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METRIC

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SUPERSEDING
MIL-STD-1580 (USAF)
Dated 10 OCT 80

DEPARTMENT OF DEFENSE

TEST METHOD STANDARD

DESTRUCTIVE PHYSICAL ANALYSIS FOR ELECTRONIC, ELECTROMAGNETIC, AND ELECTROMECHANICAL PARTS

AMSC N/A

FSC 1820

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DEPARTMENT OF THE AIR FORCE
Washington, D.C. 20360

MIL-STD-1580A (USAF)

Destructive Physical Analysis for Electronic, Electromagnetic, and Electromechanical Parts.

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by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

To ensure the required high quality of parts used in the designs of space and launch vehicles, stringent in-process controls are imposed and a comprehensive test program is conducted on the completed parts. A key ingredient of the test program is the assessment of part lot quality based on the destructive examination of samples randomly selected from each production lot. The destructive physical analysis (DPA) is used to inspect and verify the internal design, materials, construction, and workmanship of the part. It can also be used to monitor processes, for failure analysis, or to suggest corrective actions. The information derived from the DPA may be used:

a. To preclude installation of parts having patent or latent defects;

b. To aid in dispositioning parts that exhibit anomalies;

c. To aid in defining improvement changes in design, materials, or processes;

d. To evaluate supplier production trends.

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SECTION 1

SCOPE

1.1 PURPOSE

This standard describes the general requirements for performane of destructive physical analysis (DPA) on samples of parts. In addition to the requirements for the analysis procedures, the general criteria for interpreting results, such as for the acceptance or rejection of associated production lots, is included for typical electronic, electromagnetic, and electromechanical parts.

1.2 APPLICATION OF THE STANDARD

This standard is intended to be referenced in detailed part specifications, or in other documents where DPA requirements are imposed, to assure that the practices, procedures, and criteria contained herein are uniformly applied. The requirements are intended to provide the general framework and basis for detailed DPA procedures for specific part types.

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SECTION 2

REFERENCED DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

SPECIFICATIONS

Military

MIL-C-20	Capacitor, Fixed, Ceramic Dielectric (Temperature Compensating), Established and Non-established Reliability, General Specification for
MIL-T-27	Transformers and Inductors, General Specification for
MIL-C-123	Capacitors, Fixed, Ceramic Dielectric (Temperature Stable and General Purpose), High Reliability, General Specification for
MIL-C-3098	Crystal Unit, Quartz, General Specification for
MIL-R-6106	Relays, Electromagnetic (Including Established Reliability (ER) Types), General Specification for
MIL-S-8805	Switches and Switch Assemblies, Sensitive and Push (Snap Action), General Specification for
MIL-H-10056	Holder (Enclosures) Crystal, General Specification for
MIL-C-14409	Capacitors, Variable (Piston Type, Tubular Trimmer)
MIL-F-15733	Filter and Capacitors, Radio Frequency Interference, General Specification for
MIL-S-19500	Military Specification. Semiconductor Devices, General Specification for

MIL-C-19978	Capacitor, Fixed, Plastic (or Paper Plastic), Dielectric (Hermetically Sealed, in Metal, Ceramic, or Glass Cases) Established and Non-established Reliability, General Specification for
MIL-T-21038	Transformer Pulse, Low Power, General Specification for
MIL-C-23269	Capacitor, Fixed, Glass Dielectric, Established Reliability, General Specification for
MIL–T–23648	Thermistor (Thermally Sensitive Resistor) Insulated, General Specification for
MIL–S–24236	Switches, Thermostatic, (Metallic and Bimetallic), General Specification for
MIL–H-28719	Header, Hermetically Sealed
MIL-F-28861	Filters and Capacitors, Radio Frequency/Electromagnetic Interference Suppression, General Specification for
MIL-M-38510	Microcircuits, General Specification for
MIL-C-38999	Connector, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breach Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for
MIL-C-39001	Capacitor, Fixed Mica Dielectric, Established Reliability, General Specification for
MIL-C-39003	Capacitor, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification for
MIL-R–39005	Resistors, Fixed, Wirewound (Accurate), Established Reliability, General Specification for
MIL–C-39006	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum Establish Reliability, General Specification for
MIL-R-39007	Resistors, Fixed, Wirewound (Power Type), Established Reliability, General Specification for

MIL-R-39008	Resistor, Fixed, Composition (Insulated) Established Reliability, General Specification for
MIL-R-39009	Resistor, Fixed Wirewound (Power Type, Chassis Mounted), Established Reliability, General Specification for
MIL-C-39010	Coil, Fixed, Radio Frequency, Molded, Established Reliability, General Specification for
MIL-C-39012	Connector, Coaxial, Radio Frequency, General Specification for
MIL-C-39014	Capacitor, Fixed, Ceramic Dielectric (General Purpose), Established Reliability General Specification for
MIL-R-39015	Resistor, Variable, Wirewound, (Lead Screw Actuated) Established Reliability General Specification for
MIL-R-39016	Relays Electromagnetic, Established Reliability, General Specification for
MIL-R-39017	Resistors, Fixed Film (Insulated), Established Reliability, General Specification for
MIL-C-39029	Contact, Electrical Connector, General Specification for
MIL-R-39035	Resistors, Variable, Nonwirewound, (Adjustment Type), Established Reliability, General Specification for
MIL-R-55182	Resistors, Fixed, Film, Established Reliability, General Specification for
MIL-C-55302	Connector, Printed Circuit Subassembly and Accessories, General Specification for
MIL-R-55342	Resistors, Fixed, Film, Chip, Established Reliability, General Specification for
MIL-C-55681	Capacitor, Chips, Multiple Layer, Fixed Encapsulated, Ceramic Dielectric, Established Reliability, General Specification for

MIL-W-81044	Wire, Electric, Crosslinked Polyalkene, Crosslinked Alkane-imide Polymer, or Polyarylene Insulated, Copper or Copper Alloy, General Specifications for
MIL-W-81381	Wire, Electric, Polyimide-Insulated, Copper and Copper Alloy, General Specification for
MIL-R-83401	Resistors, Networks, Fixed, Film Copper or Copper Alloy, General Specification for
MIL–C-83421	Capacitor, Fixed, Supermetallized, Plastic Film Dielectric, (DC, AC, or DC and AC). Hermetically Sealed in Metal Cases, ER, General Specification for
MIL-C-83500	Capacitors, Fixed, Electrolytic (Non-Solid Electrolyte), Tantalum Anode and Cathode, Style CRL, General Specification for
MIL-C-87164	Capacitor, Fixed, Mica Dielectric, High Reliability, Style CMS, General Specification for
MIL-C-87217	Capacitors, Fixed, Supermetallized Plastic Film Dielectric, Direct Current for Low Energy, High Impedance Applications, Hermetically Sealed in Metal Cases, Established Reliability, General Specification for

STANDARDS

Federal

FED-STD-H28	Screw Thread Standard for Federal Services
FED-STD-209	Federal Standard Clean Room and Work Station Requirements, Controlled Environment
QQ-S-571	Solder, Tin Alloy: Tin-Lead and Lead Alloys

Military

MIL-STD-202	Military Standard. Test Methods for Electronic and Electrical Component Parts
MIL-STD-750	Military Standard. Test Methods for Semiconductor Devices

MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-981	Design, Manufacturing, and Quality Standards for Custom Electromagnetic Devices for Space Applications
MIL-STD-1285	Marking of Electric and Electronic Parts

OTHER

NATIONAL BUREAU OF STANDARDS

NBS Special Publication 400-35	Notes on SEM Examination of Microelectronic Devices

Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

2.2 ORDER OF PRECEDENCE

In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence. However, nothing in this standard shall supersede applicable laws and regulations unless a specific exemption has been obtained.

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SECTION 3

DEFINITIONS

3.1 CONTRACTING OFFICER

A contracting officer is a person with the authority to enter into, administer, or terminate contracts and make related determinations and findings. The term includes authorized representatives of the contracting officer acting within the limits of their authority as delegated by the contracting officer.

3.2 DEFECT

A defect is any nonconformance from specified requirements which affects form, fit, or function.

3.3 DESTRUCTIVE PHYSICAL ANALYSIS (DPA)

A destructive physical analysis (DPA) is a systematic, logical, detailed examination of parts during various stages of physical disassembly, conducted on a sample of completed parts from a given lot, wherein parts are examined for a wide variety of design, workmanship, and processing problems that may not show up during normal screening tests. The purpose of these analyses is to determine those lots of parts, delivered by a vendor, which have anomalies or defects such that they could, at some later date, cause a degradation or catastrophic failure of a system

3.4 LOT-RELATED DEFECT

A lot-related defect is an anomaly attributable to a variance in the design, manufacturing, test, or inspection process that is repetitive throughout a production lot.

3.5 PRODUCTION LOT (ELECTRONIC PARTS).

A production lot is a group of parts defined by the part specification or drawing, and identified with a lot date code.

3.6 SCREENABLE DEFECT.

A screenable defect is one for which an effective, nondestructive screening test or inspection can be reasonably developed and applied to eliminate with confidence the nonconforming items from the lot.

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SECTION 4

GENERAL REQUIREMENTS

4.1 SAMPLE SIZE

4.1.1 DPA for a Lot Conformance Test. When a destructive physical analysis (DPA) is conducted to verify lot conformance of a particular production lot of parts, the minimum sample size shall be two (2) percent or five (5) units, whichever is larger, to a maximum of 30 units per production lot, except variable capacitors, variable resistors, complex microcircuits, and crystals where a minimum of one (1) percent or two (2) devices, whichever is larger, to a maximum of 10 units, shall be analyzed. In the case of high-cost parts or parts with very limited availability, a reduced sample size may be imposed with the approval of the Parts, Materials, and Processes Control Board or other designated representative of the procuring activity. The DPA shall be performed by an agency other than the manufacturer of the part.

4.1.1.1 DPA Sample Criteria. Units in the DPA sample may either be randomly selected or selected as most revealing based upon some characteristic known to be associated with certain problems for that part type.

4.1.1.2 Parallel tests When a DPA is not conducted to verify lot conformance, but for some other reason, the various units in a DPA sample need not follow the same test sequence. Different tests may be performed on different units in a parallel test sequence to save time or to allow greater flexibility in test procedures. When a parallel test sequence is used for a particular part type, additional DPA units may be required above the maximum number specified to assure that all tests and inspections are completed.

4.1.1.3 combined Samples Combined DPA samples are acceptable for similar items manufactured using the same lots of materials, the same processes, and the same controls, if they have the same lot date code and vary only in some limited characteristics. Examples are resistors with different resistance values or capacitors with different capacitance values. Prior approval from the procuring activity is required when using combined samples.

4.1.1.4 Utilization of Rejects Electrical reject devices from a production lot may be used as DPA samples provided that the devices were only rejected due to out-of-tolerance parameters. These devices may consist of parts rejected during previous screening inspections.

4.1.2 Other. When a DPA is not being conducted as a Lot Conformance Test but for some other purpose, a sample is selected that is appropriate for the purpose. A daily or weekly DPA sample of a single unit may be adequate if the DPA is looking for long term, in-process trends in workmanship, contamination, strength, or performance. Conversely, a DPA sample every hour might be required for bonding control or for other critical process monitoring. When a DPA is used to determine the cause of a part failure, the single sample that failed may be all that is available.

4.1.3 Resampling. If equipment failures, procedural errors, or other events independent of the parts themselves resulted in the initial DPA sample being inconclusive, a second DPA sample may be selected. However, the original samples shall be retained for review by appropriate agencies. The resample sample size may be determined on the basis of any partial results from the initial sample, and the type of defects that are being investigated.

4.2 DPA PROCEDURES.

DPAs shall be conducted in accordance with documented procedures prepared for the specific part. The DPA procedures for a specific part shall be based on the requirements stated in this standard, the part procurement specification, and the configuration information for that part provided by the particular manufacturer. The critical test sequences and possible test branches to allow parallel testing shall be indicated in the procedures. All samples shall be serialized and all pre-DPA test data shall be recorded for reference at post-DPA evaluation. As a minimum, the procedure shall include applicable instructions for initial external inspections, electrical tests, radiography, disassembly, sample preparation, microscope or scanning electron microscope (SEM) examinations, and data recording. All DPA shall be done *in* a clean area. The procedure shall contain a baseline drawing or sketch and, where practicable, a photograph of the part for comparison. The procedure shall indicate the pass-fail criteria applicable to that part type. The procedure shall include a checklist, generally similar to the example shown in Figure 4-1 to be used in recording attributes data. All defects during DPA examination shall be photographed. A data sheet generally similar to the example shown in Figure 4-2 shall be included to be used in recording electrical or other variables data.

4.2.1 Baseline Sketch. The general configuration of the device that is to be examined is shown on the baseline sketch or drawing. This sketch or drawing should include critical dimensions, locations of constituent parts, and a list of the

DPA CHECK SHEET

DPA NO. ________

FIXED SOLID TANTALUM ELECTROLYTE CAPACITOR

SHEET NO. ________

Part Type ________ Supplier ________ P/N ________

Date Started ________ Lot/Date Code ________

Sample No. / Serial No.					
EXTERNAL EXAMINATION RESULTS SAFACTORY?					
TERMINAL STRENGTH TEST results satisfact.?					
SEAL TEST results satisfactory?					
Slug alignment satisfactory?					
Solder and welds satisfactory?					
Cathode lead firmly attached?					
Loose particles in void area?					

COMMENTS : ________

Analyst: ________ Date ________

Supervisor: ________

Figure 4-1. Sample DPA Check Sheet, Fixed Solid Tantalum Electrolytic Capacitor

Date Start	Date Comp.	TEST	Page No.
Specimen Descrip: Mfgr: Date Code		Proj. #	Test Oper.
General Test Description:		Requestor:	Engr. :

Cond. Per Fixt.										
Unit No.										

Figure 4-2. Sample DPA Test Data Sheet

pertinent materials and processes. Adequate baseline drawings may be obtained from the part manufacturer, produced as the result of a configuration analysis, or made from the first received lot. The baseline sketch shall be used as a comparison standard during the disassembly process. Typical drawings of baseline sketches are shown in Section 5.

4.2.2 DPA Data Records Each DPA shall be assigned a unique number for identification purposes. All markings on each part shall be recorded. Measurements shall be made and data recorded to substantiate the DPA findings in accordance with the applicable DPA procedures. Each data page and item shall reference the assigned DPA number. The DPA data records would typically include:

a. Outline of DPA procedure used;

b. The DPA Summary Sheet (Figure 4-3);

c. The DPA Check List (Figure 4-l);

d. The DPA Data Sheets (Figure 4-2);

e. Original x-rays, N-rays, and photographs, individually serialized and referenced, as required;

f. Other data or analysis results which support findings.

4.2.3 Test and Inspection Methods Test and inspection methods shall be consistent with the requirements of the applicable part specification or drawing. When test and inspection methods other than those specified in the part specification or drawing are used, they shall be selected from or based on MIL-STD-202, MIL-STD-750, or MIL-STD-883, where applicable.

4.2.3.1 External Visual. Record all markings on each part, check for configuration compliance, and inspect for any external defects that may affect reliability in accordance with the detailed requirements for each applicable section.

4.2.4 Evaluation Criteria. Criteria for evaluation of DPA variables and attributes data shall be defined in the applicable DPA procedure for the particular part. The criteria shall be based on the requirements of the detailed part specification or drawing or on other applicable baseline documentation. Defects described on the DPA Summary Sheets shall reference the criteria used to establish the defects.

DPA SUMMARY SHEET

DPA Report No. ________

Component Type ______________ P/N ______________ S/N ______________

Supplier ______________________________ P.O. No. ______________

Lot/Date Code ________ Qty. Procured ________ Sample Size ________

Specification No. __________________

RESULTS OF ANALYSIS Test Activity Analyst ______________

DPA Findings: ____

____

____

Recommendations: ____

____

____

________________________ ________________________
Test Activity Date
Responsible Engineer

DISPOSITIONN

Contains a Defect: Yes _ ._No

Recommend Use: Y e s _ .No

Overall Comments

________________________ ________ ________________________ ________
Test Activity Quality Date Contractor Date
Assurance Representative Technical Designate

Figure 4-3. Sample DPA Summary Sheet

Each defect shall be described and photographed for inclusion in the DPA report. The resolution of anomalies shall also be annotated in the report.

4.3 RAIOGRAPHY .

X-ray or N-ray examination shall be required, as dictated by device/package technology, before delidding to examine cavity devices for loose particles and to determine internal clearances. It is also useful as an aid in locating delidding and sectioning cuts and to nondestructively investigate suspected defects. When X-ray or N-ray radiographs are included as part of the DPA, suitable image quality indicators shall be used on each radiograph.

4.4 DISASSEMBLY AND SAMPLE PREPARATION.

Assure that all DPA requirements that cannot be satisfied after disassembly are satisfied prior to the start of disassembly, for example, measurements of entrapped water vapor or volatile contaminants within cavity devices. In all cases, care shall be exercised during disassembly and sample preparation to prevent damage that would introduce anomalies or the generation of contamination that would mask valid DPA data for the device being examined. The following requirements are applicable where appropriate:

4.4.1 Delidding Delidding shall be as described in the detailed requirement section for the specific part type. An example of a delidding tool is shown in Figure 4-4. In all instances, when opening devices for DPA, all reasonable precautions shall be taken to avoid introducing fluid or particulate contamination into the device or damaging its internal structure. All delidding shall be performed under laminar flow bench or clean room environments. During and after delidding all portions of a device shall be identifiable with the parent device. Samples that have been delidded shall be stored in a clean, moisture-free environment such as a nitrogen purged dry box or desiccator prior to potting and sectioning.

4.4.2 Section Samples Techniques similar to those used to prepare sectioned metallurgical and mineralogical specimens for optical examination are generally applicable to the preparation of DPA samples. The device to be examined is first potted in a suitable low shrinkage, room temperature resin. The resin is advisable to remove bubbles prior to curing. It is then cut or rough ground to the desired section plane, followed by fine grinding, polishing, and sometimes etching to bring out the necessary detail. The process by which samples are mounted, sectioned, and polished can readily induce

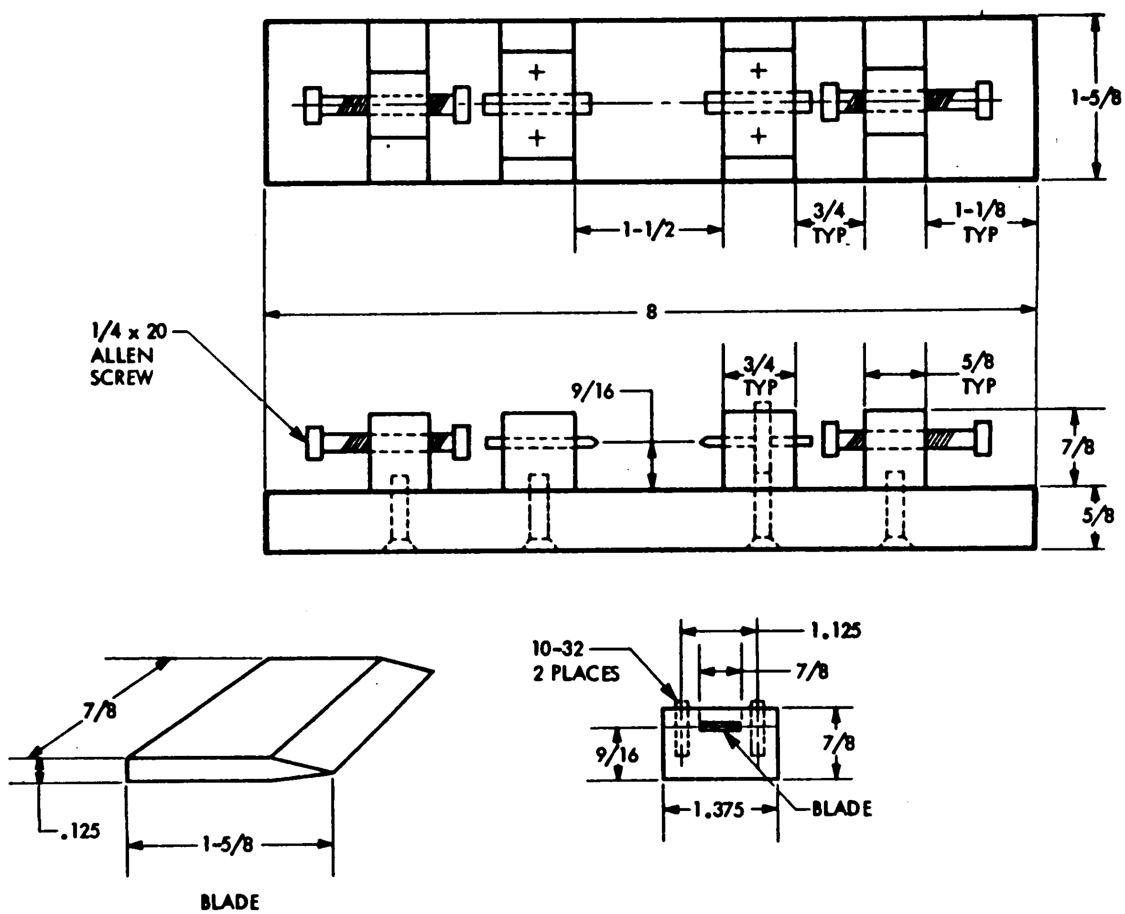

Figure 4-4. Example of Flat-pack Delidding Vise

high stresses in the materials. Such stresses can, and often do, result in damage which might be interpreted as product defects, but which never existed in the undisturbed specimen. This is particularly true for brittle materials with relatively low mechanical strength such as ceramic dielectric materials. As an aid to those involved in Destructive Physical Analysis, EIA standard RS–469 describes abnormalities resulting from faulty sample preparation for ceramic capacitors. This same information may be useful for other device types.

4.4.3 Scanning Electron Microscopy (SEM) Samples Transistor and integrated circuit chips shall be prepared for SEM examination in accordance with Method 2018 of MIL-STD-883. Additional guidelines are provided in NBS Special Publication 400-35. Other types of parts shall be prepared for SEM by using standard laboratory techniques for mounting and coating, taking care that anomalies are not introduced by the process.

4.5 PHOTOGRAPHS.

A minimum of two photomacrographs are normally required to document baseline characteristics of an opened part prior to performance of further destructive tests. These shall be supplemented with other photomacrographs or photomicrographs as required to record observed defects or anomalies. Microscopy techniques such as color, dark field, phase contrast, and interference contrasts shall be used as necessary to enhance image clarity. When scanning electron microscope examination (SEM) is performed, an overall view of the die, a photograph of the worst case oxide step, and a photograph of the worst case metallization shall be obtained where applicable. Each photograph shall be labeled or otherwise identified with the applicable DPA number, part type, part serial number, part lot date code, accelerating voltage, tilt, and the magnification used. Results of SEM energy dispersive spectrometric analysis shall also be supplied when appropriate.

4.6 RETENTION OF SAMPLES.

All DPA samples, original photographs, and related paperwork shall be identified and stored in a nondegrading environment for a minimum of twelve (12) years, or program life plus three (3) years, whichever is longer, and shall be available to the procuring activity for independent examination.

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SECTION 5

DETAILED REQUIREMENTS FOR CAPACITORS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used capacitors. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. Specification numbers are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

5.1 CAPACITORS, FIXED CERAMIC (MIL-C-20. MIL-C-123, & MIL–C–39014).

A typical radial leaded device is shown in Figure 5-1 and Figure 5-2, and a typical axial leaded device is shown in Figure 5-3.

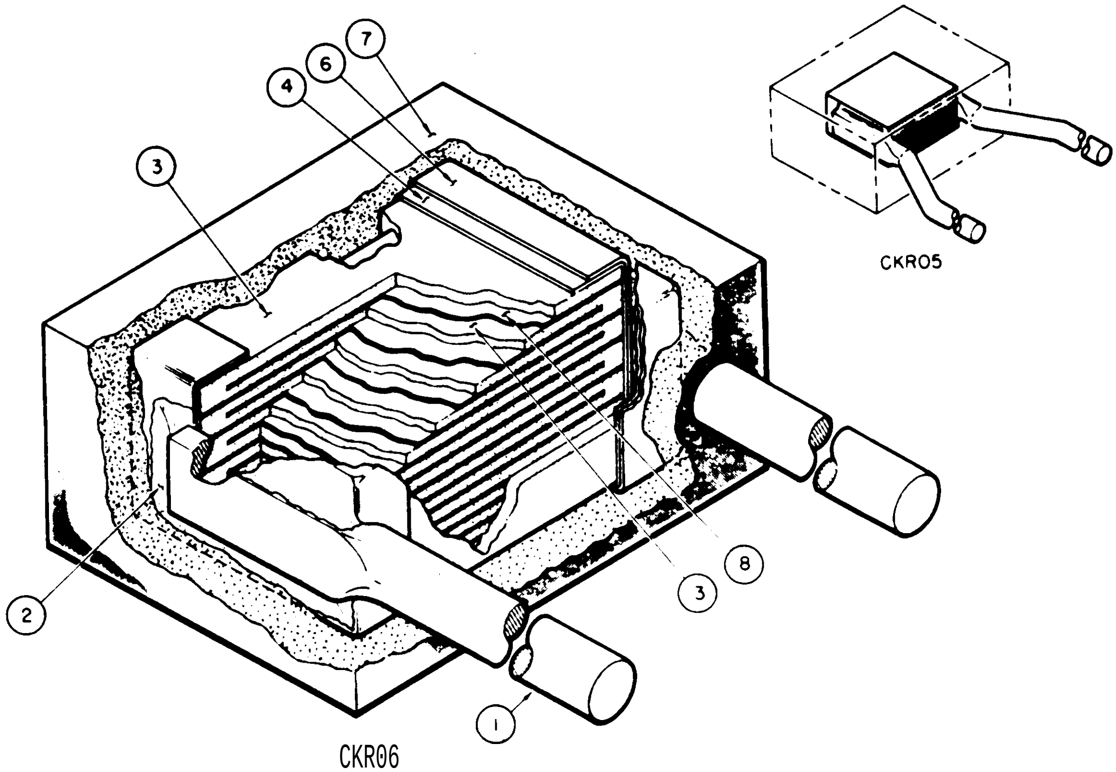
5.1.1 Method.

5.1.1.1 External Visual. Visually inspect each part for physical size and at 20X minimum magnification for cracks, pinholes, or chips in the case material. Inspect the leads for evidence of physical damage (cuts, nicks, crushing, or exposure of the base metal not allowed by the specification).

5.1.1.2 Terminal Strength Perform a lead pull strength test on all parts (two parts minimum) in accordance with the applicable specification.

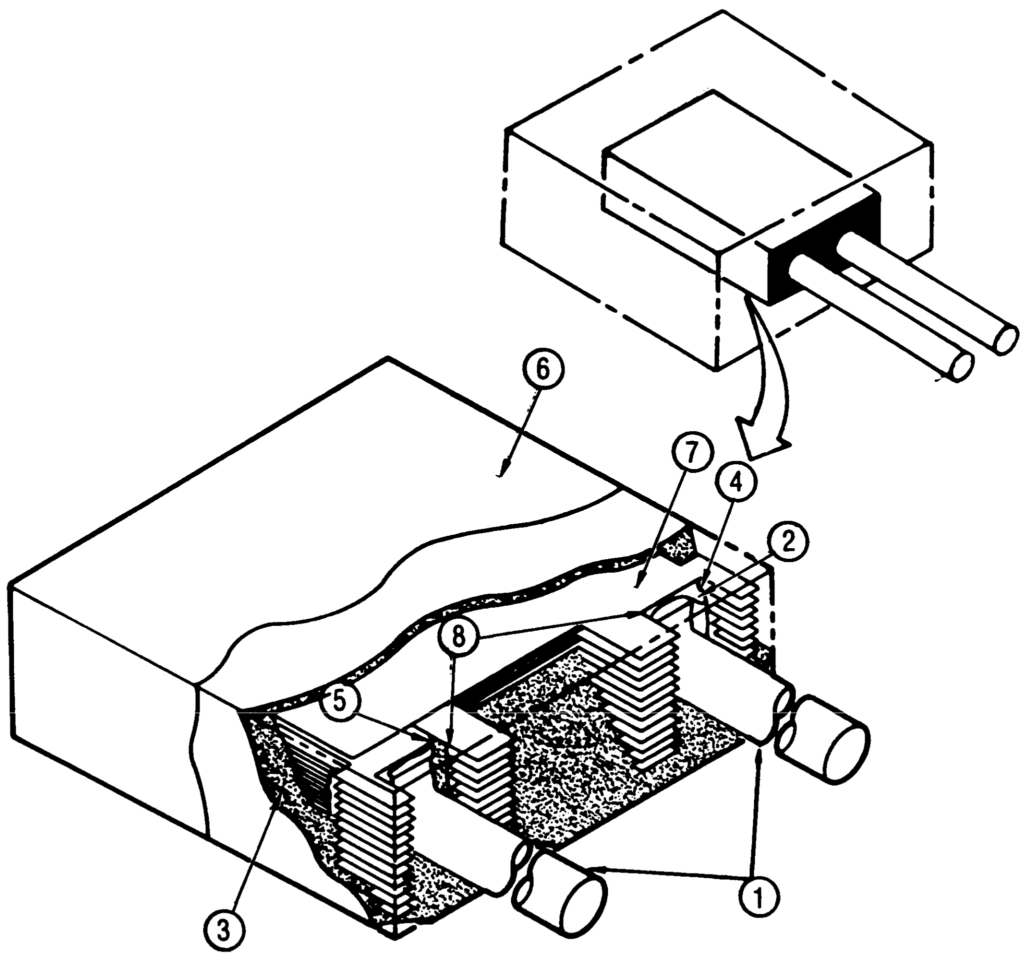
5.1.1.3 Removal of Encapsu latio. Strip plastic coating or case from encapsulated varieties. Chemical solvents or plasma etch specified in EIA-469 are recommended.

