

COUNTERFEIT COMPONENTS AVOIDANCE PROGRAM, CERTIFICATION FOR

Purpose: Establishing standard procedures for the authentication of electronic components, integrated circuits, hybrid microcircuits, semiconductors, transistors, diodes, capacitors and resistors, thereby decreasing the risk of counterfeits entering a customer's supply chain.

1 Scope

This document describes cost effective Program Requirements to be utilized by Independent Distributors (IDs), Brokers or Resellers - all referred to as IDs in this document, selling electronic components as Certified to the Counterfeit Components Avoidance Procedures, CCAP-101. This is a due diligence program that is mandatory for IDs to become Certified to CCAP-101 for their Counterfeit Components Avoidance Procedures. The ID Procedures shall address both commercial electronic components and military electronic components and apply only to new components, which have never been installed on circuit boards or in equipment.

The Certification Program provides for a choice of Level A (which includes electrical testing) or Level B (excludes electrical testing) and the customer must specify the level to be supplied.

The CCAP-101 Certification Program is trademark and copyright protected by Component Technology Institute, Inc. (CTI).

Counterfeit Electronic Component, as used in this document, refers to any component which violate any intellectual property rights, trademark or logo or is not authentic to the requirements of the manufacturer part number specified by the Customer.

1.1 Introduction

Counterfeit Electronic Components are causing major problems in the electronics industry. The problems affect production, warranty costs and safety of aerospace, military, medical electronics and many forms of consumer electronics. The safest way to avoid counterfeit components is to purchase them from the Original Component Manufacturer (OCM) or their authorized supply chain. This is not always possible when the Original Component Manufacturer has ended component production or when components are on allocation or lead times exceed customer requirements.

Millions of electronic components are purchased each year from IDs that offer availability when components are not readily available from the OCM supply chain. Some original equipment manufacturers (OEM) and contract manufacturers (CM) also purchase from these suppliers because of a lower price, even when the OCM or Franchised Distributors have the authentic components readily available. The lower price can be a function of the components being counterfeit.

This CCAP program was created to define the practices necessary to assure that electronic components, when subjected to these due diligence practices, will be authentic and not counterfeit. CTI provides this Certification service as an unbiased and independent organization, which is not involved in the buying or selling of electronic components.

IDs shall establish procedures to implement CCAP-101 requirements, which CTI will evaluate prior to the Certification Audit. The ID or Customer does not have the authority to alter, delete or change these procedures, and if they do, the components shall not be delivered as Certified to CCAP-101. The customer may add additional electrical tests, solderability tests, tape and reeling, other packaging, device programming, BGA re-balling, etc. after authenticity has been proven, but shall not alter or delete any of the Program requirements specified herein. Components shall be processed through the CCAP-101 inspections and tests until it is determined that they are counterfeit or authentic per the Level A or B Certification that is ordered.

MANDATORY ELEMENTS OF CERTIFICATION PROGRAM

1. CTI review and approval of ID inspection procedures
2. CTI audit of ID avoidance practices
3. Mandatory purchasing practices by ID
4. Documentation inspection
5. Product inspection, sampling and testing of markings
6. X-Ray inspection
7. XRF of leads
- 8.A De-capping and die inspection (Semiconductor components)
- 8.B Cross sectioning passive components
- 9.A Electrical Testing - DC, functional and product specific tests, *level A only*
- 9.B Electrical test –Passive components – Level A & B
10. Selection and control of outside test labs
11. Counterfeit Avoidance Inspection Report
12. E-Documentation retention of data specifically required
13. Supply of inspection results summary and Level A or B Certificate to the customer with delivery of the parts

When an inspection sample fails any required inspection, the lot shall be classified as Counterfeit and shall not be considered further for acceptability.

IDs whose Practices are audited and then judged by CTI, Inc. to be in compliance, shall be Certified to deliver components in conformance to this Program. This Program applies to discrete semiconductors, integrated circuits, hybrid microcircuits and passive components.

1.2 Intellectual Property Ownership

This Certification Program Document and the granting of Certification to the Requirements thereof are the Intellectual Property and under the sole ownership of Components Technology Institute Inc. (CTI Inc.) and are protected by Federal Trademark Registration and Copyright. A claim to be in compliance with CCAP-101 Program without being certified by CTI is in violation of the Federal Trademark and Copyright laws. Components shall not be identified or delivered by any seller as in compliance or conformance with CCAP-101 Program by any seller that is not currently Certified by CTI, Inc.

2 Reference documents

The following specifications and standards of the latest issue, revision or amendment, form a part of this document to the extent specified herein.

ANSI/ESD S20.20-2007, Development of an Electrostatic Discharge Control Program
ANSI/NCSL Z540-1, Calibration Laboratories and Measuring and Test Equipment – General Requirements
AS5553 Counterfeit Electronic Parts, Avoidance, Detection, Mitigation and Disposition
AS9120 Quality Management Systems – Aerospace Requirements for Stocklist Distributors
IPC/JEDEC J-STD-033, Standard for Handling, Packing, Shipping of Moisture Sensitive Surface Mount Devices
ISO - 9001, Quality Management Systems – Requirements
JESD22-B108A, Coplanarity Test for Surface Mount Semiconductor Devices
QML- 38535, Qualified Manufacturers List for Integrated Circuits to MIL-PRF-38535
QML-19500, Semiconductor Devices Qualified to MIL-PRF-19500
MIL- HDBK-103 List of Standard Microcircuit Drawings
MIL- PRF-38534, General Specification for Hybrid Microcircuits
MIL- PRF-38535, General Specification for Integrated Circuits Manufacturing
MIL- PRF-19500, General Specification for Semiconductor Devices
MIL- STD-750, Test Methods for Semiconductor Devices
MIL- STD-883, Test Method Standard Microcircuits
MIL-STD-1835, Electronic Component Case Outlines

3 General requirements

3.1 Agreements

All IDs certified to these requirements by Components Technology Institute Inc. (CTI) agree that all components sold and delivered as Certified to this Program have been subjected to all the requirements stated **herein** and that they have performed the required due diligence to avoid the delivery of counterfeit components. Neither the ID nor the Customer have the authority to change, modify or delete any of the specified component authentication practices specified herein for Levels A or B. By mutual agreement the customer and ID may specify additional services such as solderability test, electrical tests, tape & reeling, reballing BGAs, etc. after the authenticity of components has been proven. The delivery of components from lots or sub-lots of components not subjected to these requirements or a single verified shipment of counterfeit components shall result in immediate suspension of the ID's Certification and no further delivery of Certified Components shall be made until the issue is resolved by CTI Inc. and the ID's Certification is reinstated.

