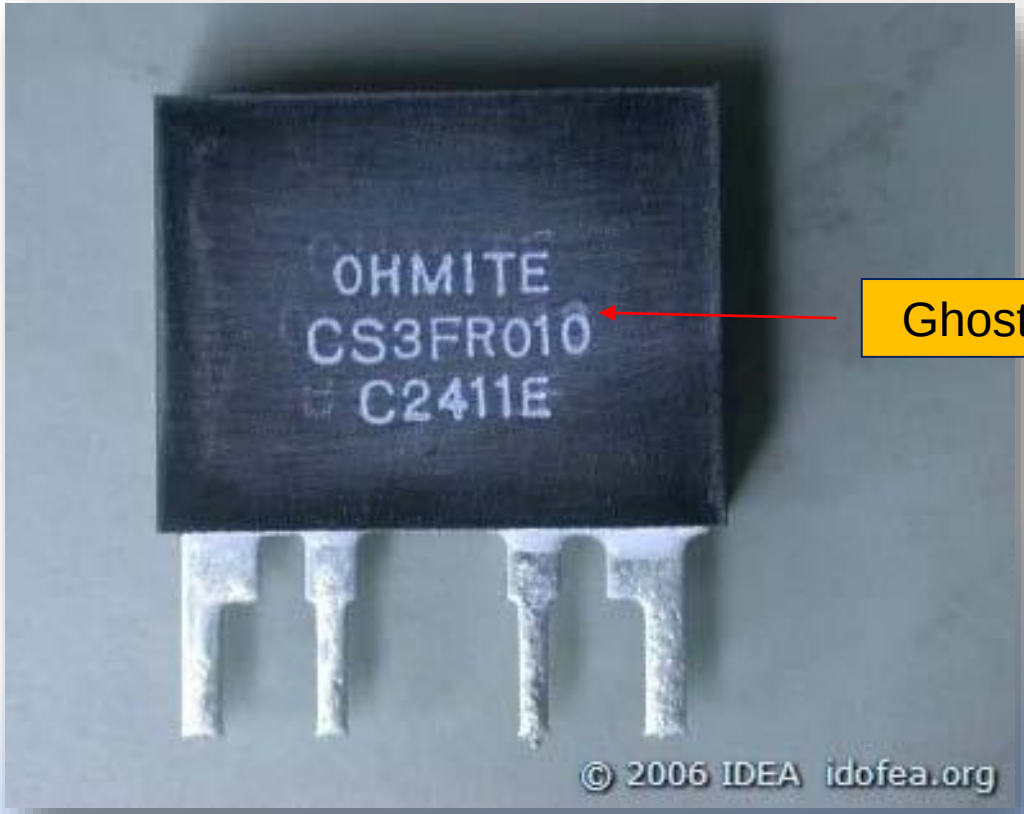
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part markings



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part markings



Ghost markings

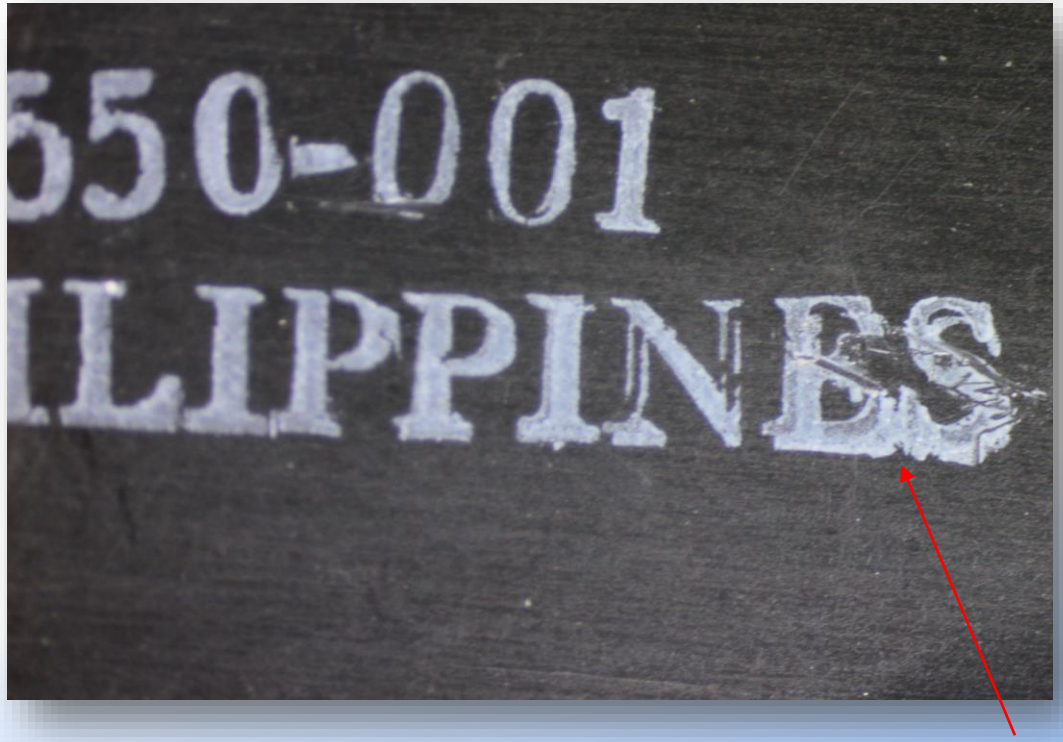
Courtesy: IDEA-STD-1010-A: Acceptability of Electronic Components Distributed in the Open Market

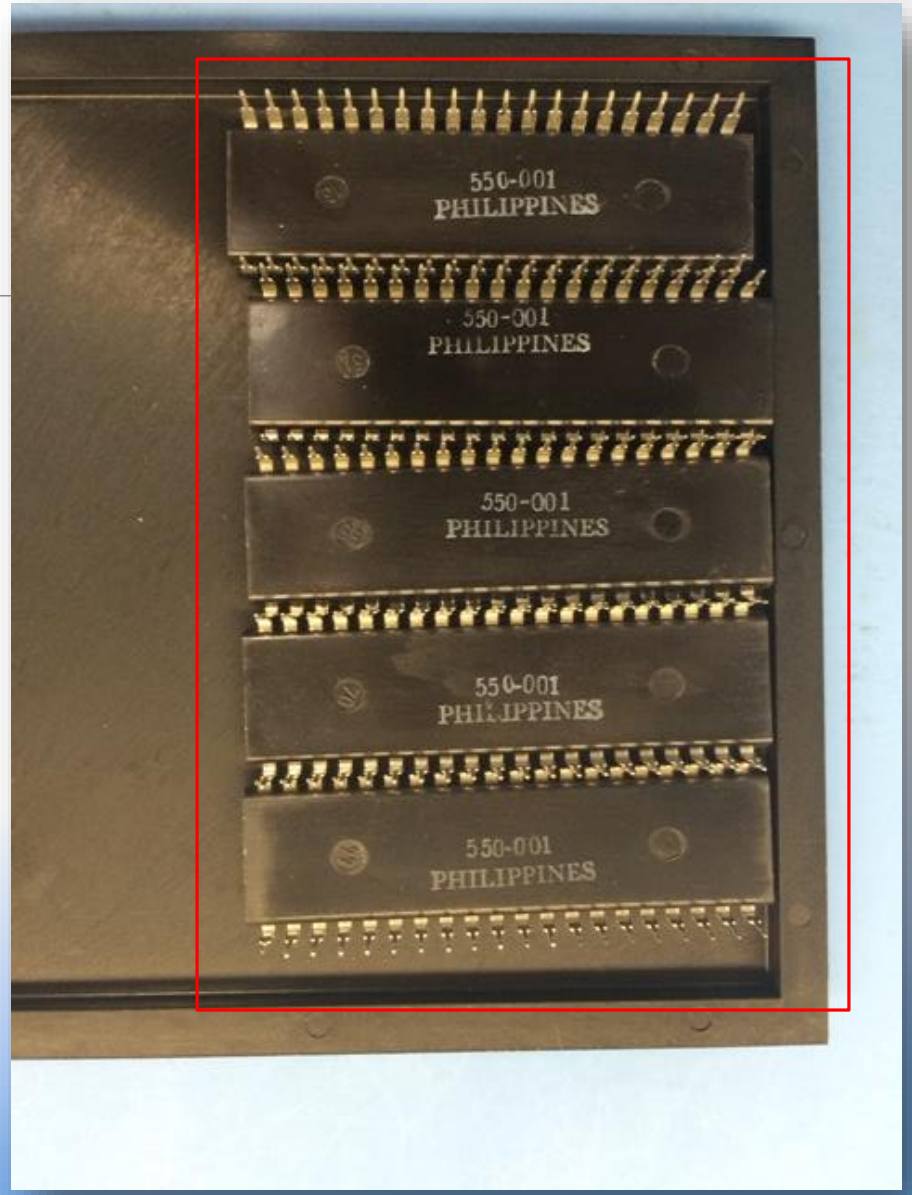
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part markings

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part markings





COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part markings

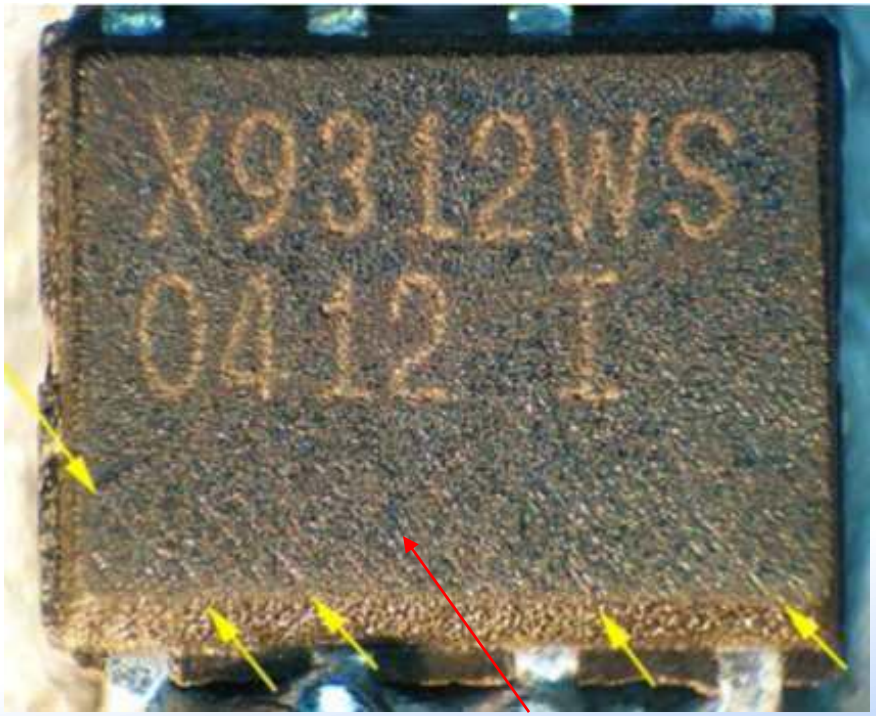
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Assessing Incoming Parts

1. Shipping/ Packaging
2. Documentation
   a) Traceability
3. External visual
   a) Part markings
   b) Part surface
   c) Indents
   d) Physical mold features
   e) Pins

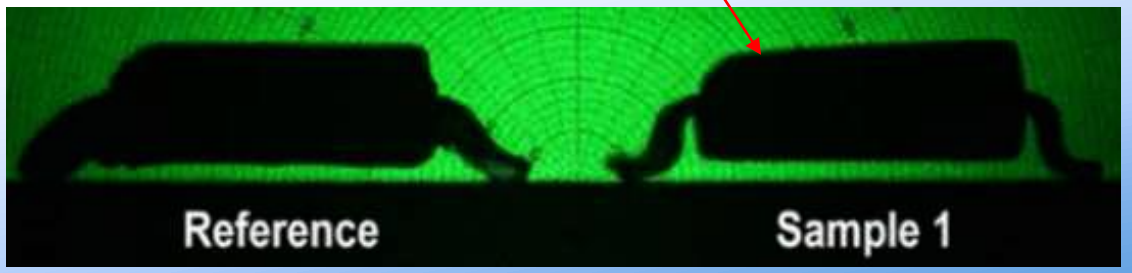
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-part surface



Directional sanding markings

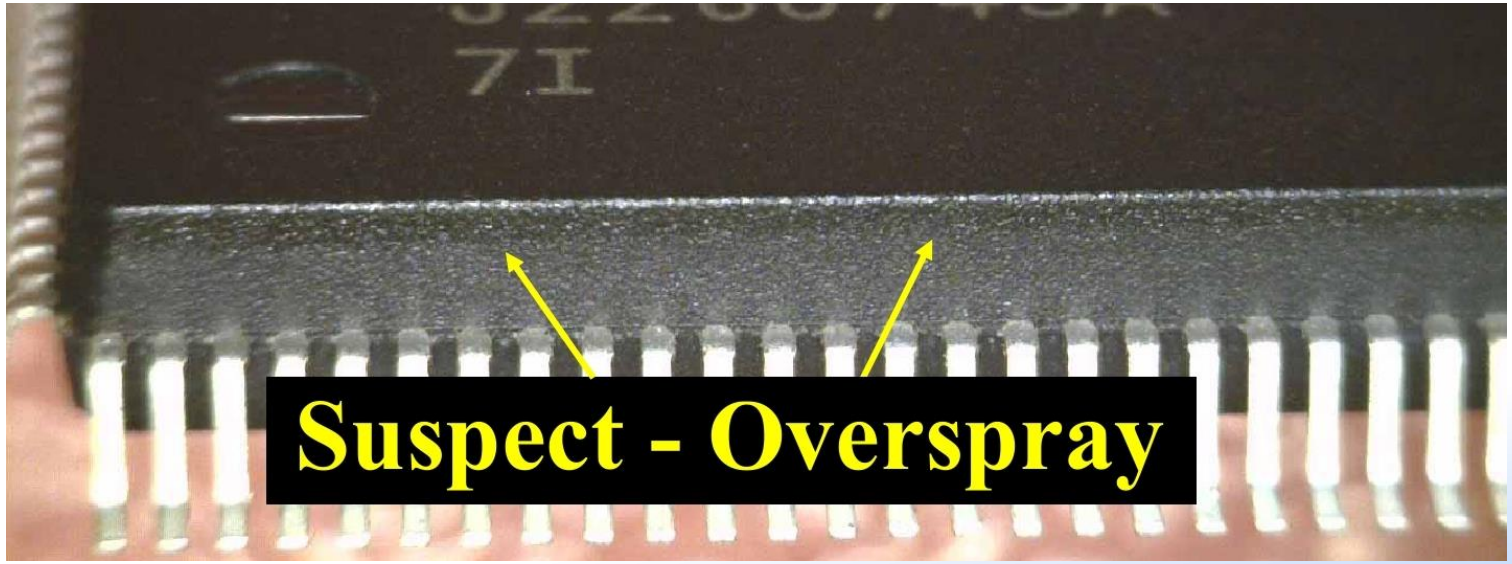
Uneven thickness resulting from sanding



Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

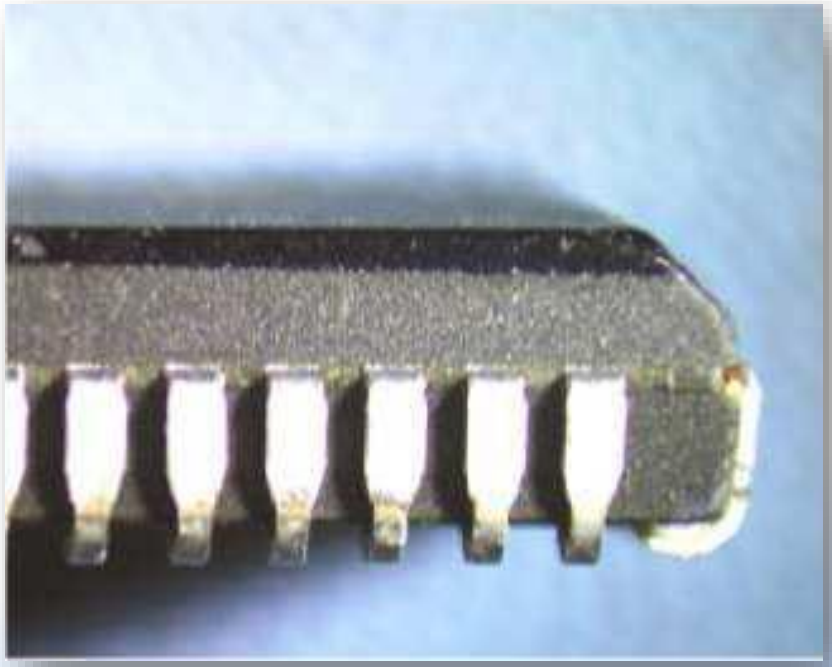
Suspect-part surface

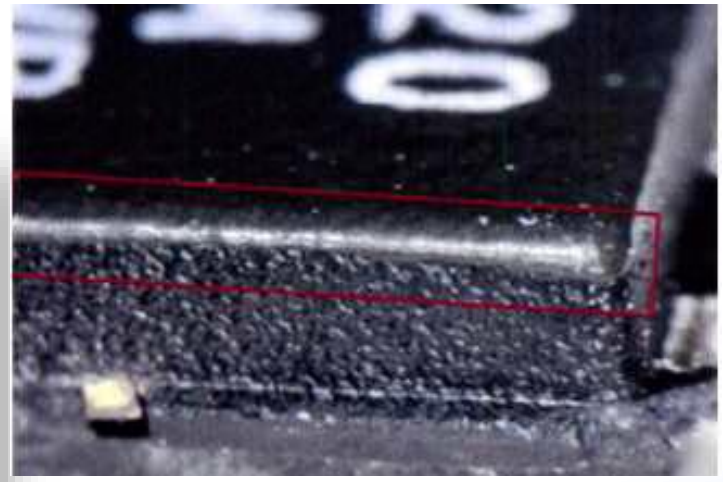


Blacktopping: resurfacing of a component so it can be remarked

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Overspray



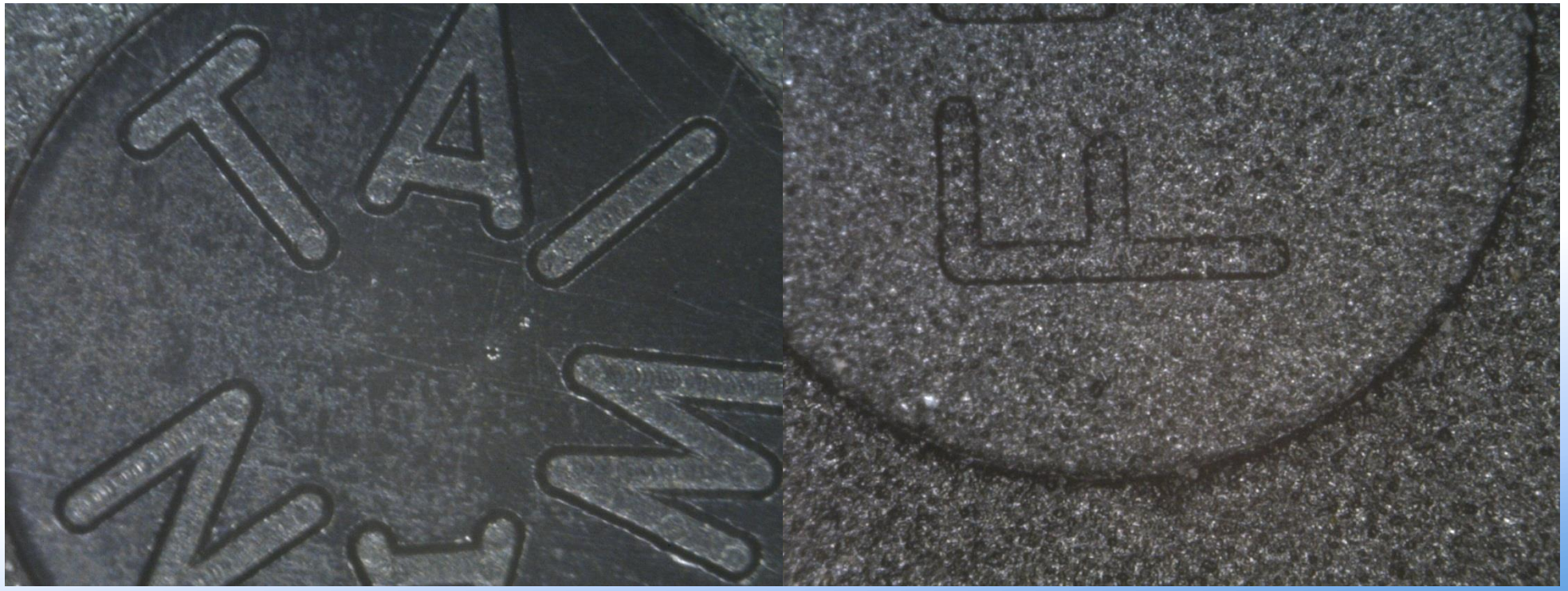


Courtesy: IDEA.org

Courtesy: SMT Corp

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Blacktopping

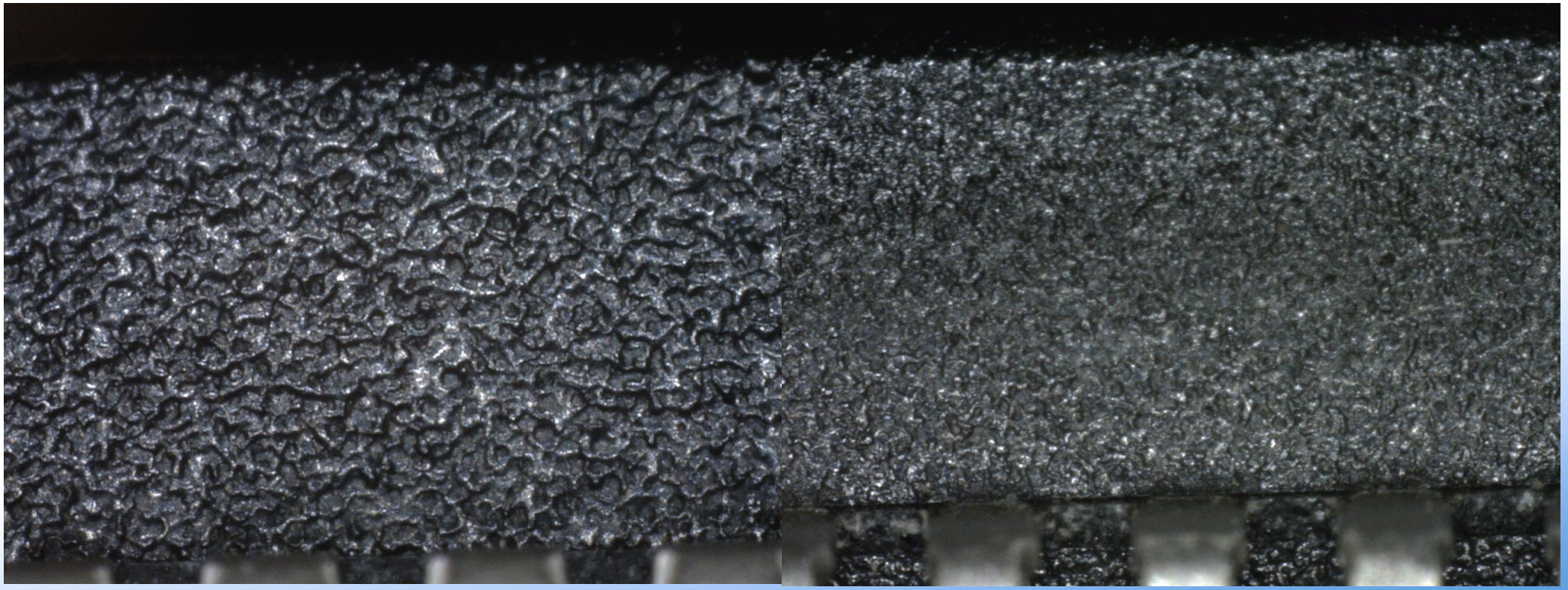


Authentic

Suspect

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Blacktopping



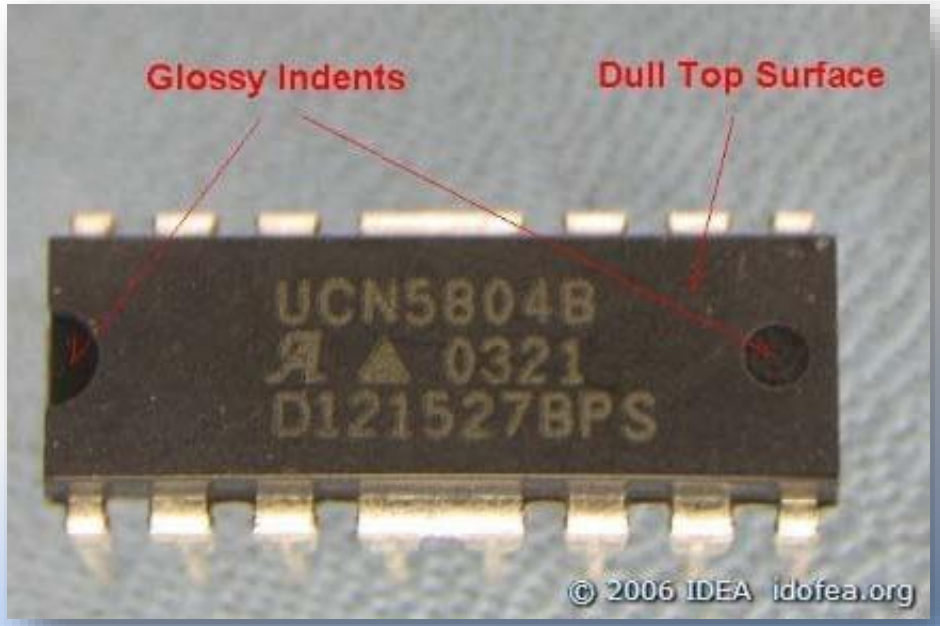
Authentic

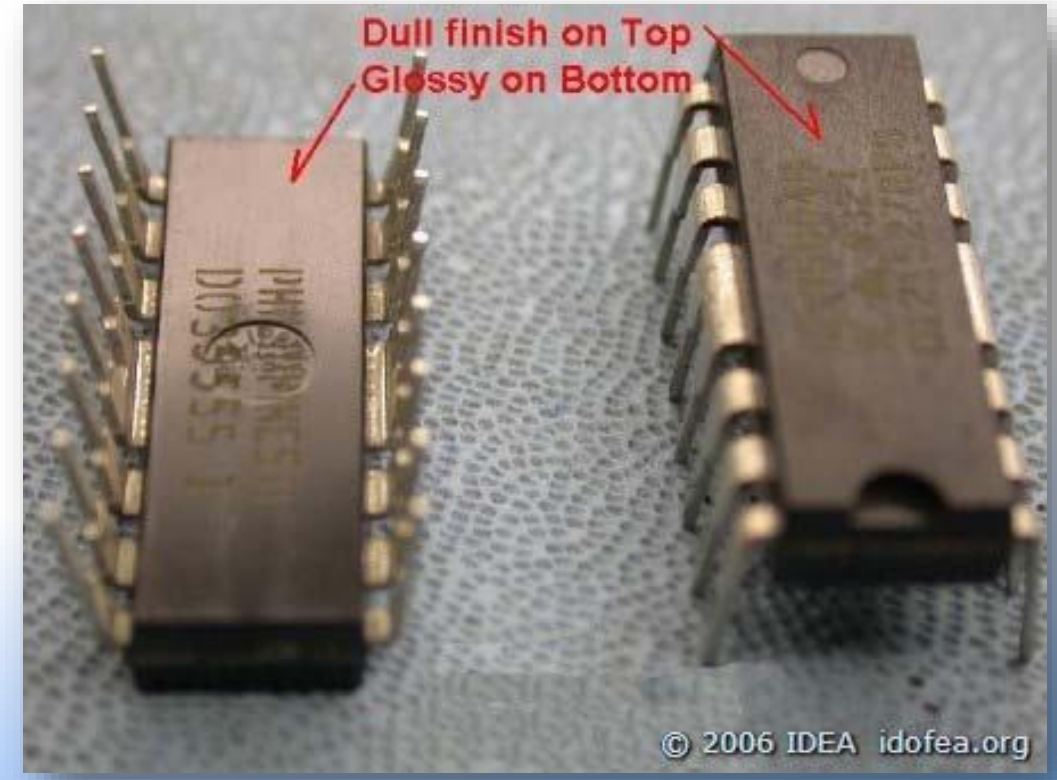
Suspect

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect part surface

- Different textures can be indicative of remarking
- Top and bottom of part should have same texture