5.1.1.4 Capacitor or Element Visual. Examine lead attachment for evidence of inadequate soldering, or cracked or cold solder joints in accordance with EIA–469. Verify use of high temperature solder, SN1O or equivalent, through scanning electron microscope (SEM) energy dispersive spectrometric analysis, differential thermal analysis, thermal galvanometric analysis, or other equivalent means of verification. Examine capacitor element for cracks, chips, delaminations, and exposed electrodes at 50x minimum magnification. High reliability, Class S, radial lead epoxy case capacitors shall have a rectangular cross section for the lead wire attachment. Established reliability military specification radial lead epoxy



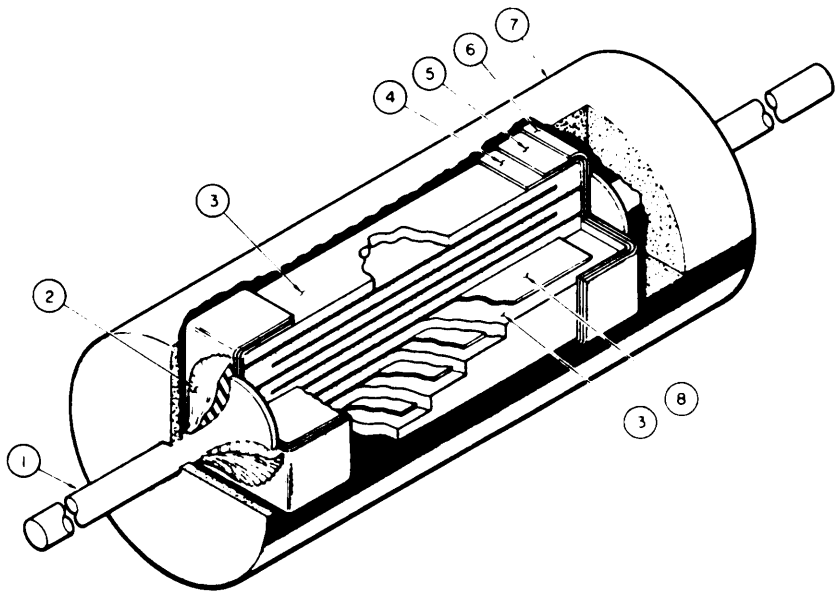
ITEM	ITEM NAME	MATERIALS OF CONSTRUCTION
1	Lead Wire	Gold-Plated Nickel or Solder-Coated Copper
2, 6	Solder	High-Temperature Alloy
3	Dielectric	Proprietary Ceramic Blend
4	End Termination	Silver (or It's Alloy)-Glass Frit Compound
7	Case	Encapsulating Media
8	Metal Electrode	Proprietary

Figure 5-1. Typical Radial Leaded Ceramic Capacitor Molded Case



ITEM	ITEM NAME	MATERIALS OF CONSTRUCTION
1	Lead Wire	Gold-Plated Nickel or Solder-Coated Copper
2, 5	Solder	High-Temperature Alloy
3	Dielectric	Proprietary Ceramic Blend
4	End Termination	Silver (or It's Alloy)-Glass Frit Compound
6	Conformal Coat	Encapsulating Media
7	Metal Electrode	Proprietary
8	Area for Lead Wire Attachment	

Figure 5-2. Typical Radial Leaded Ceramic Capacitor Epoxy Case



ITEM	ITEM NAME	MATERIALS OF CONSTRUCTION
1	Lead Wire	Gold-Plated Nickel or Solder-Coated Copper
2, 6	Solder	High-Temperature Alloy
3	Dielectric	Proprietary Ceramic Blend
4	End Termination	Silver (or It's Alloy)-Glass Frit Compound
5	Intermediate End Layer*	Electrodeposited Metal
7	Case	Encapsulating Media
8	Metal Electrode	Proprietary

* If used.

Figure 5-3. Typical Axial Leaded Ceramic Capacitor case capacitors shall have either a rectangular cross section or a semicircular cutaway (from drilling) for the lead wire attachment.

5.1.1.5 Sectioned Sample Preparation. Parts shall be cleaned, mounted, and polished in accordance with EIA-469.

5.1.1.6 Microscopic Examination The sectioned and polished samples shall be examined microscopically at 50X minimum magnification in accordance with EIA-469.

5.1.2 Data Records DPA findings that deviate from the specification configuration or other requirements shall be documented as defects. DPA findings shall be documented in a format equivalent to that given in EIA-469.

5.1.3 Evaluation Criteria When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples does not meet any of the microscopic examination and the capacitor element visual requirements specified herein.

5.2 CAPACITORS, FIXED, CERAMIC CHIP (MIL-C-123 & MIL-C-55681).

The configuration of these capacitors is similar to the radial leaded capacitor illustrated in Figure 5-1 except that they are not enclosed in plastic and do not have leads.

5.2.1 Method.

5.2.1.1 External Visual Visually inspect each part at 20X minimum magnification for chips, cracks, solder or metallization splatter or smear, exposed electrodes, end termination metallization configuration, warpage, and physical dimensions. It is recommended that parts also be examined with a fluorescent penetrant that meets the requirements of MIL-I-25135, Group VI, for fine cracks and other surface defects not resolvable at 50X magnification. A suitable part-cleaning procedure must also be developed and used with any penetrant examination to ensure that a harmful residue is not left on part surfaces.

5.2.1.2 Sample Premaration Parts shall be cleaned, oriented, mounted, and polished in accordance with EIA-469.

5.2.1.3 Microscopic Examination. The sectioned and polished samples shall be examined microscopically at 50x minimum magnification in accordance with EIA-469.

5.2.2 Data Records PA findings that deviate from the specified configuration or other requirements shall be documented as defects on a form similar to that given in EIA-469.

5.2.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples does not meet any of the microscopic examination requirements specified herein.

5.3 CAPACITOR FIXED MICA (MIL-C-87164 & MIL-C-39001)

A typical fixed mica capacitor is illustrated in Figure 5-4 l MIL-C-87164 capacitors have soldered foil-to-clamp connections.

5.3.1 Method.

5.3.1.1 External Visual. Visually inspect each part at 20x minimum magnification in accordance with applicable procurement specification to examine leads, markings, dimensions, and case.

5.3.1.2 Terminal Strength Conduct terminal strength test (pull test only) on all samples in accordance with the applicable procurement specification.

5.3.1.3 Chemical Removal of Encapsulation. Chemically strip the encapsulation from one-half of the samples.

5.3.1.4 Capacitor Element Visual. Examine decapsulated samples at 20X minimum magnification for configuration compliance, uniformity of stacking, lead attachment, clamp, solder coverage, hand cracked or cold solder connections. Disassemble units to permit evaluation of stacking workmanship intrusion of impregnant into clamp contact area? and cracks on the mica plates.

5.3.1.5 Sectioned Sample Preparation. Cast remaining half of samples in clear epoxy and cross section in a plane perpendicular to the lead plane to permit evaluation of the dielectric stacking, lead-to-clamp or foil-to-clamp connections, and the degree of impregnant intrusion.

5.3.2 Data Records. DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

5.3.3 Evaluation Criteria. With mica capacitors, particular attention should be given to ascertaining that the

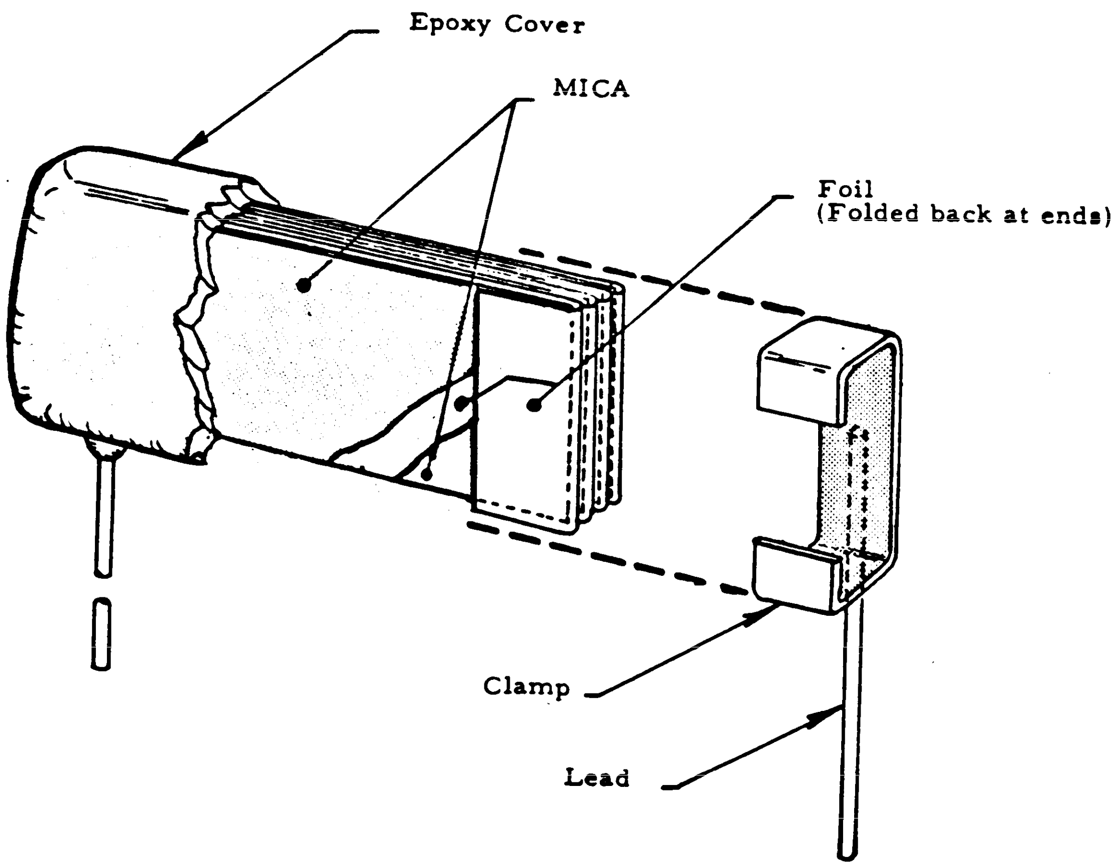


Figure 5-4. Typical Mica Capacitor (CMR style)

devices are solidly and uniformly constructed and that the end clamps make good metallurgical contact with the electrode foils. Microscopic examination shall be performed at 20X minimum magnification. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA sample parts exhibit any of the following defects:

a. Failure to meet external visual requirements or configuration requirements.

b. Excessive voids, thin spots, or cracks in the dielectric.

c. Inadequate stack clamping.

d. Excessive intrusion of impregnant into the foil/clamp interface.

e. Cracks in the case or encapsulating plastic extending through to the capacitor element.

f. Inadequate lead to clamp attachment.

g. Solder used is not a high-temperature alloy. Verify this through scanning electron microscope (SEM) energy dispersive spectrometric analysis, differential thermal analysis, thermal galvanometric analysis, or other equivalent methods.

h. Inadequate solder between foil and clamp and between clamp and lead, when applicable.

i. Failure to pass lead pull tests.

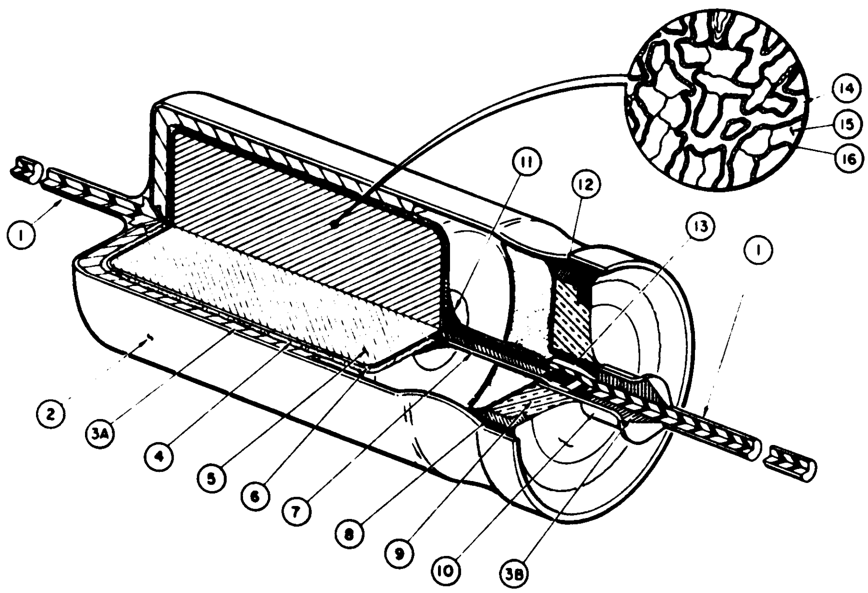
j. Any defect that reduces part reliability.

5.4 CAPACITOR, FIXED, SOLID TANTALUM (MIL-C-39003)

A typical solid tantalum capacitor is illustrated in Figure 5-5.

5.4.1 Method.

5.4.1.1 External Visual. Examine seal area at a minimum of 20X magnification for defects in the glass seal or tubulet-to-lead solder joint, and for marking and configuration compliance.



ITEM	ITEM NAME	MATERIAL OF CONSTRUCTION
1	External Leads	Solder-Coated Nickel
2	Case	Solder-Plated Brass
3A	Solder	Low-Temperature Alloy
3B	Solder	High-Temperature Alloy
4	Conductive Paint	Silver-based
5	slug	See Item No. 14, 15, 16
6	Carbon Film	Colloidal Carboh
7	Anode Riser	Tantalum Wire
8,9,10	Seal Assembly	Glass-To-Metal Seal
13	Anode Riser-To-Lead Lap Weld	
14	Oxide Coating	Manganese Dioxide
15	Core	Sintered, Pure Tantalum Powder
16	Dielectric Film	Tantalum Pentoxide

Figure 5-5. Typical Solid Tantalum Capacitor

5.4.1.2 Hermeticity Conduct seal tests on all samples of hermetically-sealed styles in accordance with the requirements of the procurement specification. Sleeving should be removed prior to conducting this test.

5.4.1.3 Sectioned Samples One half of samples shall be potted in clear plastic sectioned axially to a depth that exposes the anode lead in the header tubulet. Caution should be exercised to ensure cracks are not induced during sectioning. Examine using 30X minimum magnification for configuration compliance, and for defects in lead bond, tubulet solder, slug orientation and slug-to-case solder joint.

5.4.1.4 Delidded Sample. Open remaining half of samples by cutting and peeling the metal can in such a way that the cavity above the tantalum slug can be observed. Examine for loose solder particles, configuration compliance, slug orientation, slug-to-case attachment, and adequate anode riser-to-lead weld joint. Unless otherwise specified, the capacitors shall meet the requirements of MIL-C-39003, Figures 2, 3, and 4.

5.4.2 Data Records. DPA findings that deviate from the specified configuration”or other requirements shall be documented as defects.

5.4.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA sample parts exhibit any of the following defects:

a. Cracks extending through the glass header. Note: Care must be taken to avoid inducing cracks during sectioning. Minor chips or flaking at the tip of the glass meniscus shall not be considered an anomaly.

b. Tubulet filled with solder less than 25 percent of its length when solder-coated leads are used and less than 50 percent of its length when gold-plated leads are used.

c. Voids in tubulet solder or solder separation from the leads that reduces the solder fill requirements mentioned in “b”.

d. Anode (tantalum slug) not parallel to case within 15 degrees. Voids in tubulet solder or solder separation from lead or tubulet that reduces the fill to less than 25 percent of tubulet height for solder-coated leads or to less than 50 percent for gold-plated leads.

e. Solder spikes inside unit or eyelet solder extending beyond bottom of tubulet.

f. Broken or cracked anode lead weld.

g. Anode immersed in solder that is less than one-third of its height (See Figure 2 of MIL-C-39003).

h. Anchor solder cracked or pulled away from anode slug, except as noted in Figure 3 of MIL-C-39003.

i. Solder buildup on inside of can with height greater than 0.50 millimeters (0.020 inches) resulting from solder rundown during sealing process.

j. Anode totally immersed in solder.

k. Anode broken, cracked, or distorted.

l. Loose material 0.25 millimeters (0.010 inches) or large enough to bridge the shortest distance between lead and can, or between tantalum pellet and can.

m. Seal leakage in excess of specification requirements.

n. Any defect that reduces part reliability (e.g., bulge or dents on the case).

o. Failure to meet external visual requirements:

   1. Cracks on the glass seal

   2. Cracked or cold solder joint around seal area

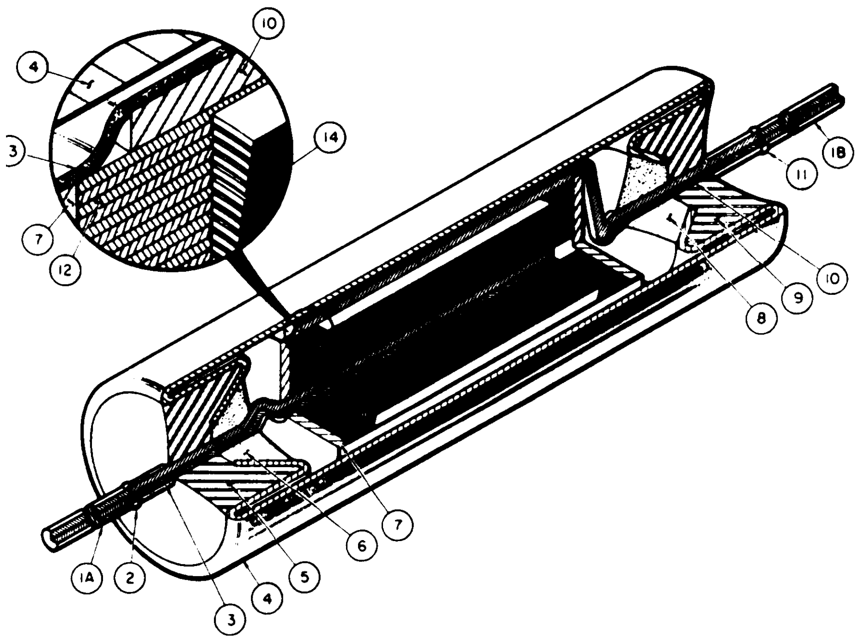
   3. Flux or foreign material on anode lead and around seal area.

5.5. CAPACITOR. FIXED. TANTALUM FOIL (MIL-C-39006)

A typical tantalum foil capacitor is illustrated in Figure 5-6.

5.5.1 Method.

5.5.1.1 External Visual. Perform external visual inspection at a minimum of 20X magnification. Check condition of glass seal and the nickel–to–tantalum lead weld. Check for



ITEM	ITEM NAME	MATERIAL OF CONSTRUCTION
1A, 1B	Nickel Lead	Nickel (MIL-STD-1276, Type N)
2, 11	Butt Weld	
3, 10	Tantalum Lead	99.9 percent Tantalum
4	Tantalum Case	99.9 percent Tantalum
5, 9	Seal Assembly	Glass-To-Metal Seal
6, 8	Header Ring	99.9 percent Tantalum
7	End Insulation	Elastomeric Material
12	Dielectric	Tantalum Pentoxide
13	Insulating Tape	Polyester Film
14	Electrode	Tantalum Foil (May be etched)

Figure 5-6. Typical Tantalum Foil Capacitor

physical damage to weld area that could be evidence of bending leads too sharply in the critical weld zone.

5.5.1.2 Hermeticity Conduct seal tests on each sample in accordance with the rEquirements of the procurement specification. Remove sleeving before conducting the tests.

5.5.1.3 Removal of Encapulation. Remove cases to permit internal visual inspection at 30X minimum magnification. Two methods have proven satisfactory. Circumferential cuts (one at each end) followed by two longitudinal cuts allows the case to be removed in two pieces. The other method uses a lathe or grinder to cut away the circumferential weld to the header at each end of the part. After de-burring, it is often possible to slide the capacitor core intact out of the case. If not, it may be necessary to make a longitudinal cut and spring the case slightly to release the core. After examination of the core, the capacitor element shall be unwrapped for examination of the lead-to-foil welds and the foils. Inspect for configuration compliance during each step.

5.5.2 Data Records. DPA findings that deviate from the

documented as defects.

5.5.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if the DPA sample parts exhibit any of the following defects:

a. Cracks, chips, or breaks extending through the end seal. Broken or incompletely welded end seals. Minor chips or flaking at the tip of the glass meniscus shall not be considered an anomaly.

b. Cracks or breaks in lead weld joints, or greater than 30-percent misalignment of butt welds.

c. Anode lead uninsulated and positioned such that it can touch case or cathode lead during shock or vibration.

d. Unanchored elements or insufficient impregnant or filler to prevent movement of elements.

e. Absence of spacer material between foils, or unwetted spacer material.

f. Anode foil color not uniform or not indicative of the dc voltage rating of the capacitor.

g. Less than three weld spots, cracked welds on lead-to-foil connection, or lead broken away from foil.

h. Scratches or cracks in leads or foil which penetrate the dielectric.

i. Contamination or foreign material inside capacitor.

L Abnormal telescoping of the capacitor element.

k. Seal leakage in excess of specification requirements.

1. Any other defect that reduces part reliability.

5.6 CAPACITOR, FIXED, PAPER OR PLASTIC FILM (MIL-C-19978).

A typical paper or plastic film capacitor is illustrated in Figure 5-7.

5.6.1 Method.

5.6.1.1 External Visual Conduct visual inspection, at 20X minimum magnification, for defects in case seal, eyelet solder, glass headers, leads and markings.

5.6.1.2 Hermeticity Conduct seal tests on each sample of hermetically-sealed parts in accordance with the requirements of the procurement specification. These tests are not required if they have previously been conducted as part of receiving inspection.

5.6.1.3 sample Preparation. Remove case from all samples by making two circumferential cuts just inside each header plus longitudinal cut to permit removal. Carefully remove cutting debris before opening case. Section headers, after completing visual inspection, through eyelet longitudinal center line to verify eyelet solder integrity.

5.6.1.4 Internal Visual. Examine the parts at a minimum of 30X magnification for configuration compliance and for tubulet solder fill, contamination, insulation, spacers, impregnation, element stability, and lead spiral to end spray solder connection. Note that this connection is critical and should be subjected to a pull test to ensure that it is not a cold solder or “low strength” joint. If necessary, remove the encapsulation from the capacitor element. Unwrap the capacitor element of all samples to examine foil and dielectric condition.

5.6.2 Data Records DPA findings that deviate from the specified configuration; or other requirements shall be documented as defects.

5.6.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if the one or more DPA sample parts exhibit any of the defects listed below. Note that the defects in this list are based on the typical part shown in Figure 5-7. Defect criteria should be adjusted as applicable for other designs.

a. Cracked or broken glass in end seal.

b. Solder rundown inside case in area of rolled-foil or end spray.

c. Loose (or moveable) element due to insufficient impregnant or inadequate restraint. When impregnant is not used, other physical restraints may be provided to restrict element movement. The DPA shall be conducted so that the existence and suitability of these restraints are verified. When impregnant is used to stabilize the element, it must be free of voids that would permit the element to move during shock or vibration.

d. Absence of insulator caps over end of element.

e. Loose lead wire or broken solder where lead attaches to the extended foil end spray.

f. Broken or damaged lead wire (internal or external).

g. Contamination and foreign material embedded between windings of the capacitor element.

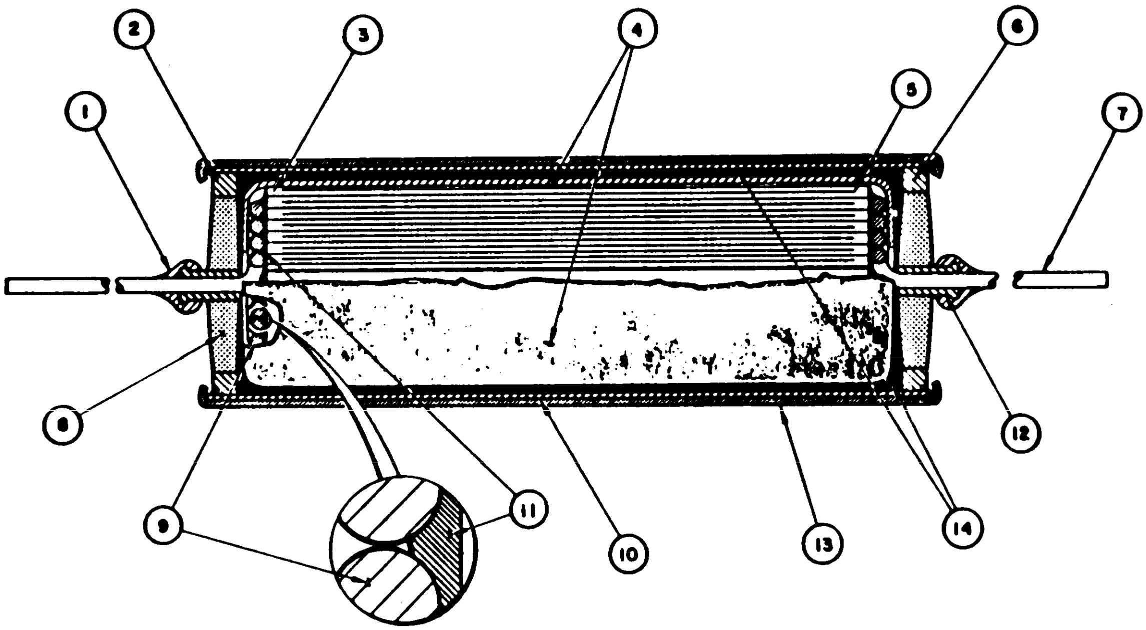
h. Burned or charred regions in the capacitor element area.

i. Less than 25-percent eyelet solder fill (from outer end of eyelet).

j. Eyelet solder separation from lead or inside diameter of eyelet.

k. Voids or holes through the outer end seal.

I. Scratches or cracks in the foil which penetrate the dielectric.



ITEM	ITEM NAME	ITEM	ITEM NAME
1	Solder-Lead Seal	7	Lead
2	Seal Solder	9	Lead-To-Foil Attachment
3	Dielectric	10	Can
4	Capacitor Element-to-case Insulator	11	Solder
5	Electrode	12	Header
6, 8	End Seal Assembly	13	Case Insulation
		14	Potting

Figure 5-7. Typical Extended Foil (Paper/Film) Capacitor

m. Folds, blisters, or wrinkles in the dielectric winding.

n. End spray coverage of less than 100 percent. Poor adhesion between end spray and foil, or between end spray and external lead connection.

o. Seal leakage in excess of specification requirements.

p. Any other defect that reduces part reliability.

5.7 CAPACITOR, FIXED, METALLIZED FILM (MIL-C-87217 & MIL-C-83421).

A metallized film capacitor is shown in Figure 5-8. The part in this illustration has the conventional lead attached to the element end spray. Parts may also utilize other means, e.g., a wire braid or several flexible leads to make this connection.

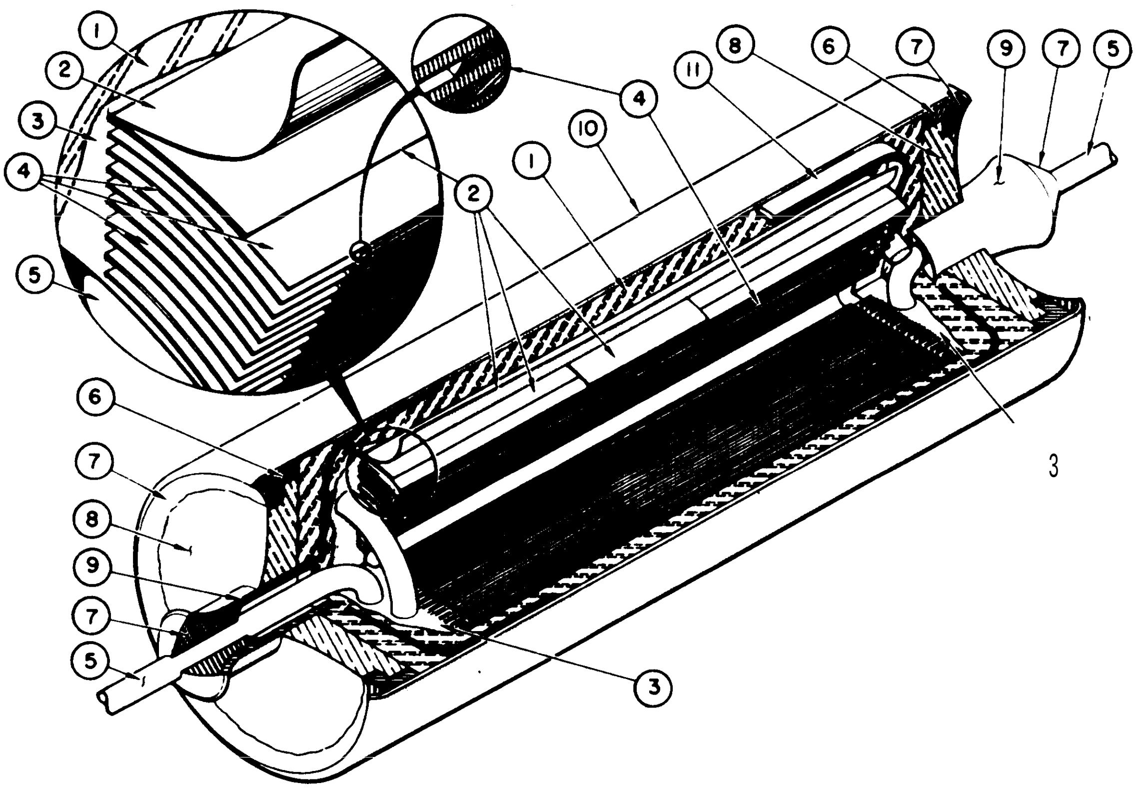
5.7.1 METHOD

5.7.1.1 External Visual. Conduct visual examination, at 20X minimum magnification, for defects in case seal, eyelet solder, glass headers, leads, and marking.

5.7.1.2 Hermeticity Conduct seal tests on each sample in accordance with the requirements of the procurement specification. These tests are not required if seal tests have already been conducted as a part of receiving inspection.

5.7.1.3 Sample Preparation. Remove case from all samples by making two circumferential cuts just inside each header plus a longitudinal cut to permit removal. After internal visual has been completed (5.7.4), section each header through the eyelet, pinhole, or other longitudinal center line to verify tubulet integrity.

5.7.1.4 Internal Visual. Examine the parts at a minimum of 30X magnification for configuration compliance and for external plastic wraps, tubulet solder fill, contamination, solder splatter, insulation spacers and washers, impregnation, element stability, and lead-to-end spray termination (babbitt) integrity. Note that the lead-to-end spray termination is critical and should be pull tested to ensure that it is not a cold solder or "low strength" joint. Unwrap the metallized plastic of all samples and examine them for workmanship defects such as wrinkled film, evidence of charring, nonuniformity of film conductor end margin, pinholes, or other defects.