3.2 Industry counterfeit avoidance standards

The Program is designed to meet the objectives of AS5553 to detect and avoid counterfeit electronic component purchased from IDs for aerospace applications in a technical and cost effective manner.

3.3 Warranty

Components that are inspected, tested and delivered by the selling ID, whether the verification is performed in house or by a contract laboratory to this Certification Program shall be fully warranted by the ID for one (1) year minimum to be authentic to the Original Component Manufacturers (OCM) data sheet or military specifications, as applicable. This warranty is limited and provides that the components are authentic to the OCM component specification that were ordered by the customer to include only OCM quality issues reasonably detectable during the authentication processes required by CCAP-101.

3.4 Quality system

The ID shall establish and maintain as a minimum a documented quality system certified to ISO 9001, the additional requirements of this document. The ID's quality system and counterfeit avoidance procedures are subject to review and analysis with appropriate notice by the customer representative and/or authorized Government representatives. This includes surveillance of products, systems, procedures, facilities and records associated with components they have ordered. The responsibility for quality functions and counterfeit avoidance procedures shall be clearly identified within the IDs organization. Personnel performing these functions shall have sufficient authority and independence to evaluate any of the problems and to initiate and recommend corrective action.

3.5 Procedure control

The ID shall establish and maintain a system to control and distribute the procedures that implement the requirements of this document. This control shall ensure that:

- 1) A master procedures list and the current revisions of appropriate procedures are available at all locations where operations are performed.
- 2) The issuance of all standards and instructions is controlled and dated.
- 3) Obsolete procedures are promptly removed from all points of use.
- 4) Current revisions of applicable Government documents shall be available on site.
- 5) When referenced government documents are revised, they shall be reviewed, and ID documents updated as applicable. Records of these reviews shall be maintained.
- 6) Changes to procedures are reviewed and approved by the same ID organizations that performed the original review and approval.
- 7) A history of procedure changes, copies of processing records, lot travelers, inspection records, including digital photos, and forms are maintained for a minimum of 5 years after the last components in the lot are delivered.

3.6 Records

- 1) Written Records - All handwritten entries shall be in ink.
- 2) Incorrect Entry – The only acceptable error correction method for handwritten entries is to line out the incorrect entry with a single line, add the new information, the date of correction and initial the new

entry. Any obliteration of data, use of correction fluid or tape, or erasers for corrections is not permitted on any record including lot travelers, calibration records, or the Certificate of Conformance.

- 3) Record Retention and Retrieval - The ID shall document and maintain all records for at least seven (7) years for both Commercial and Military components. These records shall be readily retrievable by part number, OCM's name, customer's name and status.
- 4) The inspection and tests performed for this Program shall be reported on the forms contained herein with accuracy and detail to permit analysis by the ID's internal quality, customer auditor, and Government organizations.
- 5) Samples of any counterfeit components detected shall be securely controlled and maintained for future reference.

3.7 Inventory control

The ID shall have a system for controlling inventory.

- 1) The inventory management system must provide for segregation by part number and level A or B Certification.
- 2) There shall be an effective system for the legal disposition of counterfeit components and control of nonconforming product. The system shall provide for the identification, segregation and disposition of these nonconforming products and preclude their shipment or reentering the supply chain.
- 3) The inventory shall be maintained in a local locked storage area with limited access.

3.8 Electro-static discharge (ESD) - Safe handling procedure

The ID's system for electro-static discharge sensitive (ESDS) components protection shall be Certified or in compliance with the latest revision of ANSI/ESD S20.20-2007 by a competent organization with periodic verification and test of ESD suppression and detection equipment.

3.9 Receiving, inspection, storing, packing, and shipping products

The ID's receiving, inspecting, storing, packing and shipping procedures shall prevent mechanical or electrical damage and degradation of the components in their possession. All packing materials shall be either conductive or antistatic, including tubes, trays, reels, bags, and fillers. Procedures for the handling, storing, re-baking, re-bagging and shipping of moisture/reflow sensitive devices, which have been classified to the levels defined in J-STD-020, shall ensure that the methods used maintain compliance with J-STD-033. The ID shall be responsible for verifying conformance to all the processing, packing, labeling and ESD requirements prior to shipping from their facility

3.10 Inspection, test status and traceability

The ID shall provide a means to identify the authentication inspection status of all components throughout inspection, handling, processing, and storage. This may be accomplished through the use of inspection sheets, tags, routing cards or other control devices that are attached to, or travel with, the product.

- 1) The method of indicating the person performing a function shall be controlled and allow for easy status determination (e.g., stamps, signatures, electronic identification). A personnel list shall be kept current for all stamps or initials and the log of status shall be available to the auditor for inspection and verification of names upon request.
- 2) When operators or inspectors use signature or initials in lieu of stamps on processing records the signature/initials must be on record, legible and traceable.

3.11 Calibration of equipment

The ID and their approved contract laboratories shall calibrate and maintain all inspection, measuring and testing equipment that is used for authentication or counterfeit detection activities in accordance with ANSI/NCSL Z540-1, whether owned or leased, by the ID or sub-contractor. Repair and calibration records shall be maintained in accordance with the provisions of ANSI/NCSL Z540-1.