- Top and bottom of the same part have two different textures: rough vs smooth

Courtesy: IDEA-STD-1010-A

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-part surface

Over-sanding

- Black topped surface was shinny and smooth but with a unnatural orange peel finish
- Scrapping the top layer revealed the Altera logo underneath

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-part surface

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Assessing Incoming Parts

1. Shipping/ Packaging
2. Documentation
   a) Traceability
3. External visual
   a) Part markings
   b) Part surface
   c) Indents
   d) Physical mold features
   e) Pins

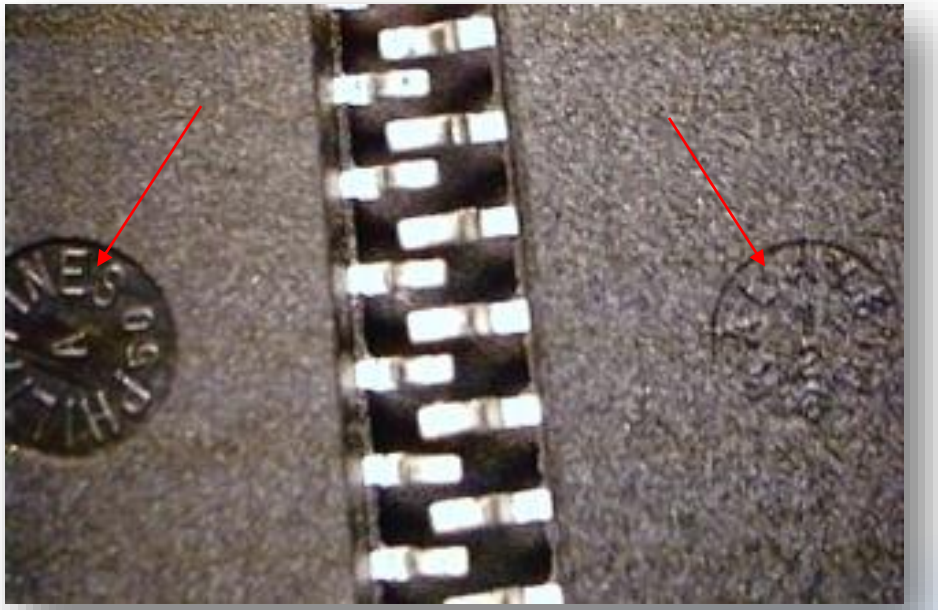
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Good-Part indents

- Example: clean indents on good parts under two different lighting scenarios

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part indents

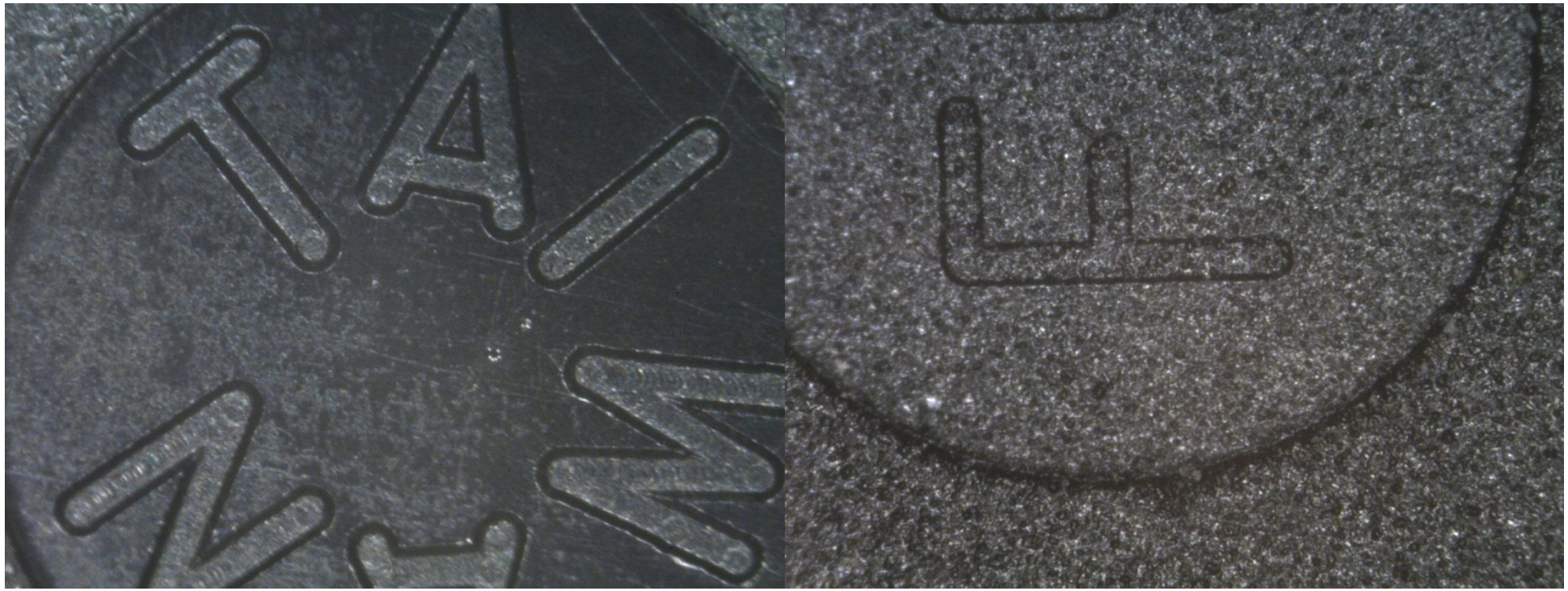


- Identical parts
- Parts on the left is marked Philippines, part on the right is Malaysia

- Indent is half-filled with black top
- Letters have rough texture

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Blacktopping



Authentic

Suspect

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

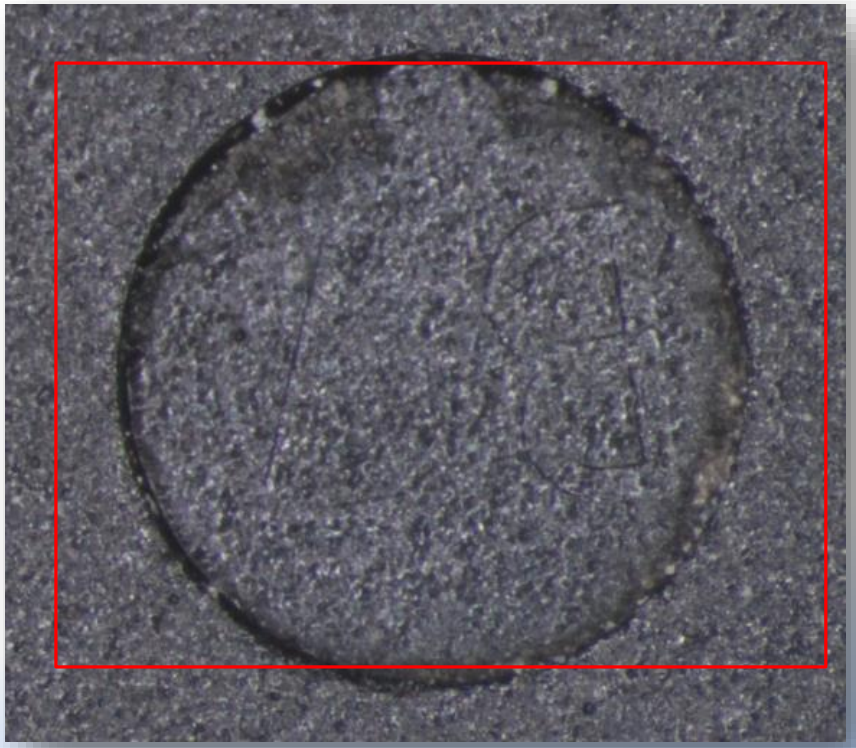
Suspect-Part indents

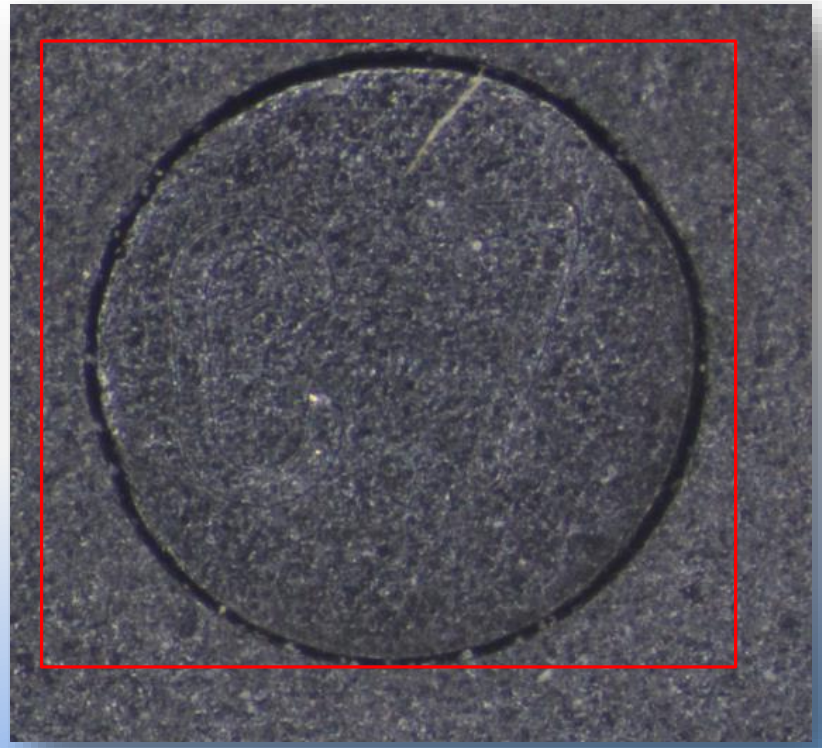
- Indent has been filled in with black topping material

- Original indents should always be clean

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

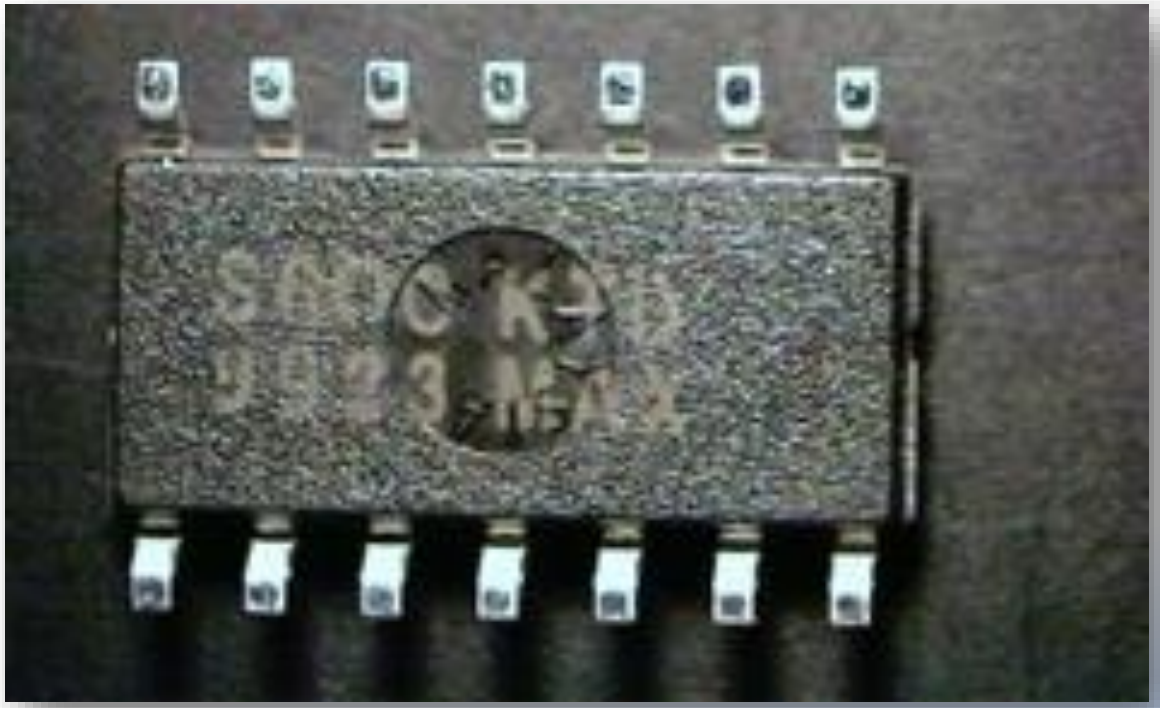
Suspect-Part indents

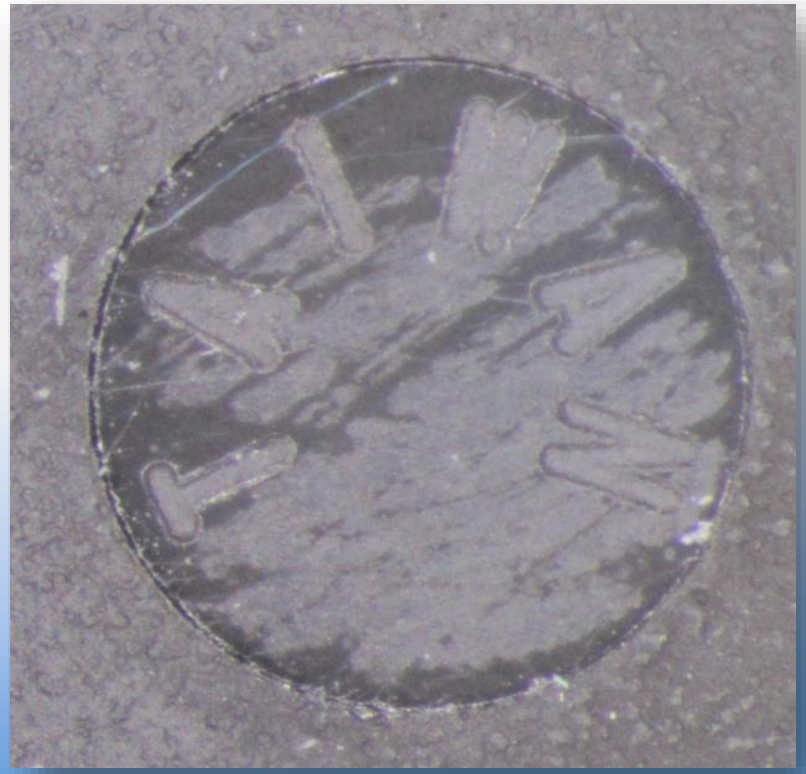




COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part indents

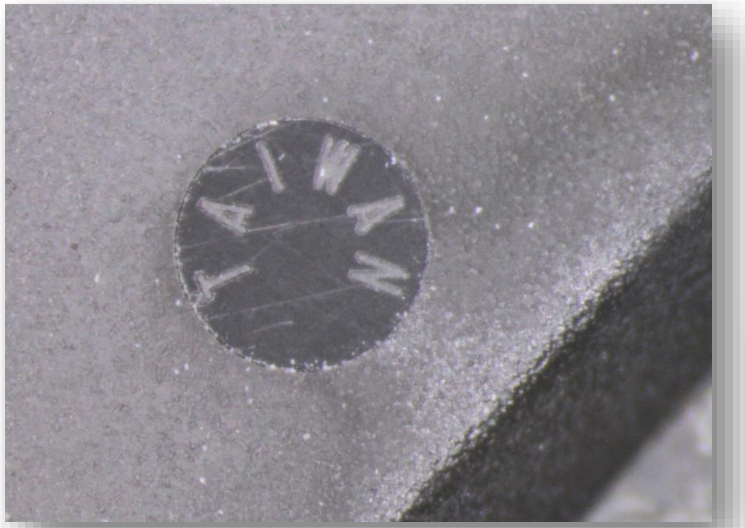


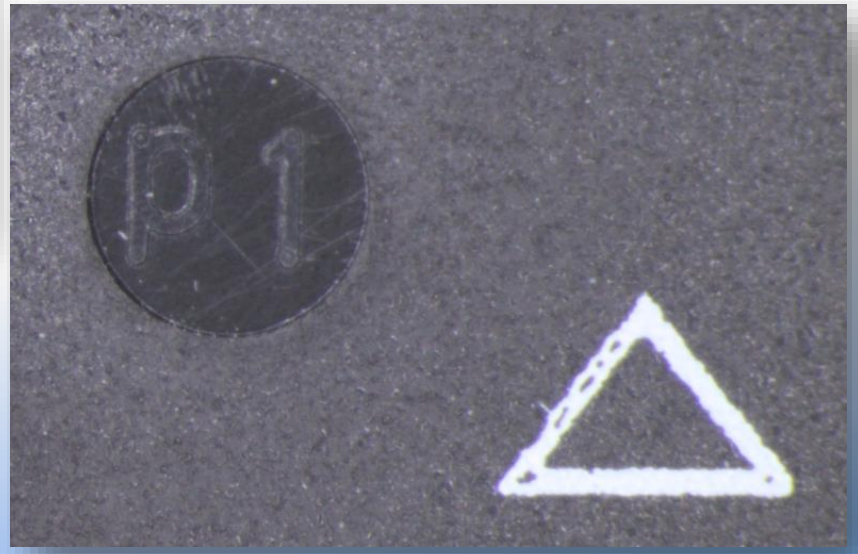


- Part has marking inside indent
- Indents with markings can signify a suspect part

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

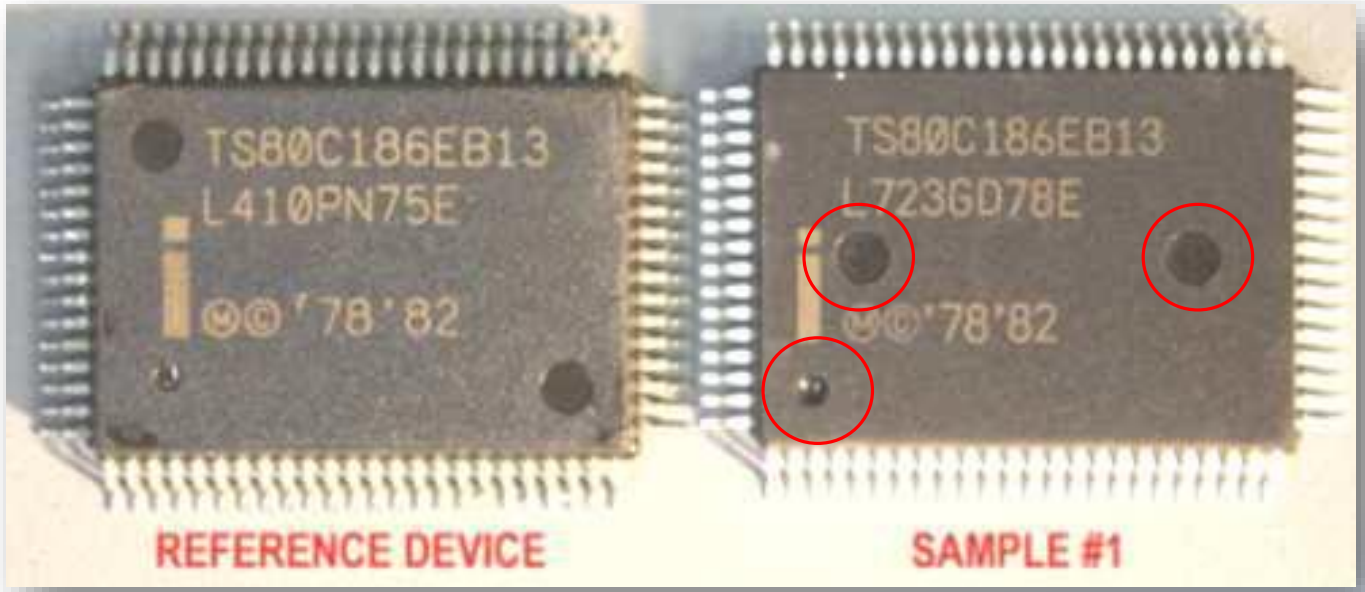
Suspect-Part indents





COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-mold features



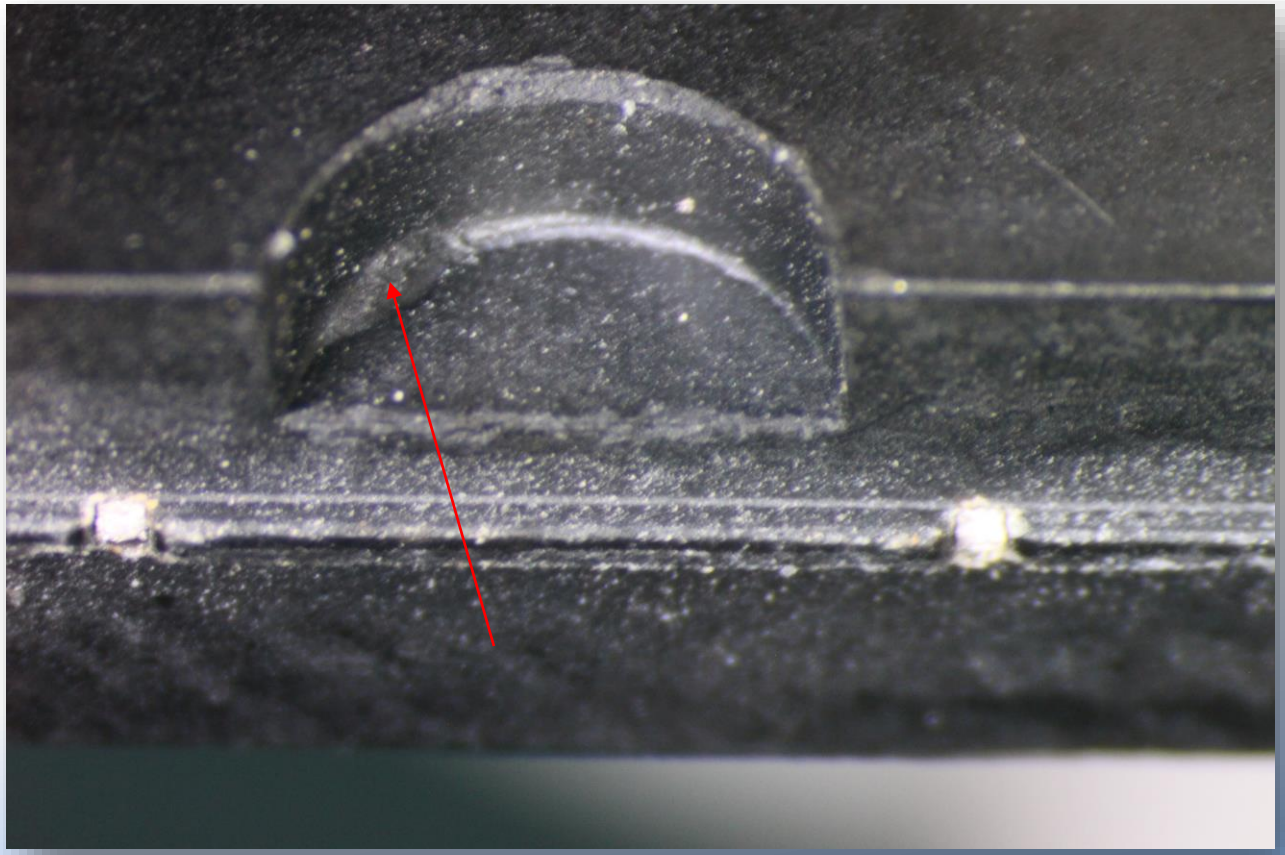
Lot L723GD78E does not exist, other variations present