ITEM	ITEM NAME	MATERIALS OF CONSTRUCTION
1	Filler *	Polymeric Compound
2	Conductor/Dielectric	Metallized Polycarbonate
3	End Spray	Proprietary
4	Dielectric Interleaf	Polycarbonate
5	Leads	Copper Clad Steel, Tin Coated
6,7,8,9	End Seal Assembly	Glass-To-Metal Seal
10	Case	Tin Coated Brass
11	End Cap	Polymeric Material

Figure 5-8. Typical Metallized Film Capacitor

5.7.2 Data Records DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

5.7.3 Evaluation Criteria This inspection should be adjusted as necessary to accommodate variations in design. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples exhibit any of the following defects:

a. Cracked or broken glass end seal

b. Solder rundown or splatter inside case in area of rolled film.

c. Loose (or moveable) element due to insufficient potting or inadequate restraint when potting is not used, (other physical restraints may be provided to restrict element movement). The DPA shall be conducted so that the existence and suitability of these restraints are verified. When potting is used to stabilize the element it must be free of voids that would permit the element to move during shock and vibration.

d. Absence of insulator caps over ends of element

e. Loose wire or broken solder joint where lead attaches to element end spray (babbitt).

f. Broken or damaged lead wire (internal or external).

g. Contamination or foreign material embedded between windings.

h. Less than 25-percent eyelet solder fill (from outer end of eyelet).

i. Eyelet solder separation from lead or from inside diameter of eyelet

j. Voids or holes through the outer end seal

k. Scratches in the metallization which penetrate the dielectric. Note that it is characteristic of these parts to have burned-out areas in the metallization caused by the high voltage "clearing" process. These spots should not be classified as defects unless there is obvious damage to the dielectric.

l. Folds, blisters, or wrinkles in the dielectric winding.

m. End spray coverage of less than 100 percent. Poor adhesion between end spray and element, or between end spray and external lead connection.

n. Seal leakage in excess of specification requirements.

o. Any other defect that may reduce part reliability.

5.8 CAPACITORS, FIXED, TANTALUM SLUG WET ELECTROLYTE (MIL-C-39006/22 & MIL-C-83500/01).

Three typical capacitor designs are shown in Figures 5-9 through 5-11.

5.8.1 Method.

5.8.1.1 External Visual. Perform external visual inspection at a minimum of 20X magnification. Check condition of glass seal and the nickel-to-tantalum lead weld. Check for physical damage to weld area that could be evidence of bending leads too sharply in the critical weld zone. Check for any bulges or dents in the case.

5.8.1.2 Hermeticity Conduct seal tests on each sample in accordance with the requirements of the procurement specification. Remove sleeving before conducting the tests.

5.8.1.3 Decapulation. CAUTION: Capacitor electrolyte is an acid solution and must be handled with extreme care. cut case around anode end to a depth equivalent to the case thickness being careful not to cut into the anode. Some capacitors have a groove in the case on the anode end. The cut must be between the groove and the cathode end, and as near to the groove as possible. Separate the two sections and remove the spacer by cutting with an Exacto blade (or equivalent) longitudinally along the lead.

5.8.2 Data Records DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

5.8.3 Visual Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA sample parts exhibit any of the following defects.

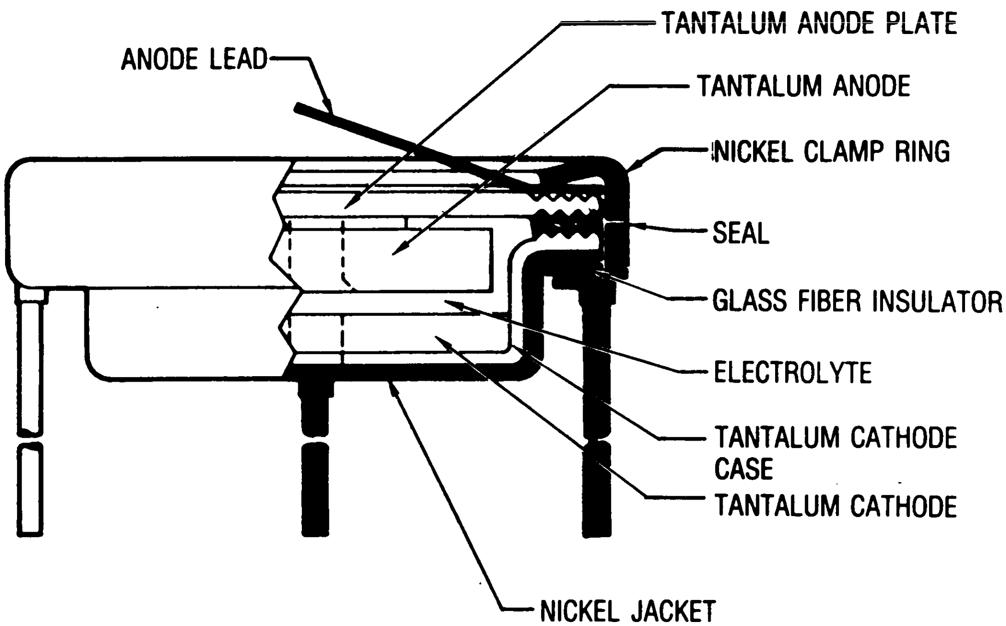


Figure 5-9. Capacitor, fixed, tantalum, wet slug.

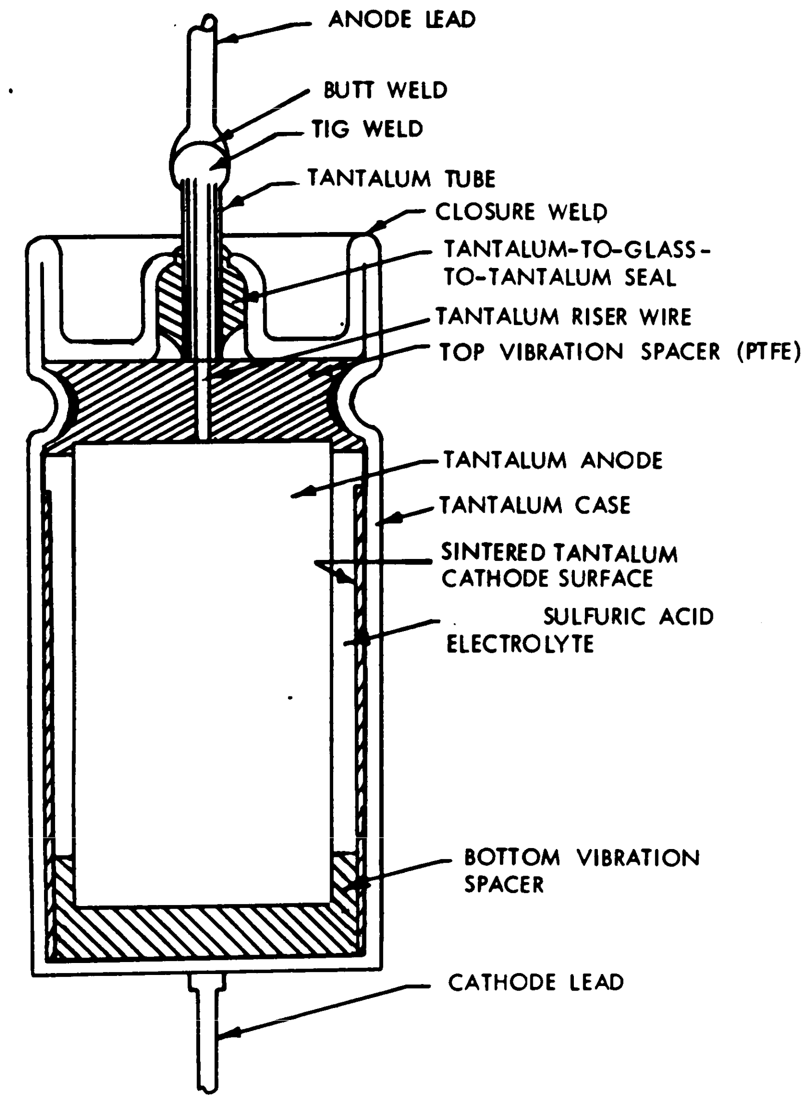
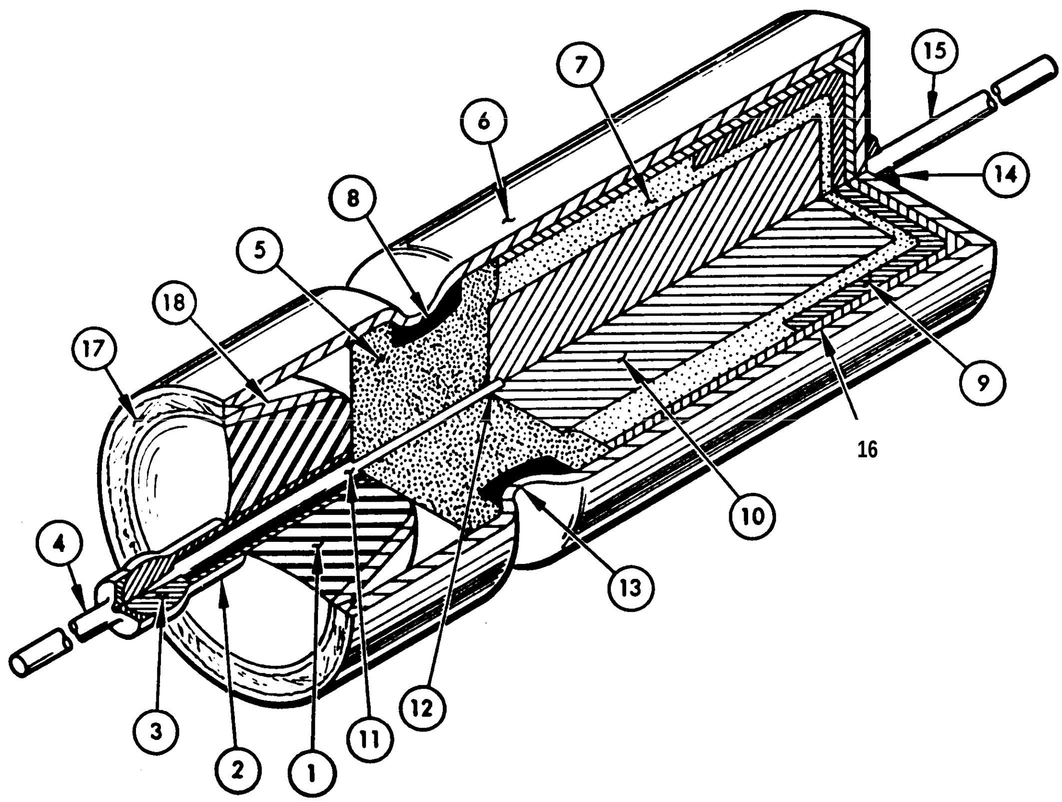


Figure 5-10. Capacitor, fixed, tantalum, wet slug.



ITEM	ITEM NAME	ITEM	ITEM NAME
1	Glass Insulator	10	Tantalum Anode
2	Eyelet Tubulet	11	Anode Riser (Ta)
3	External Lead Weld	12	10-to-11 Interface
4	Anode Lead	13	Case Crimp
5	Teflon Bushing	14	Cathode Lead-to-case Weld
6	Tantalum Case	15	Cathode Lead
7	Gelled Acid Electrolyte	16	Ta Cathode Sleeve
8	Silicon Rubber Bushing	17	Header Weld
9	Teflon Cup	18	Header

Figure 5-11. Capacitor, fixed, tantalum, wet slug.

5.8.3.1 Visual Examination. All exposed inner surfaces of each capacitor shall be examined for the following characteristics at 30X minimum magnification:

a. Space between the anode bushing and the anode.

b. Broken lead or defective lead welds.

c. Complete absence or insufficient level of liquid or gel.

d. Improper seating (fit) of the Teflon, rubber, or equivalent-type boot between the outside diameter of anode and inside diameter of case, and between anode and bottom of case.

e. Scratches or cracks that are not oxidized, or broken or distorted anode.

f. Color of anode and riser indicative of incorrect formation voltage for the dc voltage rating of the capacitor. Any secondary color or spot graying suggests abusive conditions and may be cause for lot rejection. The color shade of the oxide may differ slightly for different lots of capacitors or may even vary slightly for units within the same lot. This is normal and is not cause for rejection.

g. The external portions of glass seal and around cathode weld area shall be free of acid. A useful test technique is to apply a 0.01 percent thymol blue, which turns red in the presence of acid.

h. Cracked or broken glass in seal assembly.

i. Seal leakage in excess of specification requirements

j. Any other defect that may reduce part reliability.

5.9 CAPACITOR, FIXED, GLASS (MIL-C-23269).

A typical glass capacitor construction is shown in Figure 5-12.

5.9.1 Method.

5.9.1.1 External Visual. Record all markings and identification on each part and package, and check for configuration compliance. Inspect each sample, at 20X minimum

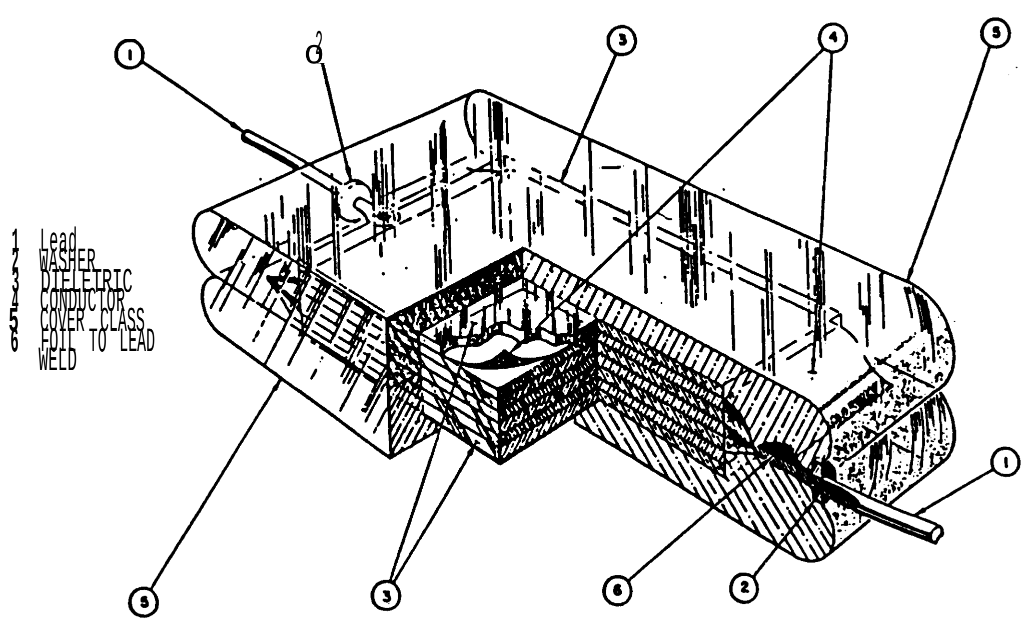


Figure 5-12. Typical Glass Capacitor

magnification, for surface cracks, voids, chip-outs, and defects on the seal and leads.

5.9.1.2 Hermeticity Conduct seal test on each sample in accordance with the applicable procurement specification.

5.9.1.3 Sample Preparation. Parts shall be cleaned, oriented, mounted, and polished in accordance with EIA-469. Polish each sample so that edges of the capacitor plates are clearly visible.

5.9.2 Data Records DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

5.9.3 Evaluation Criteria. When the DPA is conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples exhibit any of the following defects. All exposed inner surfaces of each capacitor shall be examined for the following characteristics at minimum magnification of 30X:

a. Cracked, chipped, or discolored glass

b. Holes in glass extending into the conductor area

c. Air bubble bridging plates

d. Any contamination or foreign material trapped in the glass

e. Nonuniformity of dielectric thickness

f. Any defect, like cracks, on plate-to-lead weld, lead-to-glass seal, and ceramic disc fused into glass at lead egress point.

g. Any condition that is an obvious manufacturing defect.

5.10 CAPACITOR, VARIABLE. PISTON TYPE, SEALED AND UNSEALED (MIL-C-14409).

A typical rotating piston, nonrotating piston, and a vertically mounted, sealed, variable capacitor design are illustrated in Figure 5-13 through 5-15.

5.10.1 Method.

5.10.1.1 External Visual Record all markings and identification on each part, and inspect for configuration

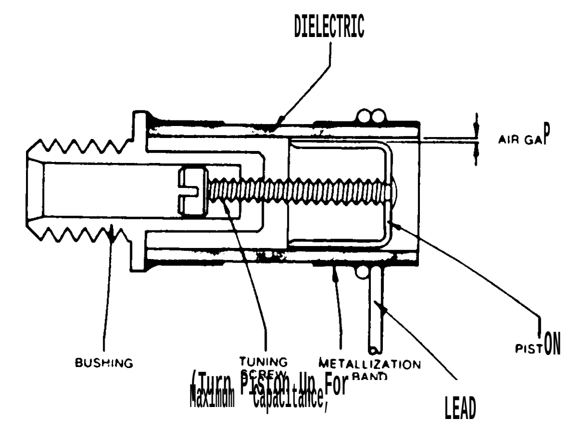


Figure 5-13. Typical Rotating Piston Style

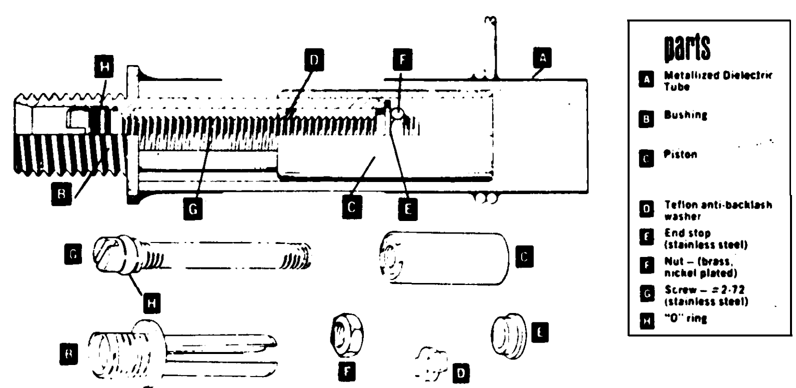


Figure 5–14. Nonrotating Piston Design

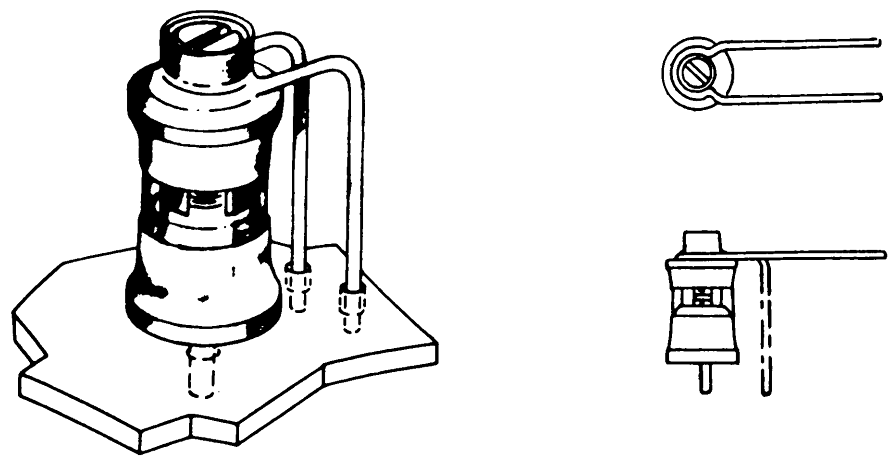


Figure 5-15. Vertically Mounted Printed Circuit Board Sealed Style (sealed)

compliance. Perform external visual inspection at 20X minimum magnification. Check condition of seal. Inspect for physical damage to body and leads. The piston shall be checked for ease of rotation (completely in and out) ten times.

5.10.1.2 Hermeticitv Conduct seal tests, if applicable, on each sample in accordance with the requirements of the procurement specification.

5.10.1.3 Examination. Examination and disassembly should be done under a microscope with 30X magnification and on a Class 1000 clean bench per FED-STD-209.

5.10.1.4 Disassembly.

a. The air dielectric units are opened by rotating their rotor screw counter-clockwise until the rotor assembly is completely disengaged.

NOTE 1: Two types of friction locks are commonly used, and the presence of the type used must be assessed. One type is a gland of plastic that binds the threads, and the alternate is a screw thread of different pitch from the main body. The "two-pitched" style probably introduces galling of the threads and may result in some minor particle generation which is normal: however, excessive particles are not allowed. No particles are permitted within the inner threads under any circumstances.

NOTE 2: In some devices it may be necessary to unsolder the end cap containing the adjustment screw to permit removal of internal parts.

b. Nonremovable rotor capacitors shall be opened by lathe-cutting of the rolled end of the bushing and by unsoldering the ceramic insulator from the bushing and stator,

c. Glass dielectric variable capacitors require unsoldering of the "rotor" plate. Internal inspection of this device is similar to the others.

5.10.1.5 Sample Sectioning. One sample shall be encapsulated and sectioned axially through the center of the device. A photograph shall be taken of a typical sample and attached to the DPA data sheets. The magnification of the photograph shall be such that the sectioned device fills the entire photograph. Any anomalies noted shall also be photographed.

a. Prior to encapsulation, the protective seal cap, if any, shall be removed and the lead screw rotated clockwise until the piston is fully engaged.

b. The device shall be vacuum-impregnated with encapsulating media such that the entire internal cavity is filled.

5.10.2 Data Records DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

5.10.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA sample parts exhibit any of the following defects.

5.10.3.1 Visual Examination All exposed inner surfaces of each capacitor shall be examined for the following characteristics at a minimum magnification of 30X.

a. Scratches or abrasions on any parts or surfaces where movement occurs with respect to other parts or surfaces within the assembly.

b. Loose metallic particles (or any other particles) or other types of contamination, such as flux residue.

co Corrosion on piston surface, screw, or cylinder walls.

d. Cracked or warped parts.

e. Burrs, gouges, or particles in the threaded areas.

f. Blistering, flaking, bubbles, pits, cracks, foreign material, or peeling of plated surfaces.

g. Nonconcentric, bent, distorted, or misaligned rotors and stators (or piston and bore); or irregularities, such as bumps and nicks on surfaces.

h. Improper seating and solder joints of the tubes.

i. Lack of Apiezon H (where applicable) from threads.

j. Cracks in glass dielectric (where applicable).

k. Insulator (where applicable) damaged or missing from stator.

1. Solder joints (as applicable) that show voids, insufficient filleting, or signs of a cold joint.

m. Noticeable amounts of lubricant.

SECTION 6

DETAILED REQUIREMENTS FOR CONNECTORS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used connectors. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests such as functional tests, mating, and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

6.1 CONNECTORS. MULTIPIN, EXCLUDING CONTACT

Typical multipin connectors are shown in Figure 6-1 and Figure 6-2. Connectors are illustrated with contacts.

6.1.1 Methods.

6.1.1.1 External Visual. Inspect each sample at 7X to 10X magnification for the following defects which may be considered risks:

a. Item marking and identification compliance to applicable specification.

b. Dimensional check against applicable specification.

c. Foreign material contamination.

d. Chips, cracks, or other defects in the inserts.

e. Check hermetic connectors for inadequate glass wetting.

f. Plating defects such as porosity, burrs, blow holes, cracks, peeling, and flaking.

h. Clocking.

i. Keys and keyways.

j. Retainers (an otoscope or similar device may be used).

k. Free running threads.

l. Lubricants.

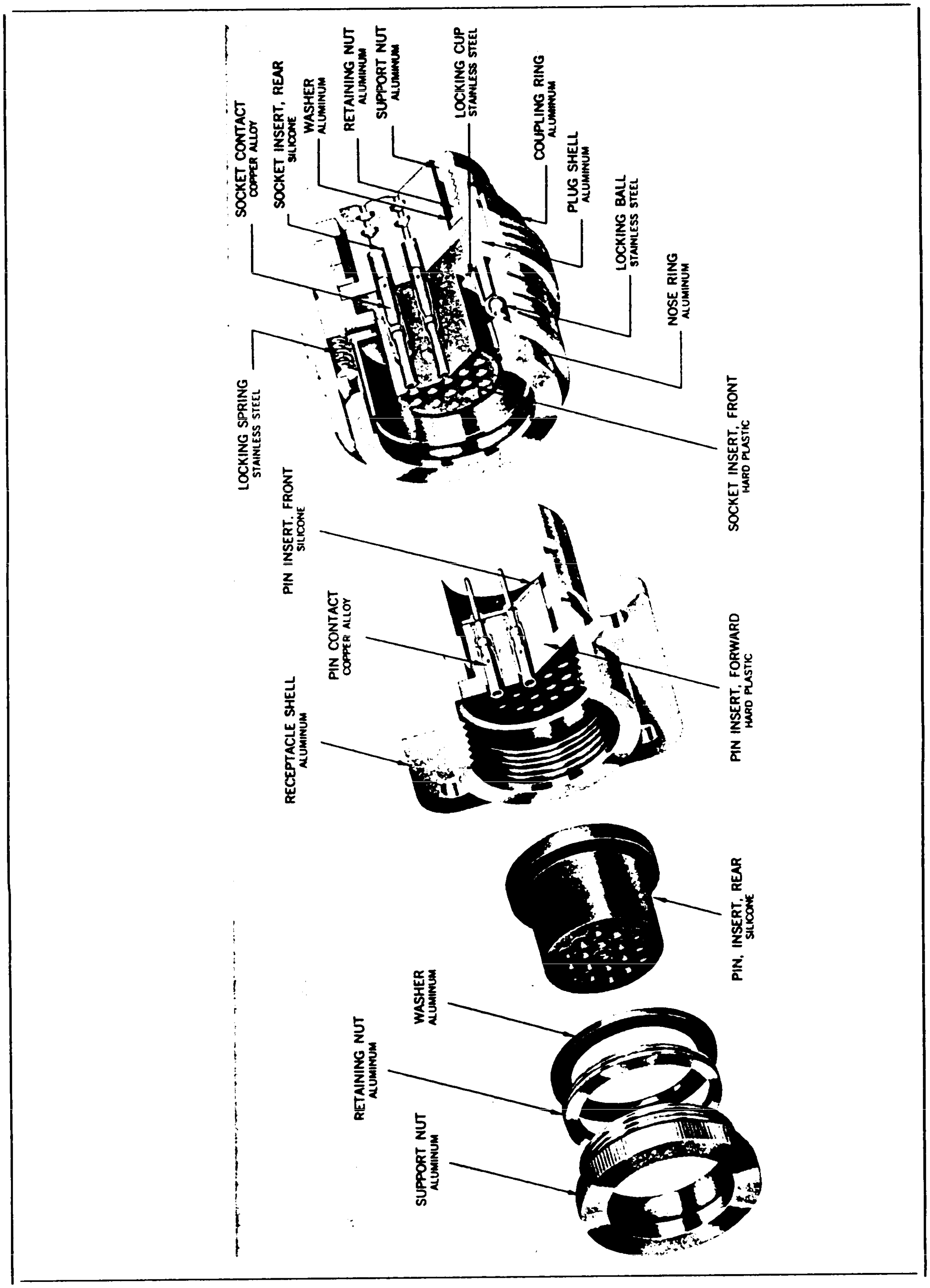


Figure 6-1. Typical Multipin Connector

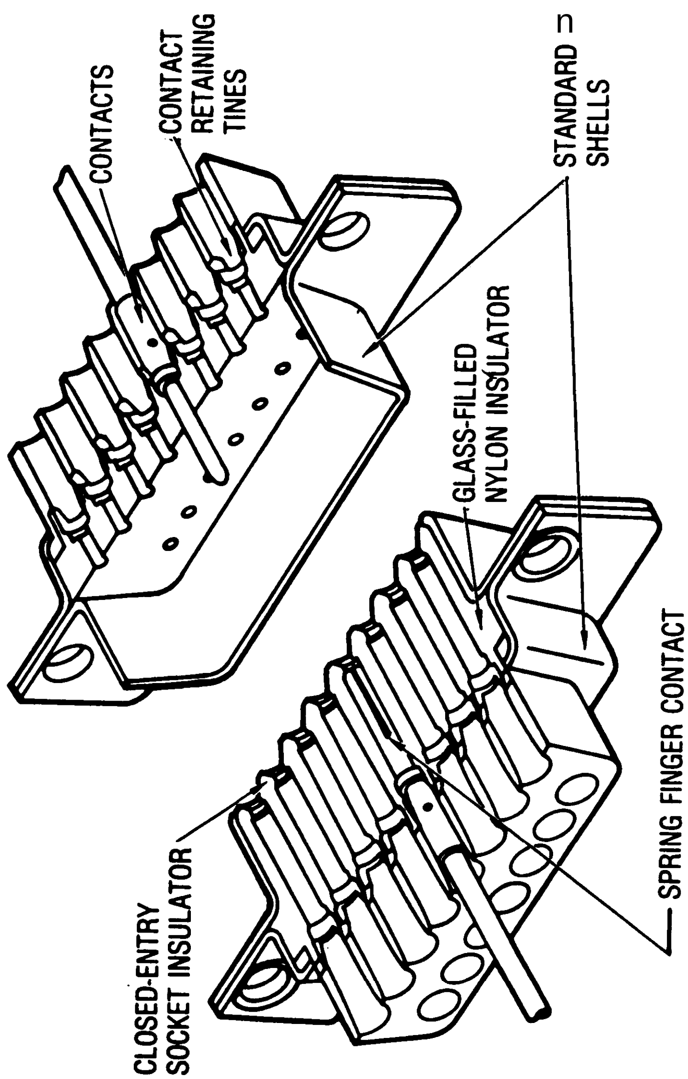


Figure 6-2. Typical Rectangular Multipin Connectors

6.1.1.2 Photographs. When required by the contract or the contractor's documentation, black and white photographs of the sample connector style or type shall be a part of the DPA package. They shall be of sufficient size, sharpness, and clarity to meet all identification requirements imposed by the controlling document. As a minimum, these should show:

a. Part number

b. Lot date code

c. Manufacturer

d. Part type

6.1.1.3 X-ray Examination. Nondestructive internal examination is accomplished by X-ray to check for misaligned or missing parts, cracks, breaks, and other defects which are considered failure mechanisms.

6.1.1.4 Physical Tests The requirements of the controlling document and the following test shall apply.

a. Each cavity shall be checked for insertion force.

b. Each cavity shall be checked for contact retention.

c. Plating thickness of the shell and other plated parts may be checked with a beta back-scatter instrument or sectioned and examined under 500X magnification.

d. Plating adhesion test shall be performed on all samples. This test may induce minor cracks in the plating or base metal and shall not be considered defects, unless accompanied by flaking, blistering, or peeling.

e. Test for insulator retention by applying a 30 Newton (7-pound) force perpendicular to the insulator face. Any displacement visible to the eye is considered a failure.