3.12 Customer returns

Components returned to the ID from a customer shall be temporarily quarantined until they can be inspected for any evidence of alteration, mishandling or improper packaging. Components returned as being counterfeits shall be quarantined in a locked secured area until they can be investigated to determine their authenticity. Upon determination that the components are authentic, they may be dispositioned back into stock with documentation including, at a minimum, the stamp or signature of the inspector(s), the completed

inspection records, and a system that retains this record for a minimum of 5 years. If it is determined that the components are counterfeit or fakes, CTI Inc. shall be notified for investigation of the contributing conditions, and the components shall be in quarantine until the investigation is complete. The ID shall not deliver additional components as certified until the investigation and corrective action is complete.

3.13 Training

The ID shall identify the training needs and provide for the training of all personnel in the proper handling of components and performing the authentication & counterfeit detection procedures required for this Program. This training shall be completed before the Certification is performed by CTI, Inc. Individuals shall be retested and/or retrained a minimum of once per year, when procedural changes occur, or when personnel performance indicates poor proficiency resulting in the shipment of components found to be counterfeit by a customer. The adequacy of personnel training to the ID's Counterfeit Components Avoidance Practices will be assessed by CTI, Inc. during the certification audit and when conditions warrant.

Training records shall be maintained for at least three (3) years, detailing the nature of training, date, length of training, personnel receiving the training and the name of trainer.

3.14 Certification audits and approvals

A non-certified ID shall not claim compliance to the CCAP-101 Program, which is protected by "Copyright and Trade Mark" and for which use must be approved by CTI. Only Components Technology Institute Inc. personnel have the authority to audit and grant Certification to IDs that comply with these Requirements for the detection and avoidance of counterfeit components and the use of CCAP-101. The ID is responsible for assuring that their personnel constantly follow these practices and shall conduct audits as necessary and a minimum of once every twelve months to verify compliance with the requirements of this document. The audit frequency within these limits shall be based on results of previous audits.

- 1) The results of the audits shall be documented and conveyed to the attention of the personnel having responsibility in the area audited, timely corrective action shall be taken, and a record of those corrective actions shall be maintained.
- 2) Corrective actions implemented as a result of audits and customer complaints shall be documented, including actual implementation dates.
- 3) A formal procedure for verification of corrective action effectiveness shall be in place.
- 4) The audit reports, corrective actions, and verification reports shall be available for review upon request.
- 5) Customer representatives may visit the ID's facility to review conformance to this standard for components they have ordered. The ID shall provide the necessary information, facilities and assistance for these reviews. Any noncompliance noted will result in corrective action by the ID and reported to the CTI Inc. for investigation. Failure of ID to conform to the CTI Inc. Certified Counterfeit Components Avoidance Practices may result in loss of certification, preventing further shipment of Certified components to customers.

3.15 ID location

The ID shall identify its location where Certified Components are inspected and processed pursuant to the Counterfeit Components Avoidance Program. The ID shall identify and provide to CTI all subcontractors and their services, which are used to determine component authenticity. The ID shall assure their subcontractors services conform to the applicable requirements of their approved Procedures as if the performance was in house. The ID is solely responsible for the subcontractors testing and inspection results. Certification is not available to off-shore operations of Certified IDs.

4.0 Detail requirements

4.1. Sources of supply

The ID shall have a documented and formal procedure for selecting, approving and monitoring their suppliers. The suppliers past performance of avoiding the supply of counterfeit components, business practices, liability insurance, financial stability, controls over their suppliers, practices for avoiding counterfeit components, ESD Certified handling practices and other useful controls.

The following terms and conditions shall be imposed on all suppliers of component orders purchased for supply as Certified Components to the Requirements of this document:

- a) New and never installed components are required.

- b) Component markings must be OCM original with no indication of change, alteration or additions unless there is an OCM Certification to prove that the parts were remarked.
- c) Allow adequate time, a minimum of 30 days from receipt, to verify authenticity of the components supplied.
- d) When components are proven as counterfeit, the supplier will not be paid and the components will not be returned and will be legally disposed of. The supplier is entitled to a copy of the report proving components are counterfeit and up to 5 samples for verification.
- e) Traceability data for ordered components to all previous suppliers shall be provided where available.
- f) Military and space specification marked components shall not be sourced from China, India, Africa or other areas of the world known to supply counterfeit military components except from the OCM or their Authorized Distributors.
- g) A Certificate of Conformance shall be provided by the Seller to the ID that certifying the components are authentic to the part markings.

4.2. Packaging inspection

Each shipment of components received by the ID shall be checked for conformance to following:

- a) Proper packing to protect the components from ESD damage, shipping stresses
- b) Meets the moisture sensitivity level for the type of component.
- c) Printed matter, labels, shippers, inventory documents etc. shall be checked for correct spelling, font consistency and other characteristics, which if different from those used by the OCM characteristics detected in packing may indicate the components as suspect Counterfeit.
- d) Check moisture sensitivity card by inserting in water to see that it registers correctly.

4.3. Component inspection

This procedure requires the inspection of components on a 100% or sampling basis as specified below. These details shall be stated in the ID Procedures with all observations recorded and photographed:

- a) Check of package and lead dimensions;
- b) Conditions of the leads, terminals, plating and flatness of package;
- c) Markings, to include any indication the components are from multiple manufacturing lots, when observed, components shall be sub-lotted;
- d) Evidence of marking alteration, re-marking or additional markings;
- e) Blacktopping to cover old markings;
- f) Other evidence of component identification change;
- g) Any indication of previous use or installation of component;
- h) Any change or alteration of component physical package or leads including re-balling BGAs
- i) Barcodes shall match component labeling and marking;
- j) Other applicable items as the technology change

The component inspection criteria shall be divided between commercial and military standards as shown below. Any non-conformance to OCM marking or manufacturing practices or military specification requirements, shall be cause for rejection of the total population the component represent as counterfeit.