Three different mold appearances

Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

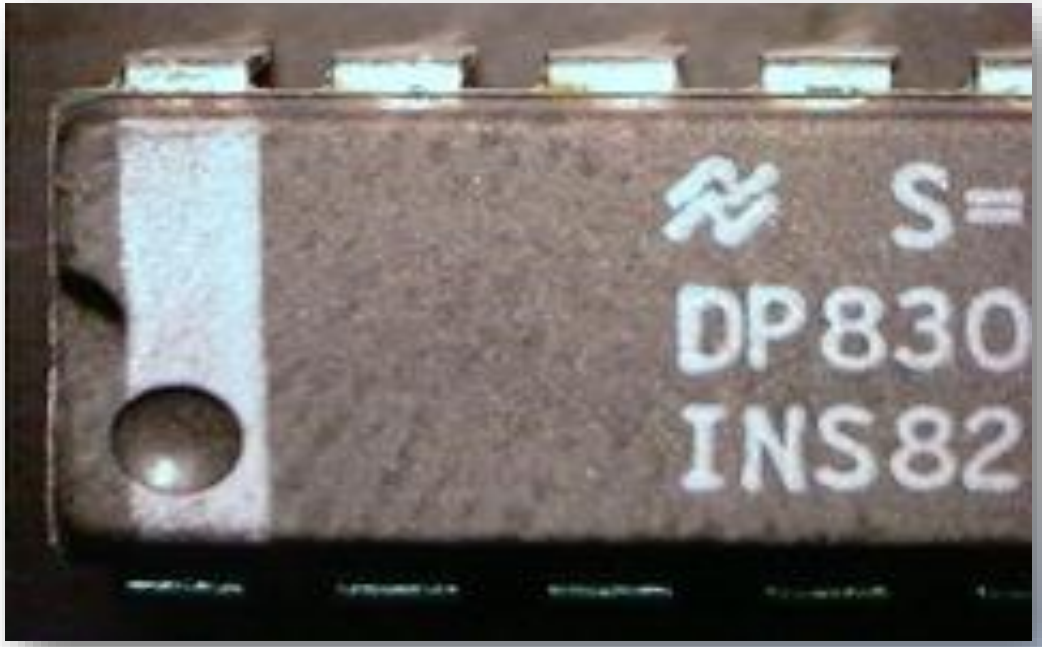
Suspect-Part indents

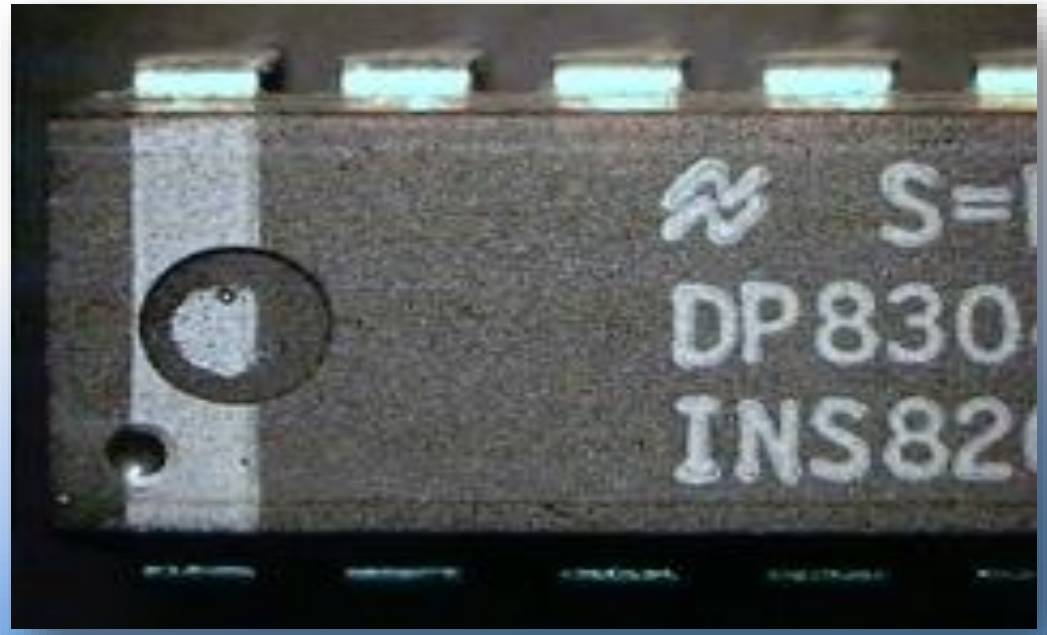


COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part indents

- Identical parts
- Indents between the two parts are not identical





COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

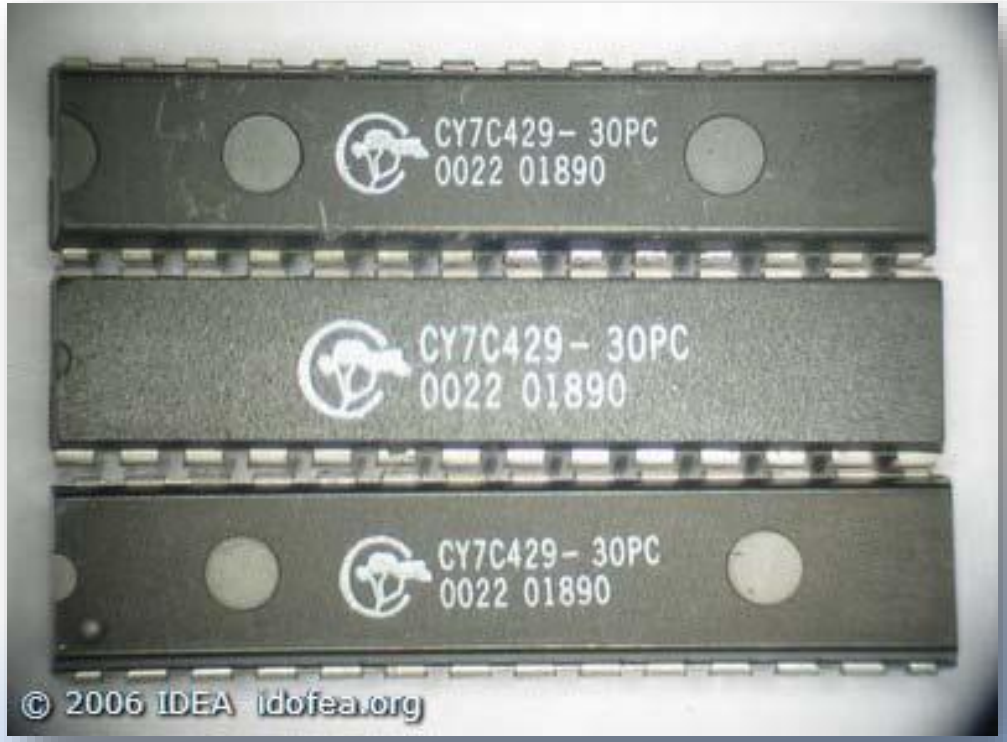
Assessing Incoming Parts

1. Shipping/ Packaging
2. Documentation
   a) Traceability
3. External visual
   a) Part markings
   b) Part surface
   c) Indents
   d) Physical mold features
   e) Pins

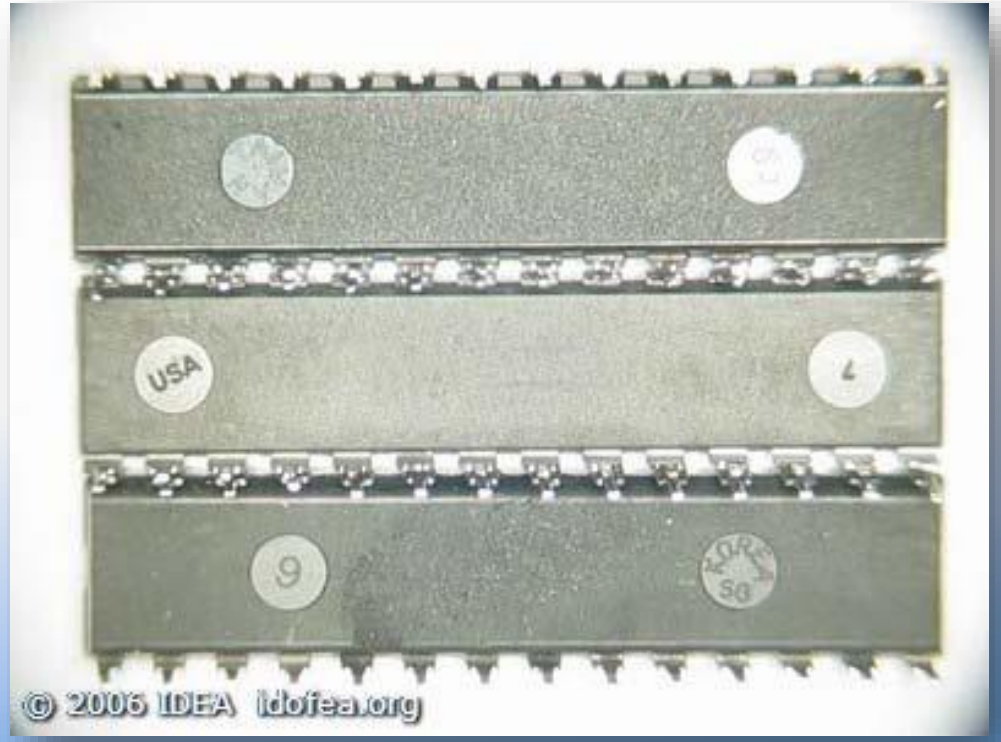
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-mold features

Top of Parts



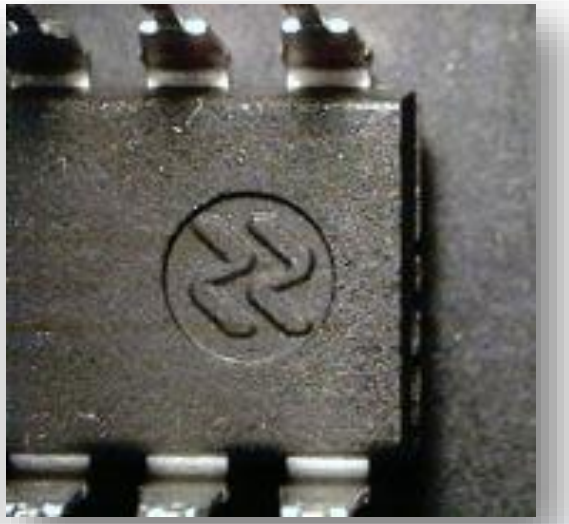
Bottom of Parts



Same P/N, MFG, D/C but three different molding!

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-mold features

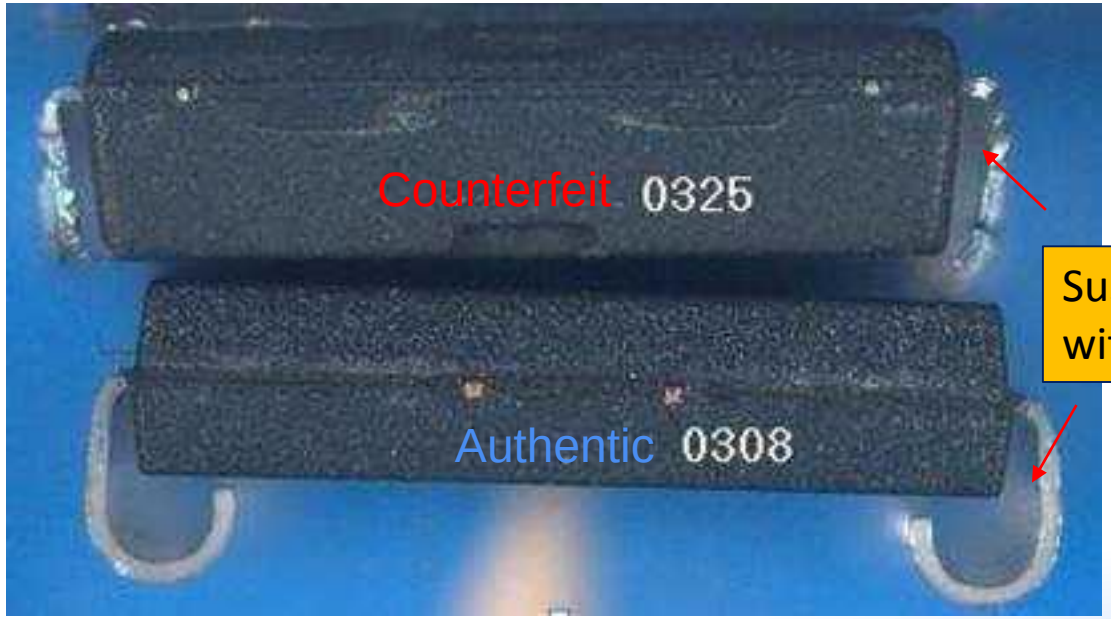


- Top surface: Identical parts
- Bottom surface: **three completely different markings**

Courtesy: AERI.com

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-mold features



Suspect part thicker and with rougher leads

Heat sink tab is different

Counterfeit

Authentic

Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-mold features

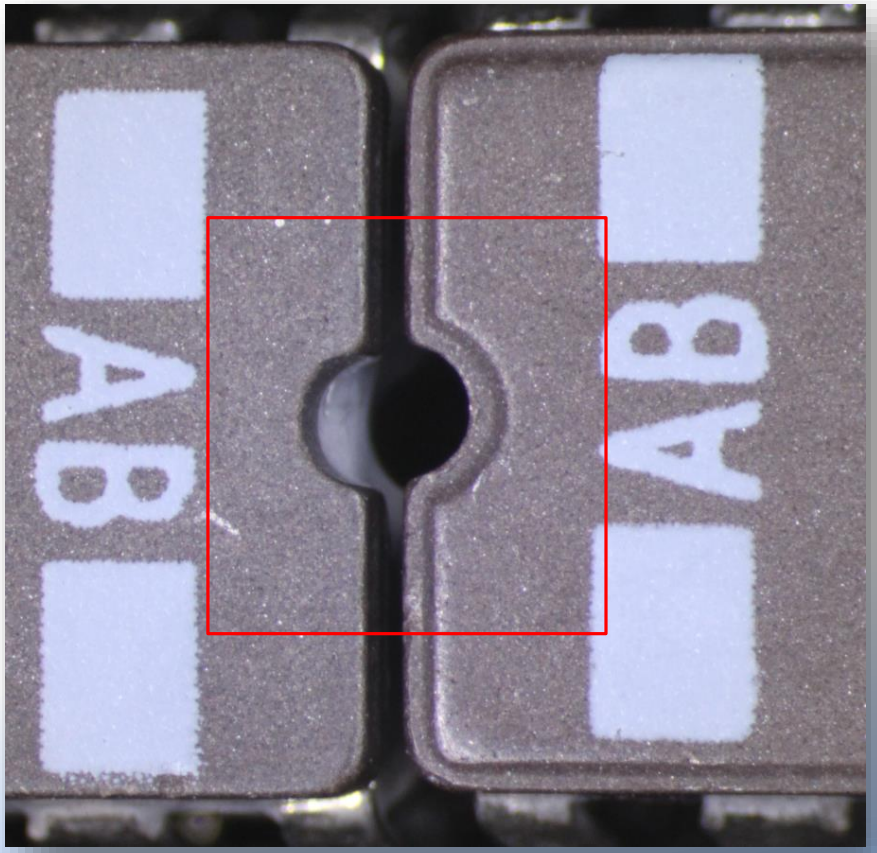
Pry marks may indicate prior use of part

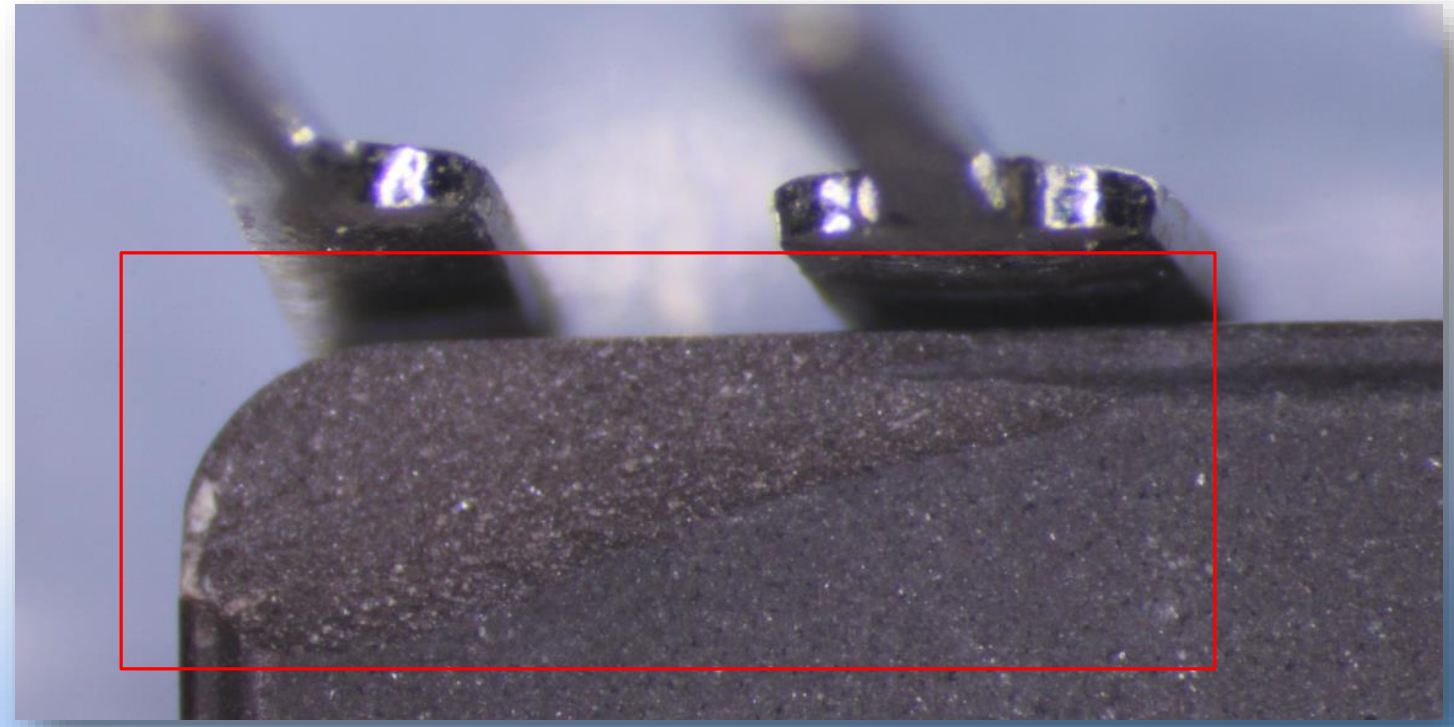
Crack in plastic package

Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

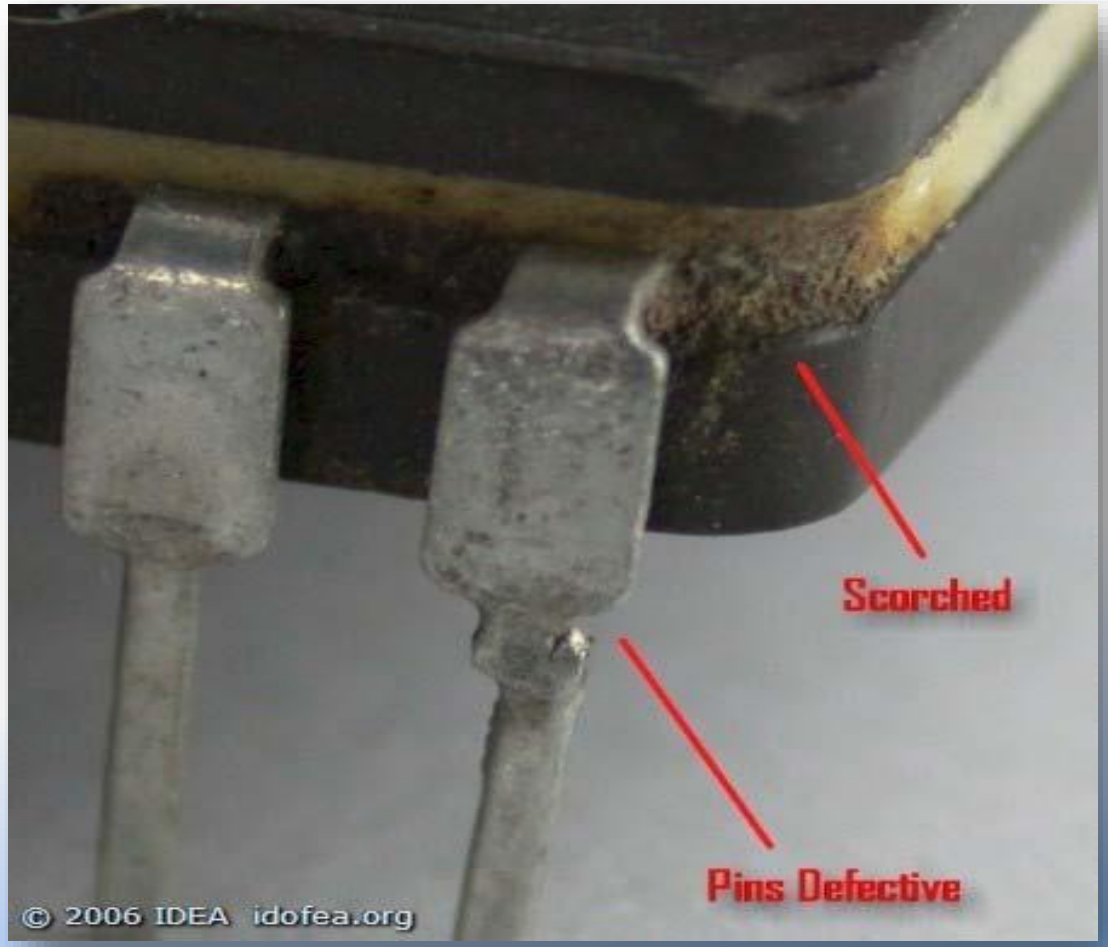
Suspect-mold features





COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-mold features



- Damaged leads
  - Lead may have been re-soldered back onto existing lead.
- Scorching indicates prior use

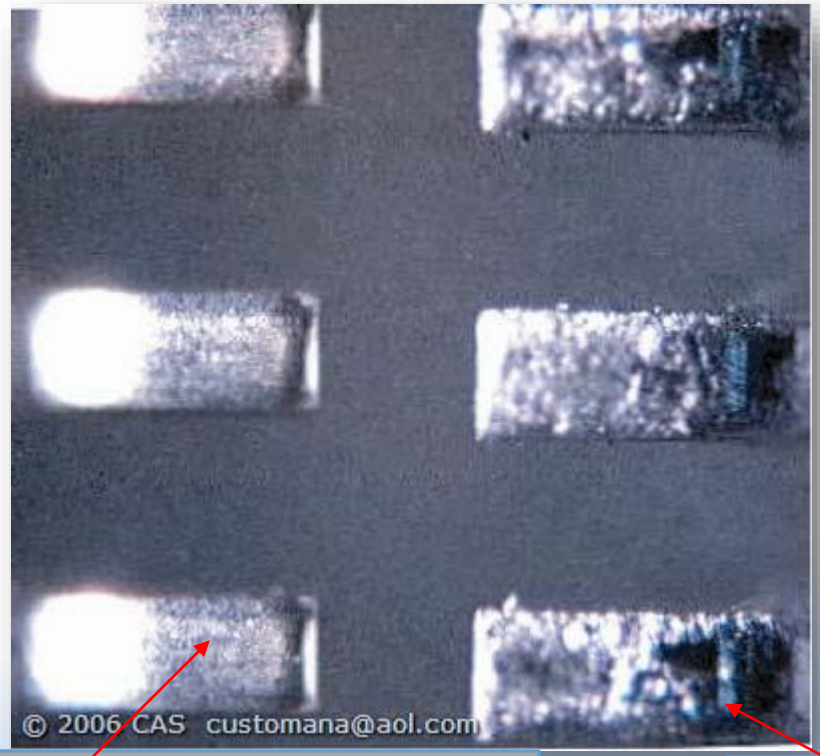
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

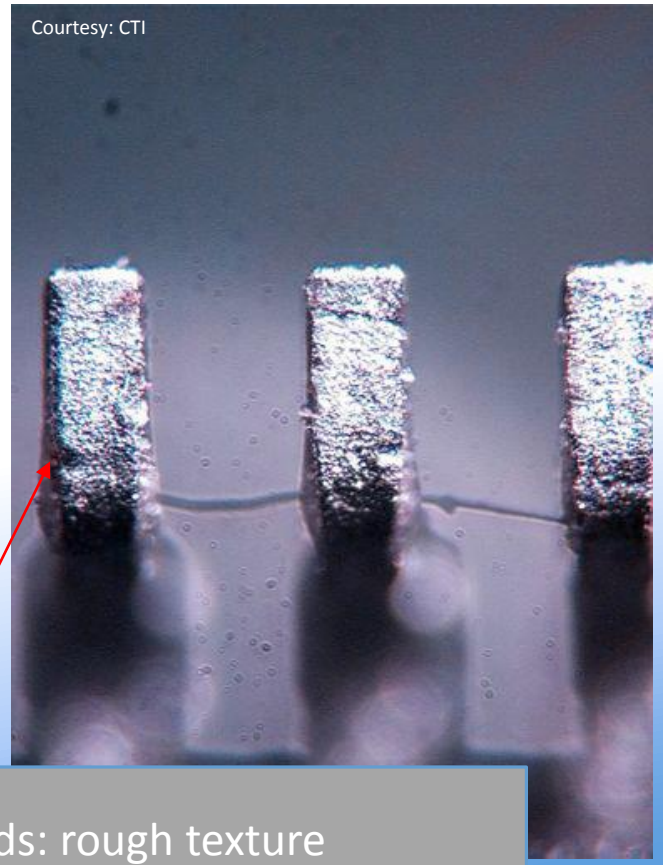
Assessing Incoming Parts

1. Shipping/ Packaging
2. Documentation
   a) Traceability
3. External visual
   a) Physical mold features
   b) Part surface
   c) Part markings
   d) Indents
   e) Pins