6.2 CONNECTORS, MULTIPIN, WITH CONTACTS.

All connector samples shall be subjected to the inspections and tests detailed in 6.1. In addition, they shall be tested per 6.2.1 and sectioned and inspected per 6.2.1.2. Figures 6-1 and 6-2 illustrate typical multipin connectors.

6.2.1 Methods.

6.2.1.1 Electrical Test Each connector sample shall meet the insulation resistance (IR) and Hi Pot requirements of the applicable specification.

6.2.1.2 Sectioning. Pot each connector sample in clear epoxy. Pull a vacuum on each sample during the potting procedure.

6.2.1.2.1 Fixed contact connectors. Cut each sample along the longitudinal axis on the center of the connector and one contact. Polish and examine both halves under 10X magnification to verify that:

a. The insulator is formed and installed per the applicable specification.

b. The elastomer and plastic members are not molded or conforming to each other.

c. There is proper bonding between the shell and insert.

In addition, section and inspect at least one contact for required plating thickness at a suitable magnification.

6.2-1.2.2 Contact Connecters. Samples maybe examined by one of two methods.

a. Cut the shell in half along the longitudinal axis. Do not cut the insulator. Remove shell halves, polish and check geometry for dimensional accuracy and for any defects or damage to the grommets and seals. Remove the rear grommet seal and check for possible bonding defects. Make a cut through a grommet cavity in the insert. Check the cross-section for correct number of seals and proper seat geometry. Inspect each insert cavity with an otoscope or similar device for presence and orientation of locking devices, and for missing tangs. Gang type devices may be removed for visual inspection.

b. Cut the connector through along the longitudinal axis on the center of the connector and a contact. Polish each half and perform the visual examination and contact plating inspection identified in 6.2.1.2.1. Then inspect the contact retention for proper installation and for possible broken or missing tangs.

c. Next, cut each half perpendicular to the longitudinal axis at a point where the rear insert grommet and the contact retaining insert meet. Repeat the inspection required for the first cut noted above.

6.2.1.3 Scanning Electron Microscope (SEM). Connector samples with known defects or suspected of containing defects shall be examined further with a SEM. The samples shall be scanned and photographed at sufficient magnification to obtain clear, sharp images of the suspect area. All SEM results are to be a permanent part of the DPA records.

6.3 RF CONNECTORS.

Typical RF connector shown in Figure 6–3.

6.3.1 Methods.

6.3.1.1 External Examination. Examine each sample for the possible defects identified in 6.1.1.1 a, b, c, i, j, k, and 1. In addition, conduct the following tests:

a. Contact stress test. A maximum diameter test pin shall be inserted 100 times. The socket shall not show evidence of cracks at the bottom of the slots.

b. Separating force test. Use a minimum diameter test pin.

c. Axial contact retention.

d. Rotational contact retention.

e. Plating thickness of shell coupling shall comply to the applicable specification.

f. Plating adhesion. See 6.1.l.4d.

6.3.1.2 Internal Examination. Pot the connector sample in clear epoxy. Pull a vacuum during the potting process. Whenever possible, connector pairs should be sectioned together. Cut along the longitudinal axis through the center of the connector(s) and the center pin. Inspect for:

a. Integrity of the epoxy staking.

b. Workmanship in areas such as brazed, soldered, and conductive epoxy joints, and the lock ring area.

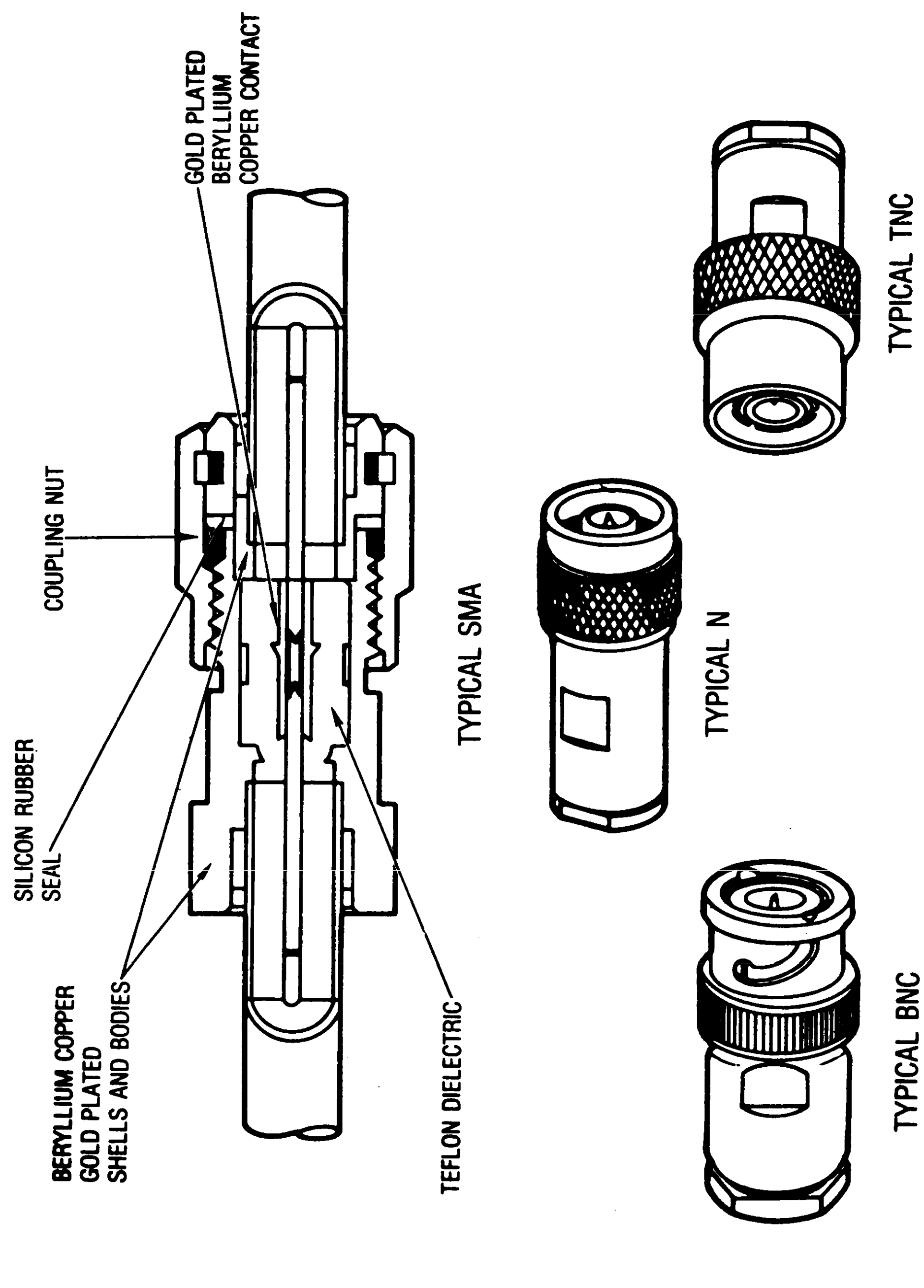


Figure 6-3. Typical RF Connector

c. The mating surfaces of the ring, body, and coupling nut cannot be rounded, chamfered, or sloped.

6.4 CONTACTS.

Test contact samples to the applicable specification requirements and the following.

6.4.1 Methods.

6.4.1.1 Visual Examination. Test a random selection of one-half the contact sample for:

a. Dimensional accuracy and marking.

b. Plating adhesion. See 6.1.l.4d.

c. Plating thickness. A beta back-scatter may be used, or pot the samples with a clear epoxy, section in half longitudinally, and measure under 500X magnification.

6.4.1.2 solder contacts. A minimum of 4 contacts shall be soldered with a length of wire 0.15 meters to 0.30 meters (6 to 12 inches) long, complying to MIL-W-81044 or MIL-W-81381. Inspect for proper wetting, solder flow, and general appearance.

6.4.1.3 Crimp Contacts Crimp a minimum of 4 contacts to the minimum allowable wire gauge, and 2 contacts to the maximum allowable wire gauge. Examine all crimps under 20X magnification for cracks or crazing of the plating or base metal. Four samples should then be tested for tensile strength per the applicable contact specification.

SECTION 7

DETAILED REQUIREMENTS FOR QUARTZ CRYSTALS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used quartz crystals. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

7.1 CRYSTAL UNITS. QUARTZ (MIL-C-3098).

A typical crystal is shown in Figure 7-1.

7.1.1 Method.

7.1.1.1 External Visual. Visual inspection at 30X minimum magnification shall be conducted with the crystal being illuminated with a light source of at least 300 foot-candle intensity and a grazing angle of about 20 degrees. Units exhibiting one or more of the following anomalies shall be rejected.

a. Adhering weld splatter exceeding 0.80 millimeters (0.031 inches) dimension in any plane.

b. Crack or holes in any welded joint.

c. Indications of corrosion or discoloration on any metal surface.

d. Any dents or protrusions into the case.

e. Cracks, fractures, misalignments, or bends in case-to-lead or case-to-stud joints.

7.1.1.2 Hermeticity. Verify hermetic seal in accordance with the requirements of part specification.

7.1.1.3 Sample Preparation. During the process of opening the crystal enclosure, care must be exercised to assure that external liquid, gaseous, particulate, or other types of contamination do not enter the interior areas. Enclosures similar to the TO-5 type and other round-type quartz crystal holders such as MIL-H-10056/21, /24, and /29 should be opened by

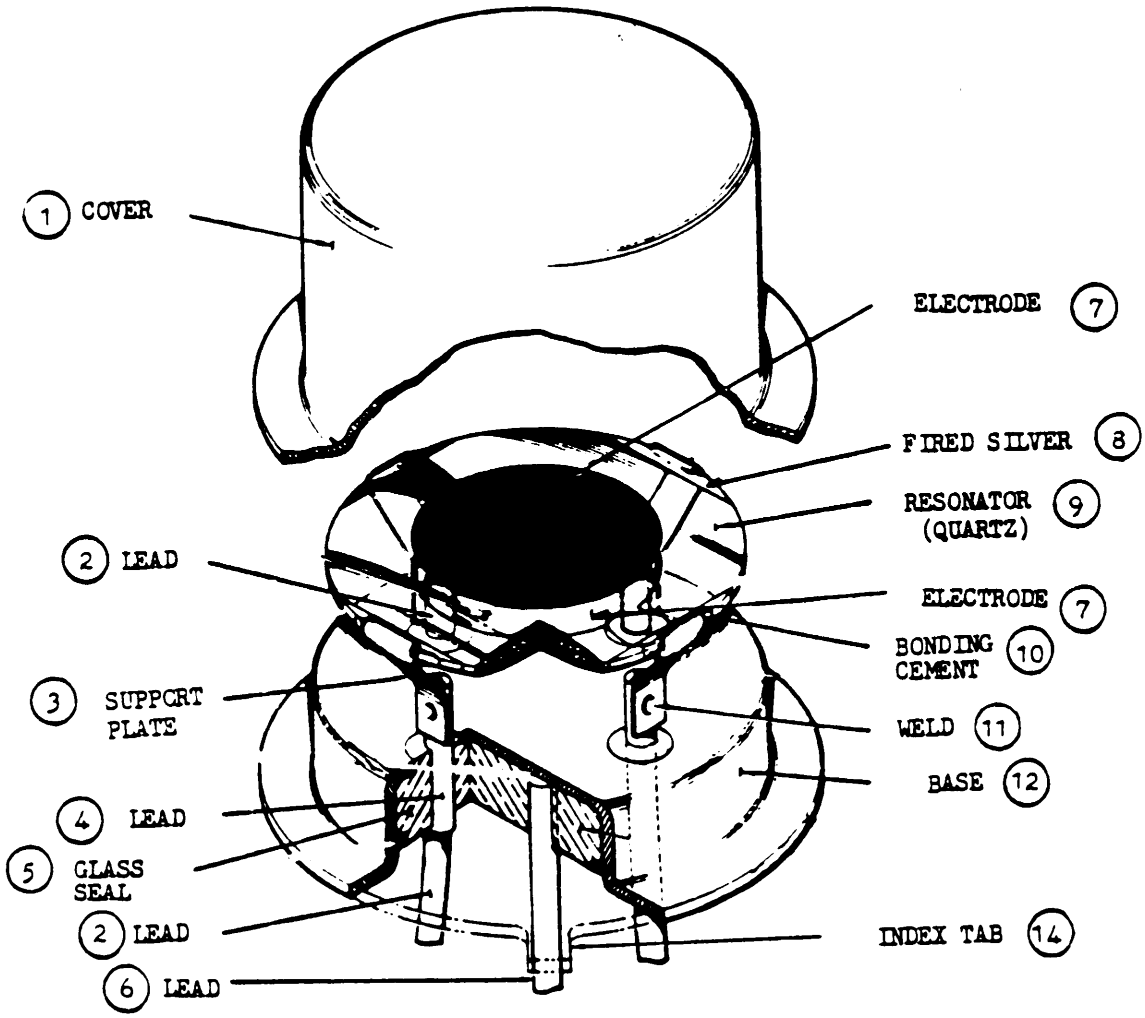


Figure 7-1. Typical Quartz Crystal Unit

using a special can opener device designed specifically for that purpose. The TO-5 can opener device (also called Head Remover, Silicon) is commercially available. For other types of hermetically sealed cold weld holders, a flat grinding wheel may be used to grind off the flange where the cover is joined by cold weld to the base. During each application of grinding the enclosure, precautions shall be taken to prevent penetration of the case. The grinding operation should only remove sufficient material to allow the can to be readily cut through with a sharp cutting instrument such as an Exacto knife blade. To avoid damage, the crystal enclosure and inner assembly should be firmly held by hand during each step of the opening procedure. Devices such as vises, clamps, pliers, or similar instruments should not be used. After completion of the grinding operation, and just prior to penetration or opening of the crystal enclosure, all external surfaces shall be cleaned to remove any particulate or other contaminants from the case. The hands and instruments used in the final opening step should also be thoroughly cleaned and free of any contaminants. The final opening step should be done over a clean white contaminant-free bench or paper surface.

7.1.1.4 Internal Visual. All exposed inner surfaces of the device shall be examined at a minimum magnification of 30X and per the procedure in Paragraph 7.1.1.1 for configuration compliance and existence of anomalies.

7.1.2 Data Records. DPA findings that deviate from the specified configuration or other requirements or exhibit anomalies shall be documented as defects.

7.1.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if the DPA sample parts exhibit any of the following defects:

a. Cracks or holes in the weld contact area where crystal support members are welded to the holder base terminal pins.

b. Loose, distorted, or broken terminal pins or crystal mounting supports.

c. Cracks or separation in silver-epoxy electrically conductive bonding cement between quartz crystal and support member.

d. Fractures of any size in any location in the crystal quartz resonator, cracked or flaked edges, and fractures, cracks, peeling, or voids in electrodes.

e. Loose weld spatter, bonding cement, extraneous epoxy, or other foreign matter found on the header, the crystal and support structure, or inside the cover.

f. Less than 0.125 millimeters (0.005 inches) clearance between the quartz crystal holder cover and the quartz crystal with its mounting support.

g. Cracks or visible bubbles in glass headers.

h. Chemical corrosion of any metallic surfaces in crystal can or associated support structure.

i. Quartz crystal resonator not perpendicular or parallel to the base within the requirements of the procurement specification.

j. Seal leakage in excess of specification requirements.

k. Joining of packages by interface that reduces part reliability.

I. Any surface, including cover, exhibiting contamination (adhering particulate, film, flux residue, or other type).

m. Nonuniform quantities of bonding cement at mounting points or bonding cement in areas other than mounting points.

n. Adhering weld splatter with a dimension exceeding 0.80 millimeters (0.031 inches) through any plane. Weld splatter shall be considered adherent when it cannot be removed with a gas blow of dry oil-free nitrogen from a 150 kilopascal (22 psi) gauge pressure source.

o. Base terminal and crystal mounting support exhibiting nicks, misalignment cuts, cracks, or distortion.

P. Quartz crystal not centered within ± 0.80 millimeters (0.031 inches) in its mounting with respect to the quartz crystal holder base.

q. Any other defect that reduces part reliability, such as evidence of peeling plateback metallization, voids, or missing metallization on either side of the crystal.

SECTION 8

DETAILED REQUIREMENTS FOR DIODES

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used diodes. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

8.1 DIODES (MIL-S-19500).

8.1.1 Method. Typical devices are shown in Figures 8–1 through 8-5.

8.1.1.1 X-ray Examination. X-ray complete sample in two views 90 degrees apart and note any anomalies.

8.1.1.2 External Visual Examination. Perform an external visual examination on all parts with magnification sufficient to adequately resolve the area being examined. Note any change from baseline dimensions. Note any discrepancies. Take one representative and record photomacrograph of the sample prior to sectioning. Look for:

1. Evidence of damage, corrosion, or contamination.
2. Defects in seal, encapsulant, chips, bubbles in the diode body, or dents.
3. Defects in plating such as flaking, peeling, or blistering.

8.1.1.3 Electrical Testing. Perform the appropriate Group A electrical test per the diode slash sheet or source control drawing. As a minimum, the following tests shall be performed.

Signal Rectifying Diodes
I_R (reverse leakage)
VF (forward voltage)

Zener Diodes
Vz (zener voltage)
I_F (forward current)

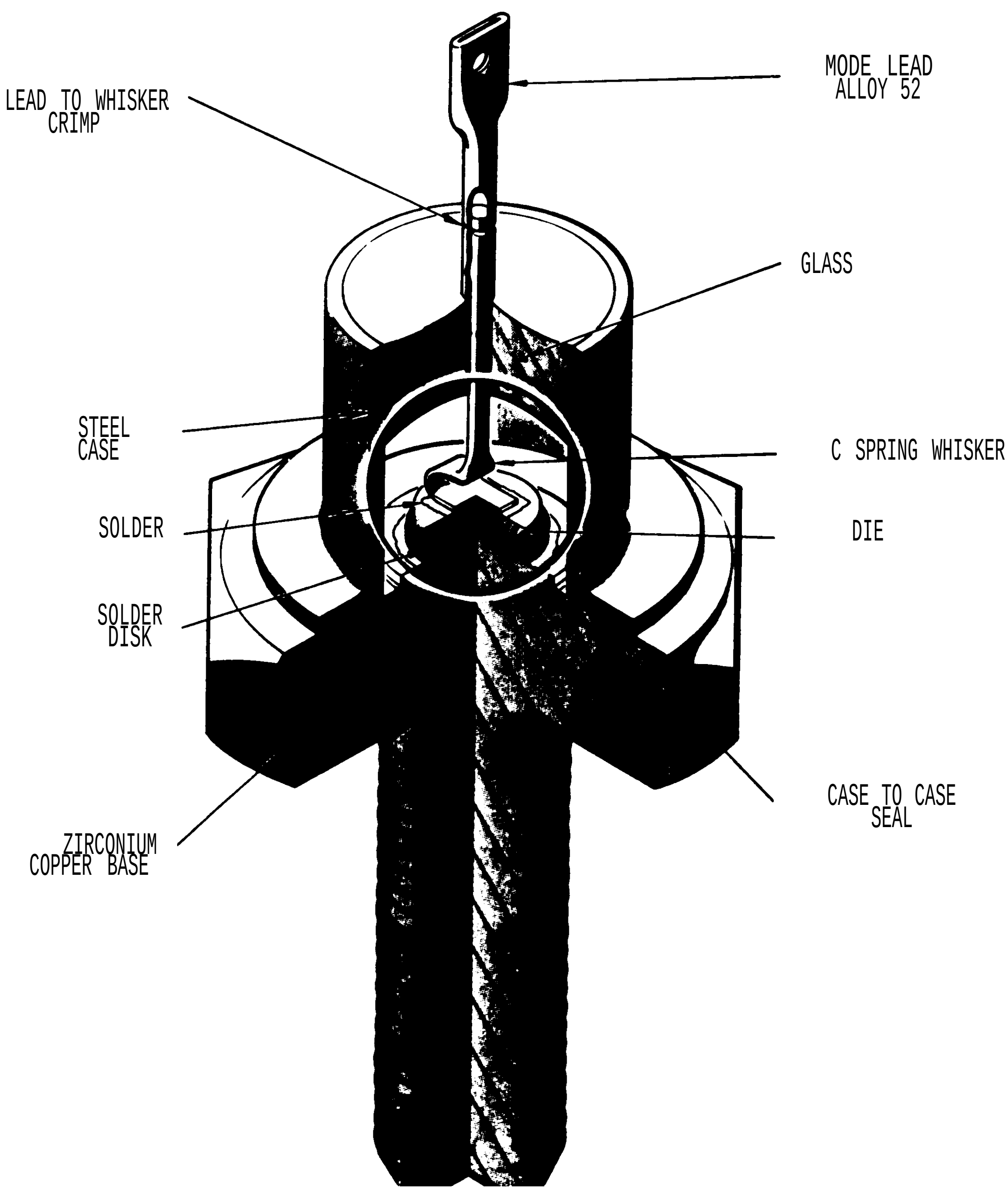


Figure 8-1. Stud Mount Diode (typical)

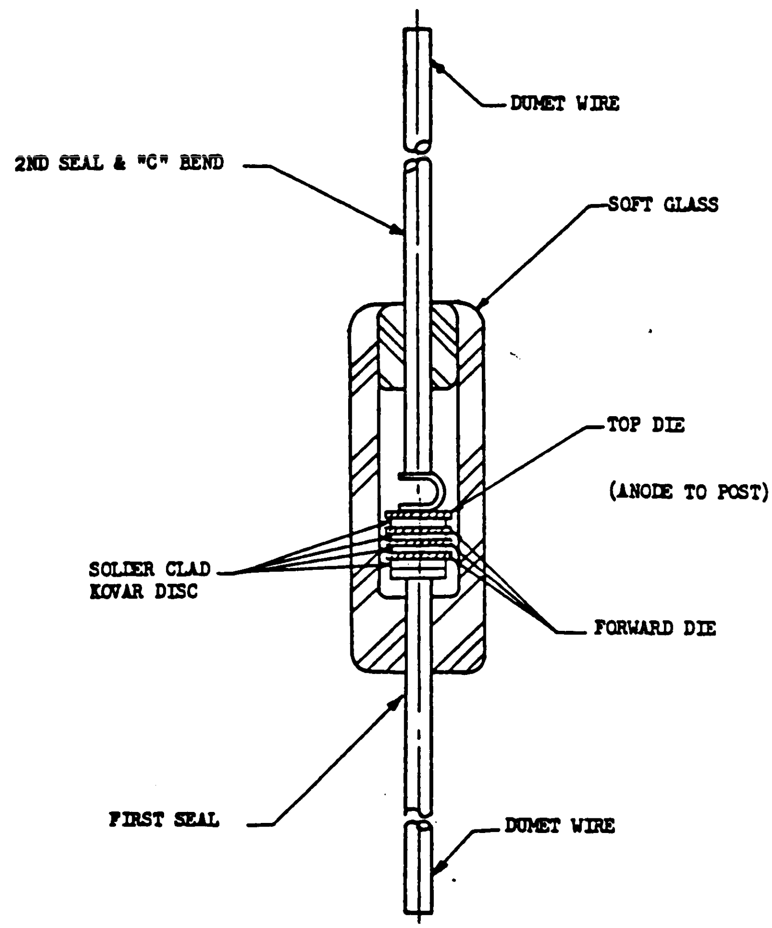


Figure 8-2. "C" Whisker Multiple Chip Diode (typical)

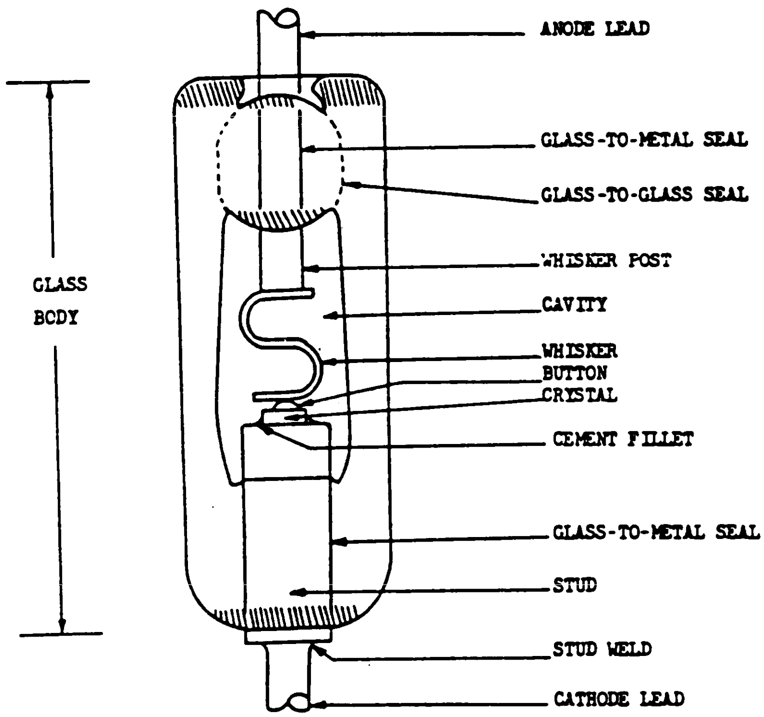


Figure 8-3. Whisker Diode (typical)

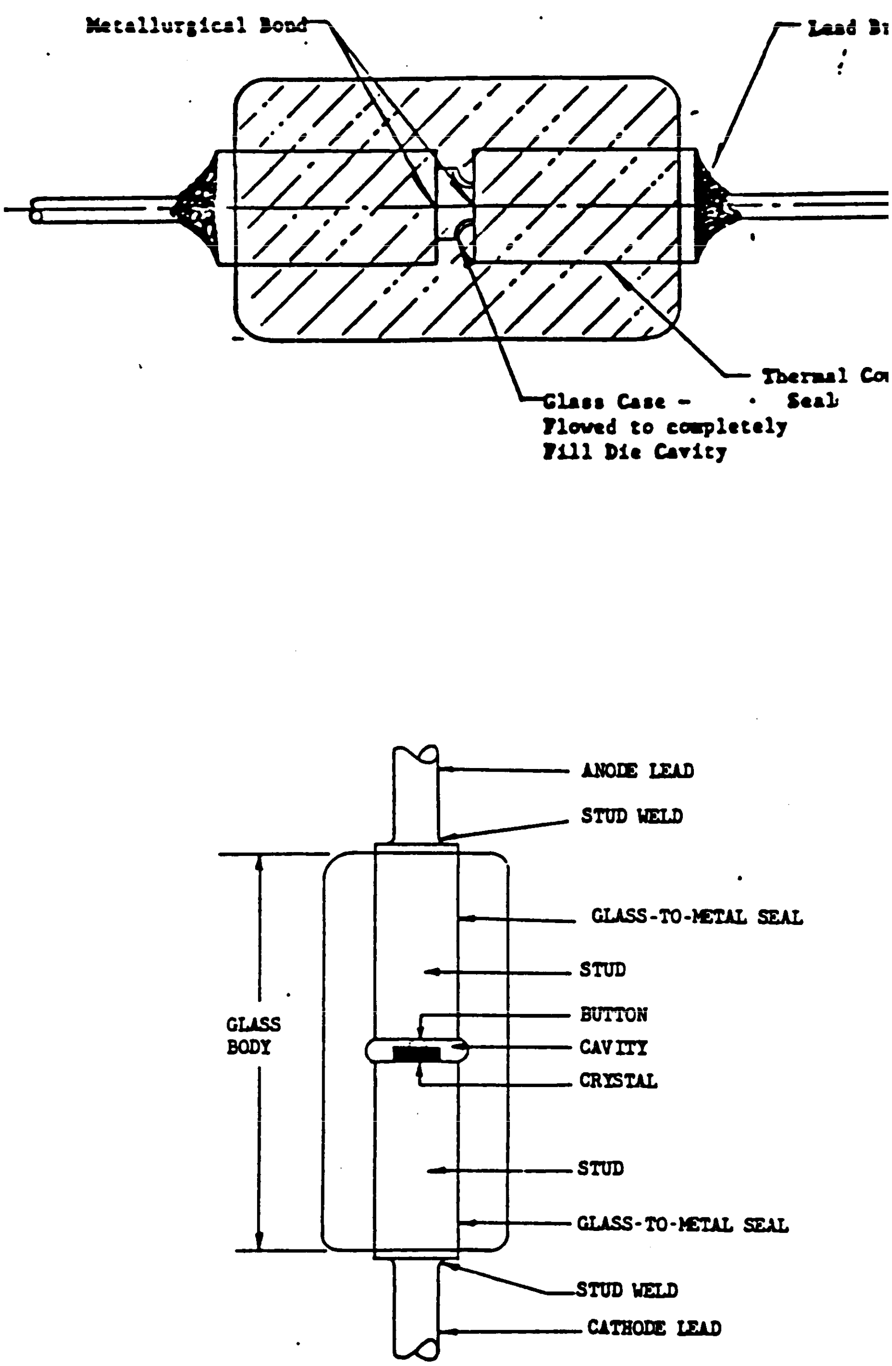


Figure 8-4. Whisker-less Diode.

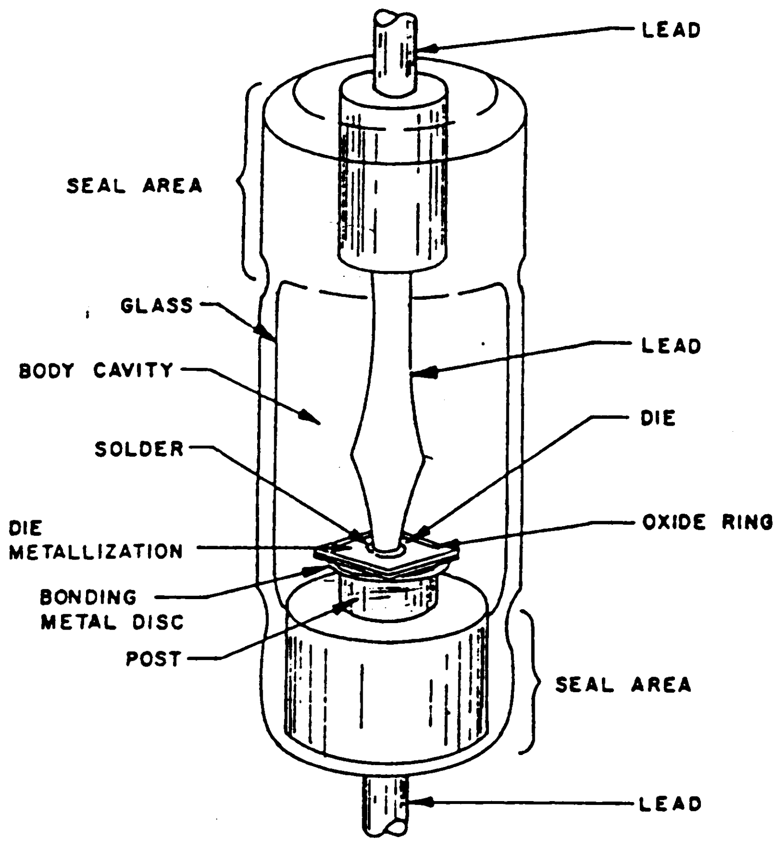


Figure 8-5. Diode Ram-rod Construction (Acceptable)

8.1.1.4 Hermetic Seal. Each part shall be subjected to fine leak testing in accordance with MIL-STD-750, Method 1071, Condition G or H. Following fine leak, each part shall be tested for gross leak according to MIL-STD-750, Method 1071, Condition C, D, or E. No bubbles or fluorescent residue should be present.