4.3.1 Visual inspection and sampling

When the shipping quantity is for 50 components or less 100% of the components shall be visually inspected. When the shipment is more than 50 components, sample inspection as stated below may be used, provided the components are a homogenous lot or sub-lot. Any variation in markings, different date codes or lot numbers, different country of manufacture or other detectable differences, such as reversed placement in tapes, shall be used to establish that the components are not from a single homogenous manufacturing lot. When it is determined that the lot is not homogenous, the total shipment shall be divided into sub lots, as determined by the characteristic(s), which are different or rejected as counterfeit when characteristics violates inspection criteria. When any of these sub-lots contain less than 50 components, they shall be 100% visually inspected. For lots and sub-lots with more than 50 components a minimum of 50 pieces per 1000 pieces of fraction thereof shall be inspected. One or more rejects shall result in rejection of the entire population represented by the sample as counterfeit components. Samples shall be randomly selected from throughout the population of components. When components are on tape and reel, a minimum of twenty 20 components shall be randomly selected for each 1000 pieces or fraction thereof from throughout the reel for inspection

and removed for inspection of all characteristics. After inspection the components may be reinstalled on the reel in conformance with industry practices.

Samples shall be clean of all extraneous foreign material that would distract from or confuse the inspection or photographic image. Items, such as fibers, hairs, mounting clay fragments, grinding particles, glue overflow, fingerprints, chips, tool scratch marks, spittle, dust, etc., are examples of such foreign material. Samples shall be oriented correctly and sensibly to minimize chances of confusion and misinterpretation. In the case of high-magnification images, an "orientation" image at low power shall be used to show the location of the region that is being examined in detail.

(Packing material properties, such as foreign language newspapers, peculiar odors, or color and texture of cardboard, can be an indication that the components are from China).

4.3.2 Microscope equipment and technique

The ID shall utilize microscope equipment suitable to examine components for external package marking and conditions indicative of counterfeiting.

4.3.2.1 Microscopist qualifications

The microscopist shall be sufficiently trained on the equipment used and to be able to distinguish normal package external variations from the manufacturer's quality problems and from counterfeiting. The microscopist shall be trained to recognize the type of illumination, which is best for the detection of defects indicative of counterfeiting. The inspector shall not be visually impaired or color blind.

4.3.2.2 Microscope inspection - low-power

The microscope shall be a binocular microscope with step-adjustable or continuously-variable magnification for external package examinations at magnifications ranging from 3X to approximately 30X at the eyepiece and shall be of sufficient quality to produce color-correct, aberration-free, well-focused images. A specimen table with X & Y axis movement shall be used to position the component during inspection. Sample illumination shall be with a fiber-optic ring-light illuminator, adjustable incandescent white or LED lights, or both. Vertical and oblique illumination shall be used to highlight surface detail. Lighting shall be adjusted to variable inclinations with respect to the axis of the lens to highlight sanding or grinding striations

Caution is advised to avoid illumination with sources having blue-white LED's, rather than white LED's, as the former produce an undesirable color shift in the final image.

4.3.2.3 Microscope inspection – high-power

A binocular metallurgical microscope with variable magnifications obtained through a three-lens system or equivalent is required for die photography after decapping or decapsulation. The magnifications shall cover a range from 30x to 400x and the optics shall provide a high quality image suitable for verifying die markings. Through-the-lens lighting of sufficient intensity shall be used to give a high quality image. A polarizing filter shall be used to highlight detail and minimize reflective glare is required for die photography. Samples shall be lighted evenly, without overexposed spots, streaks, or reflections. The sample shall be leveled on the microscope x & y axis stage to assure that the resulting images are in focus across the photograph and there is no keystone effect.

4.3.2.4 Digital photography

Digital cameras, including handheld digital cameras suitable for low-magnification photos, used in conjunction with microscopes shall have a resolution of 1.3 megapixel (Mpx) minimum, but 3 Mpx or more is desirable for image capture to avoid pixilation, sawtooth, herringbone, Moire patterning, etc., which can interfere with the information to be conveyed in the photo. Digital photos shall be made on a minimum of 3 samples at appropriate magnification and shall be a true representation of the sample as follows:

- A) Component external package
 - Full frame of entire device including the leads with upright orientation to read markings.
 - Top and bottom of package and, when useful, a side view.
 - Before and after marking permanence and acetone test, if any difference is detected.
 - Sharply focused with adequate depth of field.
 - Indications of blacktopping, overcoating or remarking.

- Lead conditions indicative of reclaim or previous use.
- Uniform lighting, no overexposure, shadows or washout of features.

B) Die photos

- Full frame of die, sharply focused and square orientation.
- Good focus to illustrate major functional blocks or metallization pattern and markings such as date, logo, mask numbers, alignment keys, etc, referenced to a low-power "location" photo of the entire die.
- Uniform lighting across the die or field of view.

Once the image is captured, it may be rotated, cropped, reformatted, darkened or lightened, etc., to enhance the image. Enhancements, if any, shall be made without altering the fundamental information contained. Images incorporated into electronic reports should avoid excessive file size, as they expand the document size to the point that they are cumbersome and cannot be sent via email. Image capture should be Joint Picture Expert Group (JPEG) formatting. Images shall be cropped to reduce file size due to extraneous background content.

4.3.3 Commercial components

Commercial components shall be verified to the OCM's specifications and data sheets for all observable characteristics to establish authenticity. Non-conforming characteristics shall be listed in the inspection report with photos and graphics demonstrating counterfeits and referencing them to the data sheet characteristics. Any samples that fail to meet these inspection criteria shall classify the component population they represent as counterfeit and shall all be rejected. Inspect components and verify the following:

- Correct part number matching customer order
- Manufacturer name marked on component is a manufacturer of the record for the component
- Documentation matches the OCM's for format and typical info provided by OCM, compare to authentic OCM documentation, if available
- Quantity in order matches P.O. quantity
- Date code(s) and lot codes
- The physical characteristics: e.g. number of leads, measure dimensions, (3 pcs), pin identifier, etc. conform to the datasheet or military specification.
- Check plating on leads or BGA balls for scratches, deformation and match to OCM characteristics
- Inspect the component's marking, body, and leads with a microscope at appropriate magnification for characteristics indicative of counterfeit

4.3.3.1 Inspect and verify the following characteristics.

The presence of any of these conditions is cause for rejection of the components, however, the inspection shall be continued until the samples have completed the inspection procedures.