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

New vs Suspect Part Leads



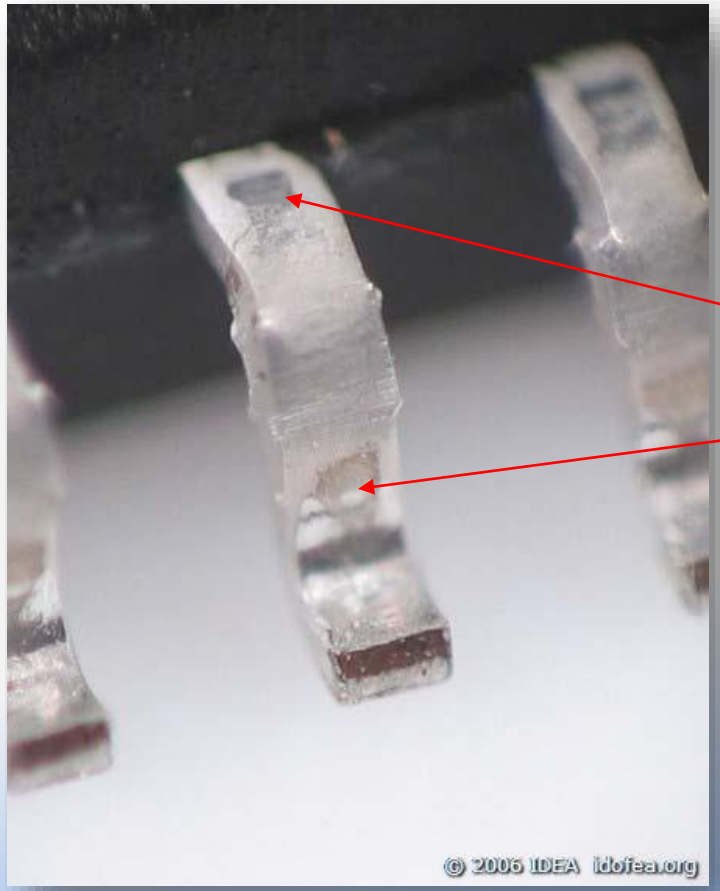


New leads: uniform, consistent finish and shape

Used leads: rough texture

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Good-Part leads

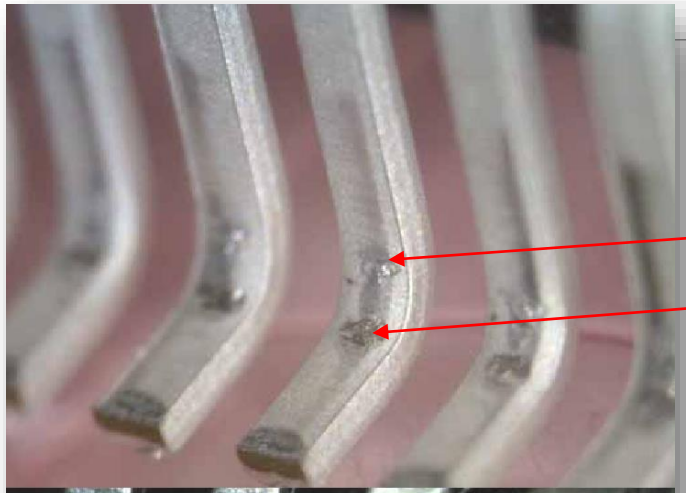


Tooling marks: result of lead formation or "bending" of leads to meet specification

Courtesy: IDEA-STD-1010-A: Acceptability of Electronic Components Distributed in the Open Market

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

New vs re-tinned leads



Leads with obvious witness marks

Same part re-tinned, witness marks are hidden

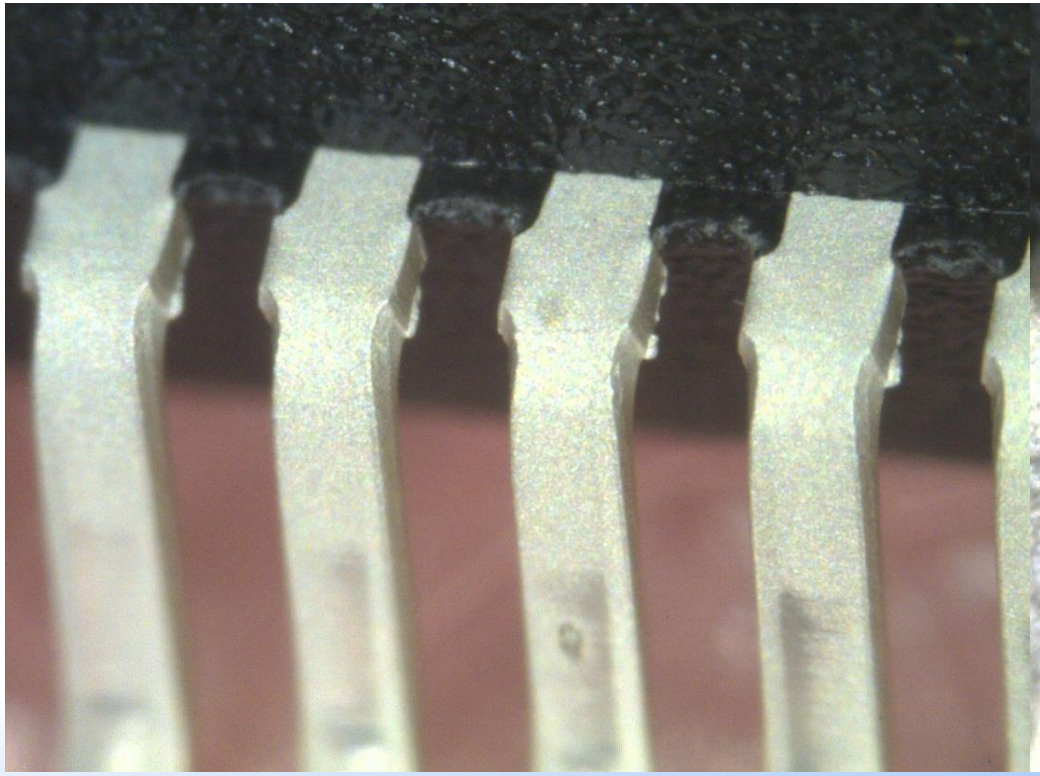
Courtesy: SMT Corp

Multiple witness marks from re-bending

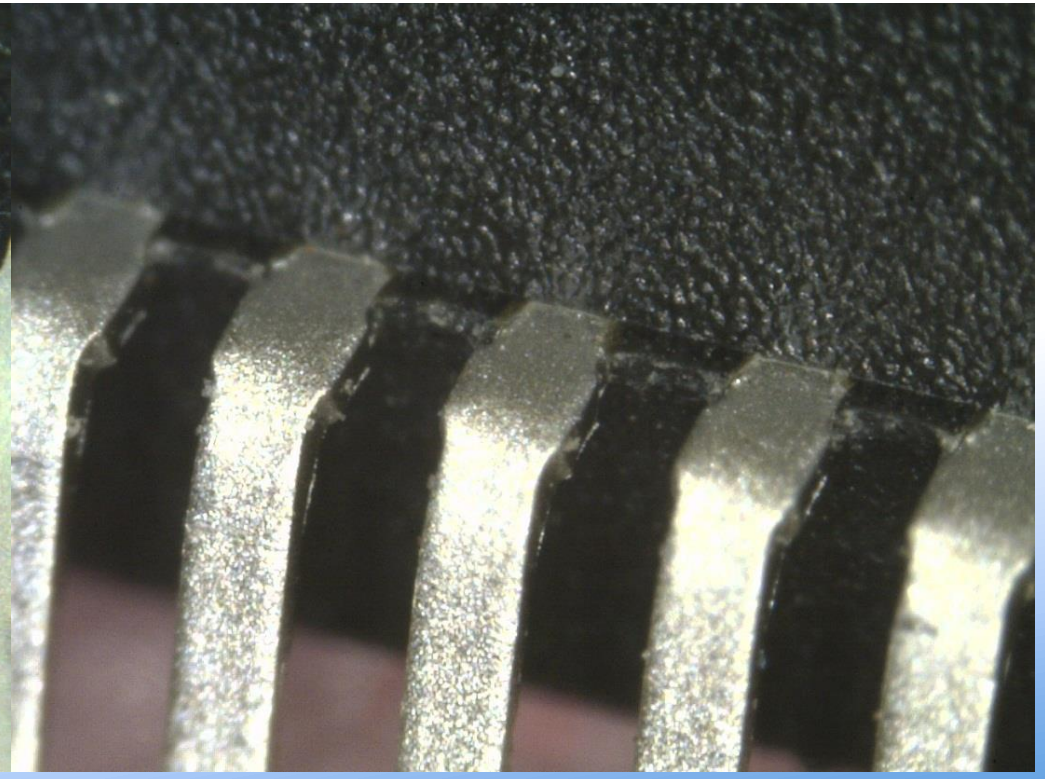
Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Lead Shoulders



Authentic

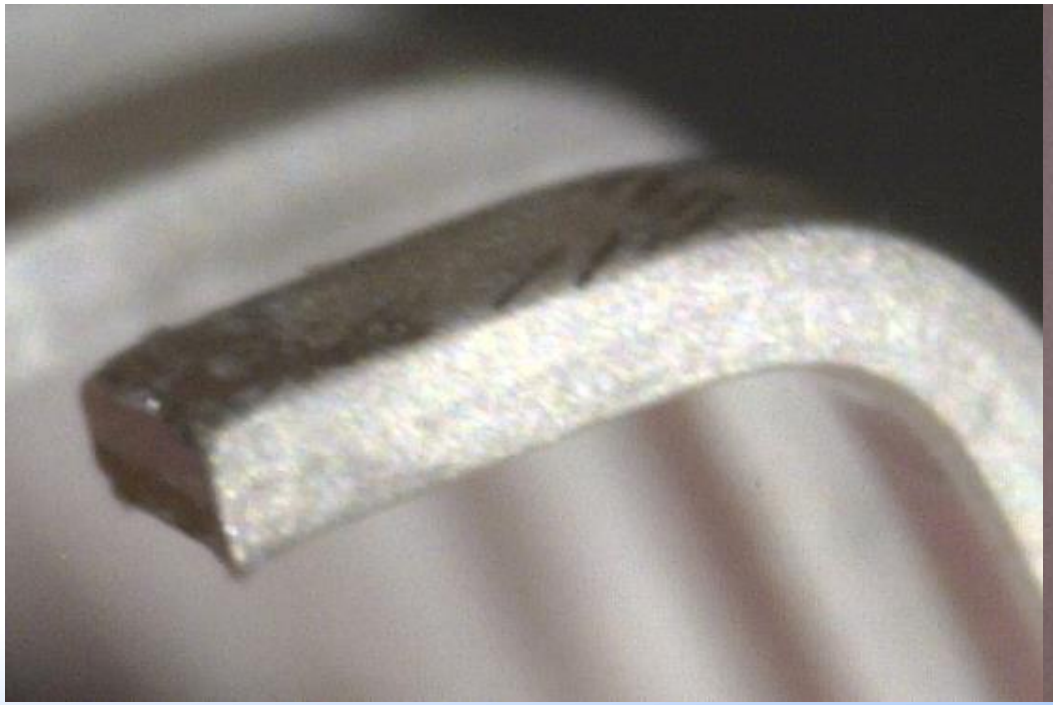


Suspect

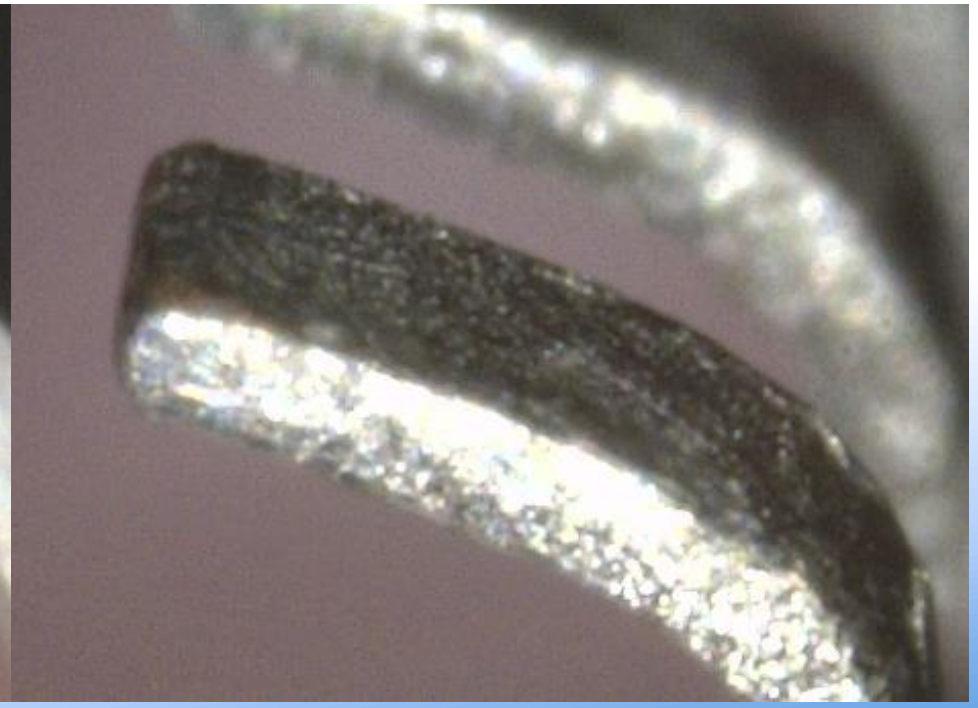
Courtesy: SMT Corp

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Lead Pads



Authentic

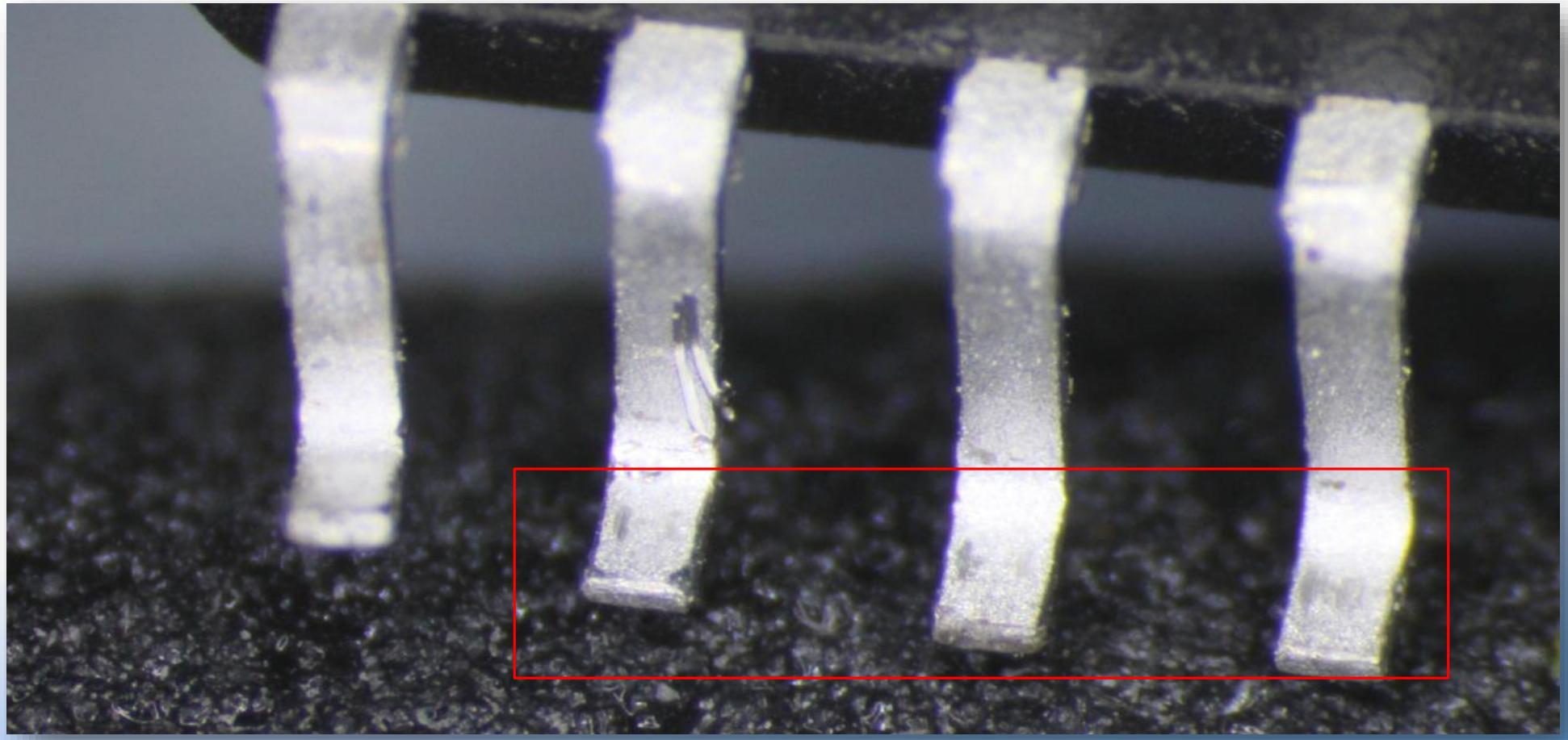


Suspect

Courtesy: SMT Corp

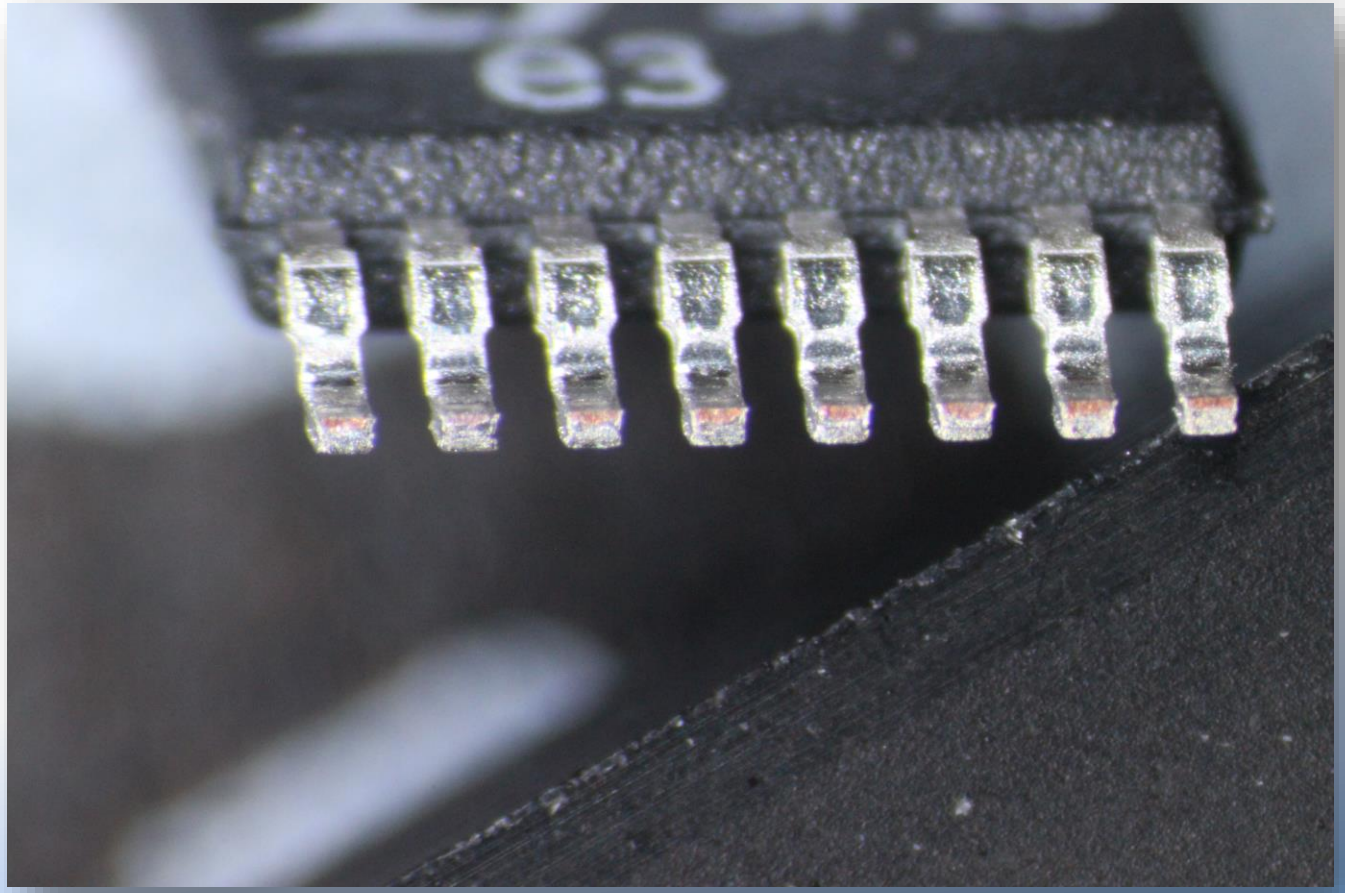
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