8.1.1.5 Sample Preparation.

1. Diodes, Glass Encapsulate diode in clear epoxy and section half the lot (minimum of 2) in an axis which can reveal the characteristics specified below as determined from the manufacturer's photo expositional drawings or from previous radiographic examination. (See Figures 8-1 through 8-5 for typical sectioning along longitudinal axis.) As soon as penetrated, the internal cavity shall be filled with clear epoxy to prevent movement of internal elements during balance of sectioning and subsequent examination. Glass-bodied diodes shall have the paint removed and shall be visually examined prior to sectioning.

2. Diodes, Can Type. Prior to opening, the internal construction should be determined from the manufacturer's photo expositional drawings or from previous radiographic examination. If the diode has crimped leads (see Figure 8-l), the lead(s) shall be sawn with a diamond-bladed jewelers saw, or equivalent, prior to delidding. With the diode lead(s) parallel to the work bench, carefully saw each lead between the cap and the crimp area. Care must be exercised to prevent introduction of external contaminants into the internal enclosure area, and to inhibit induced vibration and shock to the leads. The lid should be carefully cut with a can opener device designed specifically for that purpose (also called Head Remover, Silicon). The cut in the lid should be at a point sufficiently above the header (stud base) so that the cover can be easily removed by hand. During cutting and removal of the lid, care must be exercised to avoid damage to internal elements or introduction of external contaminants into the internal enclosure area.

8.1.1.6 Internal Visual Examination. All exposed inner surfaces of each diode shall be examined for the following characteristics at a 20X minimum magnification. One representative photomacrograph of a sample device shall be taken. The following visual criteria, in addition to the latest supplement to MIL-STD-750, Method 2074, shall constitute criteria for internal visual inspection for diodes. The lot shall be rejected if one or more of the DPA sample contains diodes which exhibit any of the following anomalies:

a. Seals

1. Diode bodies constructed in part or wholly of glass that exhibit cracks, chips, or abrasions with the exception of stress relief cracks which are confined within the outline radius on the shoulder and are less than 0.25 millimeters (0.01 inches) in length or depth.

2. Any body deformation that is 0.25 millimeters (0.01 inches) greater than the normal configuration.

3. Any glass-to-glass or glass-to-metal seal that is less than 0.25 millimeters (0.01 inches) in its smallest dimension.

b. Die

1. Surface cracks greater than 0.05 millimeters (0.002 inches) in length that extend into or toward the junction area.

2. Any lifting, cracking, or peeling of the metallized area or any die whose metallization is reduced by 25 percent or more of the designed surface.

c. Contamination

1. Any discernible conductive unattached particles greater than 0.025 millimeters (0.001 inches) in any dimension.

2. Any attached material larger than 0.025 millimeters (0.001 inches) in any dimension, of such configuration that it could break away.

d. Die Mounting

1. Solder bridges that go from the connection below the die to the top of the die or that overflow to the side of the die.

2. Lead-to-die solder connections which cover less than 50 percent of the die periphery.

3. Die tilted more than 15 degrees from the mounting plane.

4. Voids that reduce the die attach area under the active area by more than 50 percent.

e. Connection. Welded, cemented, crimped, and soldered interfaces shall be clean and firm, and indicate fusion on a minimum of 50 percent of the available area including the following:

1. Die to stud post.

2. Stud to lead.

3. Die to die.

4. Whisker to post or stud.

5. Case to base (100-percent fusion on can-type devices).

6. Die to solder disc.

7. Ram-rod to die.

8. Solder disc to post or stud.

f. Whiskers

1. Whisker which does not completely cover the contact ball (ball-ribbon construction).

2. Distance from the whisker to the die which is less than 50 percent of the ball height (ball-ribbon construction).

3. Whisker foot which is not flush with the top disc for its entire width and at least 30 percent of its length (whisker-disc construction).

4. Any die contact misaligned such that it extends over the outside edge of the oxide ring and makes contact with the scribe moat.

5. Bend opening which is less than 30 percent of the whisker height.

6. Either S bend opening that is less than 30 percent of half the whisker height.

8.1.1.7 Scannina Electron Microscope (SEM) Examination. When visual inspection in Paragraph 8.1.1.6 discloses metallization defects, voids, contamination, or particle contamination, a scanning electron microscope examination shall be performed. A quantity of devices, either one device or 20 percent of the DPA samples, whichever is larger, from each DPA sample shall be inspected on a scanning electron microscope (SEM) equipped with X-ray analysis instrumentation. If a fraction of devices is obtained when calculating the percentage, then the sample size shall be equal to the next higher integer. Particular attention shall be directed to the items mentioned or referenced in the above paragraphs. The SEM examination shall be in accordance with MIL-STD-750, Method 2077. In addition, the following items shall be inspected before bond pull:

a. Attached foreign material shall be X-ray analyzed for elemental content. Material suspected of being chemically reactive within the expected life of the component, and hence a latent defect, shall be cause for rejection of the lot.

b. Metallization corrosion which is defined as chemical or contaminant interaction with the metal shall be inspected at 500X minimum magnification. Particular attention should be made around wire bonds where contamination may be drawn by surface tension during precap cleaning or by intrusion through a leak on the hermetic seal. The corrosion shall be X-ray analyzed for elemental content. Metallization corrosion is cause for rejection of the lot.

co Wire bonds, both on the chip and package posts, should be inspected at a minimum of 1000X magnification 0.0125 millimeters (0.0005 inches) from bond, when applicable, for the presence of microcracks or intermetallic compounds. The condition of the bonds should be noted and recorded by photographs if a defect exists, and compared to subsequent bond pull information.

do The chip die attach area shall be inspected at a minimum magnification of 400X for the presence of microcracks. The presence of a perimeter microcrack, which is a fracture separation in the bonding material along the attachment interface, is not acceptable, and shall be a cause for rejection of the lot.

e. If the die is not glassivated, then the contact cuts and oxide steps shall be inspected according to the wafer SEM inspection criteria referenced in the applicable screening specification.

In addition, if any bonds pull at less than their specified pull strength, then the pads, posts, and bonds shall be examined on a SEM to determine the causes of their weaknesses. If defects are observed, SEM photographs shall be supplied with an explanation in the DPA.

8.1.1.8 Bond Pull. Each device in the DPA sample shall undergo a destructive bond pull. All internal wire bonds or clip fasteners for each device shall be pulled to destruction according to MIL-STD-750, Method 2037, Condition D. The maximum allowable pull rate shall be 0.05 Newtons (5 grams) per second. The minimum bond pull strength criteria shall be as specified in MIL-STD-750, Method 2037, Table I; results of the bond pull tests shall be recorded in the lot history records.

8.1.1.9 Die Bond Shear Test A die shear test is the final DPA stepland shall be conducted on twenty percent of the devices in each DPA sample, rounded to the next highest integer. Die shear testing shall be conducted as specified in MIL-STD-750, Method 2017. The maximum force applied, the location of the shear, and the percentage of the die still attached shall be recorded and entered in the DPA report. In addition, the results of the die bond shear test performed in screening and a comparison, made between the shears recorded in screening and DPA, shall be presented in the DPA report. The inspection lot shall be rejected if any die shears at a force less than specified in (acceptance criteria) MIL-STD-750, Method 2017. A photograph of each device tested by this method shall be included in the DPA report. The photo shall be taken of the header in such a manner as to evidence the amount of die still attached.

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SECTION 9

DETAILED REQUIREMENTS FOR FEED-THROUGH FILTERS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used filters. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests such as functional tests and solderability tests are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

9.1 FILTERS, EMI. LOW PASS. FEED-THROUGH (MIL-F-28861 AND MIL-F-15733).

Typical configurations are illustrated in Figures 9–1, 9–2, and 9-3. These devices are typically installed in a metal can with a glass-to-metal (hermetic) seal either with or without internal potting resin.

9.1.1 Method.

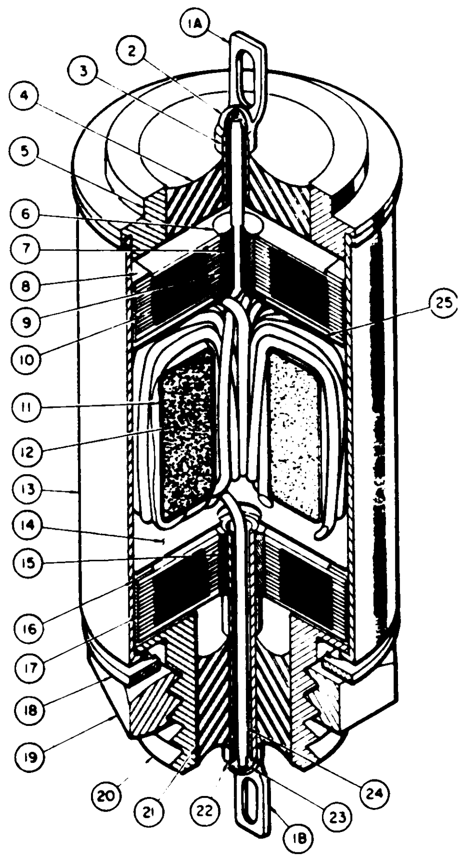
9.1.1.1 External Visual. Conduct visual examination at 20X minimum magnification. Record variances in configuration, and defects in end seals, terminals, and leads.

9.1.1.2 Hermeticity If not accomplished during receiving inspection, verify seal integrity in accordance with the requirements of the procurement specification.

9.1.1.3 Sample Preparation. Sample preparation shall be in accordance with Paragraph 30.3 of Appendix D in MIL–F-28861. Review X-ray negatives prior to sample preparation, for internal component location and/or anomalies that can be highlighted during cross-sectioning.

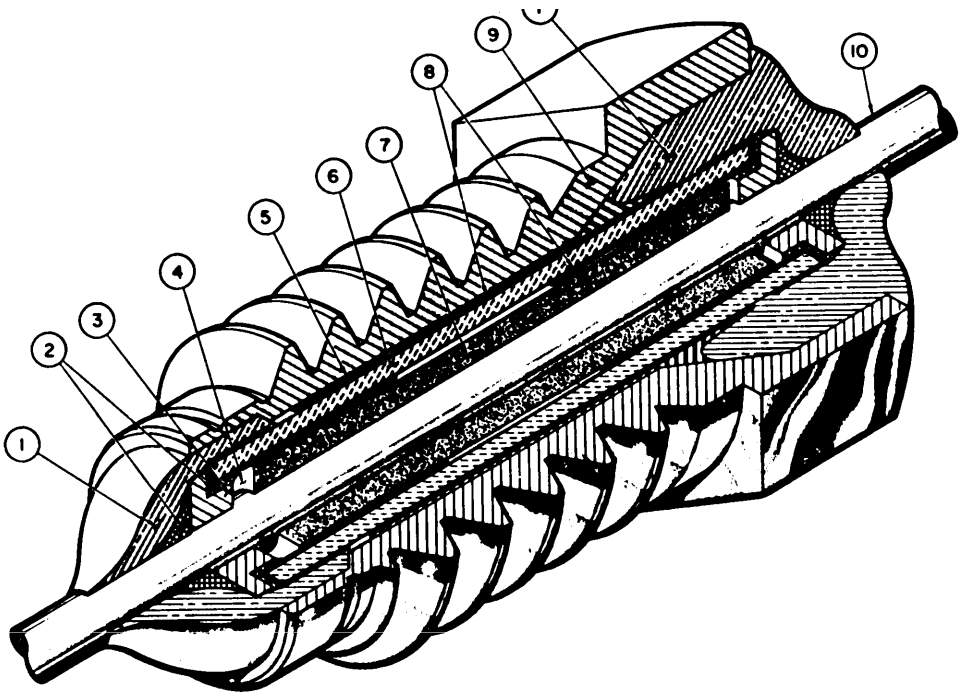
9.1.1.4 Internal Visual. Examine sectioned parts under 30X minimum magnification for configuration compliance and compliance with specification requirements and good workmanship. Examine ceramic capacitors for compliance with paragraph 5.1 herein. Take special care with insulation thickness and placement, and wire crossovers to guard against internal short circuits.

9.1.2 Data Records DPA findings that deviate from the specified configuration; or other requirements shall be documented as defects.



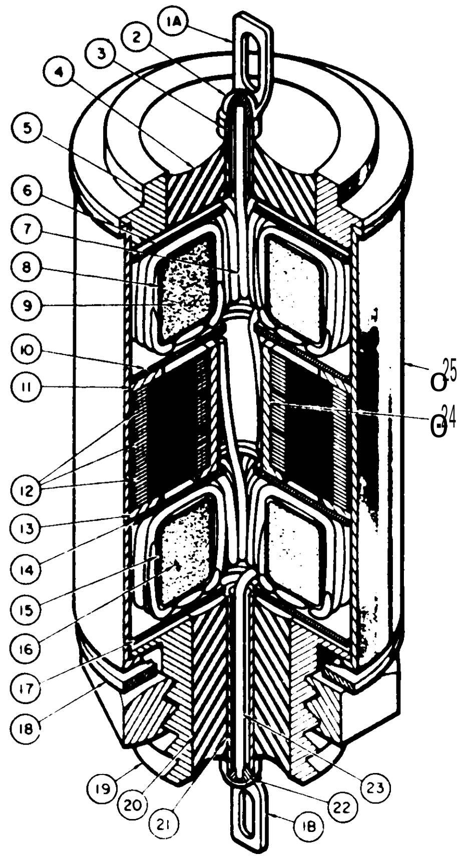
ITEM	ITEM NAME	MATERIAL OF CONSTRUCTION
1	Flag Terminal	ALLOY 52
2, 23	Solder	20 percent Sa, 77 percent Pb, 3 percent Ag
3, 22	Terminal Extension	Alloy 52
4, 21	Seal	Glass
5	Outer Flange	Gold Rolled Steel #1113
6,9,15	Solder	60 percent Sa, 38 percent Pb, 2 percent Ag
7	Eyelet	Tin Plated Brass
8, 16	Split Ring	Tin Plated Brass
10, 17	Capacitor	Ceramic Capacitor (Proprietary Composition)
11	Core Coating	Enamel
12	Core	MTP-112 Moly-Permalite
13	Can	Ledloy "A"
14, 25	Washer	Mica
18	Lock Washer	Tin Plated Phosphor Bronze
19	Max Nut	Tin Plated Brass
20	Seal (threaded)	Ledloy "A"
24	Coil Wire	Annealed Copper

Figure 9-1. Typical Ferrite Bead EMI Filter.



ITEM	ITEM NAME	MATERIAL OF CONSTRUCTION
1	Potting	Proprietary
2	Solder	60 percent Sn, 38 percent Pb, 2 percent Ag
3	Clip	Silver plated free machining Brass
4	Void	
5		Conductive Silver Epoxy
6	Ceramic	Doped Barium Titinate
7	Ferrite Bead	Ni/Zn Ferrite
8	Electrode	Silver parts, 95 percent Silver in a frit mixture
9	Bushing	Silver plated C12L15 Carbon Steel or free machining Brass
10	Terminal	Silver Plated 1/2 hard Copper Wire

Figure 9-2. Typical "P" Section EMI Filter.



ITEM	ITEM NAME	MATERIAL OF CONSTRUCTION
1	Flag Terminal	ALLoy 52
2, 22	Solder	20 percent Sn, 77 percent pb, 3 percent Ag
3, 21	Terminal Extension	Alloy 52
4, 20	Seal	Glass
5	Outer Flange	Cold Rolled Steel No. 1113
14, 6, 10, 17	Washer	Mica
7, 23	Coil Wire	Annealed Copper
8, 15	Core Costing	Enamel
9, 16	Core	MPP-112 Moly-Permalite
11, 13	Split Ring	Tin Plated Brass
12	Capacitor	Ceramic Capacitor (Proprietary Composition)
18	Lockwasher	Tin Plated Phosphor Bronze
19	Seal (threaded)	Ledloy "A"
23	Can	Ledloy "A"

Figure 9-3. Typical "T" Section EMI Filter.

9.1.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA sample parts exhibit any of the defects listed below (as applicable to the type of part being examined).

a. Seal leakage in excess of specification requirements.

b. Cracks or chips on the glass seal that are not polishing artifacts.

c. Voids in potting that permit movement of internal components or that exceed specification requirements.

d. Cracks or voids in ceramic capacitors that exceed the requirements described in Paragraph 5.1.

e. There shall be no solder balls or other foreign material lodged internally.

f. Ceramic discoidal capacitors that do not have a minimum of 240 degrees of their circumferential surface area soldered uniformly to the inner surface of the case, as can be seen on the X-ray negatives, or voids (or the cumulative effect of voids) in the solder that exceed 50 percent of the discoidal height.

g. Misalignment of the capacitive or inductive element with the case that is greater than 10 degrees.

h. Solder used for internal connections does not meet the melting temperature requirements of the procurement specification.

i. Any cracked or cold solder connection, internally or externally.

j. For filters with wound inductors, the wire and core used do not meet the requirements of the procurement specification.

k. Inductor cores that are chipped or cracked; also inductor wire that is broken, nicked, necked down, or does not meet specification requirements, including cracked or broken ferrite elements.

1. Wiring junction splices, if any, do not have joint integrity and insulation.

m. Egress of leads through the eyelet or tubulet not soldered for a minimum of 50 percent of the tube length, or the solder is cracked away from the inside of the eyelet or from the wire.

n. External tab terminals not coated in accordance with the procurement specification.

o. Inductor wire not insulated from the case and the core.

n. Resin filler shows separation from the case or from the lead wires.

0. Any defect that reduces part reliability.

SECTION 10

DETAILED REQUIREMENTS FOR MAGNETIC DEVICES (Inductors, Transformers, and Coils)

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used inductors, transformers, and coils. These requirements supplement the general requirements in Section 4 and are based upon the requirements of MIL-STD–981. Examples of typical configuration sketches are included. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

10.1 MAGNETIC DEVICES. INDUCTORS. TRANSFORMERS (MIL–STD-981)

Typical devices are shown in Figures 10-1 and 10-2

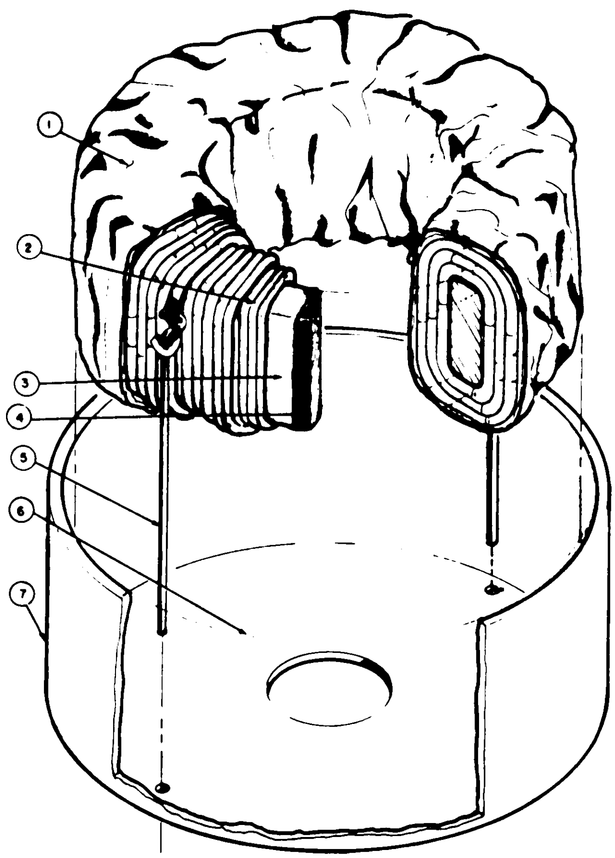
10.1.1 Method.

10.1.1.1 External Visual. Perform visual inspection at 20X minimum magnification on a11 parts. Check for defects in leads, header, feed-throughs, and seal. Examine leads, surfaces, markings configuration, and dimensions. One photograph of one typical device showing all external markings shall be taken.

10.1.1.2 Hermeticity. Verify hermetic seal in accordance with the requirements of the part specification.

10.1.1.3 Radioaraphic Inspection Radiographs shall be taken of each device in each of three axes per Appendix D of MIL-STD-981, unless radiographs that meet the quality requirements of Paragraph 30.1 of MIL-STD-981 are available from Group A testing. The radiographic examination shall include, but not be limited to, inspection for foreign or extraneous materials, alignment, dimensions and clearances, configuration, and processing damage. Accept/reject criteria shall be per Appendix D in MIL-STD-981.

10.1.1.4 Sample Preparation. During the process of opening the enclosure, care must be exercised to assure external liquid, gaseous, particulate, or other contamination types do not enter the interior areas. All metal-cased inductors and transformers shall be decapped with a special can opener device. Do not unsolder devices as part of sample preparation.



1 CUSHION MATERIAL (UNCURED TEFLON)
2 MAGNET WIRE
3 CORE INSULATION
4 CORE
5 INTERCONNECT AND LEAD WIRE
6 POTTING LEVEL
7 POTTING CUP (EPOXY)

Figure 10-1. Inductor, Power (typical).

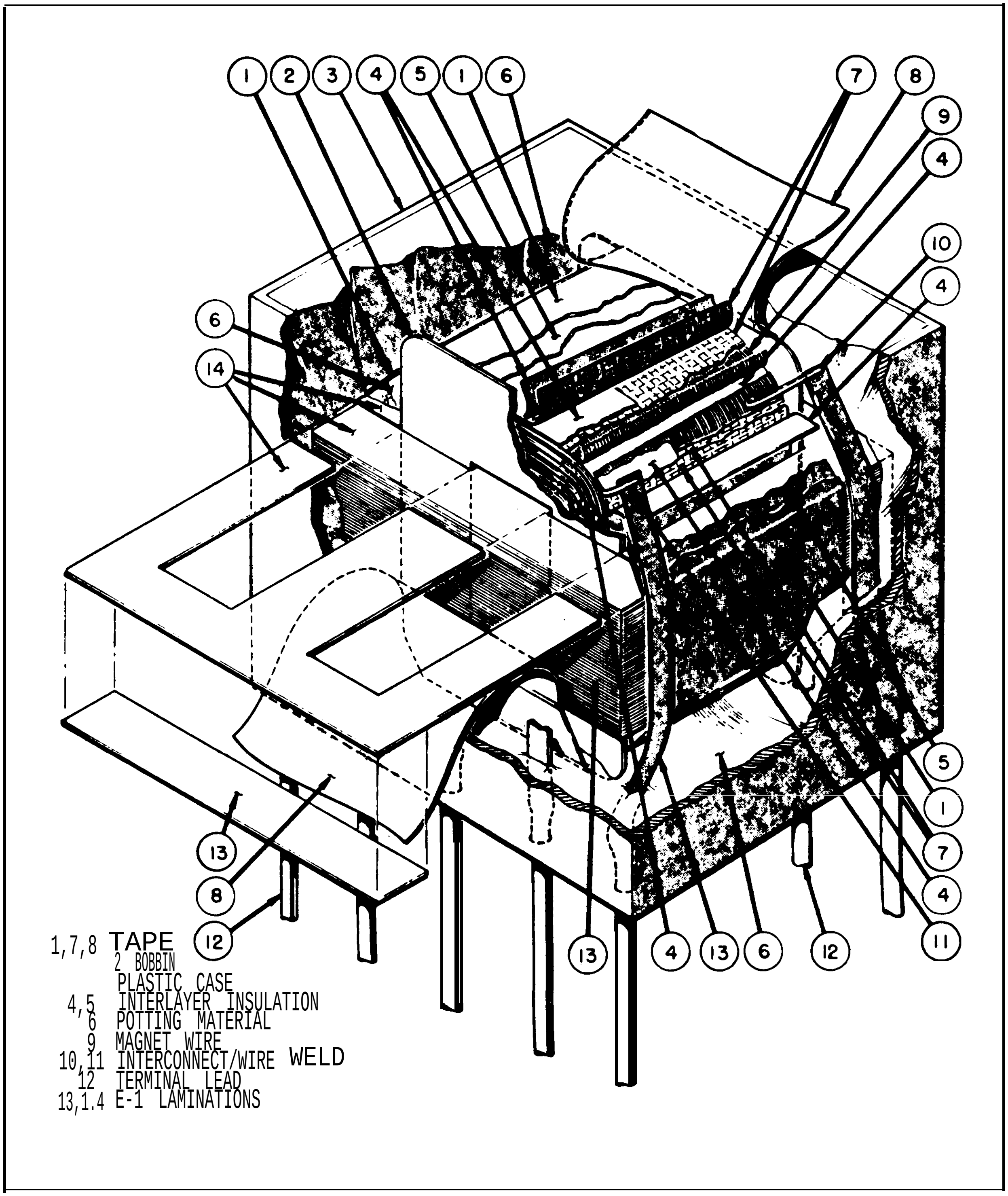


Figure 10-2. Transformer (typical)

Encapsulated inductors and transformers shall be fully submerged in a suitable stripping solution to remove the encapsulating material. The stripping solution may be used either hot or cold, as applicable, provided that it does not damage the internal structure. When possible, remove encapsulation materials in two steps. First, expose terminations at the terminal leads or terminals; secondly, expose the terminations of the wound wire (magnet wire) to the interconnect lead (terminal lead).

Carefully remove device from the potting cup and examine terminations, if any.

Remove insulating cushion material from coil. Examine wire for nicks, scratches, etc., and examine internal solder joints.

Remove windings and examine core.

10.1.2 Data Records DPA findings that deviate from the specified configuration or other requirements or exhibit anomalies shall be documented as defects.

10.1.3 Visual Examination. All exposed inner surfaces of each inductor shall be examined for the following characteristics at a minimum magnification of 30X (see Figure 10-1 and 10-2). When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples exhibit any of the following anomalies:

a. Wire size not in accordance with MIL-STD-981 and applicable specification or drawing.

b. Interconnect ribbon not in accordance with applicable specification or drawing.

c. Internal wire leads attached only by soldering with no evidence of mechanical anchoring.

d. Wire windings that cross over other turns in going from one wound segment to adjacent segment.

e. Nicks, kinks, reduction in wire cross-section, or evidence of other wire damage.

f. Evidence of flux or other types of residues.

g. Teflon tape.

h. Charred, crushed, discolored, or damaged wire insulation.

i. Repaired or spliced coil wire.

j. Wire-to-lead termination connections that do not show a sufficient stress relief loop.

k. Cold solder joints, or solder joints with no fillet around wire or termination.

l. No evidence of weld tip indentation in welded joints.

m. Cracks in welded joints.

n. Loose or splattered weld.

0. Lack of three (3) full nonoverlapping wraps of wire at each post termination.

P. Stranded conductor wire at terminations that does not show pretinning or that shows large globules of solder that obscure the wire contour, or wire swelling due to excess wicking.

q. Solder that is not chemically Type Sn 60, Sn 62, or Sn 63 in accordance with QQ-S-571 or (for wire gauges smaller than size No. 38) Sn 10 for Class S devices.

r. Coils or other electronic components that show evidence of overheating.

s. Fractures, cracks, or pinholes in solder joint.

t. Solder joints with sharp tips or peaks or with a protruding, bare wire-end or bare strands of a conductor.

u. Foreign or extraneous matter embedded in or adherent to wire joints, between windings, or cores, or thin impregnation.

10.2 MAGNETIC DEVICES. RF COILS

Typical devices are shown in Figure 10-3.

1 INTERCONNECT AND LEAD WIRE
2 SOLDER
3 ENCAPCULANT (POTTING MATERIAL)
4 COIL WIRE
5 CORE
6 ADHESIVE (LEAD TO CORE JOINT)

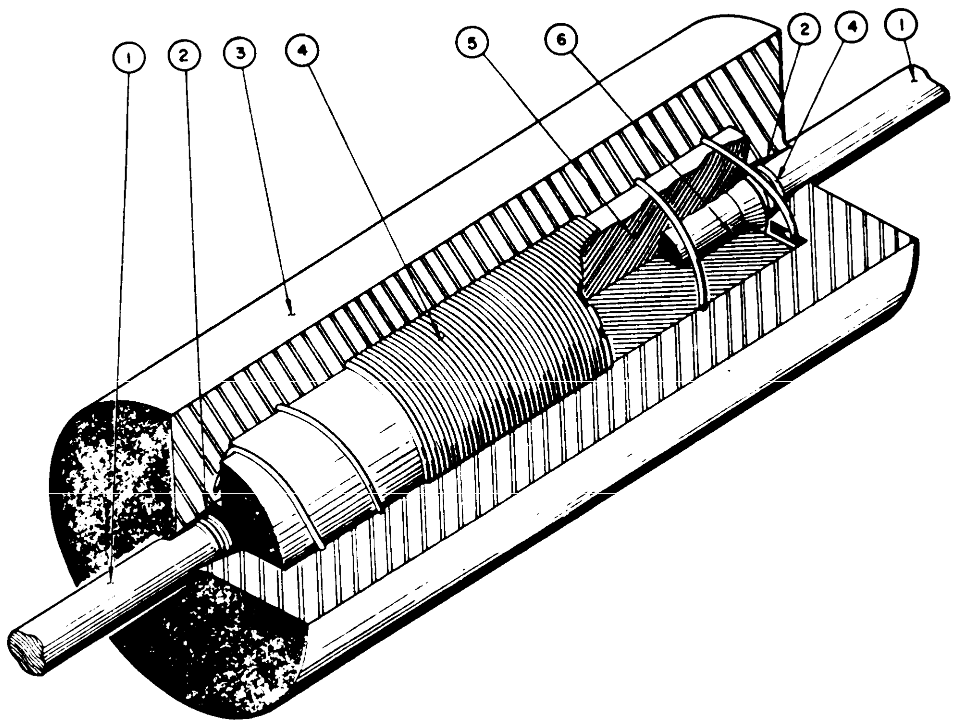


Figure 10-3., RF Coil (typical)

10.2.1 Method.

10.2.1.1 External Visual. Record all marking and identification that appears on the coil and its container and inspect for configuration compliance. Visually inspect each part at 20X minimum magnification for cracks, pinholes, or chips in the case material. Inspect the leads for evidence of physical damage (cuts, nicks, crushing), corrosion, or exposure of the base metal.