- Evidence that markings have been remarked or altered;
- Recent date codes when parts have not been manufactured for years;
- Co-planarity of SMT components per JESD22-B108A or suitable alternate procedure;
- OCM designated moisture sensitivity level packaging for surface mount components per JEDEC-J-STD-033;
- Lot code, incorrect or missing a character;
- Date code impossible, such as week 57;
- Leads have excess or lumpy solder indicative of pulled product;
- Blacktopped and/or remarked;
- Package edges rounded, sanding marks, etc;
- A small "window pane" step around the perimeter of the top of part;
- More than one part number in the lot;
- Mold mark interiors are not smooth or indentions are missing;
- Top surface mold texture looks different, than bottom surface;
- Marking is crude, amateurish, mixed fonts, mixed "0" and "O";
- Marking fails permanency or acetone tests;
- Damage or corrosion;
- Incorrect number of pins;
- Difference in color of package top, bottom or side-wall at the leads

- BGAs have been reballed, unless approved by customer
- OCM logo is incorrect, deformed, peculiar, fuzzy, crude-looking;
- Date Code on reels, tubes or containers not the same as on parts;
- Other characteristics not consistent to OCM named on component.

(The greater the number of attributes found to be suspicious or non-conforming to OCM, the higher the possibility of being counterfeit. All observations should be included in the inspection report.)

4.3.3.2 Moisture sensitive components.

Components that are moisture/reflow sensitive shall be controlled to the specified level. MSL requirements shall be verified on the OCM specification sheet when components are received. MSL sensitive components will be accompanied by a traveler card. Which will indicate the time and date that the components were removed from the original dry packaging. This traveler will accompany the components until they are shipped to the customer. If moisture sensitive components are received without proper dry packaging and MSL indicator the lot shall be rejected or the MSL reset per the applicable requirements. The components shall be packed and sealed in a moisture bag to the proper MSL level before delivery to customer. Procedures for the handling, storing, re-baking, and shipping of moisture reflow sensitive devices shall be in accordance with the levels defined in J-STD-020 and J-STD-033.

4.3.4 Military components

Apply the commercial inspections listed above plus the applicable standards listed below shall be used for determining authenticity of military components. Any samples that fail to meet these criteria shall classify the component population they represent as counterfeit and shall all be rejected. The QML, QPL specification and standards listed in Reference Documents shall be used for information to verify the authenticity of military parts.

4.3.4.1 Integrated circuits

Integrated circuits, which are ordered to military specifications, (i.e. QML/QPL, DSCC SMD and /883) shall be subjected to the inspections of para. 4.3.3 – 4.3.3.1 and the External Visual Inspection per Test Method 2009 of MIL-STD-883. In addition, the components shall contain other specialized markings as defined by the specification controlling the components. Components ordered as a MIL STD 883 (883/C) require an OCM Certificate of Conformance to verify they performed the testing and provide assurance that they meet the requirements. MIL-STD-883 compliance testing and screening, which can only be performed by the OCM. IDs shall verify if the OCM ever offered 883 parts for sale.

(Verification that the specified testing has been performed is virtually impossible after the fact. These are among the easiest components to counterfeit as only /883 and letter C has to be added to the commercial components markings to make them look authentic. This marking should match the other component markings.)

4.3.4.2 Transistors and diodes

Discrete semiconductor devices, transistors and diodes shall be inspected for conformance to paragraph 4.3.3 and the external visual criteria of Test Methods, 2066, 2068 or 2071 of MIL STD 750 as applicable.

4.3.4.3 Passive components

Passive components shall be subjected to the visual, dimensional and marking requirements of the applicable military specification and the OCM's typical marking. The package and markings shall be examined under adequate magnification to detect signs of alteration. Low ESR electrolytic (aluminum & tantalum) capacitors shall be x-ray inspected to verify correct internal elements using 100% or 50pcs per 1000 quantity and ESR electrically measured to assure correct value. Passive components for both level A and B shall be electrically tested per 4.9.6.

4.4 Ink marking

4.4.1 Marking permanence & blacktopping

The permanence of component marking shall be performed on a minimum of three (3) samples used for the visual inspection as specified below.

4.4.2 Standard marking permanency

The first marking permanency shall be performed according to JESD22-B107C Marking Permanency or MIL-STD-883, Method 2015, Resistance to Solvents. Usually all solutions A, B & D.

(This test is to verify the OCM's marking permanency, but may not identify when the markings are counterfeit, as it will not remove cured epoxy paints or special clear overcoats)

4.4.3 Acetone test

This is a test for blacktopping with solvent-soluble, non-epoxy blacktopping to cover sanding marks and previous markings. Mask-off part of the component markings to protect them and perform this test on half a corner of the part that intersects a portion of the marking. This provides a sharp line of contrast between coated and uncoated areas for inspection and photomicrography, and removes any possibility of confusing the solubility of markings with the solubility of the blacktopping. The acetone test for "blacktopping" should be done by rubbing the component surface with a cotton swab that has been immersed in acetone. Acetone should not remove properly formulated and properly processed OCM markings, explaining why parts are sanded by counterfeiters.