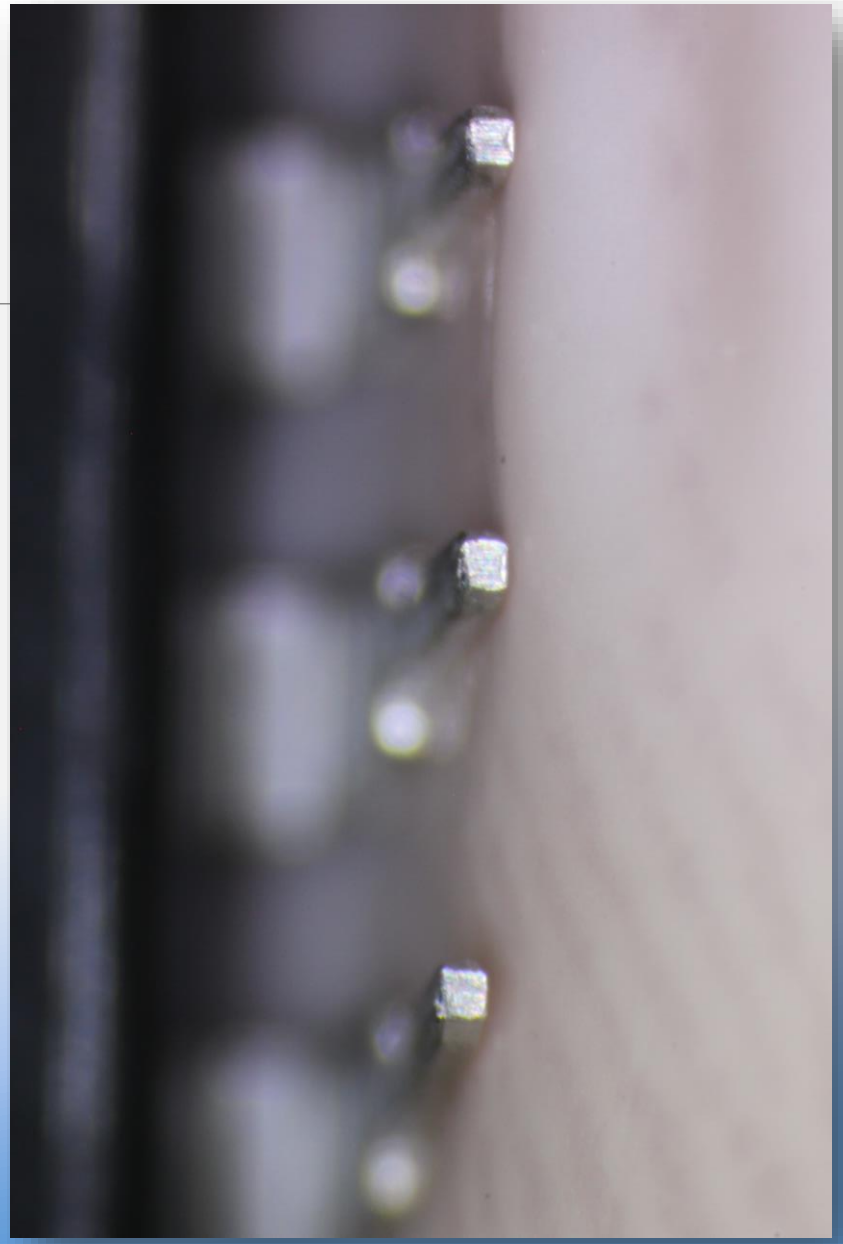
Tooling marks absent



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

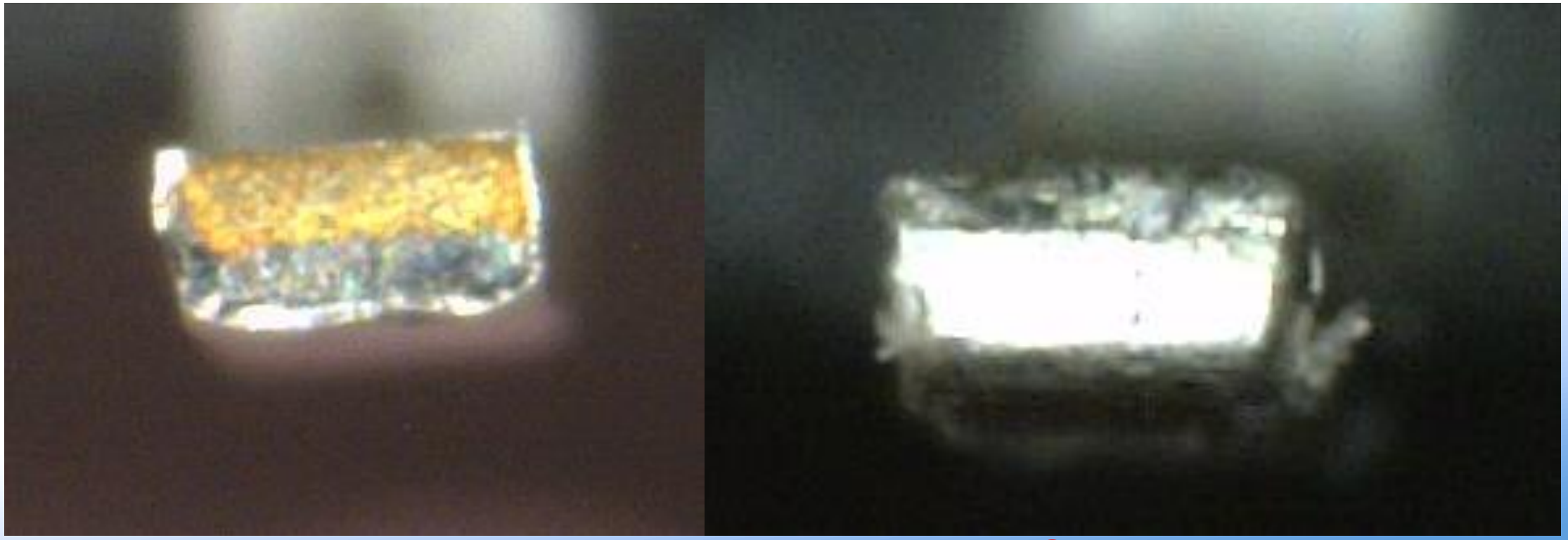
Exposed copper





COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Exposed copper



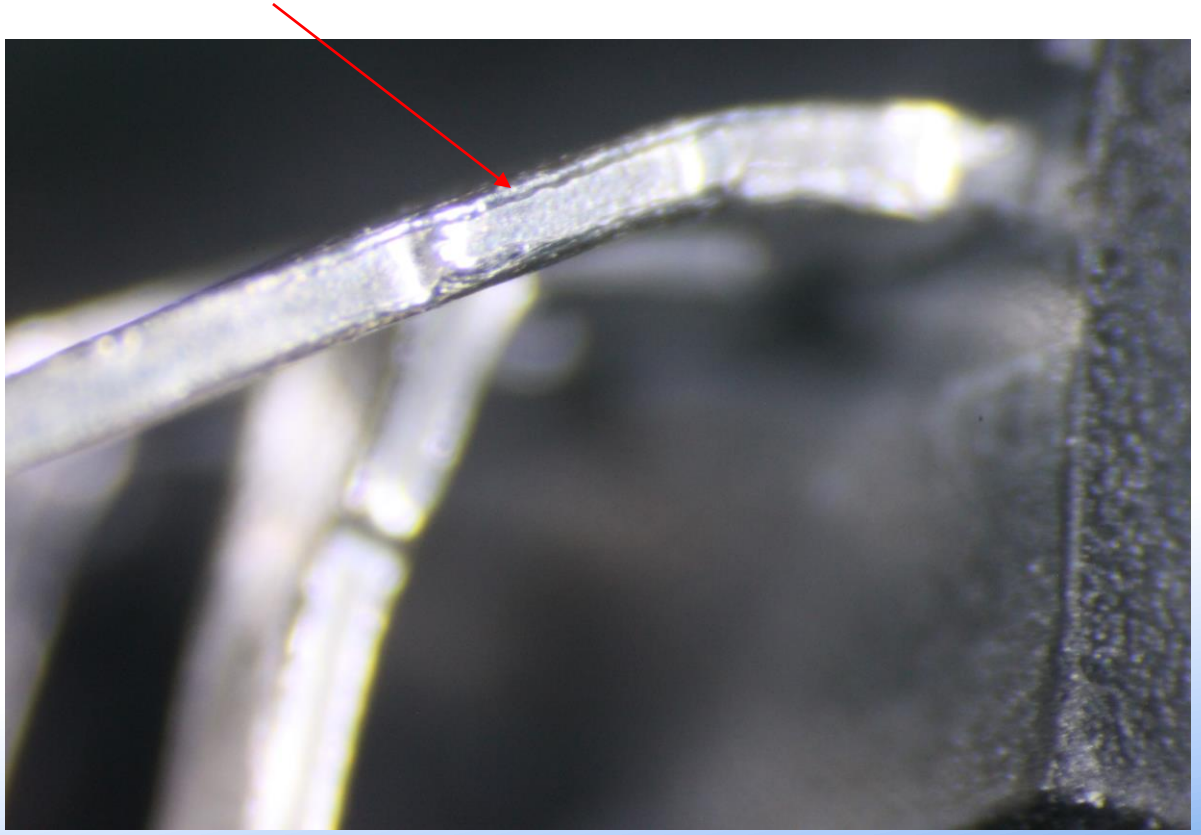
Authentic

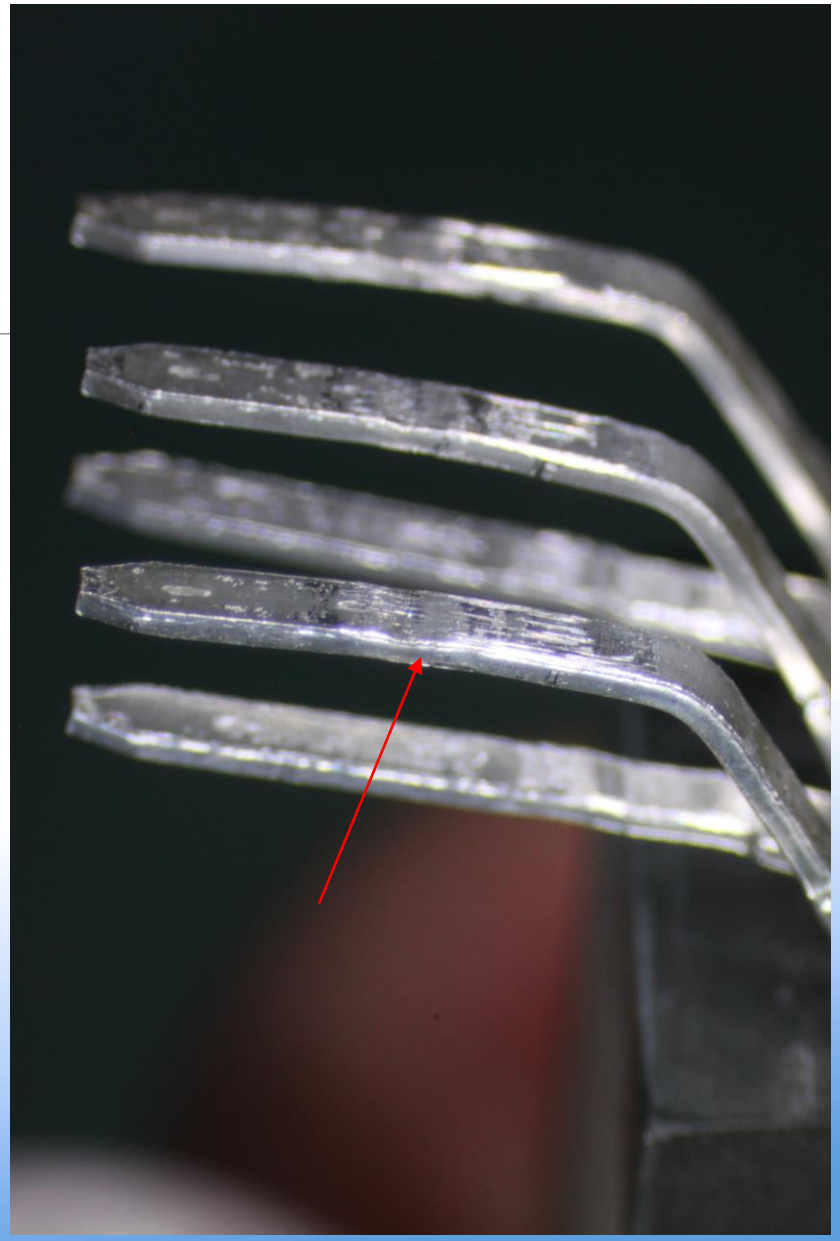
Suspect

Courtesy: SMT Corp

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

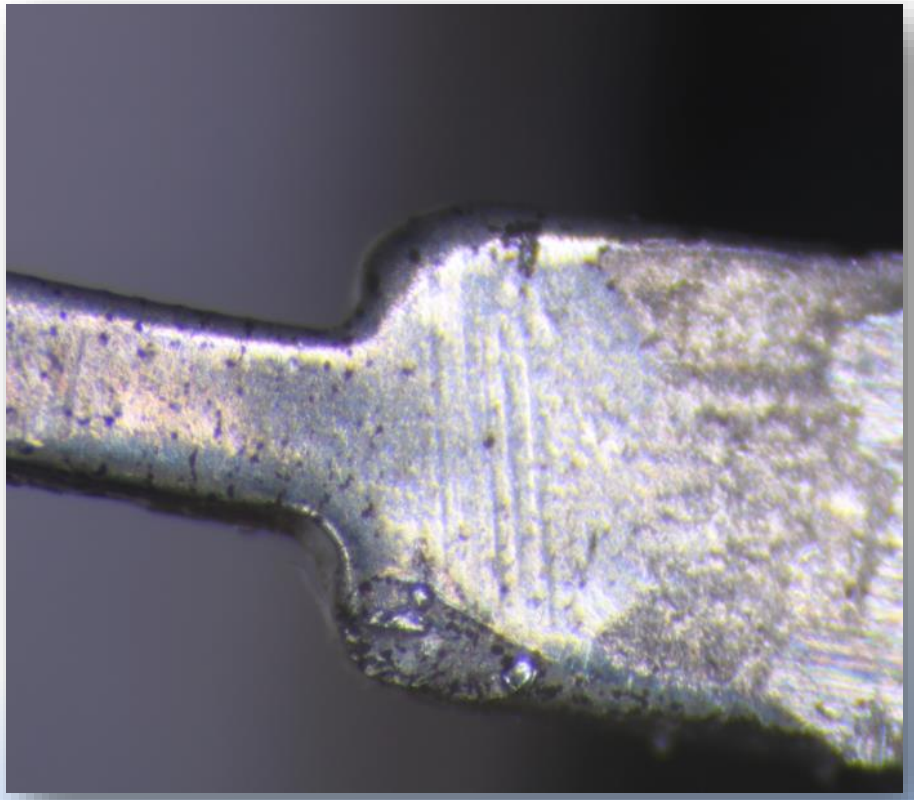
Suspect-Part leads

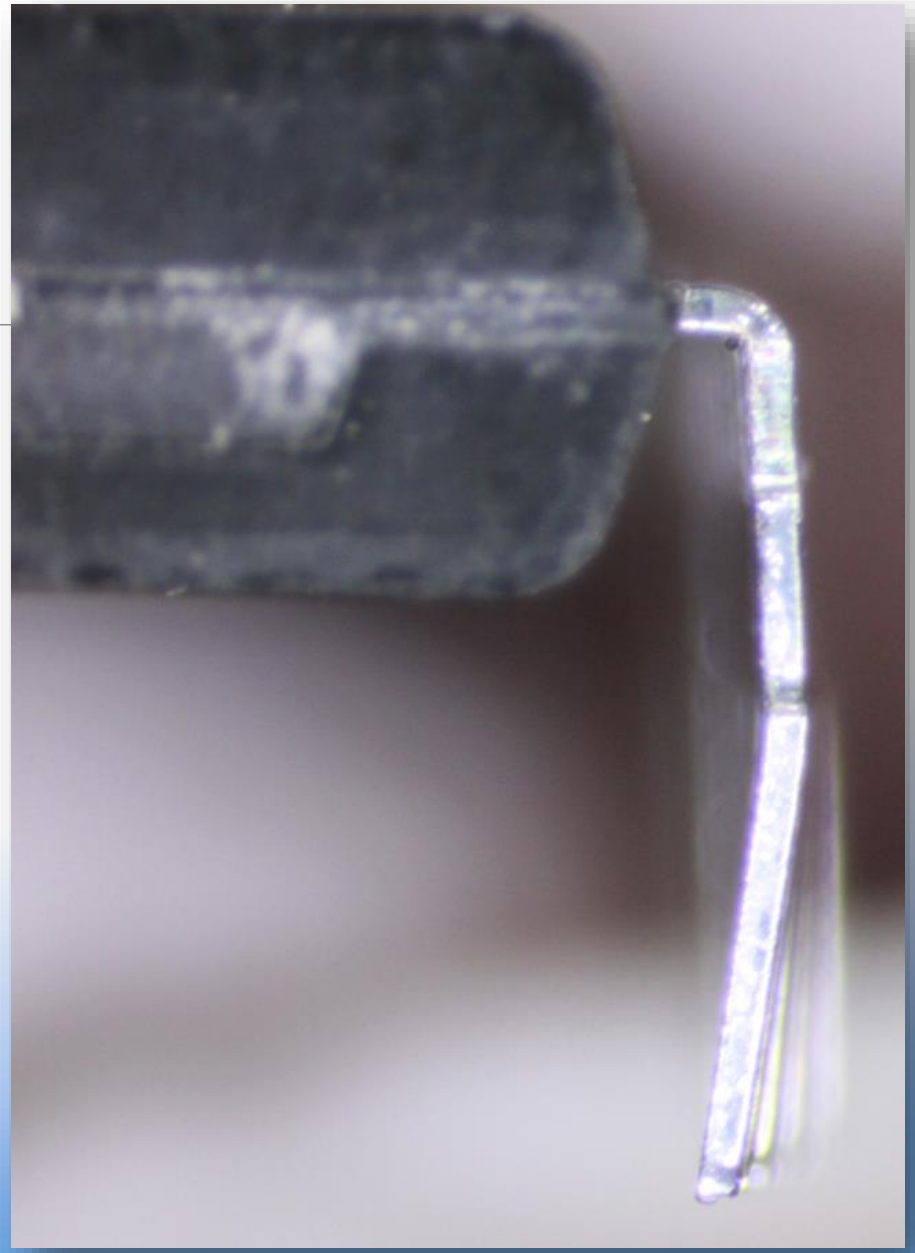




COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

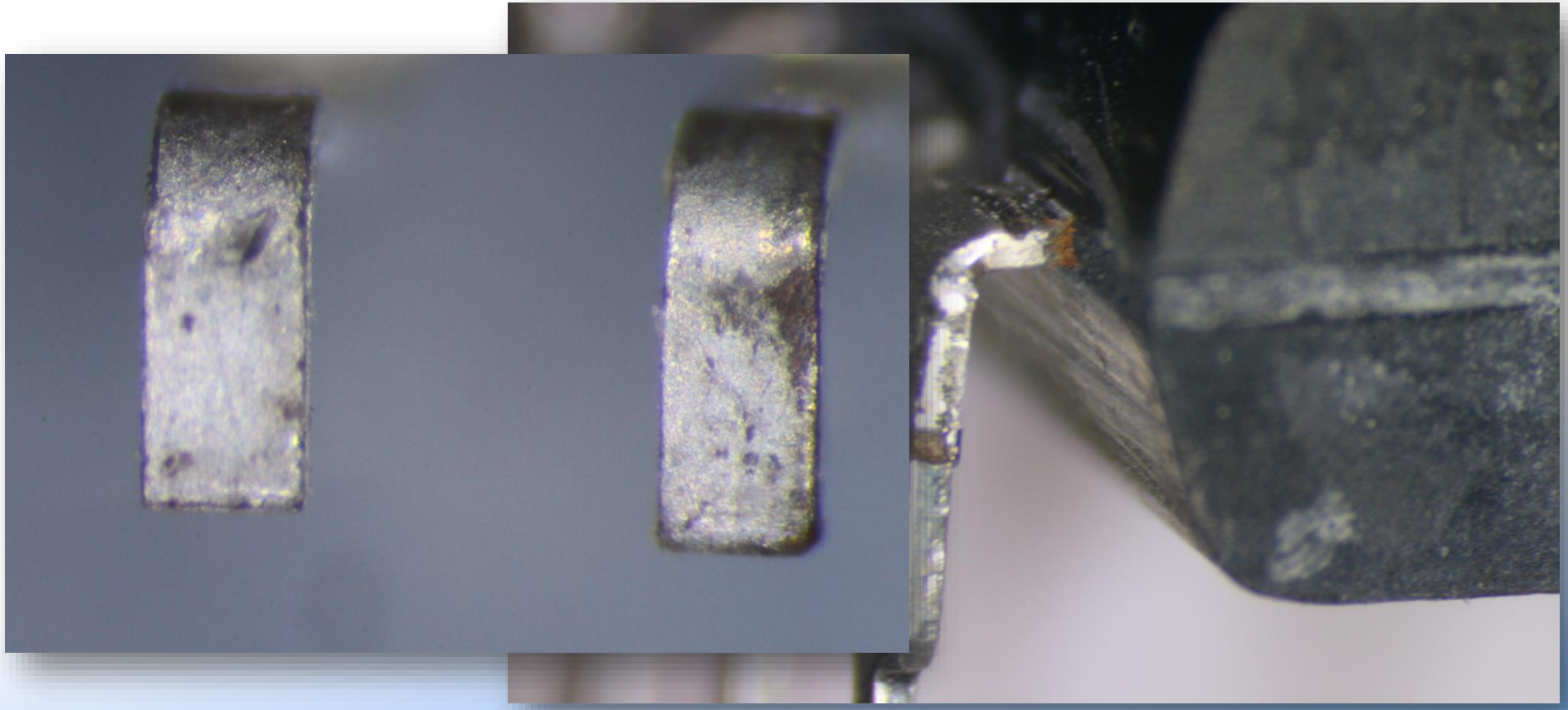
Suspect-Part leads





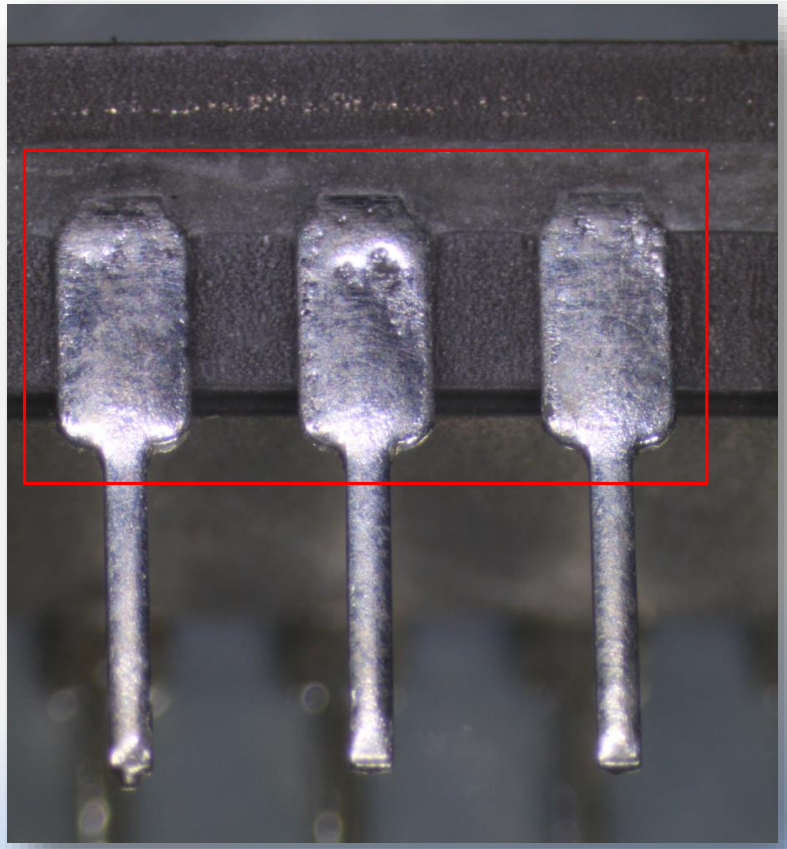
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

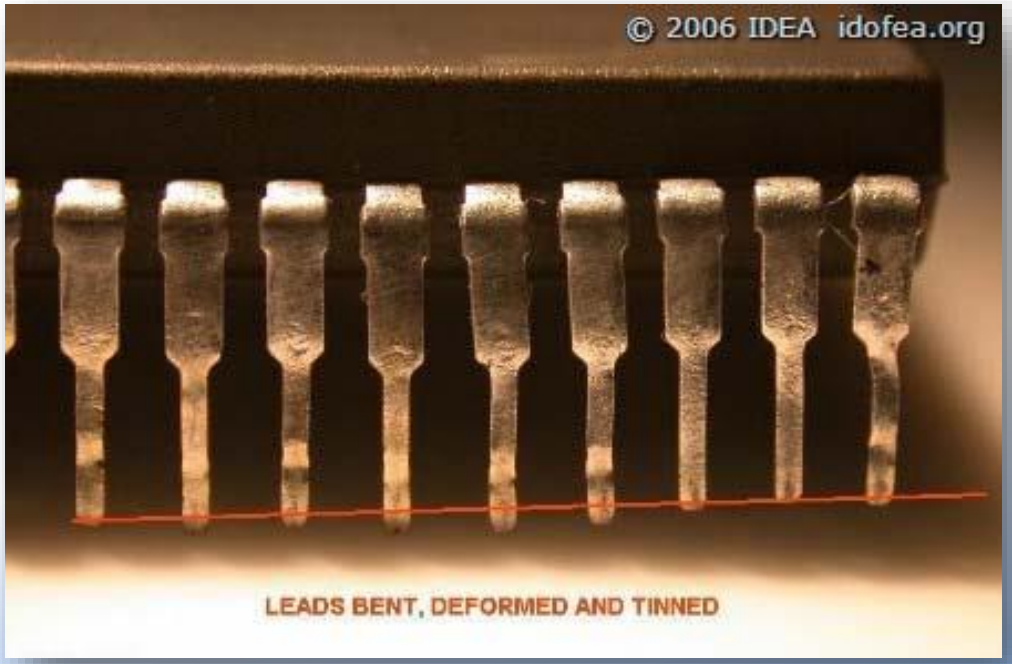
Suspect-Part leads



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part leads



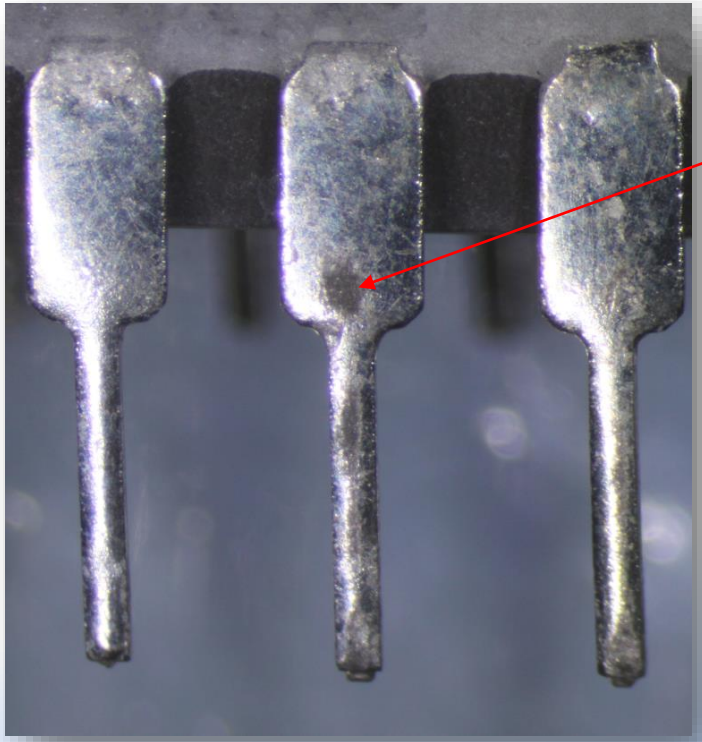


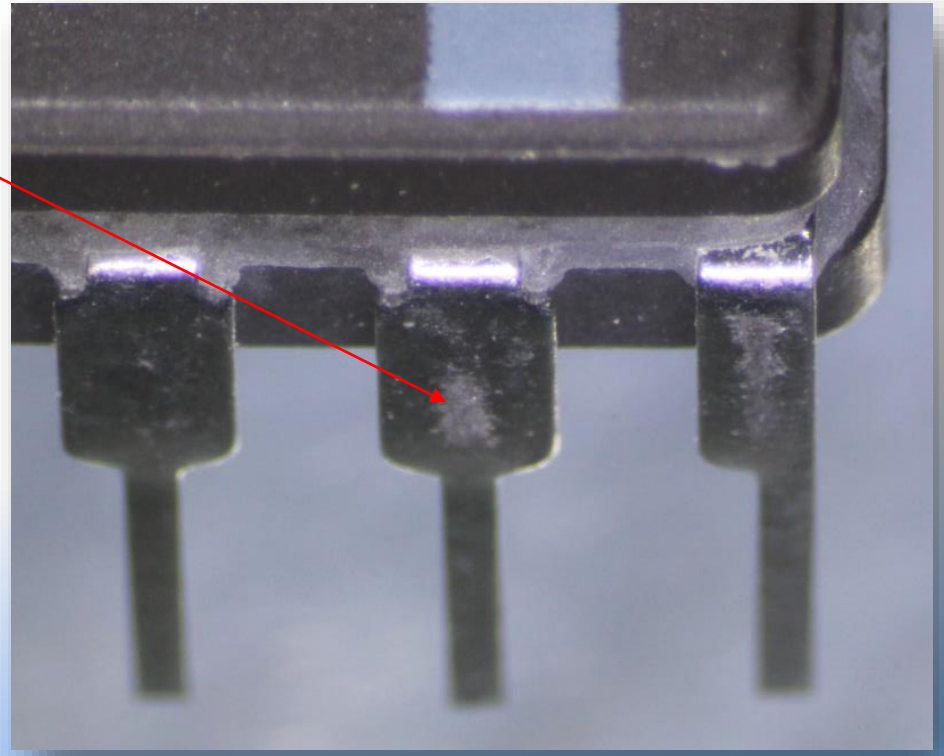
- Bent, re-tinned, and deformed leads

Courtesy: IDEA-STD-1010-A: Acceptability of Electronic Components Distributed in the Open Market