10.2.1.2 Terminal Strength Perform a lead pull strength test on two devices in accordance with applicable specification requirements.

10.2.1.3 Decapsulation. Strip coating or case from one half of the number of samples in accordance with 10.1.1.4.

10.2.1.4 Coil Examination Examine depotted coil under 20X minimum magnification. Care shall be exercised when viewing the area where the magnet wire leaves the bobbin and goes to the solder joint at the lead wire.

10.2.1.5 Sectioning Samples Cast remaining half of samples in a suitable encapsulation media selected per EIA RS469 and cross-section in a plane perpendicular to the lead plane to permit evaluation of material, internal design, construction, and workmanship. Extreme attention shall be paid to the area where the lead wire exits from the encapsulant.

10.2.2 Data Records DPA findings that deviate from the specified configuration or other requirements or exhibit anomalies shall be documented as defects.

10.2.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA sample parts exhibit any of the defects listed below. Each defect shall be described and photographed for inclusion in the DPA report.

10.2.3.1 Visual Examination All inner surfaces of each coil shall be examined for the characteristics given in paragraph 10.1.3 at a minimum magnification of 30X.

a. Evidence of contamination, including flux and cleansing agents.

b. Evidence of poor solder connection (no solder fillet or dewetting around wire or ribbon).

c. Evidence of loose, cracked, or cold solder, or voids in the solder.

d. Inadequate stress relief, bend or kink in wire, or improper interconnect wire to external lead (i.e., wire under tension).

e. Nicks or reduction in wire diameter greater than 25 percent along the length of the wire and at the solder joint.

f. Bobbin with cracks, chips, voids, discoloration, or distortion.

g. Evidence of unprotected magnet wire or splicing of the wire.

h. Evidence of poor winding on the bobbin or crossed wire turns.

i. Improper shielding connections (if applicable).

j. Low insulation resistance across bobbin. If the resistance is low (below specification) compared to the impedance at operating frequencies, the bobbin should have an insulation barrier protecting the magnet wire. Also, if the voltage that can appear across the coil is high at the operating frequency, insulation should be used between the magnet wire and the bobbin.

k. Wire size not in accordance with applicable procurement specification.

l. No evidence of weld tip indentation on welded terminations.

m. Terminal strength not meeting specification requirements.

SECTION 11

DETAILED REQUIREMENTS FOR MICROCIRCUITS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used microcircuits. These requirements supplement the general requirements in Section 4. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests such as functional tests and solderability tests are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

11.1 MICROCIRCUITS. MONOLITHIC (MIL-M-38510, MONOLITHIC, MULTICHIP, AND HYBRIDS)

Configuration photographs and drawings or diagrams as supplied by the manufacturer.

11.1.1 Method. DPA examination shall be performed in accordance with MIL-STD-883, Method 5009.

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SECTION 12

DETAILED REQUIREMENTS FOR RELAYS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used relays. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

12.1 RELAYS (MIL-R-6106, MIL-R-39016)

12.1.1 Method

12.1.1.1 External Examination. Examinations shall be performed using a microscope with 10X magnification, except when an abnormality is suspected and then 30X magnification (maximum) may be used to verify product integrity on the following:

a. Header glass seals. The glass seals of the header shall be in compliance with MIL-H-28719.

b. Protective finish and Plating.

1. There shall be no unplated areas or discontinuities of protective finishes.
2. The finish shall be smooth and free from chips, blisters, or rough spots.
3. There shall be no evidence of plating flaking off.
4. There shall be no evidence of chipping, peeling, or blistering of the finish.
5. There shall be no evidence of inadequate protection against corrosion.
6. The case shall be free from distortion and dents.

c. Part Marking. Shall be per MIL-STD-1285.

d. Terminals, studs, and mounting.

1. There shall be no bent or broken terminals.

2. Relay terminals shall be in accordance with the detailed specification, and shall be free from burrs and malformations.

3. Screw threads, tapped holes, and threaded inserts shall be of the size shown on the detailed specification, and shall be in accordance with FED-STD-H28, unless otherwise specified. No malformed threads shall be accepted. A minimum of three full threads of engagement shall be provided.

4. Clearance holes and hardware such as nuts, washers, etc. shall be of the size shown on the detailed specification, and shall be free of burrs and malformations.

5. Studs, flanges, brackets, etc. shall be securely fastened to the relay case.

12.1.1.2 Hermetic Seal. Perform seal leakage test per MIL-R-6106O

12.1.1.3 Residual Gas Analysis. The relay(s) shall be submitted for residual gas analysis (RGA) to a laboratory approved by the qualifying activity of the detail specification. Relay shall be preheated for 15 minutes (minimum) at 100 degrees C immediately prior to being punctured for RGA. The method of sampling the backfill gas from the relay (i.e., puncturing the relay can) shall not cause damage to the internal parts of the relay nor shall it introduce contaminants into the relay. Immediately after removal from the test chamber, the puncture hole shall be covered with a noncontaminating adhesive tape to prevent the introduction of foreign particles. The composition of gases found shall be in agreement with the supplier's baseline (approved) processes and gases for backfilling the relays. The moisture (H_2O) content detected shall not exceed 1000 ppm.

12.1.1.4 Suggested Opening. CAUTION: The introduction of foreign particles during opening can result in unacceptable conditions during the micro-clean inspection of 12.1.1.5. When possible, the micro-clean inspection should be performed through the RGA puncture hole prior to opening the relay can. To avoid damage or deformation of the relay, the use of holding devices such as wire, clamps, or pliers is prohibited. Remove all adjunct sealants from relay headers prior to opening.

12.1.1.4.1 TO-5 Type Enclosures. Diagonal cutters may be used to minimize the possibility of the introduction of metal flakes inside the device. Alternatively, a modified or equivalent easy-view can opener device designed specifically for the purpose of opening the TO-5 type enclosures can be used (also called Head Remover, Silicon). The modification includes enlarging the clearance hole for the TO-5 lid so the device can accommodate the various TO-5 lid heights and allow the side of the cutting wheel to touch the lid side of the TO-5 enclosure during the cutting operation. In addition, a metal guide bar is added over the cutting wheel to maintain the minimum possible clearance between the TO-5 flange and the flat surface of the device cutting wheel to prevent cocking and to assure cutting through the TO-5 enclosure as close as possible to the flange. The adjustment of pressure between the cutting wheel edge and the TO-5 enclosure should be set for the minimum required to allow cutting without deformation of TO-5 enclosure. (See Figures 12-1 and 12-2.)

12.1.1.4.2 Rectangular Type Enclosure - Method #1.

a) Securely mount the relay in a vice-like fixture. The fixture should not deform the relay nor disturb internal dimensions and settings which may require measurement in latter parts of the DPA.

b) Orient the relay so that the header-to-can weld can be end-milled. This may be done as shown in Figure 12-3.

c) Both the height and depth of the material to be end-milled away must be closely controlled. This may be done by using a drill press which has vernier calibration of the table’s movement in three axes. When possible, the specific header dimensions and can-wall thickness should be obtained from the relay supplier or by examining a nonDPA test sample.

d) Gradually machine away the weld area. Typically, removal of 0.025 millimeters to 0.050 millimeters (0.001 inches to 0.002 inches) of the relay wall thickness per pass with the end-mill is suggested.

NOTE: If rotational speed of the end-mill is too fast, overheating and other problems can occur. If rotational speed is too slow, unacceptable vibration of the relay assembly may be induced.

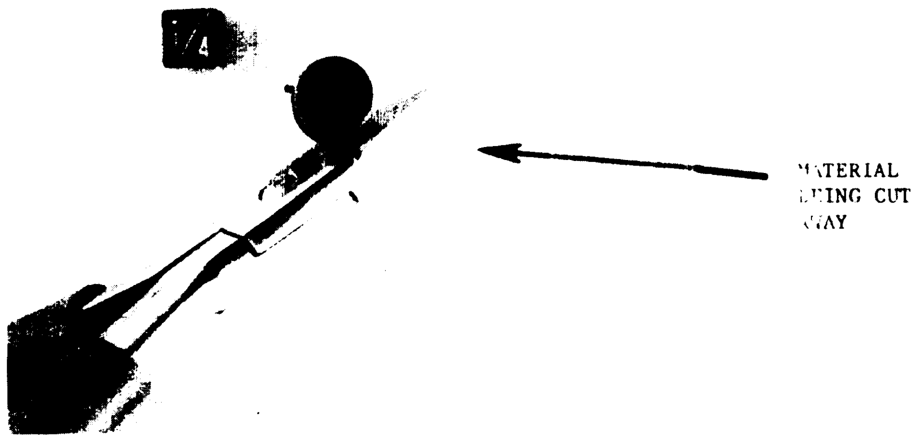


Figure 12-1 TO-5 relay enclosure opening tool. Allows precise opening of enclosure without causing internal damage. Also known as the can opener.

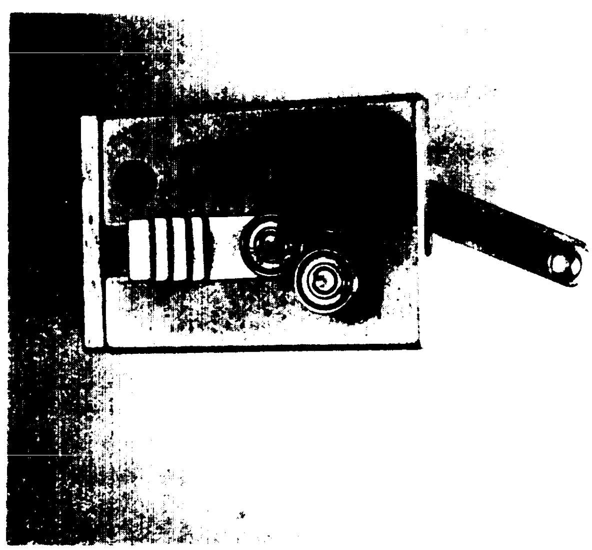


Figure 12-2 Second view of opener. This tool is also utilized for opening quartz crystals, transistors, and other devices packaged in TO-5 enclosures.

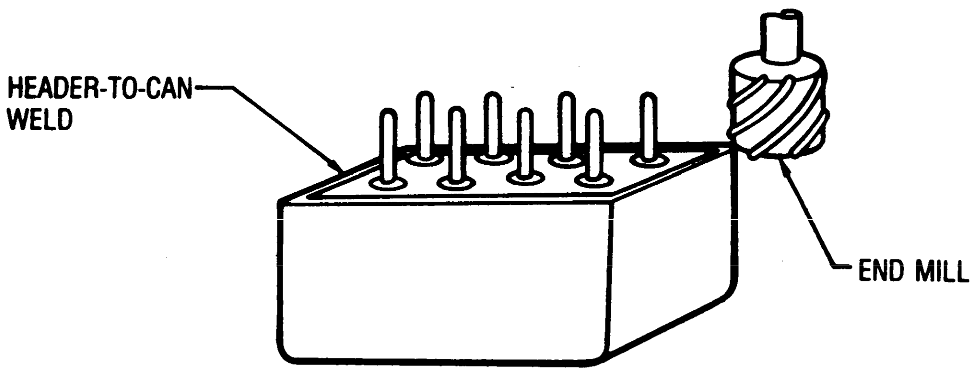


Figure 12-3 End-milling of header-to-can weld.

e) During the machining, vacuum off the machined area continually or as often as possible so as to remove loose metallic particles that could disrupt later examinations.

f) Ideally, the weld is machined to a depth which reveals a seam around the relay in place of the weld. This should be a closed seam, i.e., the milling should not be so deep that any actual openings into the cavity exist.

NOTE: DO NOT ATTEMPT TO SEPARATE THE RELAY ASSEMBLY FROM THE HEADER IN A SHOP AREA.

g) Take the relay to the clean room where the final micro-clean inspection (12.1.1.5) is to occur.

NOTE: A specially cleaned area should be dedicated to the micro-clean inspection. Personnel traffic shall be limited to those involved in the inspection. An enclosed Class 100 laminar flow bench is typically required to maintain cleanliness. All equipment and material such as microscopes, filters, containers, tweezers, etc. shall be thoroughly cleaned prior to entering the area.

h) Using adhesive tape and a vacuum, remove all loose (or potentially loose) particles from around the machined surfaces. Examine the weld area at 30X magnification to verify that no loose particles are present.

NOTE : If adjunct sealants were not completely removed, their presence on the header may be visible at this point, as evidenced by silicone particles around the periphery of the header.

i) Once it has been verified at 30X magnification that the relay exterior is free of particles, do not handle it without wearing finger cots or lint-free rubber gloves.

12.1.1.4.3 Rectangular Type Enclosure – Method #2. NOTE: Method #1 is preferred and should be used whenever possible. Method #2 is an alternate approach to be used when the equipment of Method #1 is not available or the procedures of Method #1 are incompatible with the relay being dissected.

a) A cut is made around the periphery of the enclosure approximately 2.5 millimeters (0.10 inch) above the base of the header. Depth of cut is not to exceed 90 percent of the thickness of the enclosure wall utilizing a cutting wheel (aluminum oxide) mounted in table saw fashion. After completion of the peripheral cut, the entire relay surface is vacuum cleaned. A sharp knife edge is then used to cut through the remainder of the wall enclosure. (See Figures 12-4, 12-5, and 12-6.)

12.1.1.5 Micro-clean Inspection. All metal shavings and foreign particles shall be removed from the relay exterior prior to the initiation of micro-clean inspection.

a. Prior to separating the relay assembly from the can, the materials and equipment necessary to perform the micro-clean inspection should be set up l

1. A “particle free” source of freon is required. This may be achieved by obtaining the highest–grade–purity freon available and then cycling it several times through 1.2-micron filters. A quantity of this freon should be placed in a pressure-rinser that is also equipped with its own 1.2–micron filter (use a 25 millimeter diameter filter).

Figure 12-4 Relay with 90 percent of wall thickness cut away in grove around outer periphery approximately 2.5 millimeters (0.10 inch) above header.

Figure 12-5 Cutting through 10 percent remaining wall thickness with Exacto knife around grove.

Figure 12-6 Opened relay.

NOTE : Gelman Model No. 7074 and David J. Tripp Associates Model No. 4743 are typical pressure-rinsers.

2. The pressure-rinser with its freon shall be pressurized from a clean, dry air (or nitrogen) source.

3. Obtain a clean 1.2-micron filter (use a 47 millimeter diameter filter). Verify its initial cleanliness by examining it at 30X magnification.

4. Place the clean filter across the orifice of a flask through which a vacuum can be pulled (see Figure 12-7).

5. Spray a small amount of freon from the pressure-rinser through the filter with the vacuum pump on.

6. Re-examine the filter at 30X magnification to verify cleanliness of the freon. If particles are observed, repeat step (a) above to obtain clean freon.

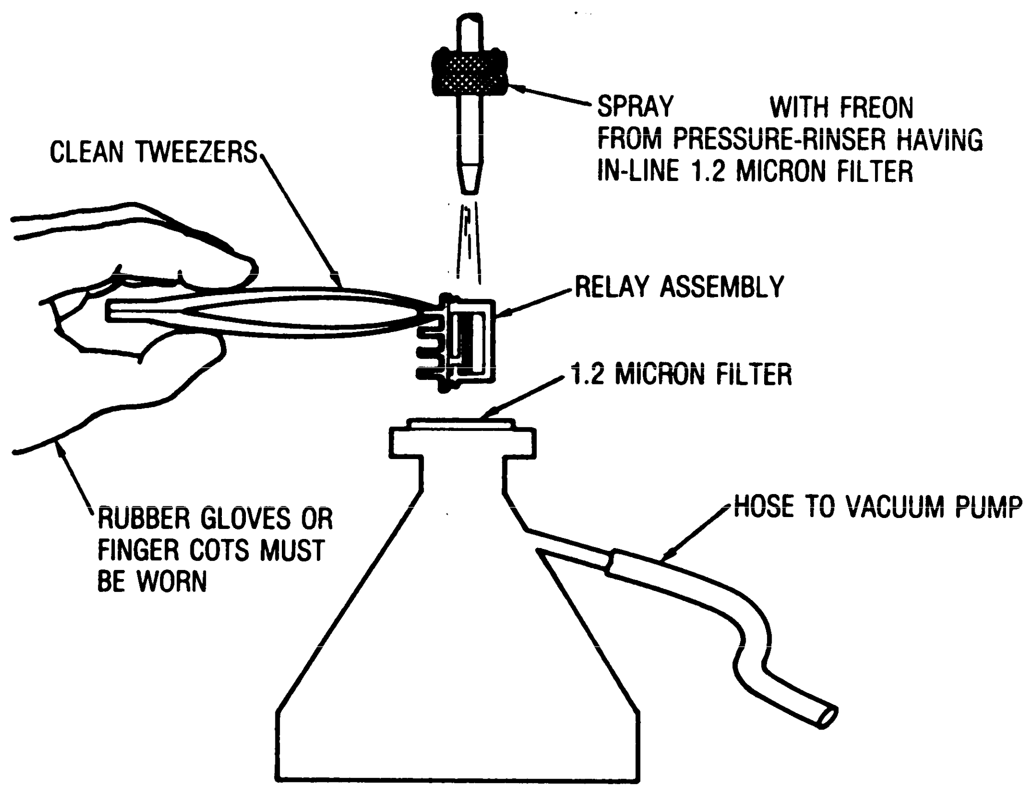


Figure 12-7 Micro-clean Inspection of Relay Assembly

b. The relay, whose external cleanliness has been verified, may now be opened in the specially cleaned area where the pressure-rinser, filter, and vacuum assembly have been set up. If the relay assembly cannot be pulled from the can, the weld may not have been completely eliminated. It may be possible to cut through the final weld areas with an Exacto knife. This operation should be done at 30X magnification with observance for the creation of particles. It may even be necessary to do additional end-milling. However, any cutting or grinding which is done after the exterior of the relay had been cleaned requires that the cleaning procedures be repeated.

NOTE: To this point all activity has been performed to open the relay without introducing particles, to ensure that there are no loose particles on the relay's exterior and to provide an inspection system which is in itself "particle-free". The importance of not introducing erroneous results cannot be over-emphasized.

c. With the relay assembly separated, place the empty can on the table with its opening facing up so that particles (if present) are not dropped out. Be sure that nothing falls into the can after it has been separated.

d. Examine the edge of the header and the edge of the can at 30X magnification for loose shavings or other particles.

NOTE: It is best to handle the relay assembly and can with a clean pair of tweezers.

e. Use the freon from the pressure-rinser and wash the relay assembly through the filter with the vacuum on as illustrated in Figure 12-7.

f. Examine the filter at 30X magnification. Characterize any particles seen, e.g., metallic or nonmetallic; spherical, thread-like, or oblong; glass-like or plastic; and size such as diameter or minor dimension and major dimension. Nonmetallic particles greater than 0.025 millimeters (0.001 inches) in any dimension and metallic particles greater than 0.125 millimeters (0.005 inches) in any dimension are unacceptable.

g. Use the pressure-rinser to flush the inside of the relay can and pass this freon through a clean filter with the vacuum on. Examine the filter paper at 30X magnification for particles and characterize any particles seen as in (f) above.

12.1.1.6 Internal Examination Figure 12-8 shows a typical relay. All exposed inner surfaces of each relay shall be examined for the following characteristics at a minimum magnification of 20X.

a. Contamination. Loose particles of metallic or nonmetallic type or loose Teflon insulation or other fibrous material within the relay or cover which was not previously detected in 12.1.1.5 is unacceptable.

b. Internal Adjustment Using appropriate gauges in conjunction with the appropriate contact monitoring equipment, the following internal adjustment of the contacts shall be measured and shall comply with supplier's baseline (approved) settings.

1. Contact Gap. Measure the gap between the N. O. contact and the movable gap by optical or mechanical means.

2. Overtravel Utilizing feeler gauges (in increasing sizes) placed between the armature and pole face, energize the relay by activating the Universal Tester. The proper overtravel measurement is obtained when the first feeler gauge is inserted that does not permit transfer of contacts, as indicated by contact position lights.

3. Contact Pressure. Measure contact pressure with force gauges while monitoring the contact position. Measure the force necessary to open the mated contacts.

NOTE : When using the force gauge, the arm of the gauge is to remain parallel to the moving contact and in the same plane.

c. Contacts and Terminals.

1. Burrs, cracking, or peeling of plating detectable at 20X magnification is unacceptable, if movable when probed with a force of 1.2 Newtons (125 grams) at 10X magnification.

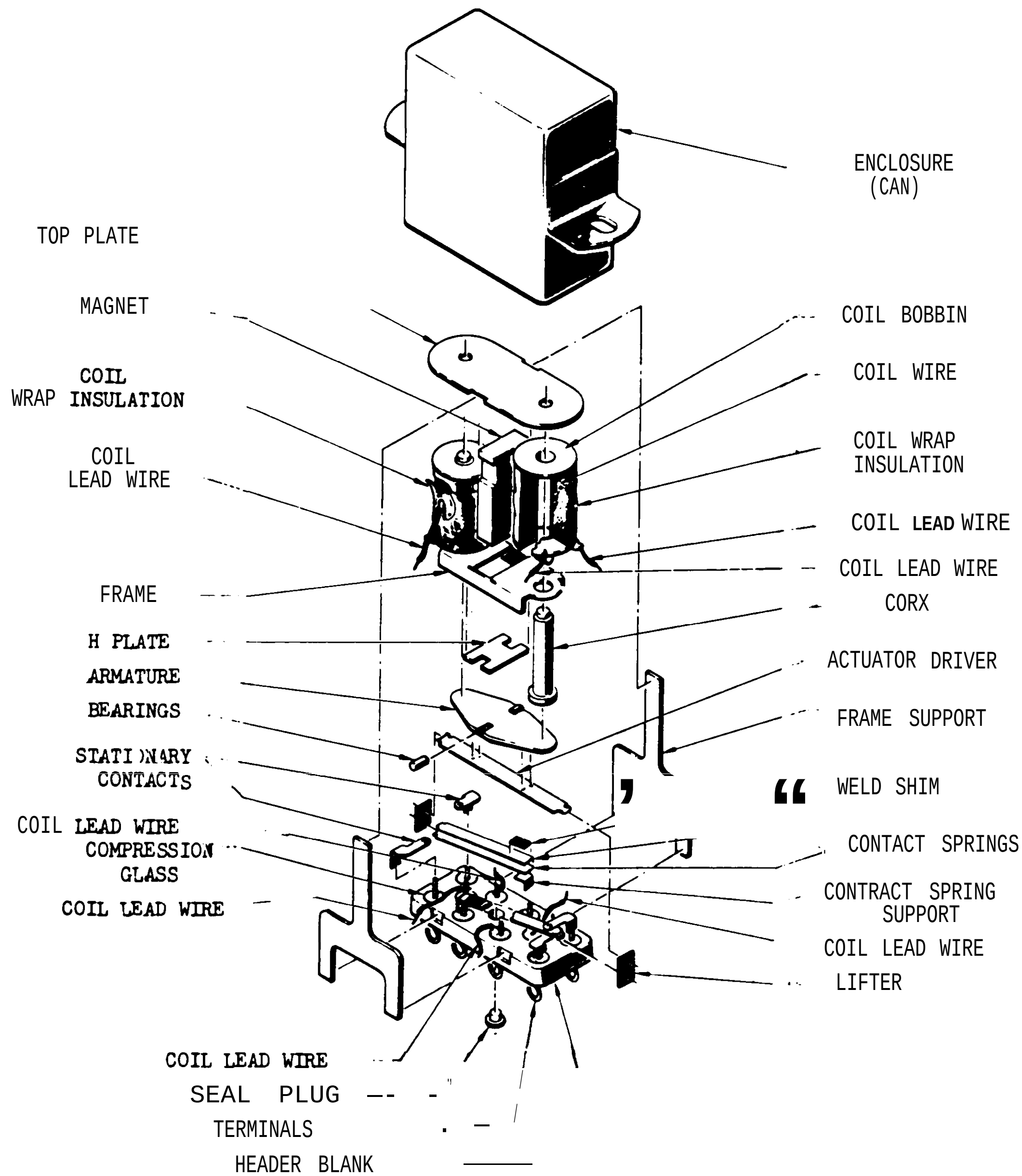


Figure 12-8. Typical Latching Relay.

2. Contacts not in alignment with their mating contact and parallel (equal contact gap) with each other are unacceptable.

3. Contact terminals with flash and ball type weld splatter or expulsion detectable at 20X magnification is unacceptable, if movable when probed with a force of 1.2 Newtons (125 grams) at 10X magnification.

d. Armature and Pole Piece.

1. Armature and pole piece gaps for burrs, cracking, or peeling of plating detectable at 20X magnification is unacceptable, if movable when probed with a force of 1.2 Newtons (125 grams) at 10X magnification. (Reduction in magnification facilitates discernment of movement.)

2. Rust detectable at 20X magnification between gaps or in armature or pole piece surfaces is unacceptable.

3. Cracked or eroded glass on contact pusher bead detectable at 20X magnification is unacceptable.

e. Coil Assembly.

1. Ensure coil does not rotate nor exhibit looseness upon its core.

2. Coil lead between coil and the coil terminal does not exhibit uninsulated portions where possibility of shorting exists, interference with moving parts, kinks, or tension (stretched tight).

f. Coil Assembly Frame. Must meet the following weld pull test:

1. Grind or peel excess can material to provide frame tab clearance for pull test.

2. Remove coil assembly (frame) from header by use of small hand grinder and cut-off diamond-impregnated wheel approximately 25 millimeters (1 inch) in diameter and 0.5 millimeters (0.02 inches) thick.

3. Each weld tab shall have a minimum of 1.5 millimeters (0.06 inches) protruding above the header after cut-off operation.

4. Grip protruding end of tab and peel away from header. Take note and measure force to separate weld. Examine weld remnants. If either observation arouses suspicion of weld integrity, investigate other welds more thoroughly as directed by the responsible relay parts engineer. A good weld should withstand a pull force of 85 Newtons (20 pounds) minimum.

5. Relays are considered marginal when they exhibit coil assembly frame spot weld misalignment or spot weld area partially penetrating frame-to-header. (Pull force minimum requirement specified herein shall be adhered to).

g. Relays If a leadless inverted device (LID) is used, it shall pass die shear and adhesive bond tests, and also-bond strength of small interconnect wires per microcircuit specification MIL-STD-883. Die shear requirements are based on area or adhesion. Wire bond strength is based on diameter of wire to chip on the LID.

12.1.1.7 Materials All materials shall be per the approved supplier's baseline material list. Verification can normally be accomplished by visual examination and comparison with previous DPA samples or qualification samples. If a material's composition is questionable, scanning electron microscope (SEM), X-ray analysis, chemical analysis, or other analytical means may be used to determine material composition.

SECTION 13

DETAILED REQUIREMENTS FOR RESISTORS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used resistors. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

13.1 RESISTORS VARIBLE WIRE WOUND (MIL - R- 39015)

Typical resistors are shown in Figures 13-1 and 13-2. It is recommended that variable resistors not be used in space applications.

13.1.1 Method.

13.1.1.1 External Visual Conduct visual examination at 20X minimum magnification, and examine terminals, leads, marking, case, and adjustment screw.

13.1.1.2 Sample Preparation. During the process of opening the enclosure, care must be exercised to assure that external liquid, gaseous, particulate, or other types of contamination do not enter the interior areas. The three basic types should be opened as follows:

a. Resistor with a round lid seal in a square plastic enclosure (see Figure 13-1). Insert probe under edge of lid and pry lid off. Remove gear and actuator screw, then chemically strip per EIA-469 the remainder of assembly to expose all terminations.

b. Resistor assembly with an oblong plastic case with solid molded ends and base (see Figure 13-2). Scribe a notch along the bond between case and body . Insert a probe into the notch and pry cover from body. This separates the worm screw drive and wiper arm from the resistance winding. The base containing the resistance wire shall be carefully broken by means of a vise or similar device to expose the wire and lead terminations.