4.4.4 Blacktopping and overcoat detection

The acetone test may or may not reveal a coating applied after sanding to restore surface smoothness and conceal striations. This coating may also be of the thermal or UV-cured epoxy type, which is not soluble in acetone. The PEMs components, which pass acetone test, have a color difference on the side wall and appear to have a coating, rough surface compared to other areas of package shall be tested by scratching the component surface with a scribe or a new, sharp blade to detect if a coating has been applied to the body of component to inhibit the acetone test. Any peeling or flaking of the material indicates coatings that were not soluble in acetone and have been remarked. The acetone resistant coatings can be tested with aggressive solvent (Dynasolve 750, Uresolve Plus or equivalent) heated per the manufacturers' directions. The top half showing date code shall be protected with Kapton tape from the solvent liquid/fumes. The unprotected half shall be inserted in solvent in vertical position using a metal holder such that the heated solvent reaches to the tape. The solvent shall be preheated in a beaker using a hot plate under a vented hood until simmering and the part inserted for adequate time to dissolve the coating. The part shall be removed and solvent extracted with water or alcohol. Inspect the part for signs of overcoating, old markings and sanding marks. This test requires extensive safety practices and should only be performed by a qualified lab. Any component whose markings are removed or disturbed by these tests shall result in rejection of the complete population that the component represents.

4.4.4.1 Plastic ball grid and pin grid arrays (PBGA)

Coatings are being used that will withstand acetone and many of the traditional strippers. PBGAs shall be tested in an epoxy solvent heated to the boiling temperature (per supplier data sheet) for 15 to 25 minutes as appropriate. This test can be very dangerous and must be performed under vented hood with full safety equipment (goggles, gloves, etc.) in accordance with solvent manufacturers instructions. Kapton tape shall be used to cover half of the markings including the date code and only the uncovered section immersed standing up in the solvent for the selected time. Do not allow chemical to cover the kapton tape. Photographs shall be made before and after the test to clearly show the results. This is a destructive test and the part shall not be delivered to the customer as part of the order. It is recommended that the test should be performed by a laboratory with approved safety procedures.

4.5 Laser Markings

Laser markings shall be smooth and consistent and show no signs of burned package or holes and match the OCMs typical markings. Counterfeiters have become very proficient in remarking parts with laser. The previous markings have to be removed or covered before laser marking can be applied. This is the reason extensive effort must be made to determine if the components have a coating applied. Attempts must be made to determine if the OCM was using laser markings for the date code shown on the part. Extra investigation must be made to view the original surface of the package to detect removal of previous markings using the heated solvent technique.

4.6 X-ray inspection

X-ray inspection shall be performed on all of the visual inspection samples, prior to decapping to determine: if the package contains a die, the die size, consistent internal construction and if the die has wire bonds. X-ray

inspection and imaging should be used to determine the exact die location within the package, so as to avoid cutting of internal wires when opening the component. Any components exhibiting construction differences detected by x-ray shall be decapped to identify that the die are all exactly alike, if not the inspection lot shall be rejected as counterfeit.

The value of X-ray is increased when there is a known good OCM device available for comparison of internal details.

4.7 Decapping or cross section analysis

Decapping shall be performed on a minimum of three (3) random selected components from X-ray for each lot/sub-lot as defined in Paragraph 4.3.1. When the order is for 20 components or fewer, only one (1) randomly selected component is required to be decapped. Chemical decapping shall not be performed by immersing the entire PEM package in acid but through selective etching. Cross section analysis shall be performed on passives in lieu of decapping.

Decapping of semiconductor devices is performed to allow high magnification photomicrographs for inspection of the internal die for authenticity to the OCM named on the external package. The entire die, along with its markings and manufacturer's logo shall be photographed as described in 4.3.2.4.

4.7.1 Integrated circuits and semiconductor components

The ID shall have specialized equipment and personnel especially trained in these decapsulation practices or use competent sub-contract labs for this operation.

Hermetically sealed components should be decapped by mechanical method of cutting or shearing open package, glass diodes are excluded. Decapping of plastic encapsulated semiconductors shall be performed by chemical techniques. Precaution must be taken to prevent damage of the die or interconnection wires. Samples shall be decapped or decapsulated and examined for:

- a) Correct OCM die for the marked part number. Even when the correct OCM name or logo is marked on the die, additional research is required to assure it is the correct die for the part number marked. Some may contain no markings at all.
- b) Numbers on legitimate OCM IC die may not be the same as the part number.
- c) Logos on legitimate OCM die may not be those of the manufacturer marked on the package, due to cross-licensing and patent expiration. Without proof of these facts by the OCM, the components must be rejected as counterfeit. There may be a significant time difference between the date on the package and the date on the die, as the same die mark could have been used for many years.
- d) Ink dots on the die that indicate, it was rejected by the OCM.
- e) Condition of the bonding wires
- f) Determination that the markings on the die match the OCM markings for the component type marked on the package.
- g) Indication of electrical overstress such as fused metal, ruptured oxide, excessive heat, etc.
- h) Indications of corrosion due to moisture or other contaminants entering the package.
- i) Photo records shall be made with enough detail to clearly reveal the characteristics being inspected by use of: 1) digital photomicrographs of the die including the wire bonds to chip pads and package leads; 2) Higher magnification photos that clearly show any markings and name or logo on the die.

4.7.2 Passive components

Passive components physical characteristics vary considerably by the type of component. Various methods are required to verify authenticity and use of a competent outside lab is recommended:

- a) Cross-section analysis to verify materials, plates, dielectric thickness, termination materials dimensions, etc.
- b) X-ray of internal elements and comparison to known good components.
- c) Measure electrolytic capacitors, relays and magnetics for parameters specified in 4.9.6.
- d) Workmanship issues.

4.7.3 Decap or cross section data

The decapped device or cross section shall be photographed and observations made shall be recorded in the inspection report. Observation of any characteristics or condition that is not authentic to the named OCM or

indicates the component was previously used shall result in rejection of the total population the sample represents. Use of an authentic device (Gold Standard) for comparison is a useful technique.
Some OCMs will provide assistance to determine whether the die is authentic.