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

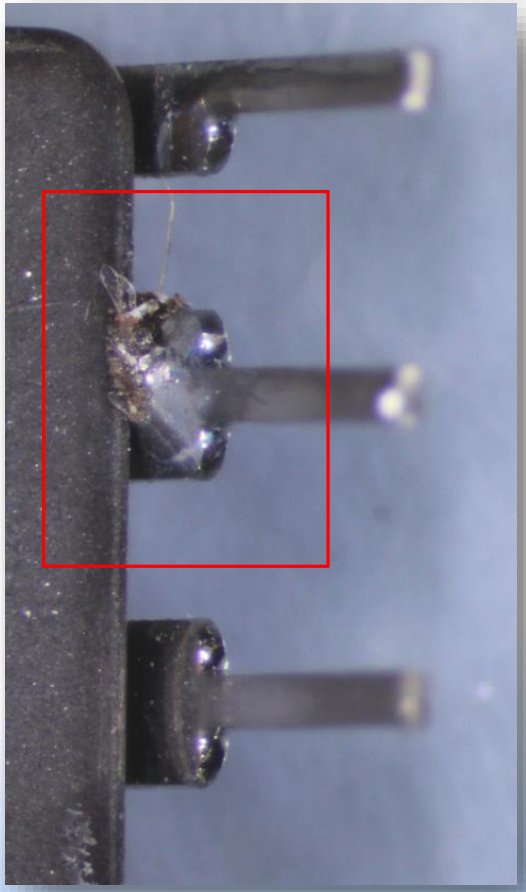
Suspect-Part leads

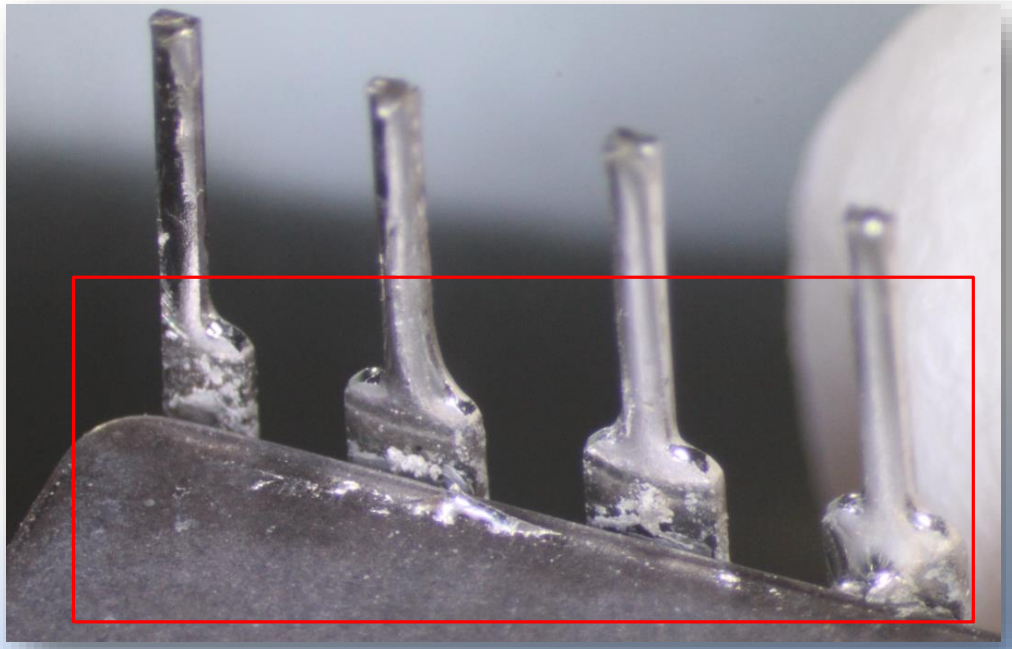


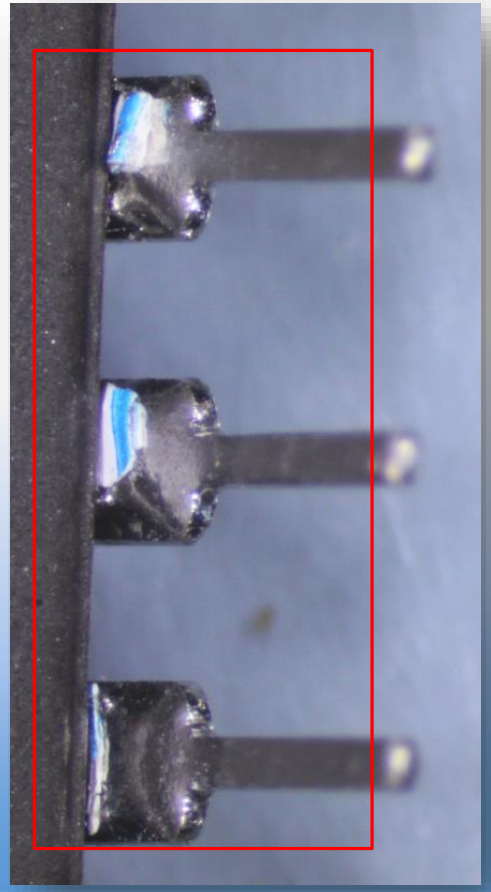


COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part leads Foreign Material

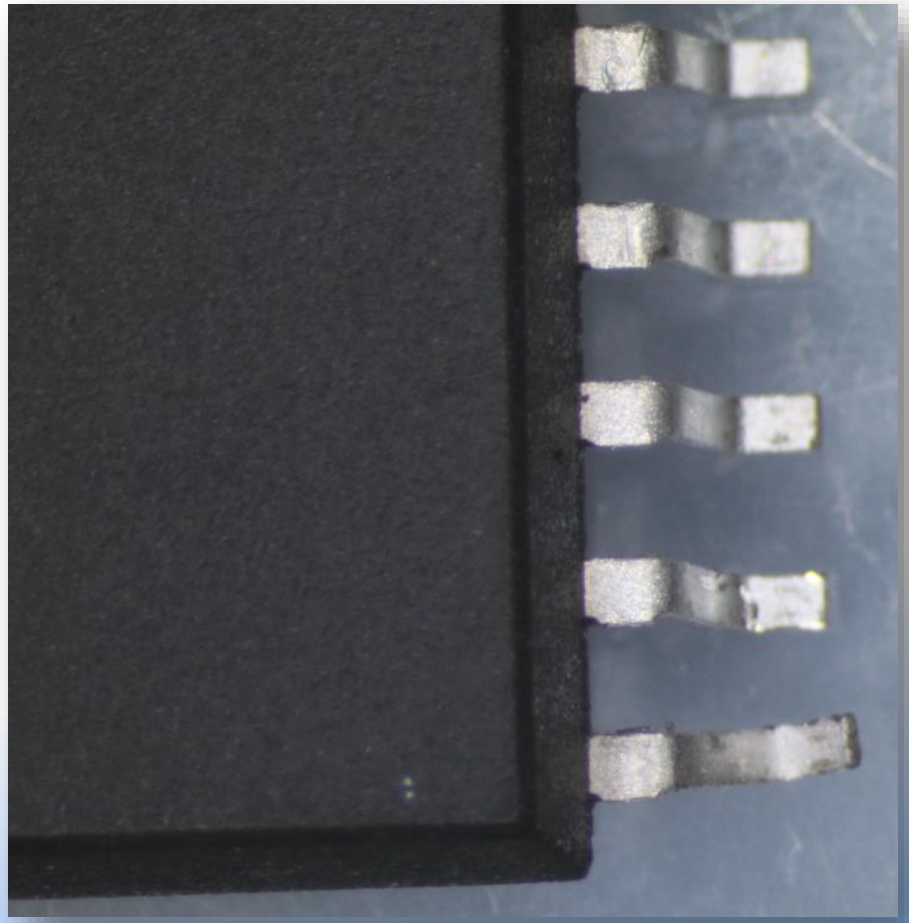


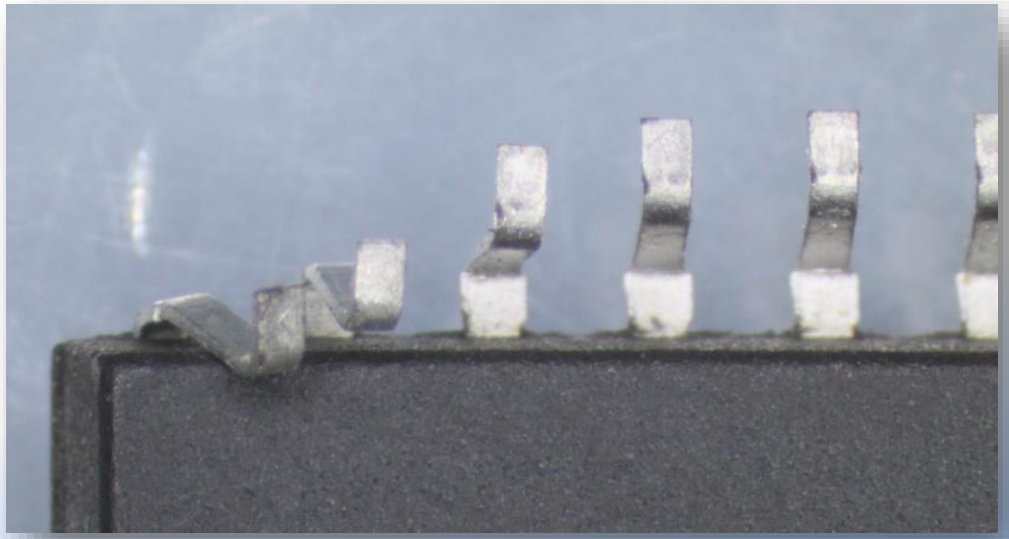




COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part leads



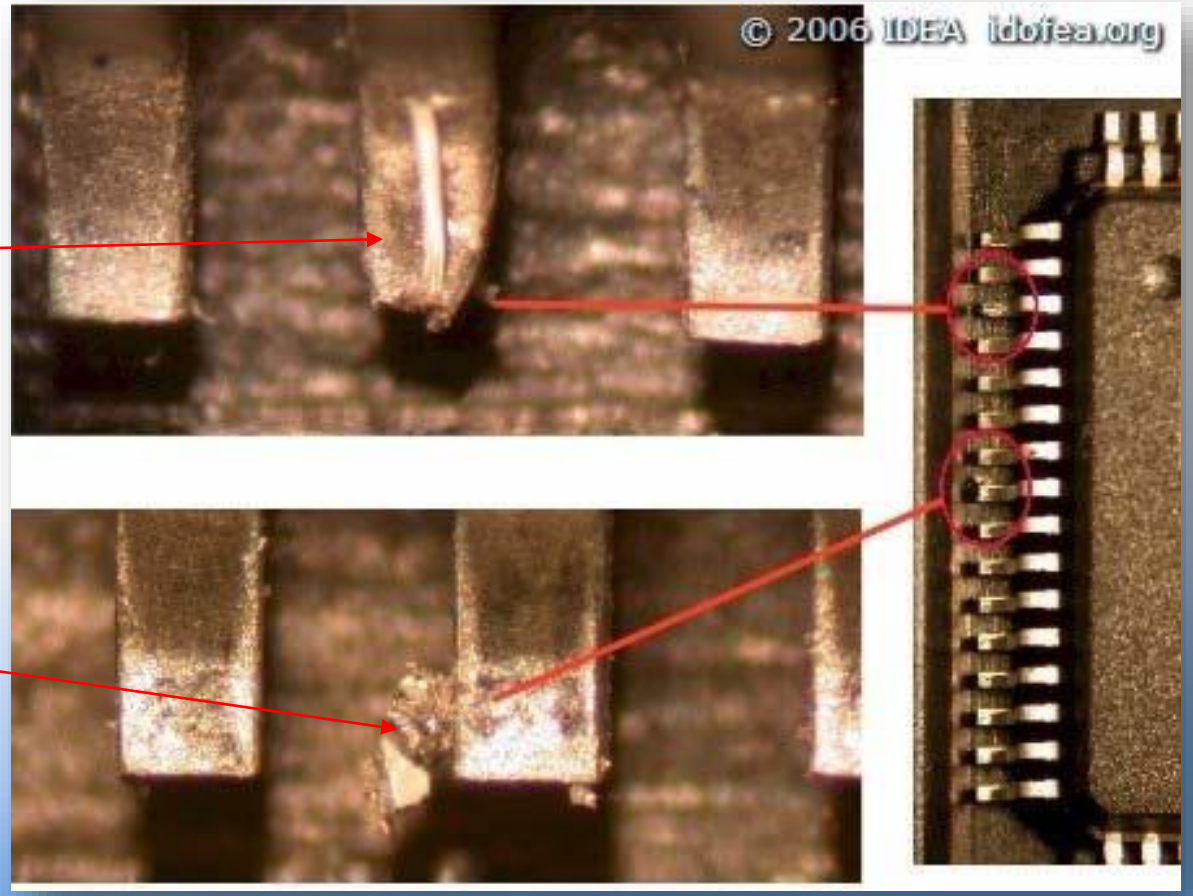


COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Suspect-Part leads

Damaged leads can occur from previous use and from salvaging of ICs from old boards

Leads with loose solder and debris

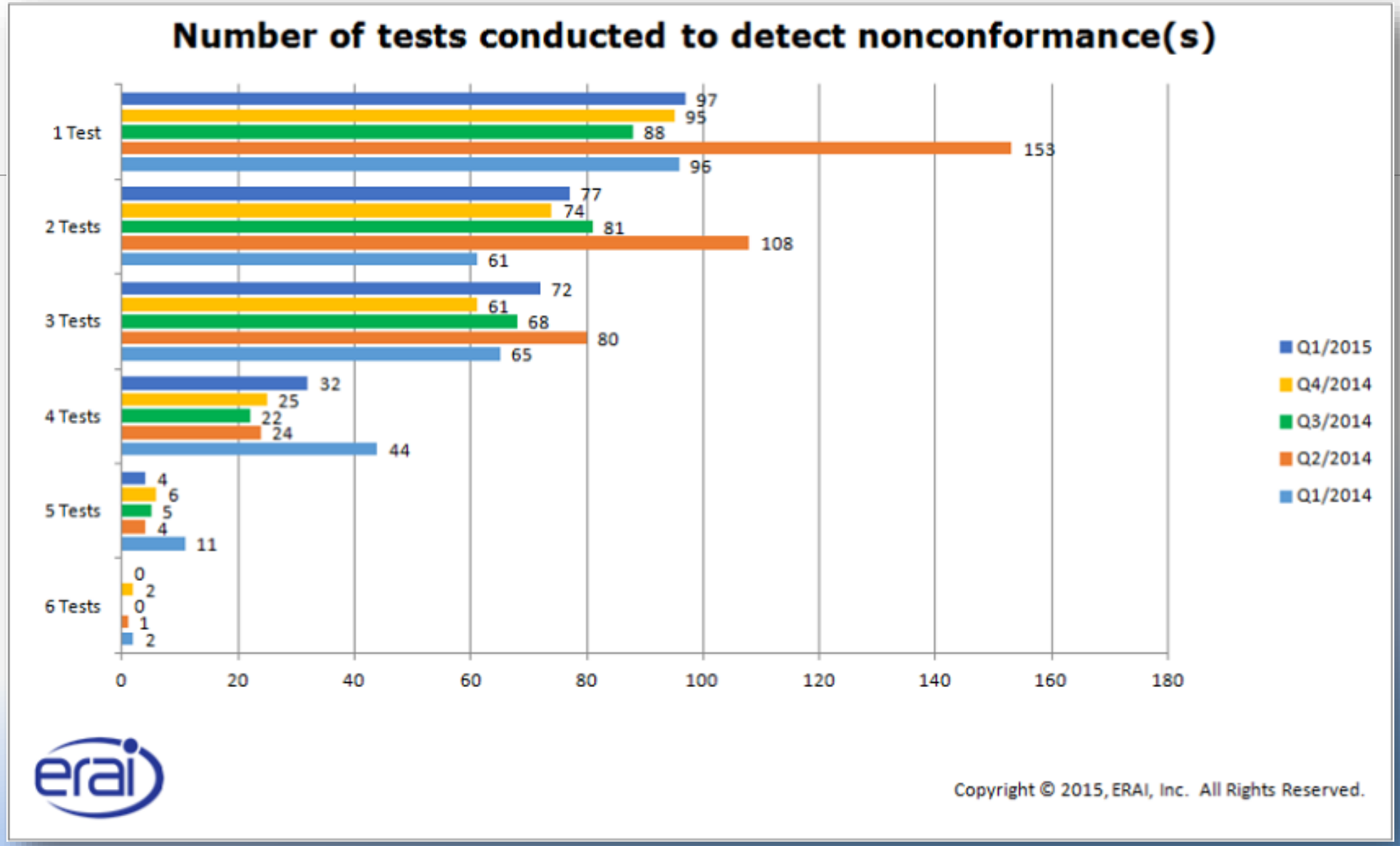


Courtesy: IDEA-STD-1010-A: Acceptability of Electronic Components Distributed in the Open Market

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Section 7 – Additional Testing Examples

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED


Number of tests conducted to detect nonconformance(s)
1 Test
2 Tests
3 Tests
4 Tests
5 Tests
6 Tests
97
95
88
153
96
77
74
81
108
61
72
61
68
80
65
32
25
22
24
44
4
6
5
4
11
0
2
0
1
2
0
20
40
60
80
100
120
140
160
180
Q1/2015
Q4/2014
Q3/2014
Q2/2014
Q1/2014
Copyright © 2015, ERAI, Inc. All Rights Reserved.

Marking Permanency/ Solvents Testing

- 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

Courtesy: MIL Std 883 Method 2015; SAE AS5553

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Marking Permanency/ Solvents Testing

Scraping from razor removed fake “top”

Ghost markings

Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Marking Permanency/ Solvents Testing

Courtesy: GIDEP

Acetone removes black from surface of part

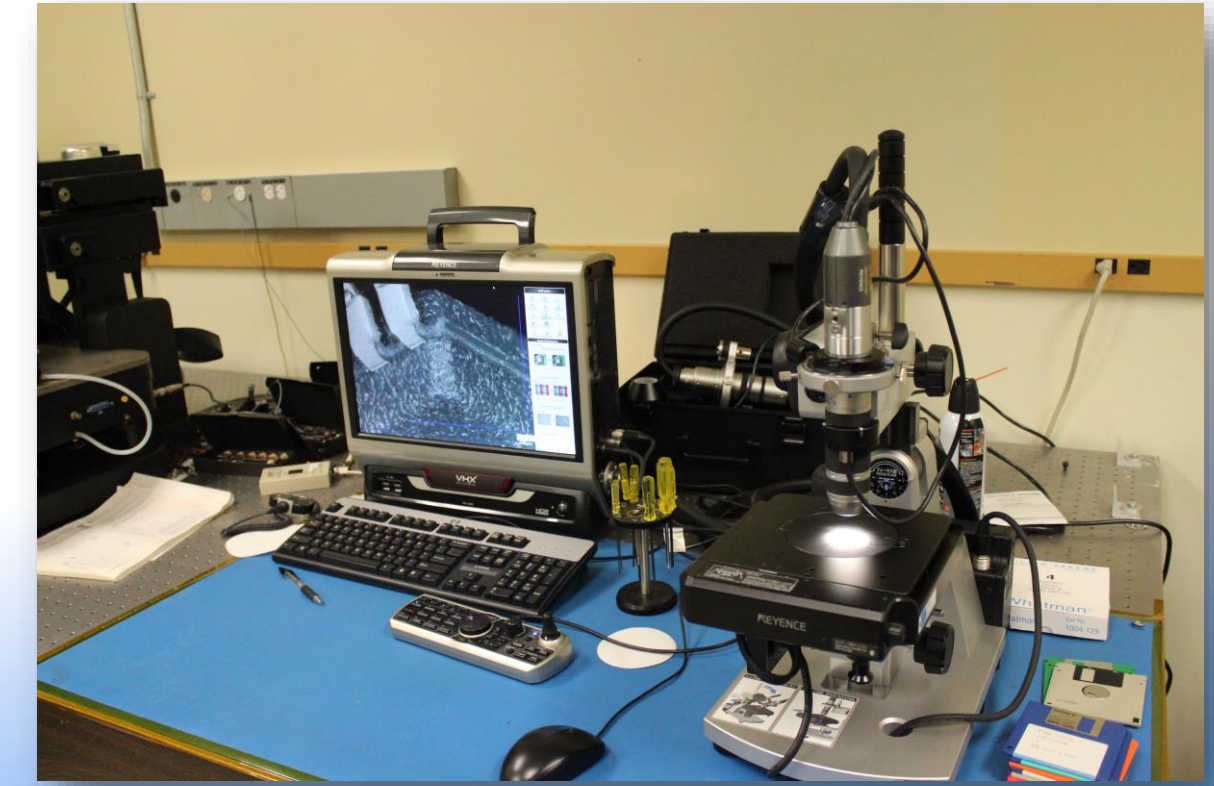
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Marking Permanency/ Solvents Testing

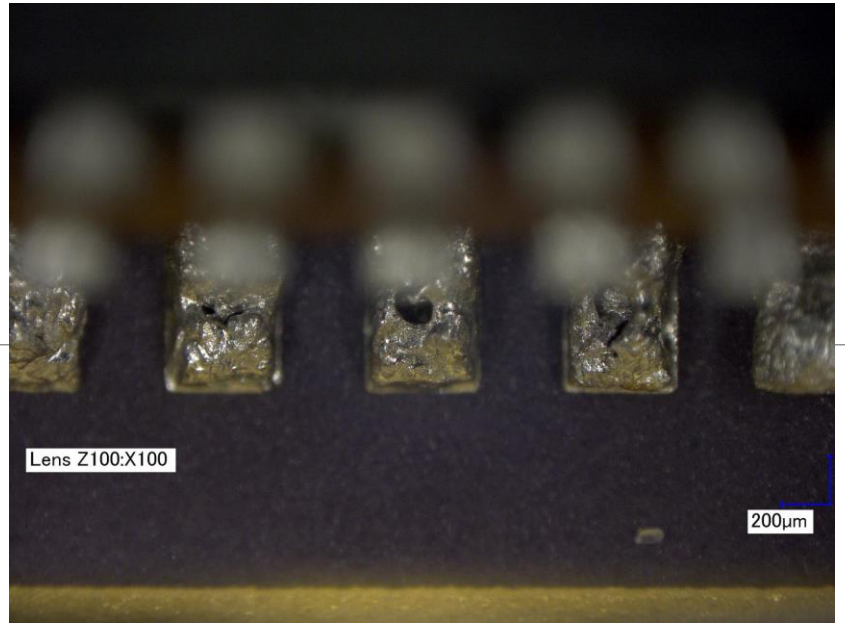
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

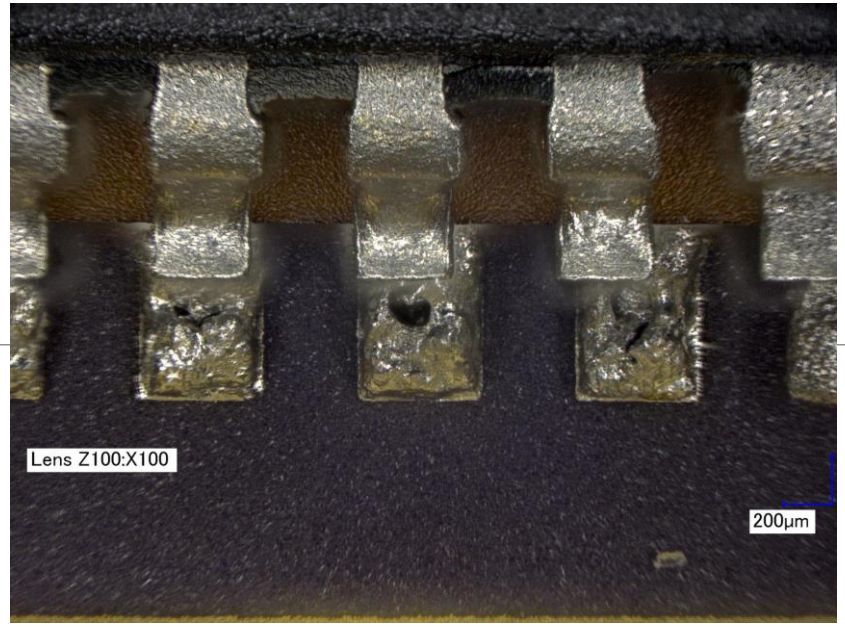
Microscopy

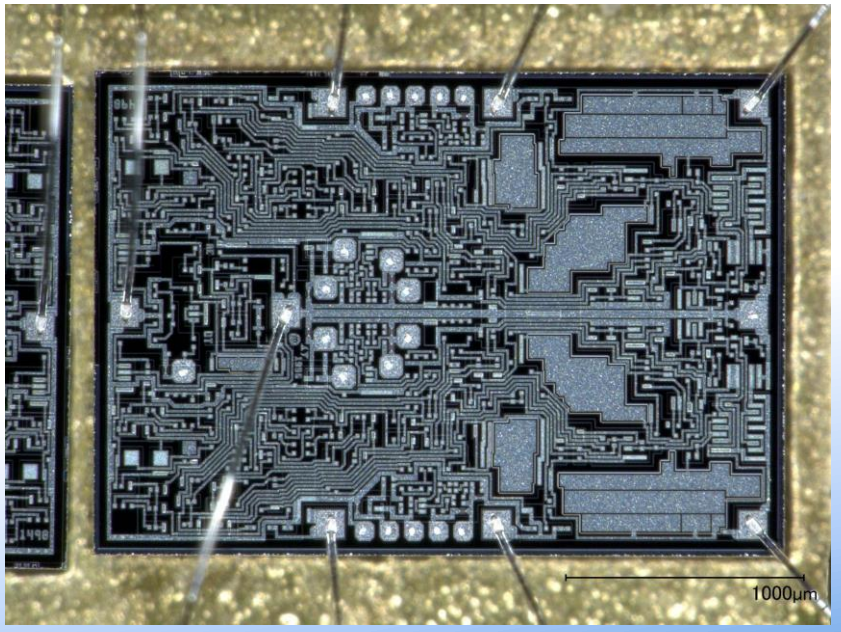
- High magnification
  - 20x-1000x
  - Confocal capabilities