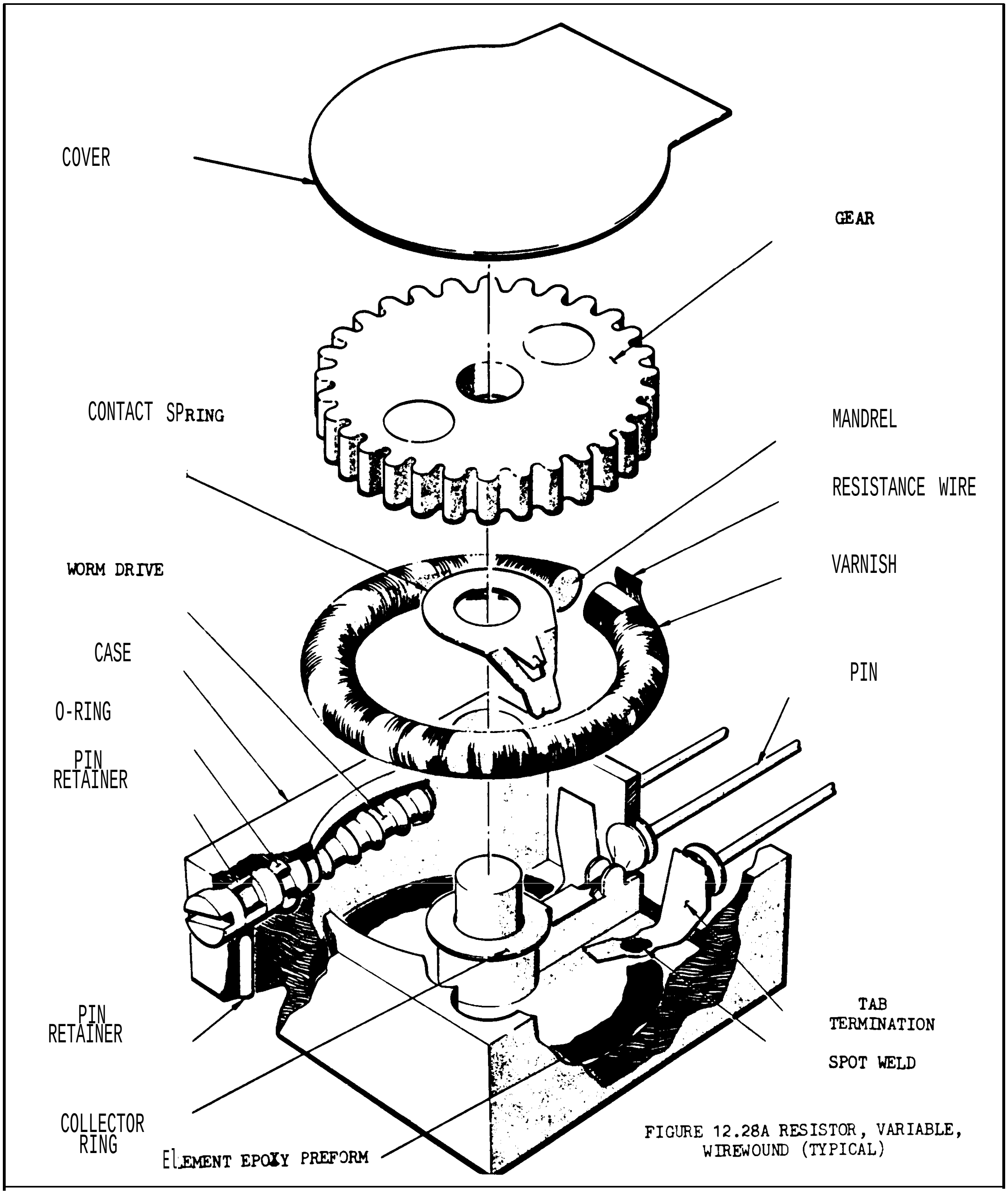


Figure 13–1. Variable Wire Wound Resistor (typical)

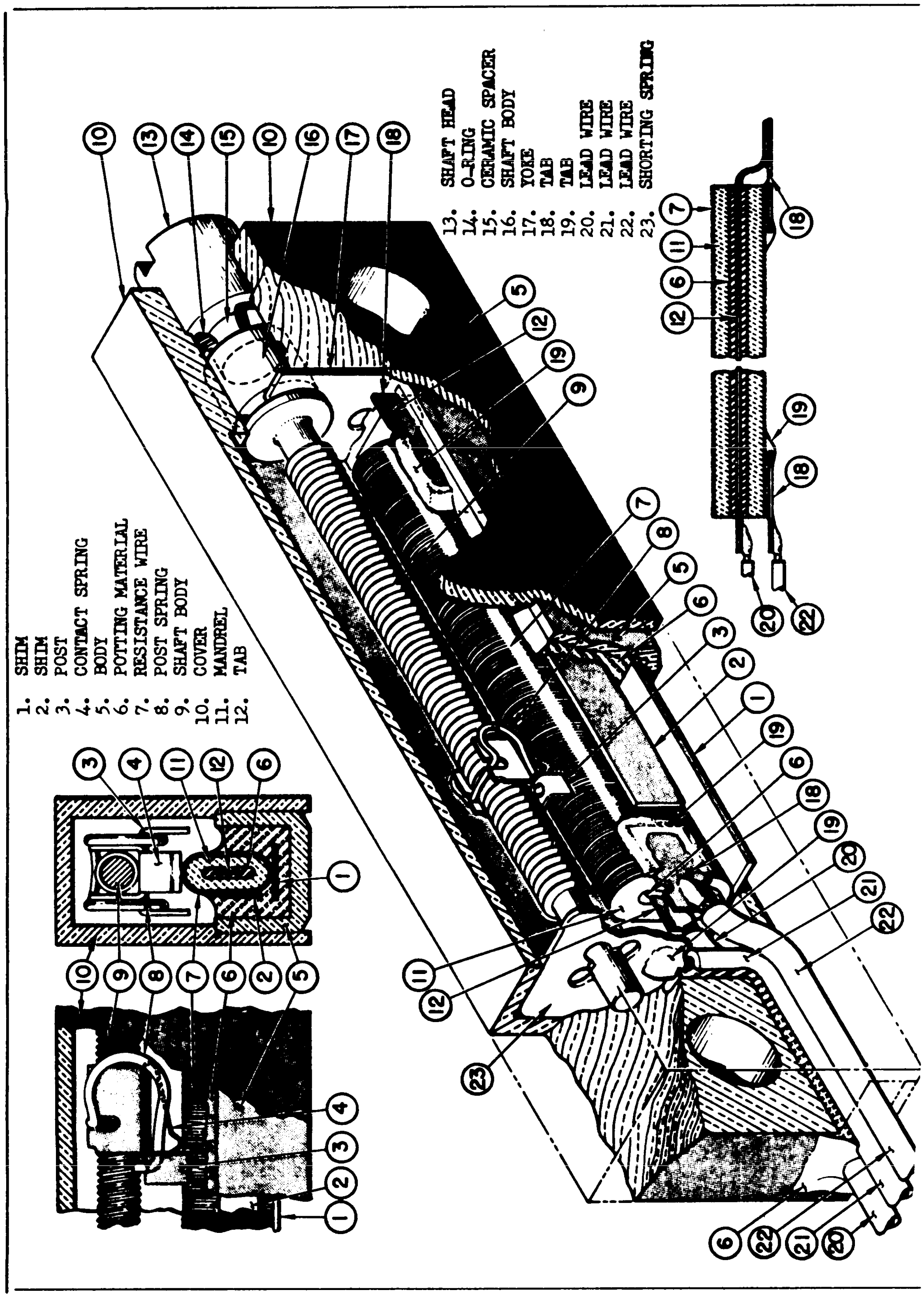


Figure 13-2. Variable Wire Wound Resistor (typical)

c. Single-turn type. This resistor consists of an extended shaft, metal case, and a plastic insulated end containing the terminals. Disassemble by straightening the case roll-over which holds the plastic end and removing the internal rotor assembly.

13.1.2 Data Records DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

13.1.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA sample parts exhibit any of the defects listed below (as applicable to the type of part being examined). All exposed inner surfaces of each resistor shall be examined at a minimum magnification of 30X during each phase of the opening procedure for the following characteristics:

a. Loose windings on active portion of resistor.

b. Wire kinks, abrupt bends, or overlaps.

c. Loose wire ends or wraps capable of touching each other or other conductive parts.

d. Any lubricant, contamination, or flux residue on resistance element.

e. Resistance element not secure to body.

f. Body and wiper stops cracked, damaged, or distorted.

g. Loose or cracked welds.

h. Burning at weld greater than l/5th of tab width.

i. Loose, cracked, or broken terminals.

j. Foreign or extraneous material, such as weld or fractures, solder splatter, flux residue, particle slivers, etc.

k. Internal connections that are soldered, not welded.

1. Reductions in diameter of resistance wire to 5/6ths or less of initial diameter.

13.2 RESISTORS. VARIABLE. NONWIREWOUND (MIL-R-39035)

Variable resistors are not recommended for critical space applications.

13.2.1 Method

13.2.1.1 External Visual Conduct visual examination at 20X minimum magnification, and examine the terminals, leads, marking, case, and adjustment screw for defects. Also, check for configuration compliance.

13.2.1.2 Sample Preparation Follow the same procedure as in paragraph 13.1.1.2.

13.2.2 Data Records. DPA findings that deviate from configuration and other requirements shall be documented as defects.

13.2.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples exhibit any of the following defects listed below. All inner surfaces shall be examined at 30X minimum magnification during each phase of the opening procedure for the following characteristics:

a. Foreign or extraneous material, such as fibers, wear debris, etc., on the resistor element or body.

b. Any scratch, lifting or blistering, or discoloration of the resistor element.

c. Cracks or chip-outs on ceramic substrate in and around the resistor element.

d. Contamination, such as flux residue, lubricant not intended by design, etc., on the resistor element.

e. Wiper arm cracked, damaged, or distorted.

f. Loose or cracked welds.

g. Burning at weld greater than 1/5 of tab width.

h. Cracks on the outer casing.

13.3 RESISTOR. METALLIZED FILM (MIL-R-55182 and MIL-R-39017)

Typical configurations are shown on Figures 13-3 and 13-4.

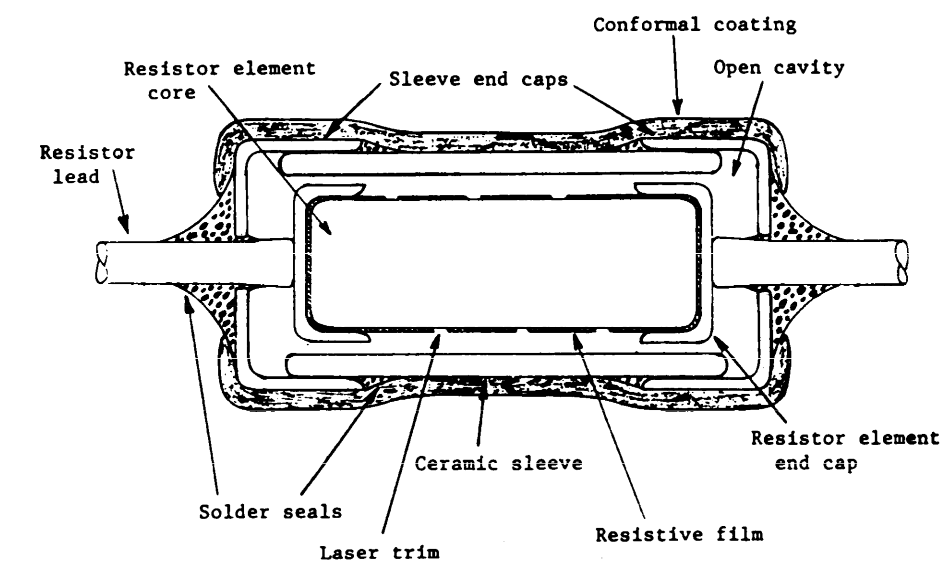
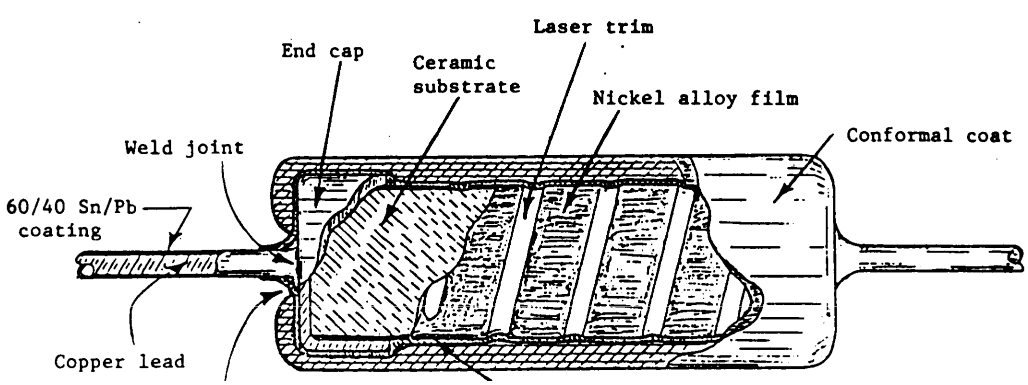


Figure 13-3. Typical Hermetically Sealed Metal-Film Resistor, RNR Style



Coating may not have 100% cup face, but may extend to lead.

Resistive film protective coat and moisture barrier. This coating may visibly extend out onto lead.

Figure 13-4. Nonhermetically Sealed Metal-film Resistor, RNC Style

DPA shall not be required when a precap visual inspection has been performed on 100 percent of the lot using the criteria listed herein. Otherwise, resistors shall be examined using the following procedures:

13.3.1 Method

13.3.1.1 External Visual Examine resistors at 30X minimum magnification for cracks on the epoxy coating or glass seal, flaws on the leads (nicks, cuts, crushing, or exposure of the base metal) and marking, and nonconformance with configuration requirements.

13.3.1.2 Hermeticity Conduct seal test on each sample, when applicable, after all other tests have been performed and just prior to sample preparation for internal inspection. Seal test shall be performed in accordance with the requirements of the procurement specification.

13.3.1.3 Sample Preparation.

13.3.1.3.1 Conformably Coated Resistors Conformal coating can be mechanically or chemically removed. When mechanical means are employed, potential physical and mechanical damage could be induced; therefore, extreme care must be taken in order not to introduce defects to the resistor itself that could cause the lot to be rejected. When chemically stripping the coating, use a process and material which dissolves the coating and exposes, but not attacks, the metal film, core, and terminations, leads, and welded connections, and which does not discolor or stain any surface As required, perform scanning electron microscope (SEM) inspection and check for corrosion.

13.3.1.3.2 Hermeticallyl Sealed Resistors

a. Conformably Coated, Ceramic Body Strip resistor's conformal coating per paragraph 13.3.l.3.1, then examine the hermetic packaging for any signs of contamination, cracks on the ceramic sleeve, and pits or voids on the solder seal. Open the ceramic outer packaging by using a small lathe machine to expose the metallized resistor, being careful not to introduce any contamination. Prepare the lathe by cleaning both jaws and tool bit with alcohol to remove the oils. Carefully place the resistor between the jaws so that one end protrudes. (NOTE: Do not close the jaws too tightly.) cut the metal end cap, keeping the lead attached, just beyond the corner radius. Repeat this procedure for the other end, then slide the ceramic sleeve out to expose the internal resistor.

b. Glass Body Scribe the glass sleeve with a diamond wire saw, then place the resistor on a lint-free tissue, and fold the tissue over. Lightly tap the device with a small hammer until the glass breaks and the glass chips can be removed. Care must be exercised in performing this procedure in order not to induce damage to the internal resistor.

13.3.1.4 Removal of Internal End Caps. The end caps shall be removed to inspect for any sign of corrosion, blistering, or peeling away of the plating material or metal film under the caps. This procedure shall be performed after the internal visual inspection has been completed.

Roll the internal resistor between two clean, flat, hard surfaces. Aluminum pads and a glass sheets have been used with success. After rolling several times, the end caps should fall off from the resistor core. Typically, the caps come off one at a time. When rolling the remaining cap, care must be taken to ensure that damage is not induced to the exposed end. Inspect caps and ends of resistor element at 30X minimum magnification. Any corrosion, peeling, or blistering of the plating or metal film under the end caps shall be cause for rejection.

13.3.2 Data Records

13.3.3 Evaluation Criteria. When the DPA is conducted as a Lot Conformance Test, the production lot shall be rejected if one or more of the DPA samples exhibit any of the defects listed below. All exposed inner surfaces of each resistor shall be examined at 30X minimum magnification for the following characteristics:

a. Cracked or chipped core

b. End cap misalignment greater than 10 degrees

c. Weld splatter at lead-to-end cap termination, or cracks in weld joint

d. Cracks, splits, or holes (from welding operation) on end caps

e. Corrosion lifted, blistered or missing plating material on the end cap; discoloration due to welding is not cause for rejection.

f. Foreign material or contamination on the metal film

g. Any particle seated on the spiral cut

h. Feathering of the metal film due to laser trimming that extends to more than 50 percent of the width of the trim.

i. Damage to resistance element which reduces the width (from overtrimming) of any of the metallized turns to less than 50 percent of the original design value

j. Number of spiral turns different between samples having similar resistance values up to 5 percent or 1 turn, whichever is greater.

k. Evidence of heavy stain or corrosion on resistance element. Discoloration of tantalum-based resistors due to thermal stabilization or laser trimming shall not be cause for rejection. Water marks are not included.

l. Metal film lifting, peeling, or blistering as observed visually or determined by a cellophane tape test.

m. Intermediate coating, when used, that does not extend to 1/2 the length of the skirt of the end caps

n. Discoloration, foreign material, bubbles or pinholes on the intermediate coating, or coating that is peeling away

o. Discolored or hollow core

p. Excessively deep cuts during laser trimming. Laser trim cuts of more than 0.18 millimeters (0.007 inches) deep for thick films or 0.0125 millimeters (0.0005 inches) deep for thin films.

q. Uncut material remaining after a laser scribe due to "skipping" of the laser beam.

13.4 RESISTORS FIXED, METAL-FOIL (MIL-R-55182, RNC90 Style

13.4.1 Method.

13.4.1.1 External Visual. Conduct external visual examination as in 13.3.1.1.

13.4.1.3 Terminal Strength. A terminal strength test shall be performed on 1/3 of the samples in accordance with the procurement specification.

13.4.1.4 Sample Preparation. Either of the following methods may be used in opening (exposing) resistor for internal examination:

a. Chemical Decapsulation. The case may be chemically removed using a process and material which dissolves the case and the underlying coatings and exposes, but not attacks, the resistor element, substrate, terminations, leads, and welded connections, and which does not discolor or stain any surface. The solvent used shall be identified and recorded in the report.

b. Mechanical Decapsulation.

1. Gently hold the sample at the two narrow sides parallel to the leads. Slowly grind off the flat (wide) side of the case with a 180, or finer, grit paper until the plastic is thin enough to break off with pointed tweezers or when the rubber coating starts to show through.

2. Repeat Step 1 for the other flat side. When only the four narrow sides have the plastic case material still attached to them, gently break these off with a pair of pointed tweezers.

3. The rubber film surrounding the substrate package can be easily removed with the tweezers. However, the moisture barrier coating (varnish) under the rubber may not be as easy to take out. Carefully and slowly scrape the varnish with the toothpick and tweezers, making sure that no rejectable defects are introduced to the resistor element.

13.4.2 Data Records DPA findings that deviate from configuration and other requirements shall be documented as defects.

13.4.3 Evaluation Criteria. When the DPA is conducted as a Lot Conformance Test, the production lot shall be rejected if one or more of the DPA samples exhibit any of the defects listed below. All exposed inner surfaces of each resistor shall be examined at 30X minimum magnification for the following characteristics:

a. Cracked or chipped substrate or film. However, small chips on the edges of the substrate are permissible as long as they do not extend under the film.

b. Substandard welding, such as:

   1. Weld print missing the film pads by more than 20 percent

   2. Half of each weld print is outside the lead outline.

   3. Lead is over active grid lines.

   4. Weld splatter.

   5. Cracked paddle or the flat welded portion of lead terminal.

   6. Torn ribbon connection.

   7. Epoxy dot material running under or into weld connections.

c. Cracked, nicked, or dented lead terminal

d. Resistor images which indicate hot spot possibility by a 20-percent reduction of path-metal.

e. Lifting or blistering of resistor metal.

f. Heavy scratches or gouges in active area of resistor element.

g. Any particle large enough to bridge active grid lines.

h. Three or more particles of any size that are detectable under 30X magnification.

13.5 RESISTORS. FIXED. CHIP. STYLE RM (MIL-R-55342)

13.5.1 Method

13.5.1.1 External Visual. Perform visual examination on all samples at 30X minimum magnification. (NOTE: Due to the nature of the design and open construction of these parts, DPA is not normally performed on chip resistors.)

13.5.2 Data Records. DPA findings that deviate from configuration and other requirements shall be documented as defects.

13.5.3 Evaluation Criteria. When the DPA is conducted as a Lot Conformance Test, the production lot shall be rejected if one or more of the DPA samples exhibit any of the defects listed below. All exposed surfaces of each resistor shall be examined at 30X minimum magnification for the following characteristics:

a. Cracked or chipped parts

b. Foreign material or discoloration on the substrate, resistive film, or terminal bands

c. Lifting, blistering, or peeling of the resistive film, terminal bands, or protective coating (when applied).

d. Any one rejection mode described in Figure 13.5.

13.6 RESISTOR NETWORKS. (MIL-R-83401)

13.6.1 Method.

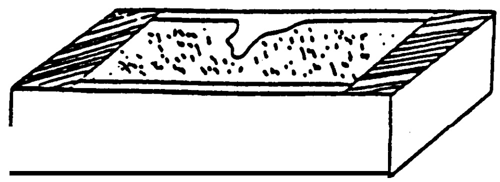
13.6.1.1 External Visual. Conduct visual examination at 20X minimum magnification of terminals, leads, markings, all surfaces, and dimensions. One representative photograph of one device showing all markings shall be taken and provided.

13.6.1.2 Hermetic Seal Test As applicable, hermetic seal testing shall be performed in accordance with MIL-R-83401.

13.6.1.3. Pull test One-third of the samples shall be tested in accordance with the specification requirements.

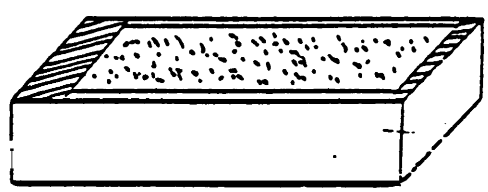
13.6.1.4. Delid. The following techniques are recommended for delidding samples. Other techniques may be used, providing appropriate prior approval has been obtained.

a. Solder and Brazed Sealed Lids. Using a sharp carbide scribing tool carefully scratch the solder (or braze) down and inward (toward the package center) on all four sides. Continue scribing using moderate pressure until there is sufficient



REJECT : Void, nick, bubble or cut in active resistor area that is greater than 25 percent of the resistor width, except calibration cut. The usable resistance width Shall not be less than 60 percent of the active resistor element.

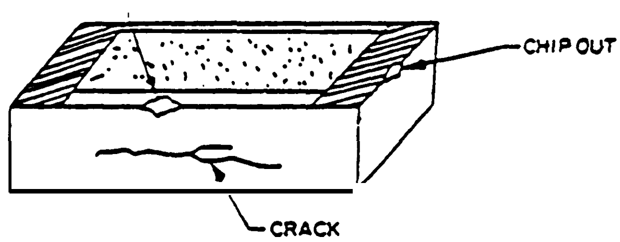
FIGURE 13.5a. Chip Resistor Visual Examination



REJECT : Termination bandwidth that is less than 0.25 millimeters (0.01 inches), but not more than 0.40 millimeters (0.015 inches).

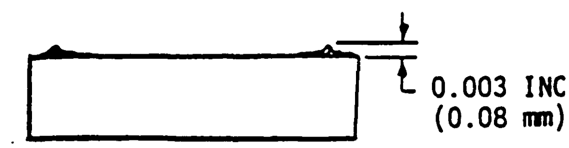
FIGURE 13.5b. Chip Resistor Visual Examination

CHIP OUT



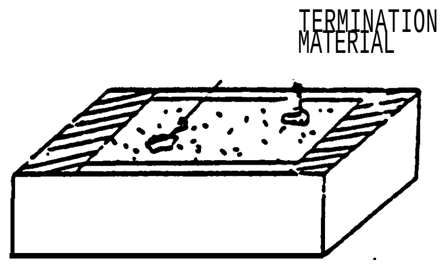
REJECT : Any crack, chip-out, or void in the substrate that is greater than 0.08 millimeters (0.003 inches) in any dimension

FIGURE 13.5c. Chip Resistor Visual Examination



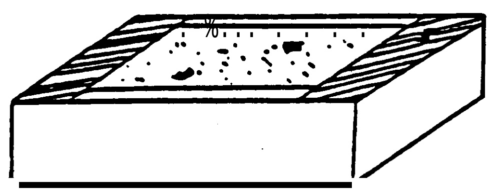
REJECT : Excessive build-up of termination that is greater than 0.08 millimeters (0.003 inches) and 0.20 millimeters (0.008 inches) for solderable and weldable finishes, respectively.

FIGURE 13.5d. Chip Resistor Visual Examination



REJECT : Termination material splattered on the active resistor area.

FIGURE 13.5e. Chip Resistor Visual Examination



REJECT: Foreign particles that are embedded in either the resistive film or termination bands. (NOTE: Foreign particles are those other than the materials used as resistive film or termination band.)

FIGURE 13.5f. Chip Resistor Visual Examination clearance under the lid to insert an Exacto knife blade. Carefully insert the blade and pry up the top at one corner of the lid. Carefully insert the Exacto knife further into the package (holding the blade parallel to the package surface) and work the blade outward from the corner along the joint until the lid separates.

b. Welded Packages Using a fine Swiss file (equivalent file Number 1 or 2), carefully file a chafer approximately 30° around all four sides of the package at the well seam. Continue filing until microscopic examination at 20X magnification reveals minute cracks forming between the top and case edge on all four sides. Remove all metal filings using an artist brush. Carefully insert a sharp Exacto blade in the crack at one corner and pry the top of the package off in a can opener fashion.

co Frit-sealed Packages Using a sharp carbide scribing tool, carefully scribe the glass frit on four sides. Scribe the package evenly on all four sides. Using only moderate pressure, grasp the package between thumb and forefinger, top to bottom.

NOTE: BE CAREFUL NOT TO TOUCH THE LEADS WITH THE SCRIBING TOOL.

Continue scribing this area until a crack appears between the top and the remainder of the frit. The frit must show signs of cracking on all four sides. At this point, the operator should be holding the package together with his thumb and forefinger. Lay the package down and carefully pry up the lid at one corner; do not touch the leads.

NOTE: Once the lid has been removed, handle the device only by the sides.

d. Molded.Packages. The device shall be submerged in a suitable stripping solution to remove the encapsulating material and expose the substrate. The stripping solution may be used either hot or cold, as applicable, provided that it does not damage or discolor the internal structure.

13.6.1.5 Internal Visual. All exposed surfaces of each resistor network and substrate shall be examined at 30X minimum magnification. All anomalies shall be noted and documented.

13.6.2 Data Records. DPA findings that indicate deviation from specified configuration or other requirements, or the existence of defects, shall be documented.

13.6.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA sample parts exhibit any of the defects listed below.

13.6.3.1 Particles.

a. Metallic Particle.

1. Unattached - There shall be no unattached metallic particles.

2. Attached - Attached metallic particles shall not exceed 0.125 millimeters (0.005 inches) in the major dimension. Particles shall not touch nor extend over the metal film. Particles shall be considered attached when they cannot be removed with a gas blow of dry oil-free nitrogen from a 150 kilopascal (22 psi) gauge pressure source.

b. Nonmetallic Particles. Glass, fibers, and other nonmetallic materials within the enclosure shall not exceed 0.125 millimeters (0.005 inches) in their major dimension.

13.6.3.2 Residue There shall be no visible laser trim residue at 50X magnification within the enclosure.

13.6.3.3 Metallization Defects. Any of the following anomalies in the active circuit metallization shall be cause for rejection.

a. Metallization Scratches. A scratch is defined as any tearing defect that disturbs the original surface of the metallization.

1. Any scratch in metallization through which the underlying resistor material also appears to be scratched.

2. Any scratch in the interconnecting metallization which exposes resistive material or oxide anyhere along its length and reduces the width of the scratch-free metallization strip to less than 50 percent of its original width.

b. Metallization Voids Any void in the interconnecting metallization which leaves less than 50 percent of the original width undisturbed. A void is defined as any region in the interconnecting metallization where the underlying resistive material or oxide is visible which is not caused by a scratch.

c. Metallization Adherence. Any evidence of metallization lifting, peeling, or blistering.

d. Metallization Probing. Probe marks on the interconnecting metallization other than the bonding pads that violate the scratch or void criteria.

e. Metallization Bridging.

1. Metallization defect that reduces the distance between any two metallization areas to less than 0.008 millimeters (0.0003 inches).

2. Bridging between metallization and resistor pattern, not intended by design, that reduces the distance between the two to less than 0.0025 millimeters (0.0001 inches).

f. Metallization Alignment. Any misalignment between the resistor patter and the metallization such that more than 0.0125 millimeters (0.0005 inches) of resistor on a side is exposed.

g. Metallization Corrosion. Any evidence of localized heavy stains, metallization corrosion? discoloration or mottled metallization.

13.6.3.4 Resistor Defects The active area of a resistor is that part of the resistance pattern which remains in series connection between resistor terminals and is not shorted by metallization. Any of the following anomalies within the active resistor area shall be cause for rejection:

a. Resistor Scratches. Any scratch within the active resistor area.

b. Resistor Voids.

1. Any void or neckdown in the active resistor path which reduces the width of the stripe by more than 50 percent of the original width.

2. Any void or necking down in the active resistor path for a line width design of less than 0.005 millimeters (0.0002 inches) which reduces its original width by 25 percent or more

3. Any void or chain of voids in the resistor element at the gold termination.

c Resistor Adherence. Any evidence of resistor film lifting, peeling, or blistering.

d. Probe Marks. Any probe mark on the resistor material.

e. Resistor Material Corrosion. Any evidence of localized heavy stains or corrosion of resistor material in the active resistor path. However, discoloration of tantalum-based resistors due to thermal stabilization is not a cause for rejection.

f. Resistor Bridging Defects.

1. continuous Bridging, Any conductive continuous bridging between active resistance stripes.

2. Partial bridging defect that reduces the distance between adjacent active resistance stripes to less than 0.0025 millimeters (0.0001 inches) or 50 percent of the design separation, whichever is less, when caused by smears, photolithographic defects, or other causes.

Exception, For a partial bridge within lines and spacing of 0.0025 millimeters (0.0001 inches) design width, visual separation (evident at 400X magnification) is sufficient for acceptance.

13.6.3.5 Laser Trim Faults.

a. A partial cut, or bridged coarse or midrange trim link.

b. Remaining width in fine-trim top hat area after laser cut is less than the width of the narrowest line within the same resistor pattern.

1. Uncut material is remaining after a laser scribe due to "skipping" of laser beam.

2. If laser cut is not in straight lines, the narrowest remaining width must be equal to or greater than the width of the narrowest lines within the same resistor pattern.

c. Laser cut scribed to indicate a reject chip when the scribe does not meet the requirements of the individual mask model lists.

d. Oxide voids, cracking, or similar damage caused to the SiO_2 underlayer by laser beam where such damage touches active interconnects or resistor path.

e. Laser trim cut where edge of cut touches the active resistor path.

f. Any discoloration or change in surface finish of a resistor stripe by the direct laser beam or by spurious reflections caused by optics of the system.

g. Any chip intended to be laser-trimmed that is not laser-trimmed.

13.6.3.6 Resistor Bonding Pad Defects. Any resistor containing one or more bonding pads with one or more of the following anomalies shall be rejected.

a. Globules. A globule is defined as any material with a smooth perimeter extending out from the bonding pad onto the resistor or substrate material. Such globules are usually featureless and of low reflectivity and therefore difficult to focus upon.

b. Missing Metallization. Any indications of missing metallization whether at the perimeter or totally within the bonding pad. Resistor material may be visible in the areas of missing metallization.

c. Metallization Corrosion.

1. Any evidence of localized heavy, diffused stains, discolored material, or low-density material either on the pad's perimeter or totally within the bonding pad.