4.8 XRF and solderability testing

The semiconductors samples used for decapsulation shall have a minimum of two leads from each sample tested for solderability in accordance with J-STD-002 or MIL-STD-883, TM 2003 as applicable. XRF testing shall be performed before solderability testing. Any lead failing solderability requires customer approval for acceptance. In addition, one lead from each component shall have base metal and plating tested for conformance to the materials identified by the OCM markings.

BGAs and Pin Grid array packages are excluded from solderability as no standard procedures for this test are available. The balls and pins shall be XRF tested for correct plating content.

It may be necessary to verify if a legitimate change in lead plating material was made by the OCM.

4.8.1 XRF testing

Two leads from each of the decap components shall be analyzed to ensure that the components elements match the OCM specifications. Two balls minimum from one BGA shall be tested for correct materials. The results shall verify that the component leads contain the correct metals. Failure of one or more of the components shall result in the lot being rejected.

4.8.2 Solderability

Leads tested for solderability shall exhibit a continuous solder coating free from defects for a minimum of 95% of the critical area of the individual lead. For exposed pad packages, the exposed pads surfaces shall exhibit a continuous solder coating free from defects for a minimum of 80% of the critical area of those surfaces. Anomalies other than de-wetting, non-wetting and pin holes are not cause for rejection. Rejection of one of the samples shall result in the lot being rejected. JPEG images shall be captured of all three (3) samples, after this test pass or fail.

4.9 Electrical testing, required for Level A verification (discretes and integrated circuits)

Electrical testing is a key procedure in determining that components are authentic to an OCM's component, however, it may not assure that the components are new or not refurbished. The operator must be trained and knowledgeable in electrical testing. Some basic electrical testing may be performed by the ID on certain component types using handheld or bench top testers. This testing can determine whether the components internal bond wires are connected or shorted before performing more expensive testing. The testing of more complex components will have to be performed by an experienced test house with suitable test equipment. The ID shall specify the tests to the test lab, which shall be based upon the generic types of tests specified below for the different components. These tests shall be identified/marked by the ID on the OCM data sheet or military detail specification for the test contractor.

4.9.1 Electrical test samples for semiconductors

For lot sizes of 30 components or less, all (100%) of the devices shall be tested as defined herein. For homogenous lots larger than 30 components, the ID shall randomly select 30 test samples per 1000 pieces and tested from each lot/sub-lot. A catastrophic failure (open, short, other) in one or more of the test sample shall be cause to reject the entire population. In the case of failure of one or more samples for minor parameter limits, the whole lot can be 100% tested to salvage the compliant components. This only applies when none of the previous inspections and tests indicate components are suspect counterfeit. The specified tests shall be performed to the OCM's data sheet for commercial devices and the Military detail specification for military part numbers. The customer may specify larger quantities to be tested.

The electrical test samples shall be maintained separately from the remainder of the lot.

4.9.2 Parametric

Parametric testing, pin opens and shorts, DC and AC can determine whether the device is grossly defective or not authentic to the component ordered. Comparative bench testers can test basic electric parameters if a known-good-authentic device for the type under test is available.

(Improper parametric testing can damage otherwise good and authentic devices. When a curve tracer is used, the operator shall be fully trained on the equipment and semiconductor device operation.)

4.9.3 Functional testing

Functional testing is not required for CCAP-101 Level A components, however, the customer may specify such testing when required for their applications. This testing can be difficult to perform but valuable in component authentication to the OCM component data sheet, it is typically expensive and in many cases OCM functional test software is not available.

4.9.4 Integrated circuits

Integrated circuits shall be electrically tested to the extent necessary to assure authenticity of the test samples to the markings. Specific parameters shall be specified by the ID or approved test lab and identified to the OCM applicable data sheet or military specification. Examples of minimum parametrics to be tested are listed below:

Digital logic:

- DC parameters, 25 °C and min/max temperature
- Other tests useful to verify authenticity

Linear, Op Amps & Mixed logic

- Full power & voltage conditions
- DC parameters, 25 °C and min/max temp
- AC parameters 25 °C

Microprocessors, DSPs, Microcomputers & similar

- Key DC parameters at 25 °C and min/max temperatures

Memories, RAM, SRAM, FPGA, etc.

- Input and output pins, open and short
- DC parameters at min/max temperature
- FPGAs are unprogramed
- Write and read to memory and speed, for RAM and FPGA
- Other applicable tests

Other Type Devices

- Similar parameter verification based upon datasheet

4.9.5 Discrete semiconductors

Specific tests to be performed shall be marked on the OCM data sheet or military specification as applicable to the component by the ID or approved test lab. The following minimum tests are guidelines for electrical testing.

Transistors,

- H_{fe} (gain) 25 °C and max temp. at medium and min/max current
- h_{fe} and leakage currents
- I_{EBO} , I_{CBO} , at rated voltage
- V_{ce} (sat) at rated current

Diodes,

- V_F Forward voltage drop at rated current
- I_R Reverse leakage current at rated voltage

Zeners,

- V_Z Knee voltage
- I_R Leakage current

SCRs, thyristors

- Holdoff voltage
- Peak trigger current

Leakage current

4.9.6 Passive components

All passive components (both Level A & B) not contained in OCM verified packaging shall be sample tested, 50 pcs/1000 components for parameters specified below.

Most passives can be tested with electronic bridges, DWV testers and curve tracers.

Capacitors:

Capacitance and tolerance at 25 °C and min/max temp
DWV
ESR (Electrolytics only)

Inductors:

Inductance over or within specified frequency and temperature range
Q
Series resistance

Resistors:

Resistance and tolerance at 25 °C and min/max temp.
Temperature coefficient

Other Passives

Applicable parameters

4.9.7 Electrical Test Data recording

The organization performing the electrical testing shall record the parameter conditions and limits used for acceptance of the components. The data from these tests will be recorded for all parameters that have a minimum or maximum limit on the datasheet. This data shall be included with the CCAP-101 inspection report to customers.