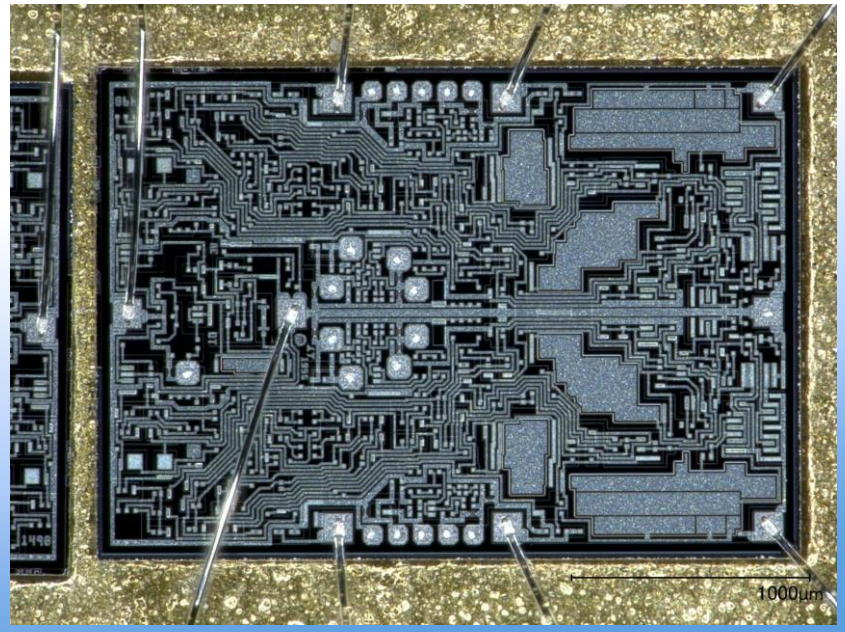


COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED



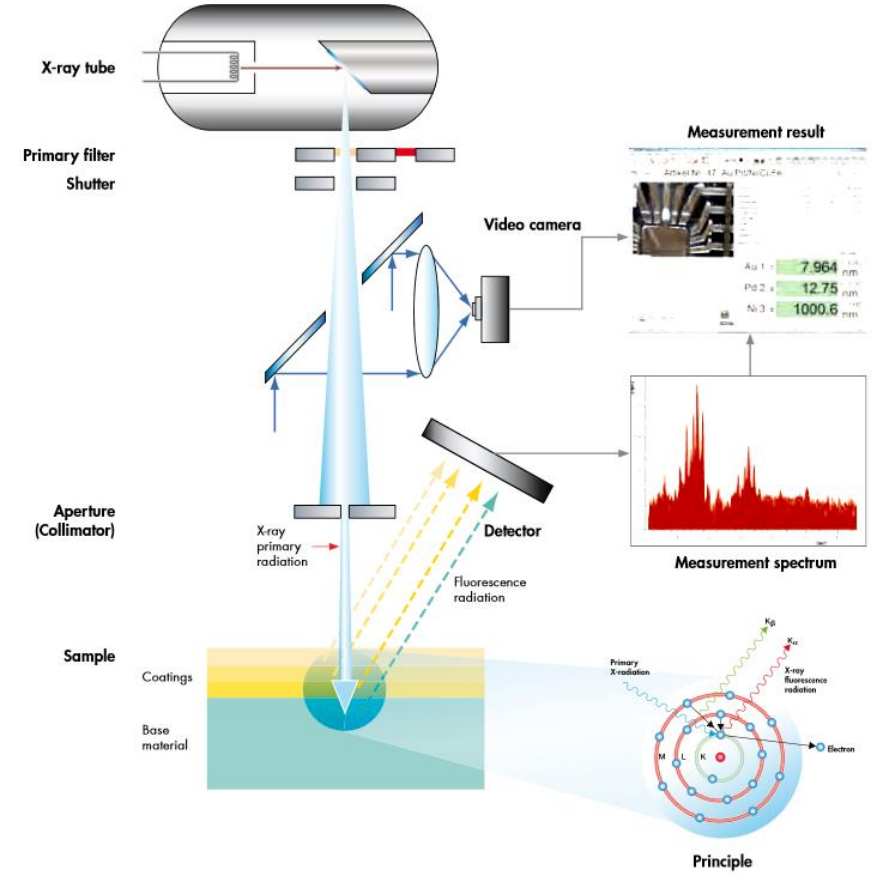


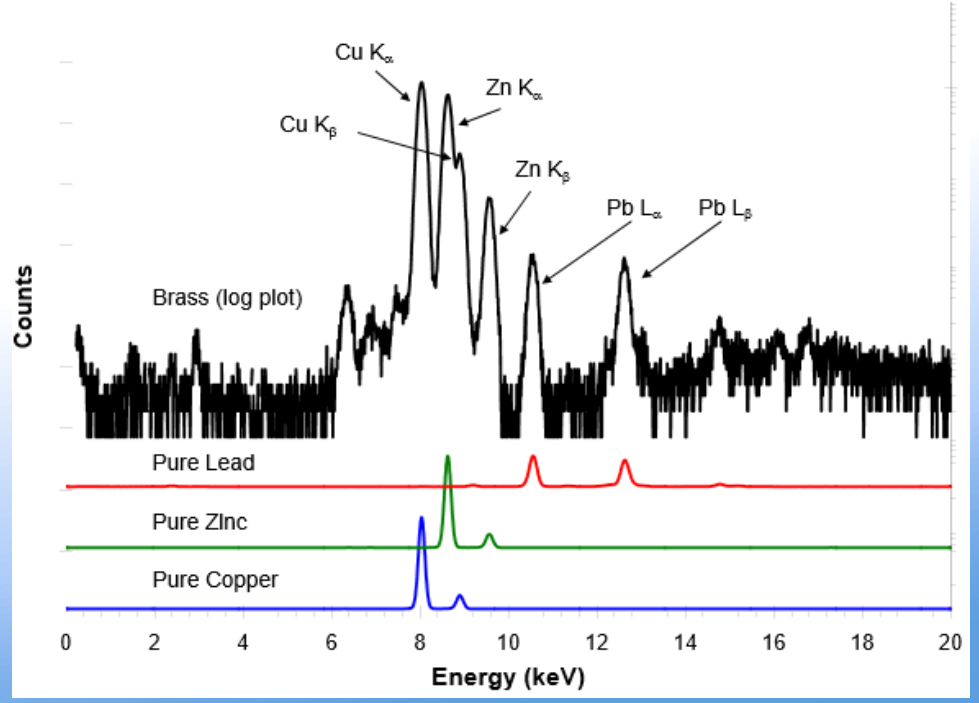




COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

X-Ray Fluorescence (XRF)

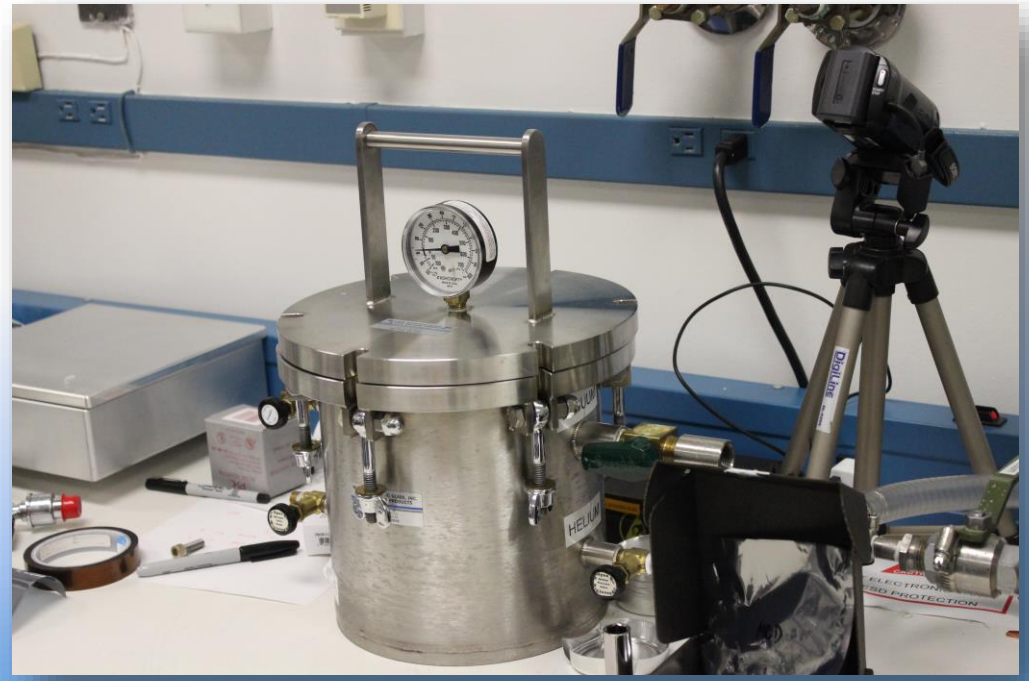




COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Hermiticity

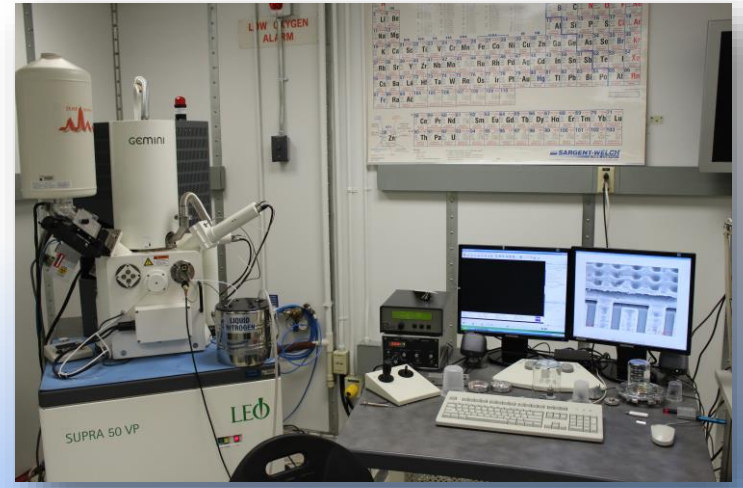
- Used to determine the effectiveness of package seals in microelectronic packages
  - Defective or damaged seals can allow air or liquids into internal cavity of package and degrade reliability

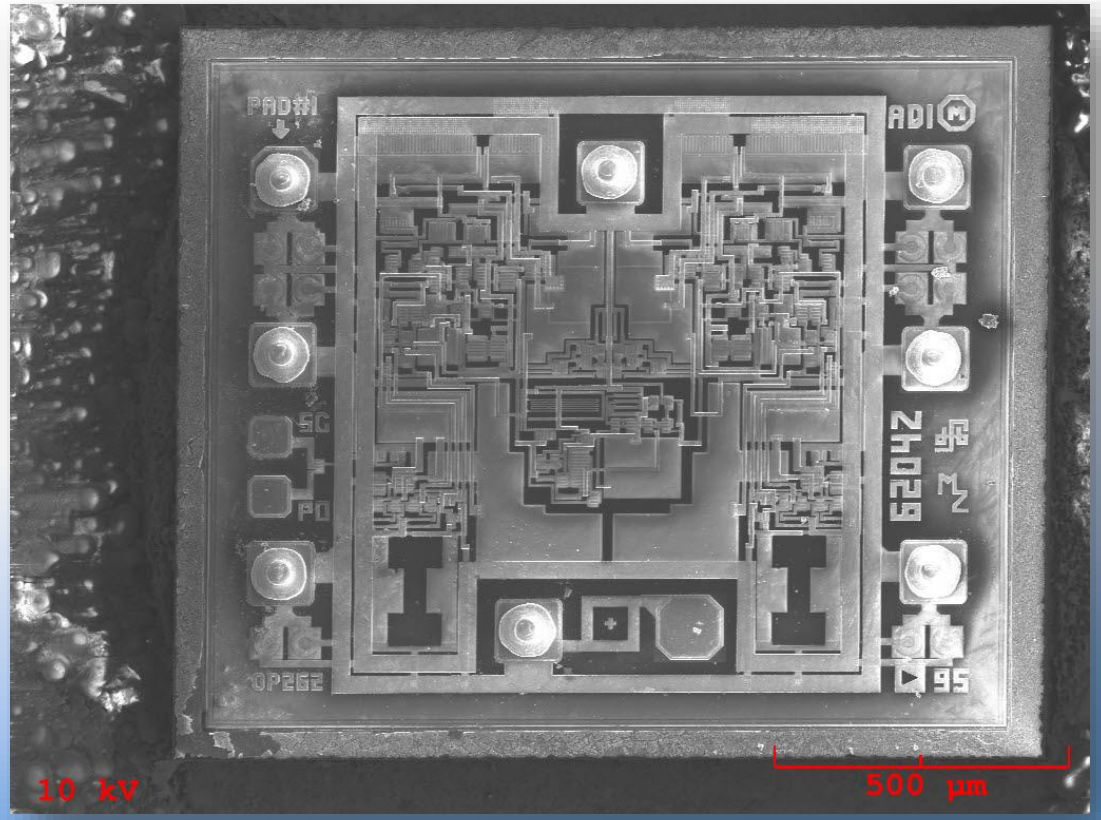


COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Scanning Electron Microscope (SEM)

- Uses electrons to form image instead of light
  - Electrons interact with sample producing signals that contain data on sample's structure and composition.
- 250 times magnification limit as light microscopy!

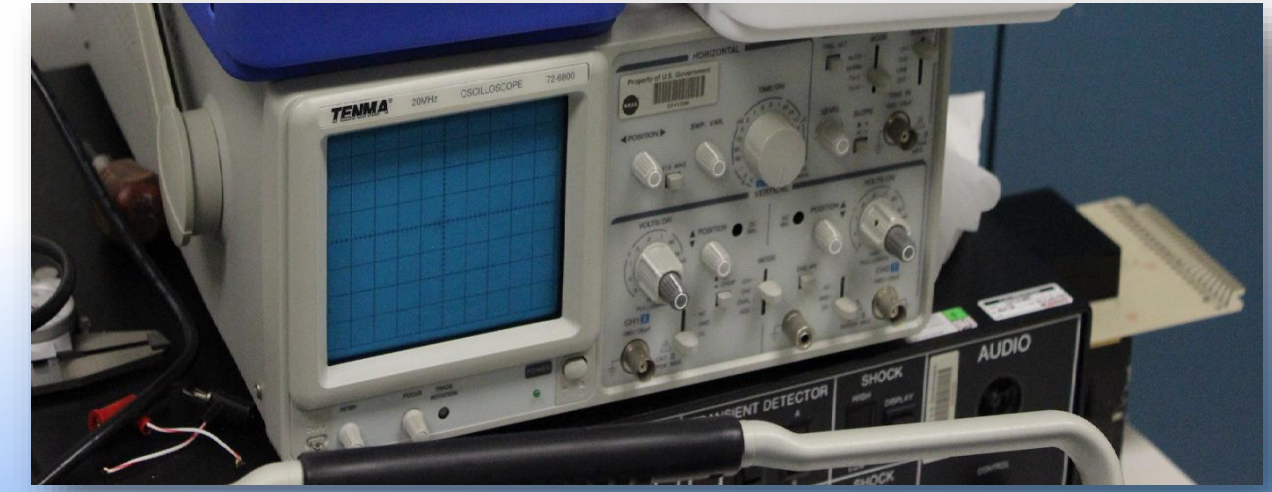




COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Particle Impact Noise Detection

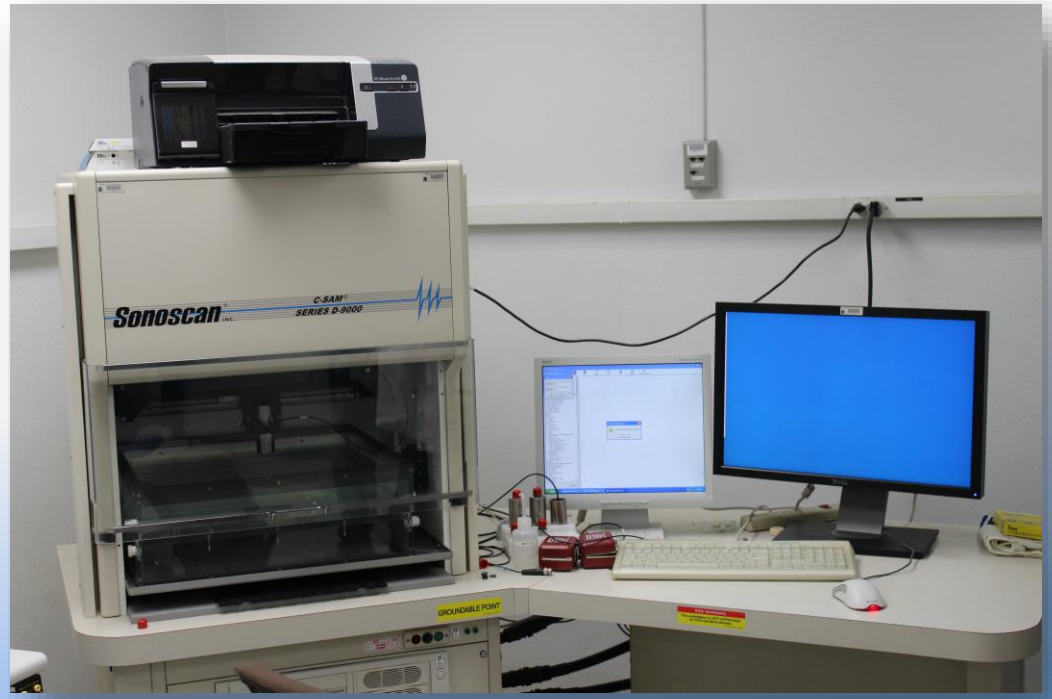
- Detect loose particles inside a microelectronic cavity
  - Conductive contamination can bridge active metallization causing failure
  - Non-conductive particles can cause mechanical damage
- Non-destructive test



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

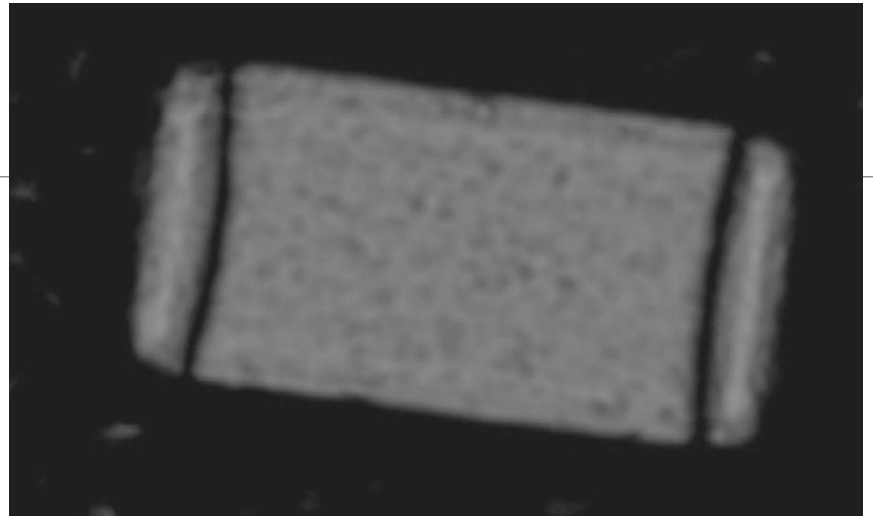
Scanning Acoustic Microscopy (SAM)

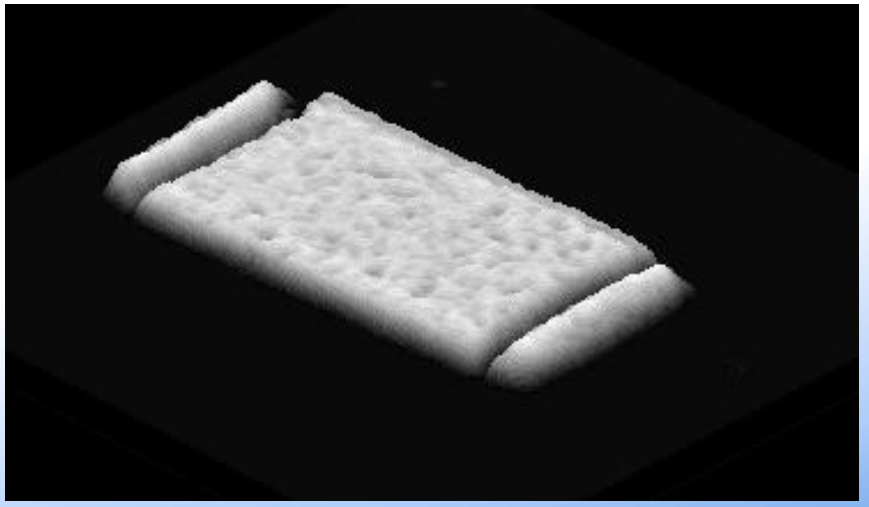
- SAM uses ultrasound waves to detect changes in acoustic impedances in integrated circuits
  - Detect air gaps as thin as 0.13 um
  - Nondestructive technique
- Used in detecting die cracks, voids, delaminations, “popcorning”, material density variations in microelectronic packages



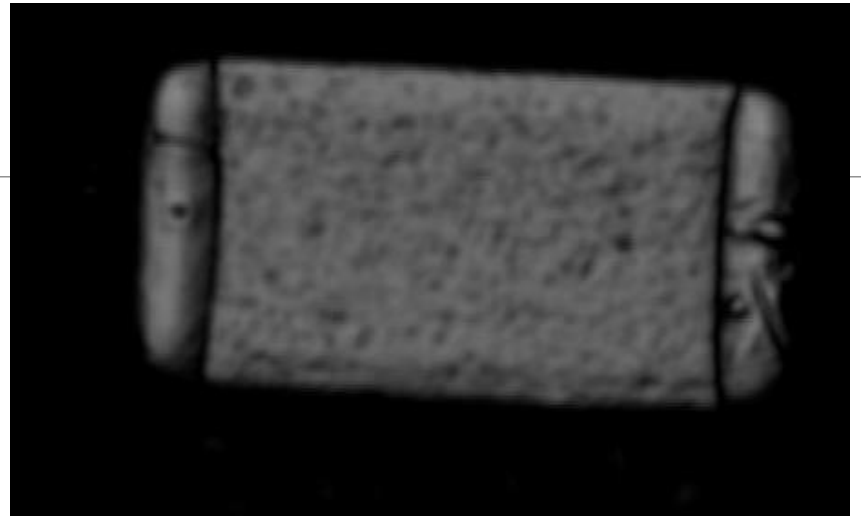
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

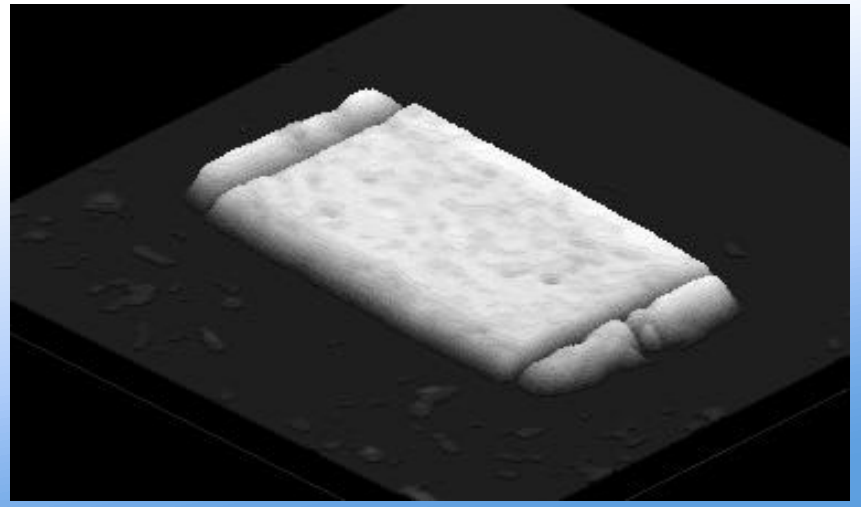
Conforming





Non-Conforming

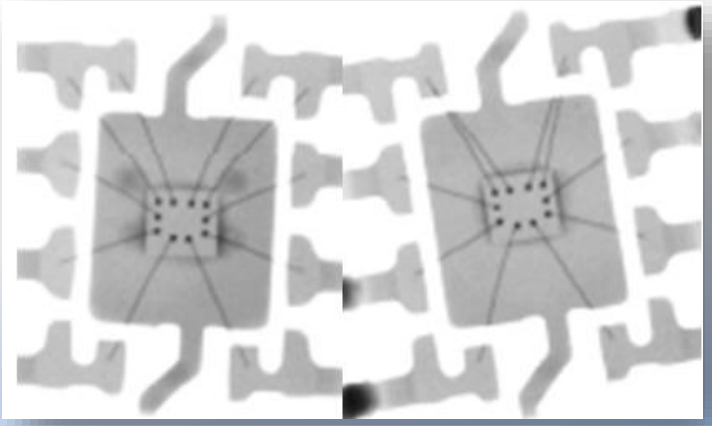




COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Real-time X-ray

- Provides internal inspection of IC while being able to manipulate sample.
  - Non-destructive technique
  - High magnification and resolution
- Inspect die attach, wire bonding, lid seals, etc



Courtesy: GIDEP

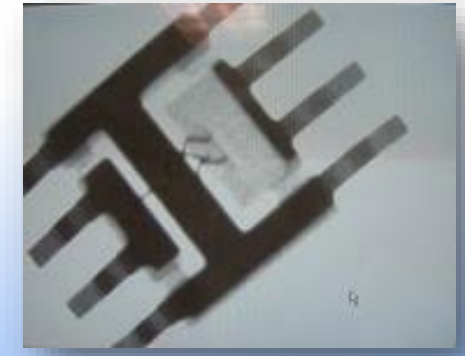
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

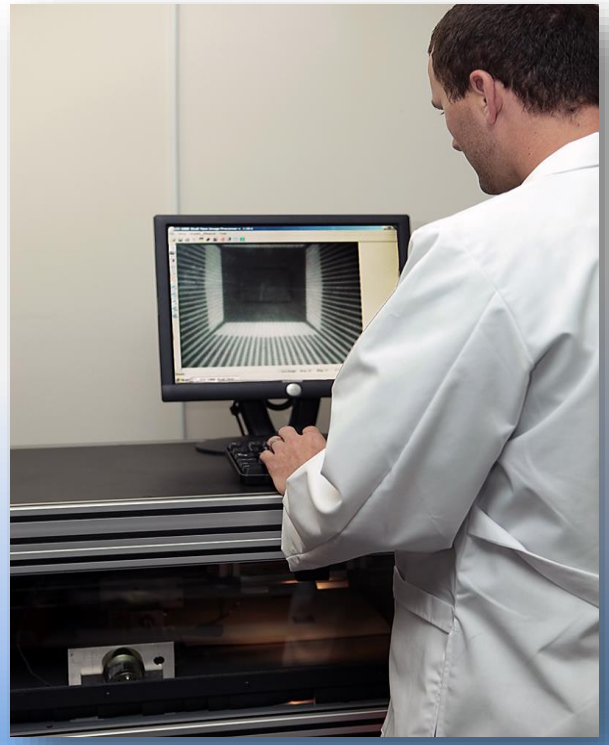
Detecting a repackaged part: X-ray

- X-ray - effective to look for manufacturing differences in die size, lead frame, bond wire patterns and voids. In some cases there have been no bond wires.

Bond wires present

Some bond wires missing

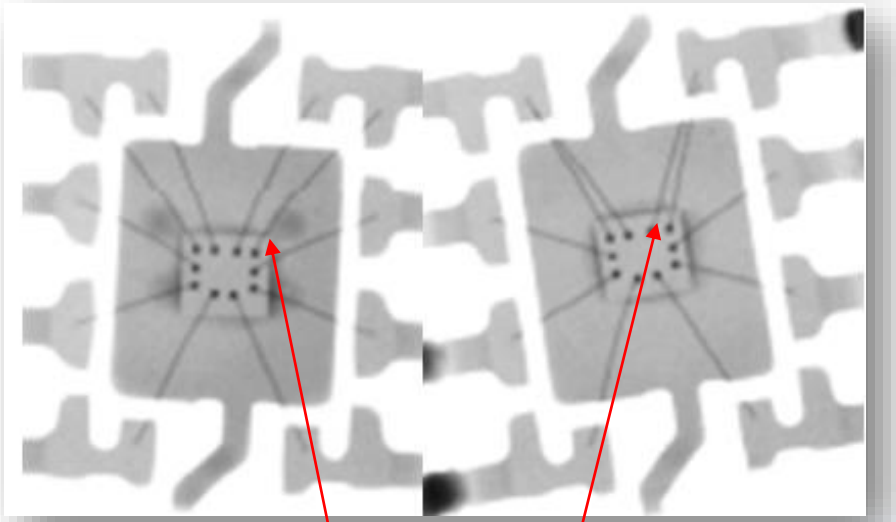




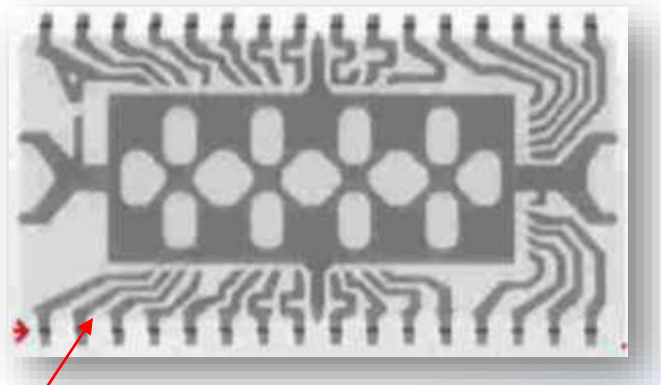
Source: American Electronic Resource

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

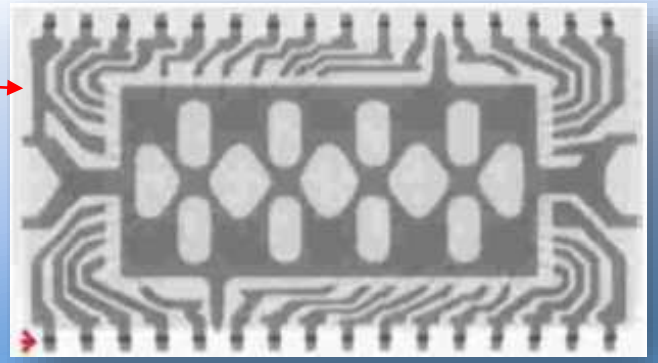
Detecting a repackaged part: X-ray



Different die bond patterns in the same lot CHANGE photo



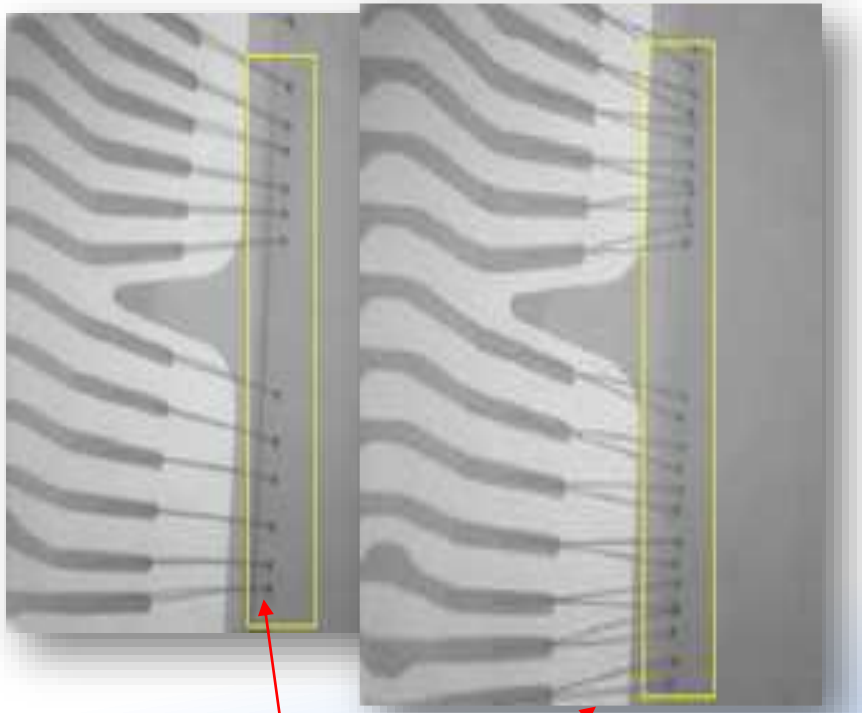
Different lead frames in the same lot



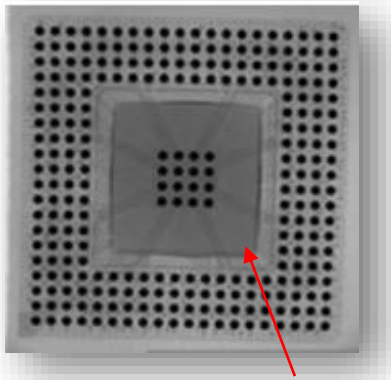
Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

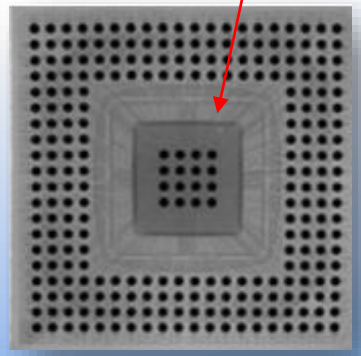
Detecting a repackaged part: X-ray

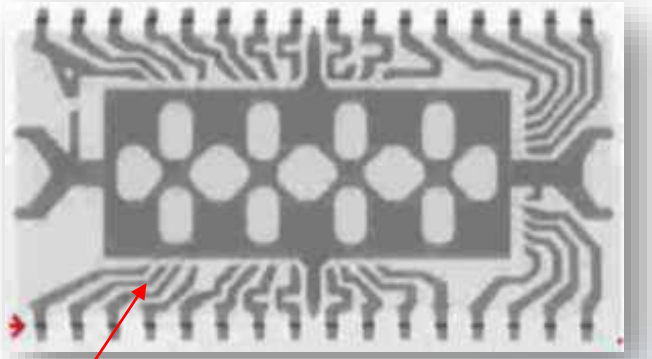


Different die bonding pattern between parts in the same lot

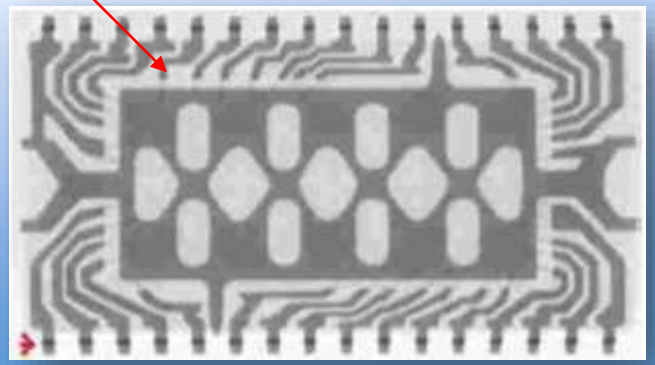


Suspect part has smaller die





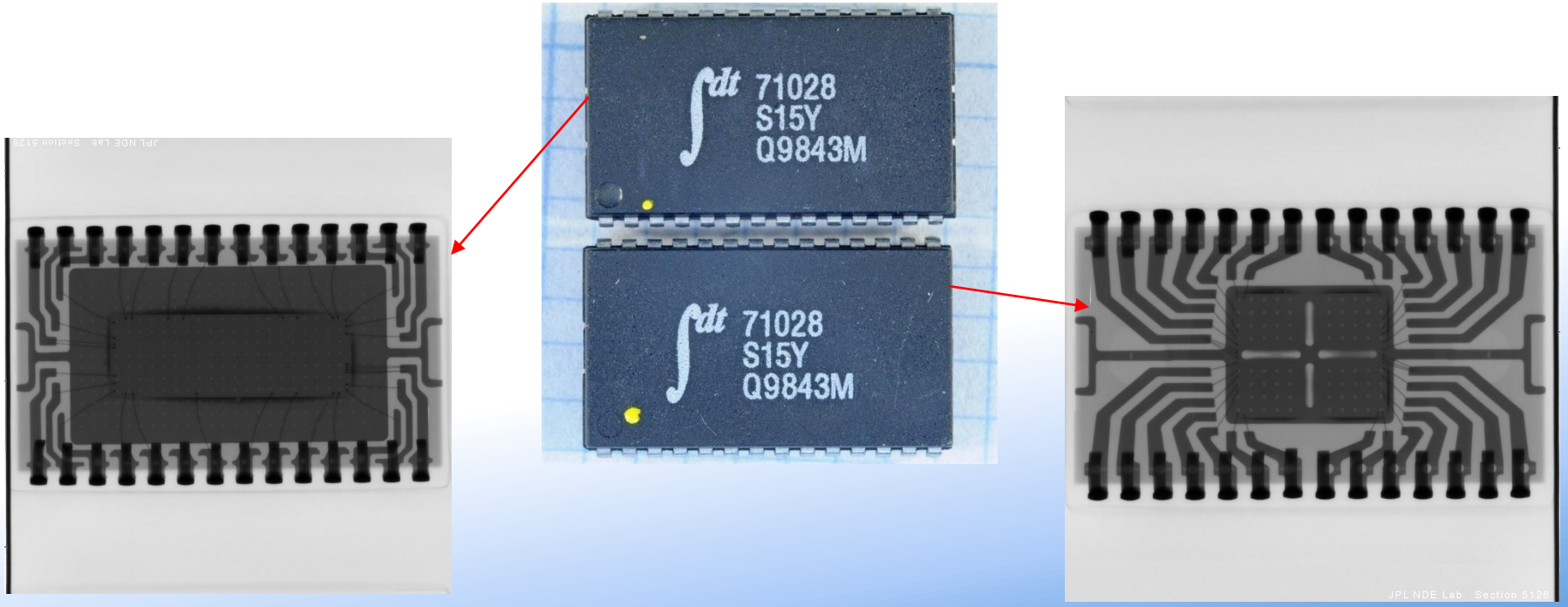
Different lead frames in the same lot



Courtesy: GIDEP

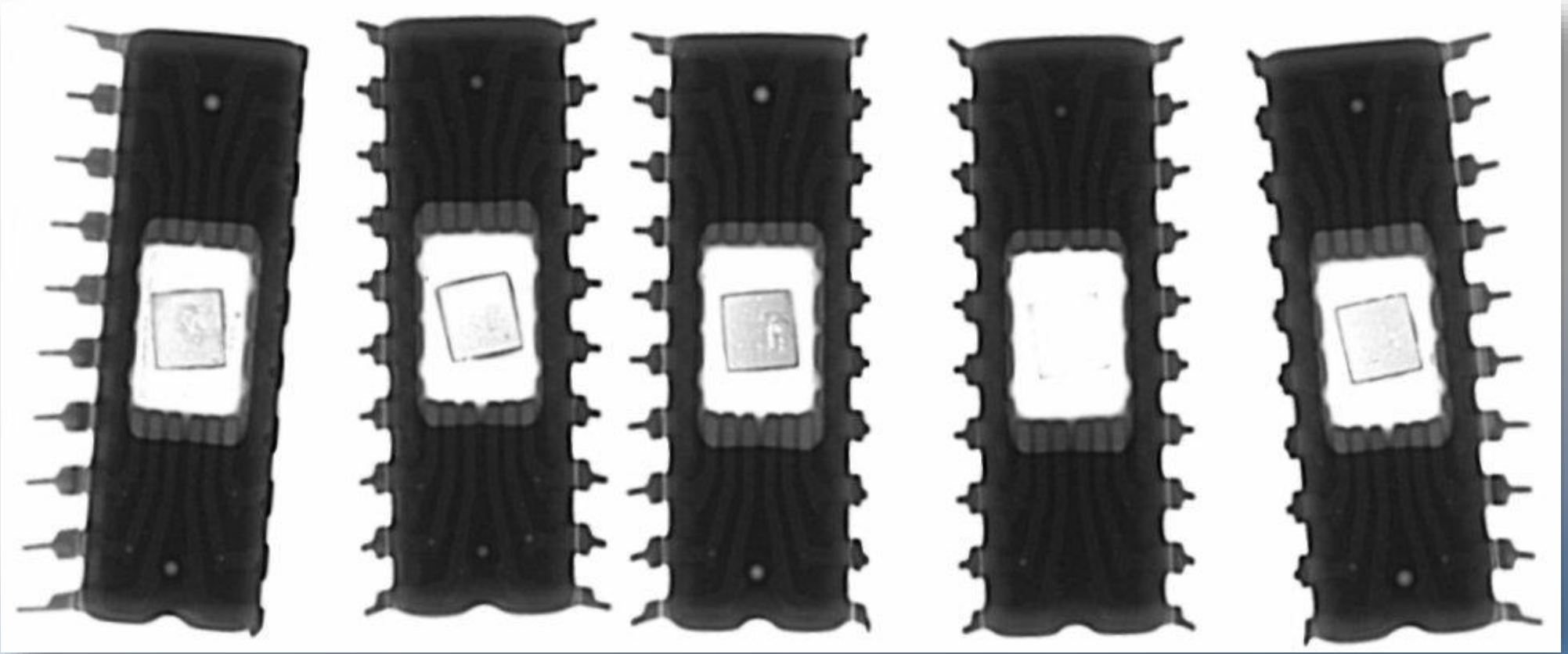
COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Detecting a repackaged part: X-ray



COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

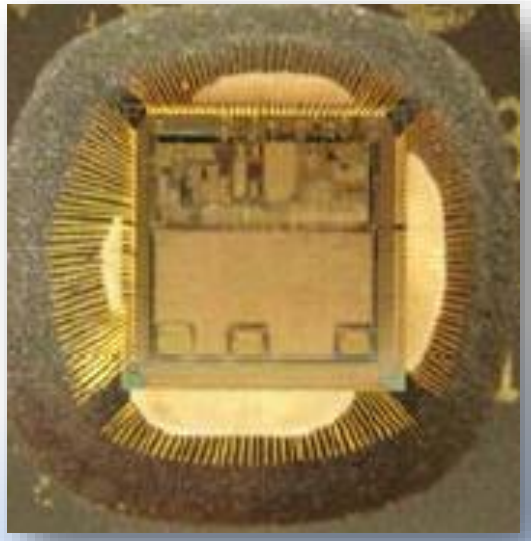
Detecting a repackaged part: X-ray

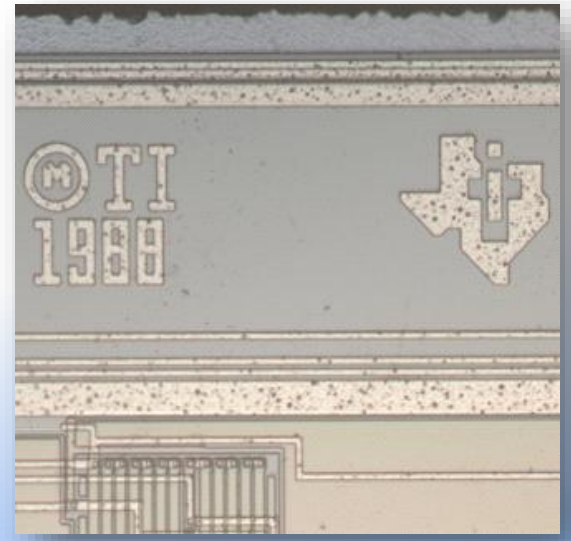


COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Detecting a repackaged part: decapsulation

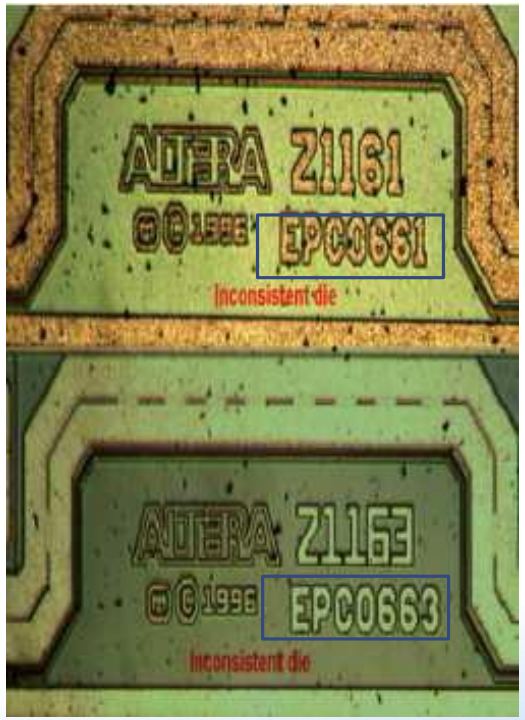
- Decapsulation-verify die MFG, year, and P/N are consistent





COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Detecting a repackaged part: decapsulation



Different die markings

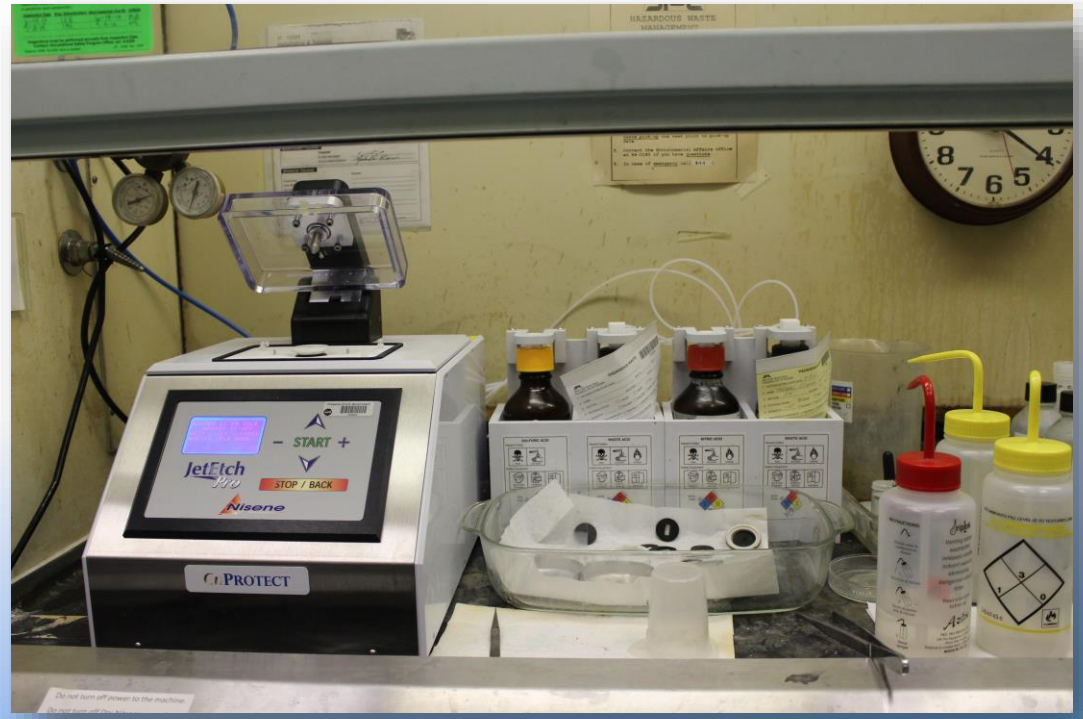
Different die markings

Courtesy: GIDEP

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Decapsulation

- Process of removing the package the protects the integrated circuit to access die
- Most common method is using chemical acids: sulfuric acid, nitric acid



- Home labs can be set up for$60 using household products

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Temperature Cycling

- Testing performed on electronic devise to determine resistance of exposure to alternating extremes of high and low temperatures.
  - Evaluates reliability and latent defects by inducing failure through thermal fatigue
  - Determine ability of components and solder joints to withstand mechanical stress
  - Destructive test

Photo courtesy: orslabs.com

Courtesy: JESD22-A104E

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

the New Frontier: Hardware and Software tampering

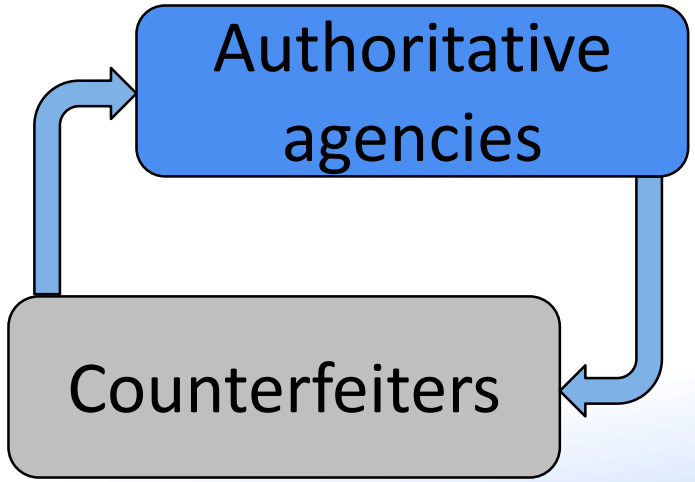
- Trojan: innocuous piece of software that contains malicious code
- Hardware Trojan: small change in an IC that can disturb chip operation
  - Failure at crucial time
  - Produces false signals
  - Added backdoor
- When they are inserted:
  - During coding
  - MFG/ FAB

Photo Courtesy: http://s.hswstatic.com/gif/trojan-horse-1.jpg

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Counterfeiting is not static, it's dynamic!

- Counterfeiters are always one step ahead of authoritative agencies.



Contacts:

Mark LeBlanc
Mark.leblanc@jpl.nasa.gov
818-354-0953

Carlo Abesamis
Jose.carlos.s.Abesamis@jpl.nasa.gov
818-354-0211

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED

Additional References

- SAE Aerospace Standard AS5553: Counterfeit Electronic Components; Avoidance, Detection, Mitigation, and Disposition
- SAE Aerospace Standard AS6174: Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel
- http://www.analog.com/en/other-products/sampletrack-and-hold-amplifiers/ad585/products/product.html
- SMT Corp – Miscellaneous charts and images on sample counterfeit parts
- IDEA-STD-1010-A: Acceptability of Electronic Components Distributed in the Open Market
- Pecht, Humphrey , "Addressing Obsolescence – The Uprating Option", IEE Transactions on Components and Packaging Technologies, V31, No. 3, September 2008
- http://counterfeitparts.wordpress.com
- http://www.acq.osd.mil/dpap/index.html
- http://www.integra-tech.com/
- COTS: Reliability Concerns for COTS Microelectronics in Space and Military Applications. Sander & Agarwal

COPYRIGHT 2016 CALIFORNIA INSTITUTE OF TECHNOLOGY. GOVERNMENT SPONSORSHIP ACKNOWLEDGED