4.10 Use of contract test labs

When the ID elects to use outside test labs for x-ray, decapsulation, die authentication, XRF of lead material and verification or electrical characteristics, the ID is still fully responsible for the results and actions taken from this testing. The ID shall employ valuation criteria and rating form to select only competent labs with equipment suitable and personnel trained for the test and inspections they will perform. The requirements specified herein for these tests and inspections shall be imposed upon the contractor. The contractor shall not change, alter or modify the test requirements. The contractor shall return specific data (photos, narrative description of the findings), read and record electrical test data that verifies the status of the components. The approved test labs shall complete Appendix A7, Certification for Test Labs.

CTI reserves the right to audit each contractor to verify their training, equipment and procedures suitable for the contracted work. When the tested components and data are returned, the ID shall thoroughly inspect the photos and test results to assure conformance to the requirements, the same as if performed in house. ID should keep the number of Approved Labs used to no more than two (2) or three (3) for each type of testing required.

4.11 Additional testing and services

The ID shall identify the value added testing and analysis and ensure that the operations are carried out under controlled conditions, including the following:

- 1) Documented work instructions defining the operations, handling, package/container opening, ESD, name of the approved lab that was utilized, etc.
- 2) For packaged products the marking process shall not obliterate or alter the OCM's marking;
- 3) Customer specified component programming and electrical tests shall be documented in procedures covering the master units and shall include program revisions/changes as required.
- 4) Components which have had extra testing, screening or programming performed on them in accordance with a specific customer order shall not be restocked with, or sold as, OCM virgin product.

- 5) Value-added processing (e.g., environmental screening tests) performed by the ID's subcontractors shall conform to the same quality system requirements contained herein.

The customer may specify additional tests and services to be performed by the ID after the component's authenticity has been established. The types of additional tests and services may include:

- a. Reballing BGAs
- b. Additional electrical tests
- c. Programming
- d. Tape and reel or other packaging
- e. Solderability testing
- f. Other value added tests

4.12 Documentation and inspection records

The ID shall record all inspection results on A1 – A4 forms as appropriate for the samples from each lot or sub-lot that is inspected. The records shall identify:

1. OCM's name marked on the part
2. Date code and lot number, if marked
3. Name of country marked
4. Marking permanency results
5. All observations made, including photos: shall be used to assure markings match the OCM practices, fonts, dimensions, correct number of leads, condition of leads, other areas of concern, internal observations from decapping and to detect any sanding or blacktopping,
6. Digital photos of components and marking from at least 3 angles and 3 samples per lot/sub-lot.
7. X ray results and copy of units
8. Decap findings and photos of all markings on the die and metal pattern
9. Electrical test results, Level A only.
10. Status of components inspection results: accepted ___rejected___(For the file process no further)
11. Names of persons performing the inspections and date
12. Supplier of components
13. Customer that ordered the components and purchase order number
14. Certificate of Compliance – Appendix A-5

4.12.1 Submission to customer

A printed or electronic copy of the CCAP-101 inspections results as selected by the customer, including digital photos and Certificate of Compliance for the order shall be supplied to the customer with the shipment.

4.12.2 Retention

A complete copy of the report and data package shall be maintained by the ID for a minimum of five (5) years for both commercial and military components.

4.12.3 Annual review by certifying organization (CTI Inc.)

A summary report of all lots processed (rejected and accepted) for CCAP-101 Certified Components shall be available for review by CTI Inc. within 30 days of the anniversary date of the ID's Certification. This report shall be prepared for both authentic components and counterfeits detected.

4.13 Appendices

The Appendices contained herein provide details to be included in the IDs Certification Procedures and Inspection of components to detect counterfeits.

5.0 Responsibilities

5.1 Independent Distributors (IDs)

Electronic component Independent Distributions certified in accordance with this document are fully and completely responsible to implement the requirements of the Counterfeit Components Avoidance Program as defined herein and in accordance with their procedures approved by CTI Inc.

5.2 Certification request

An ID desiring to become a Certified to CCAP-101 supplier shall complete and submit an application to Components Technology Institute, Inc. The Application for Certification can be found on web: <http://www.cti-us.com/CCAP.htm>

5.3 Certifying organization

Components Technology Institute, Inc. has full ownership rights to the Counterfeit Components Avoidance Program and the Copyright and Trademark for CCAP 101 Certified document. CTI is the only organization that has the authority to provide training on the implementation of this Program, to approve ID Counterfeit Avoidance Practices, to investigate and resolve counterfeit issues, to grant Certification to IDs, to de-certify IDs, when they violate requirements of CCAP 101, and to make changes to the Program.

5.3.1 Certified Independent Distributors

CTI will maintain on their web site www.cti-us.com a list of IDs that have been certified to CCAP-101. The Certified ID list will be promoted to OEMs that use electronic components. IDs have the right to link their web site to the CTI list of Certified IDs.

5.3.2 Delivery of Counterfeits

The ID shall report to CTI by e-mail within 3 working days of being notified by customer that counterfeit components or counterfeit suspects were delivered to them and provide data requested by CTI.

5.3.3 Impact of Counterfeit Components

If Certified counterfeit components are delivered to a customer, the ID Certification may be suspended by CTI until the contributing cause and corrective action is resolved. Multiple deliveries or unresolved issues may result in termination of the ID's Certification.

5.3.4 Contact information:

Components Technology Institute, Inc.
904 Bob Wallace Ave., Suite 117
Huntsville, AL 35801
256-536-1304, Fax: 256-539-8477, www.cti-us.com
Leon.Hamiter34@cti-us.com

Appendices

Appendices A-1 thru A-5 are available from CTI to certified IDs, A7 is on the web, A-6 is separate due file size of 18 mb. and available by request.

- A-1 Summary of Inspection Results
- A-2 Component Inspection Results
- A-3 Decap Inspection Results and XRF Test Results
- A-4 Electrical Testing Results
- A-5 Certificate of Compliance for the customer
- A-6 Examples of Counterfeit Characteristics, Contact CTI for a copy if too large to download.
- A-7 Test Lab Certification