2. Any evidence of stains or discoloration extending out onto the resistor or substrate material

13.6.3.7. Oxide Defects. Any resistor having the following oxide, scribing, or die anomalies shall be rejected.

a. Oxide Void. An oxide void is defined as a fault in the oxide evidenced by localized double- or triple-colored fringes at the edges of the defect visible at 100X magnification. The following shall be cause for rejection:

   1. Any oxide void that bridges any two resistor or metal areas not intended by design.

   2. Any oxide void under metallization or resistor geometry.

b. Scribing and Die Defects. The following shall be cause for rejection:

   1. Less than 0.125 millimeters (0.005 inches) oxide visible between active metallization and edge of a die. Excluded from this are any inactive metallization lines.

   2. Any chipout or crack in the active resistor or metal area.

   3. Any crack that exceeds 0.125 millimeters (0.005 inches) in length or comes closer than 0.025 millimeters (0.001 inches) to an active area on the die.

   4. Any crack in a die that exceeds 0.025 millimeters (0.001 inches) in length and points towards the active circuit area.

   5. A die having an attached portion of an adjacent die which contains metallization or resistor material.

   6. A crack or chip in the backside of a die that leaves less than 75 percent of area intact or a crack or chip under a bonding pad.

13.7 RESISTORS. WIREWOUND. ACCURATE (MIL-R-390051.

A typical configuration is shown on Figure 13-6

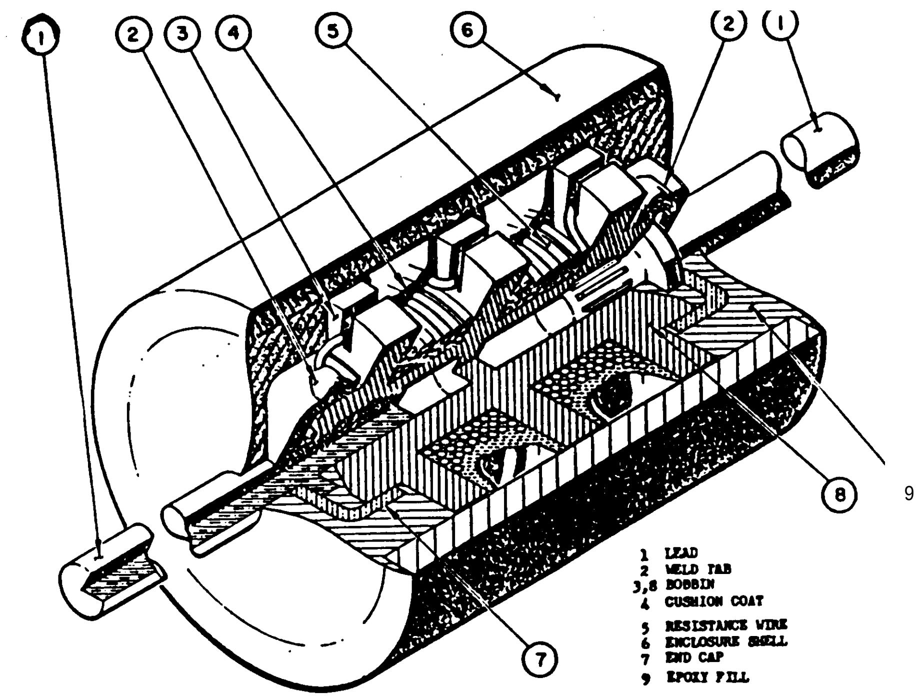


Figure 13-6 Typical Wirewound Resistor (MIL-R-39005)

13.7.1 Method.

13.7.1.1 External Visual Conduct visual examination at 20X minimum magnification of terminals, leads, external coating, markings, all surfaces, and dimensions.

13.7.1.2 Sample PreParation. Each group of 3 samples shall be prepared as detailed below.

13.7.1.2.1 sample One. One sample shall be encapsulated and sectioned in a plane parallel to the longitudinal axis to a depth exposing the core and terminal leads. The manner of sectioning shall be such that minimal damage is done to the device.

13.7.1.2.2 Samples Two and Three Two samples shall be gently submerged in a suitable soluti~n that dissolves the external coating and exposes but not attacks the resistance wire, core, terminations, and welded connections.

13.7.1.3 Internal Visual Examination. All exposed surfaces of each resistor shall be examined at 30X minimum magnification. All anomalies shall be noted and photographed.

13.7.2 Data Records DPA findings that indicate deviation from specified configuration or other requirements or the existence of defects shall be documented.

13.7.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples exhibit any of the defects listed below.

a. Wire kinks, abrupt bends, or overlaps

b. Cracks or lifting in tab welds

c. Cracks or distortion in bobbin or core

d. Damage or discolored portion of encapsulant

e. No evidence of weld tip indentation at welds

f. Burning at weld greater than 1/2 of tab width

g. Absence of soft cushion coating over wire winding and beneath encapsulant

h. Less than 0.60 millimeters (0.025 inches) gap between leads

13.8 RESISTORS, FIXED, WIREWOUND, POWER, (MIL-R-39007) AND WIREWOUND POWER, CHASSIS-MOUNTED (MIL-R-39009)

Typical configurations are shown on Figure 13-7 and Figure 13-8.

13.8.1 Methods

13.8.1.1 External Visual. Conduct visual examination at 20X minimum magnification, and examine terminals, leads, marking, general dimensions, and appearance for any evidence of defective workmanship.

13.8.1.2 Sample Preparation. When resistors contain beryllium-oxide ceramic cores, there shall be no machining, grinding, filling, or polishing performed on the cores. Beryllium-oxide dust is highly toxic.

Preparation of the samples shall be done as follows:

13.8.1.2.1 For MIL-R-39007 Resistors:

a. Dissolve external coating in a suitable solution which exposes but does not attack the resistance wire, core, terminals, and caps and welded connections. The solvent shall not discolor or stain any surface.

b. When the resistor core is the only element left to be examined, cut resistance wire from caps at locations sufficiently distant from weld connections or terminations such that the connections are not disturbed. This procedure facilitates core examination.

13.8.1.2.2 For MIL R-39009 Resistors:

a. Make two saw cuts (180 degrees apart) along the horizontal axis, deep enough to just penetrate the internal potting material.

b. Immerse resistor in a suitable solution to dissolve the potting material and remove the housing in order to expose the internal element. Solvent shall not damage the resistance wire, core, terminals, end caps and welded connections, or discolor or stain any surface.

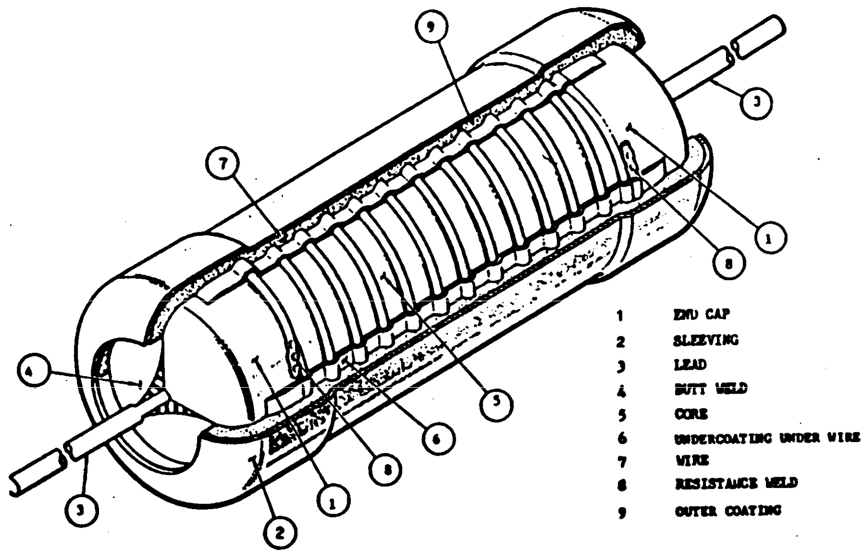


Figure 13-7 Typical (Wirewound Power Resistor (MIL-R-39007)

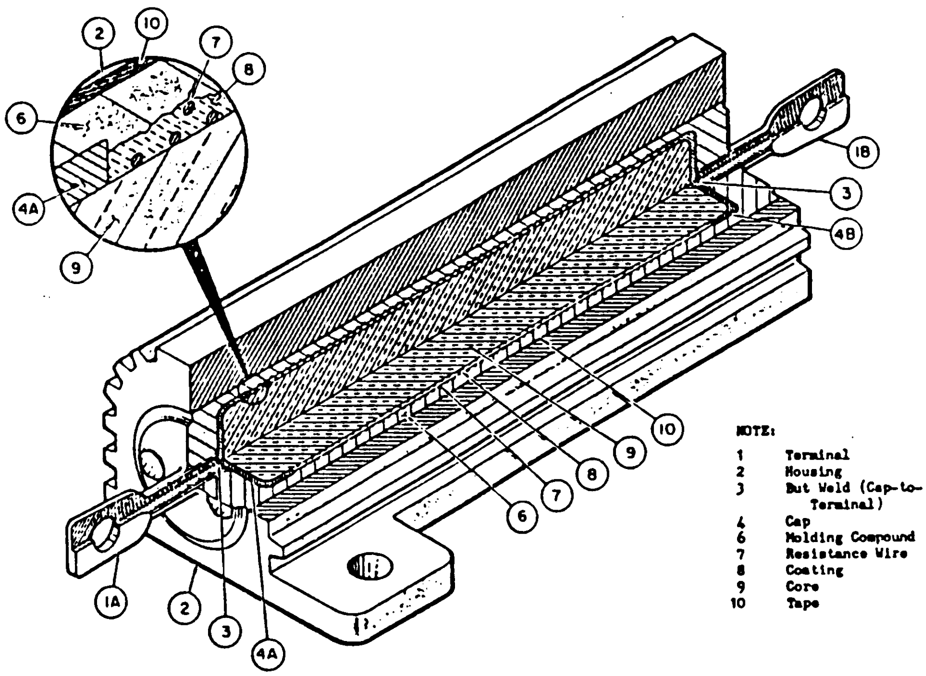


Figure 13-8 Typical Wirewound Chassis-Mounted Power Resistors

c. When the resistor core is the only element left to be examined, cut resistance wire from caps at locations sufficiently distant from weld connections or terminations such that the connections are not disturbed. This procedure facilitates core examination.

13.8.2 Data Records DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

13.8.3 Evaluation Criteria. When the DPA is conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples exhibit any of the defects listed below. All exposed inner surfaces shall be examined at 30X minimum magnification during each phase of the DPA for the following characteristics:

a. End cap misalignment greater than 10 degrees

b. End cap showing corrosion, lifted or missing plating

c. Weld splatter at lead-to-cap termination, or cracked or partially lifted weld.

d. Split, cracks, or holes on the end caps

e. Sudden kinks, bends, or sharp distortion on the resistance wire that reduces the wire diameter to 5/6ths or less of the initial value

f. Loose windings on active portion of the resistor

g. Wire not secure at weld on end cap

h. Number of wire turns different between samples having similar resistance values, up to 5 percent or 1 turn, whichever is greater.

i. Space between wire turns more than 5 times the wire diameter except for values less than 1 ohm, or space between turns of less than the wire diameter except for high-value resistors using insulated wires.

j. Cracks, spans, or surface holes on the core that exceed 0.60 millimeters (0.025 inches) in the greatest dimension

13.9 RESISTOR, CARBON COMPOSITION, RCR (MIL-R-39008)

DPA is not required.

SECTION 14

DETAILED REQUIREMENTS FOR SWITCHES

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used switches. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

14.4 SWITCH, SNAP ACTION

14.1.1 Method.

14.1.1.1 Leakage. Switches shall be tested for seal leakage per the following paragraphs as applicable.

a. Hermetic seal. Hermetically sealed switches shall be tested the same as relays (Reference para. 12.1.1.1).

b. Evironmental seal Environmentally sealed switches shall be tested per the procurement specification.

c. Nonsmkd. Nonsealed switches shall not be subjected to any type of seal test.

14.1.1.2 External Examination. Examinations shall be performed using a microscope with 10X magnification, except when an abnormality is suspected and then 30X magnification (maximum) may be used to verify product integrity.

a. Header glass seals The glass seals on the headers of hermetically sealed switches shall be in compliance with MIL-H-28719.

b. Protective finish and plating (as applicable)

1. There shall be no unplated areas or discontinuities of protective finishes.

2. The finish shall be smooth and free from chips, blisters, peeling, or rough spots.

3. There shall be no evidence of plating flaking off.

4. There shall be no evidence of inadequate protection against corrosion.

5. The case shall be free from distortion and dents.

c. Part marking (as applicable) Marking shall be per MIL-STD-1285.

d. Terminals, studs, and mounting (as applicable)

1. There shall be no bent or broken terminals.

2. Switch terminals shall be in accordance with the detailed specification and shall be free from burrs and malformations.

3. Screw threads, tapped holes, and threaded inserts shall be of the size shown on the detailed specification, and shall be in accordance with FED-STD-H28, unless otherwise specified. No malformed threads shall be accepted. A minimum of three full threads of engagement shall be provided.

4. Clearance holes and hardware such as nuts, washers, etc. shall be of the size shown on the detailed specification, and shall be free of burrs and malformations.

5. Studs, flanges, brackets, etc. shall be securely fastened to the switch case.

14.1.1.3 Residual Gas Analysis (hermetically sealed switches only) The hermetically sealed switch shall be submitted for residual gas analysis (RGA) to a laboratory approved by the qualifying activity of the detailed specification. Switches shall be preheated for 15 minutes (minimum) at 100 degrees C immediately prior to being punctured for RGA. The method of sampling the backfill gas from the switch (i.e., puncturing the switch can) shall not cause damage to the internal parts of the switch nor shall it introduce contaminants into the switch. Immediately after removal from the test chamber, the puncture hole shall be covered with a noncontaminating adhesive tape to prevent the introduction of foreign particles. The composition of gases found shall be in agreement with the supplier's baseline (approved) processes and gases for backfilling the switches. The moisture (H_2O) content detected shall not exceed 1000 ppm.

14.1.1.4 Sectioning The most common hermetic, environmental, and nonhermetic types of snap action switches are opened as follows:

a. Metal enclosure (hermetic seal and environmental seal). Place one side of switch enclosure on a flat grinding (disc) surface and apply a steady firm pressure by hand until surface is ground to a point where the remaining side wall thickness (approximately 10 percent) permits easy puncture with a sharp cutting tool such as an Exacto knife blade. Prevent the grinding operation from penetrating the enclosure by testing the wall thickness frequently during the grinding with the point of the Exacto blade. (The hands, instruments used, and all external surfaces of the switch enclosure should be cleaned and free of any contaminants upon completion of the grinding operation and just prior to penetrating switch enclosure). After completion of grinding and cleaning perform the final opening step over a clean white contaminant-free bench or paper surface. Penetrate enclosure with the point of the Exacto knife blade. Orient the switch enclosure so that particles generated during opening do not enter inner areas of the switch.

b. Plastic enclosure (nonhermetic seal). Place the point of an Exacto knife blade cutting edge into the groove where the enclosure sections are joined and force cutting edge into groove around outer periphery until all bonding material (usually an epoxy type) has been cut through. Prior to separating case, orient switch enclosure with respect to gravity to minimize entry of external contamination into the interior areas.

14.1.1.5 Internal Examination. NOTE: Figure 14-1 is a visual example of a switch assembly containing two subminiature nonhermetic-seal-type snap-action switches with plastic enclosures. All exposed inner surfaces of the device shall be examined for the following characteristics at 20x minimum magnification:

a. Any detectable loose particulate matter is unacceptable.

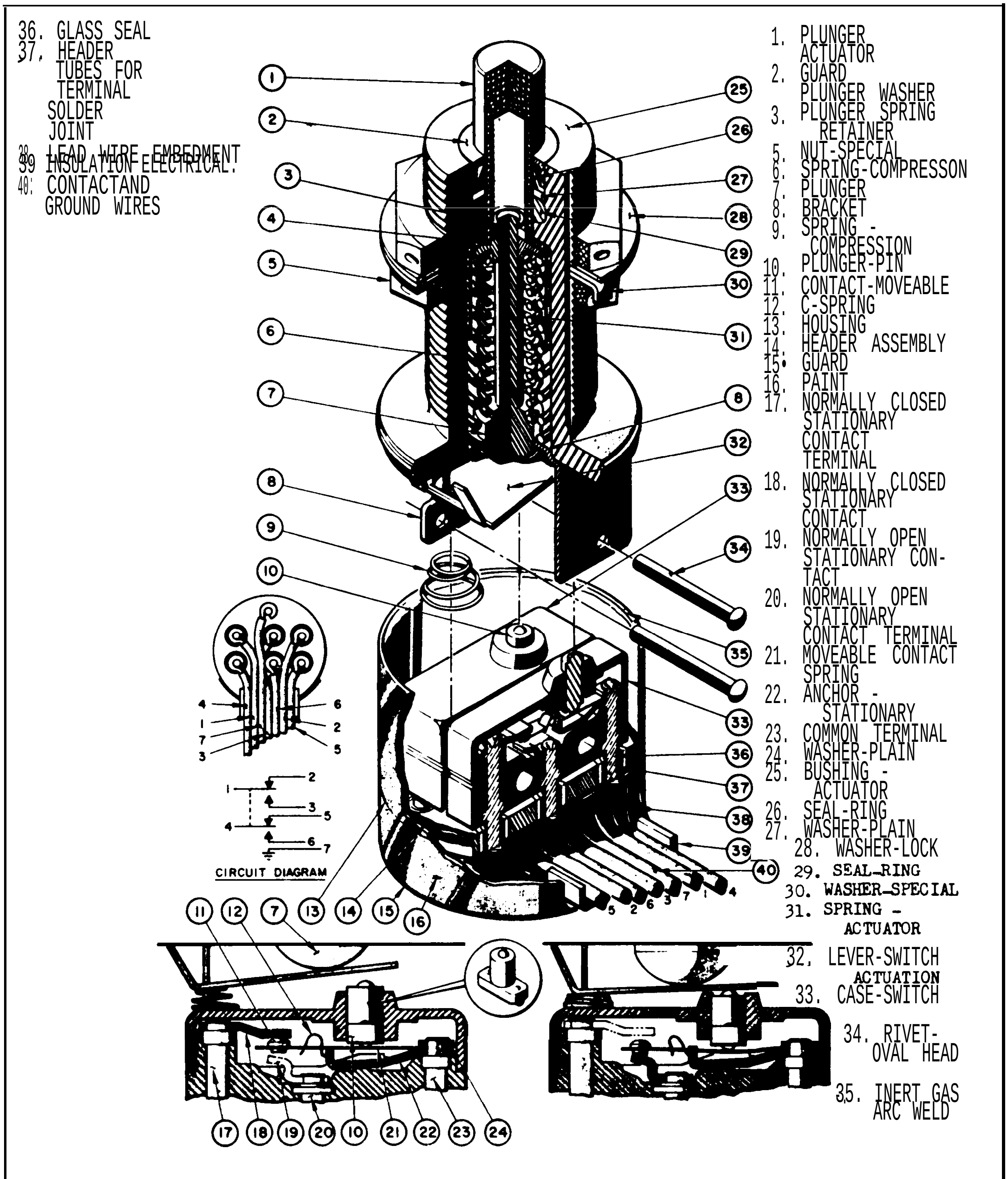


Figure 14-1 Switch assembly (typical) .

b. Loose, broken, or misaligned components not caused by the opening procedure is unacceptable.

c. Corrosion or peeling of plating or finish is unacceptable.

d. Devices shall be considered marginally acceptable if they exhibit the following characteristics:

NOTE: Corrective action to eliminate any marginally acceptable conditions shall be initiated at the supplier when such conditions have been detected in DPA.

1. Adhering conductive or nonconductive particles (metal burrs or case flashing).

2. Incomplete swagging or staking of assembly components (not 360 degrees).

3. Scratches or nicks on contact interface surface areas.

14.1.1.6 Material. All materials shall be per the approved supplier's baseline material list. Verification can normally be accomplished by visual examination and comparison with previous DPA samples or qualification samples. If a material's composition is questionable, scanning electron microscope (SEM), X-ray analysis, chemical analysis, or other analytical means may be used to determine material composition.

14.2 THERMAL SWITCHES

14.2.1 Method. This section covers several manufacturer's types of thermal switches. The various types covered are depicted in Figures 14-2 through 14-5. The type to be analyzed should be determined before dissection.

14.2.1.1 Hermetic Seal. The hermetic seal of the thermal switch shall be tested using the same procedures as defined in para. 4.7.28 of MIL-R-6106J. The seal shall meet the requirements of the thermal switch detailed specification.

14.2.1.2 External Examination. Thermal switches shall be examined to verify that the materials, external design and construction, physical dimensions, weight, marking, terminals, and workmanship are in accordance with the applicable detailed specification. Examination shall be performed using a microscope with 10X magnification, except when an abnormality is

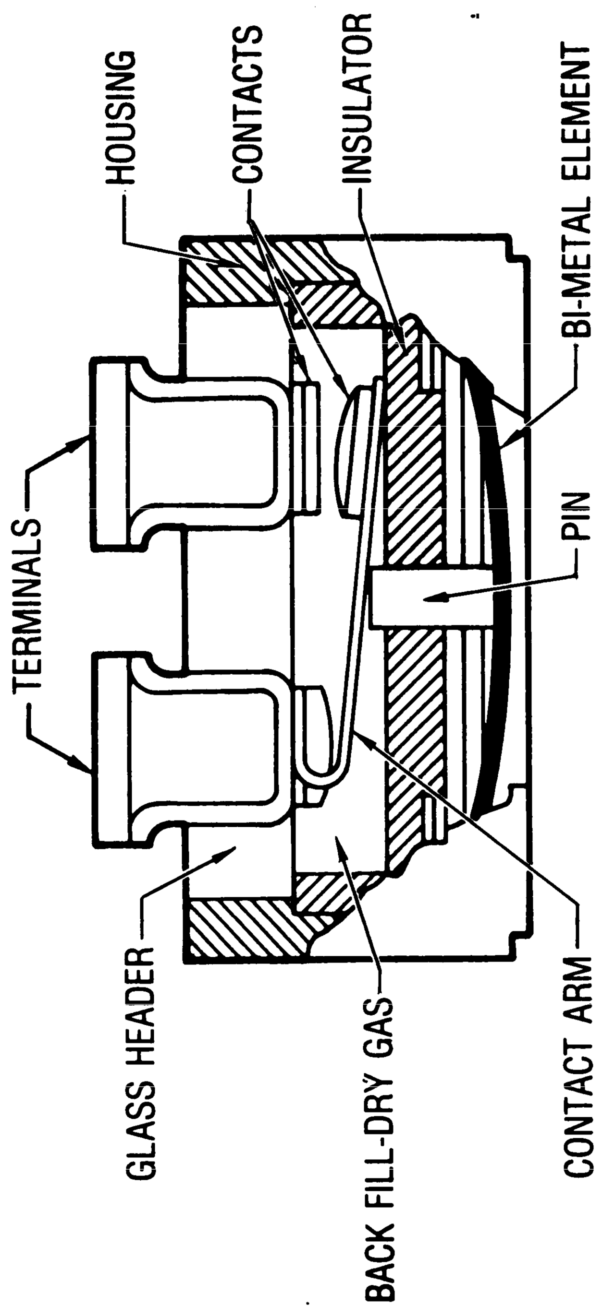


Figure 14-2 Type A Thermal Switch Cross-sectional View.

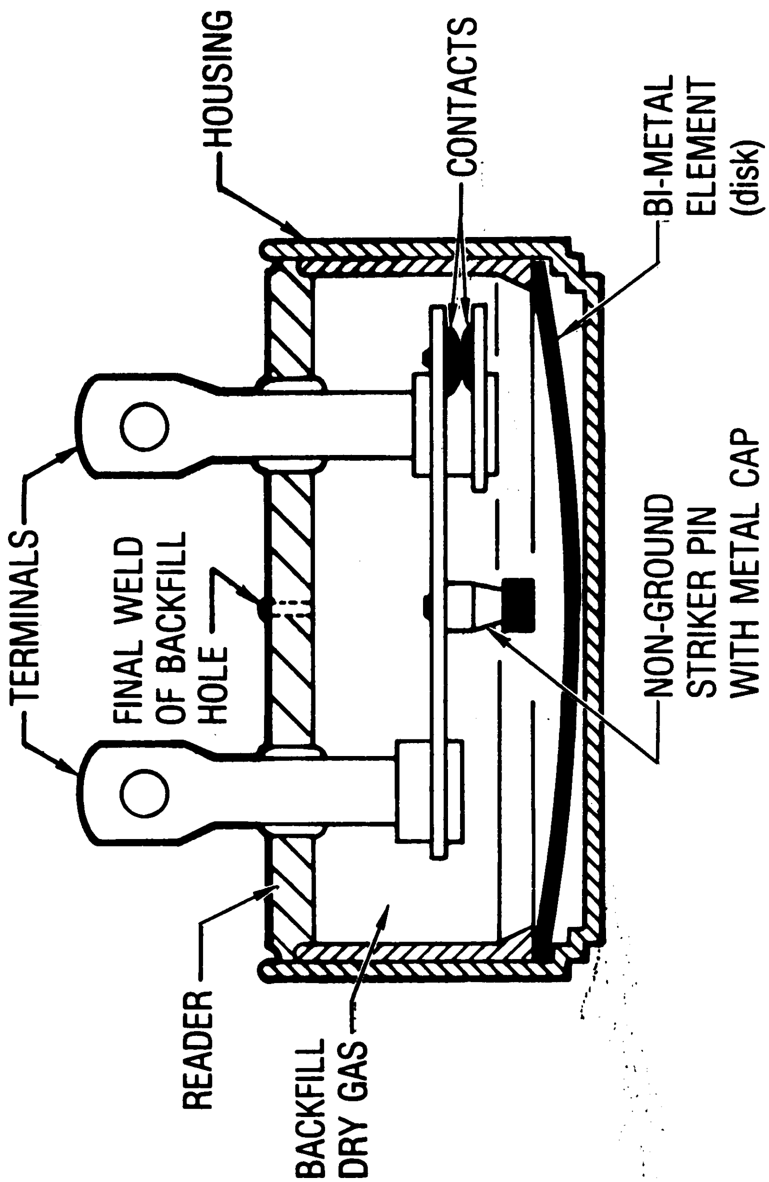


Figure 14-3 Type B Thermal Switch Cross-sectional View.

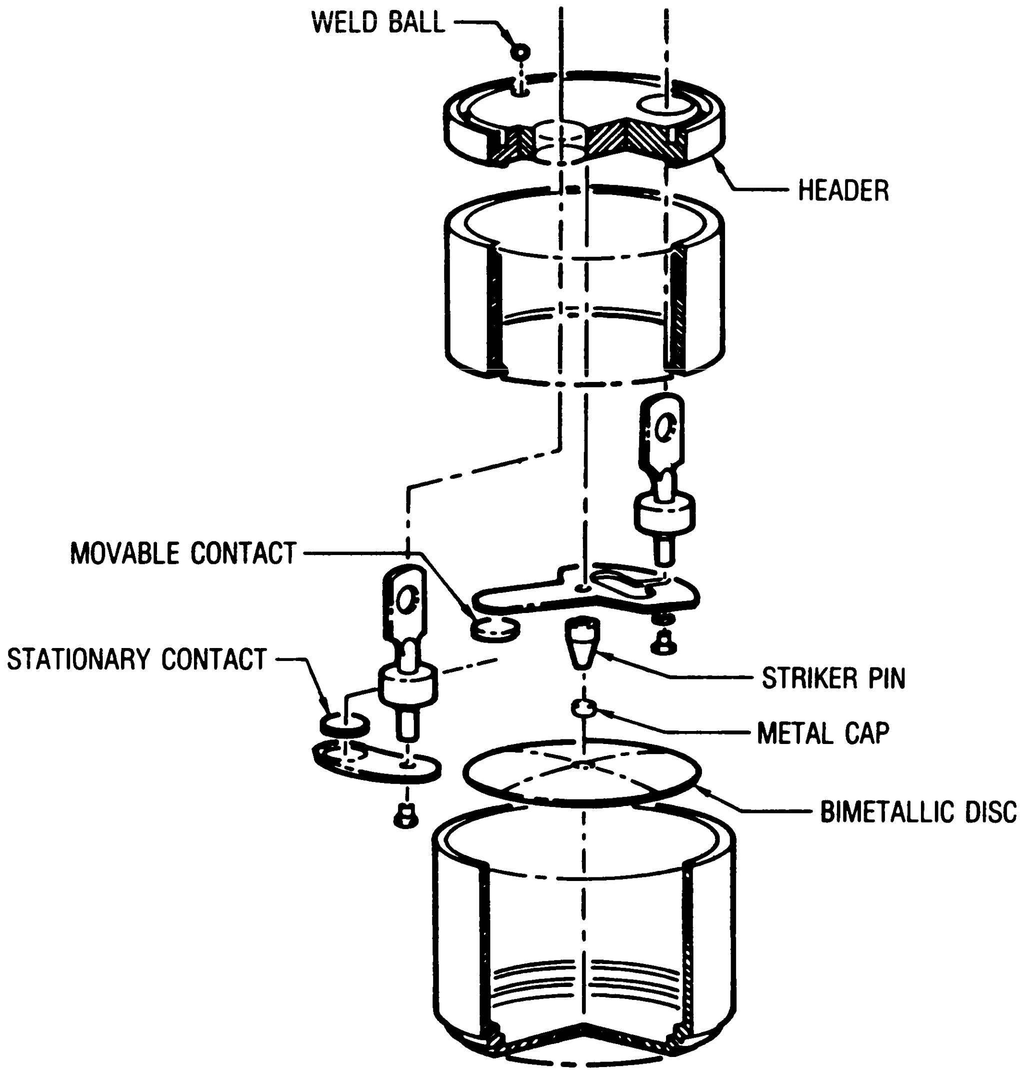


Figure 14-4 Type B thermal switch exposed view.

1 COVER
2 DISK
3 ADJUSTING SCREW (WITH HEX FLANGE)
4 RIVET
5 MOVEABLE ARM
6 STAND OFF BUMP (2 ON BASE)
7 BASE
8 RETAINING NUT (MOLDED INTO BASE)
9 CUP
10 CONNECTOR
11 INSULATOR
12 WELD JOINT
13 BARRL
14 SEAL GLASS
15 LEAD WIRE
16 TERMINAL FEED-THRU
17 WELD (FINAL SEAL)
18 TERMINAL EXTENSIONS
19 STATIONARY CONTACT
20 MOVEABLE CONTACT
21 INSULATOR BEAD
22 SPRING
23 MOUNTING BRACKET

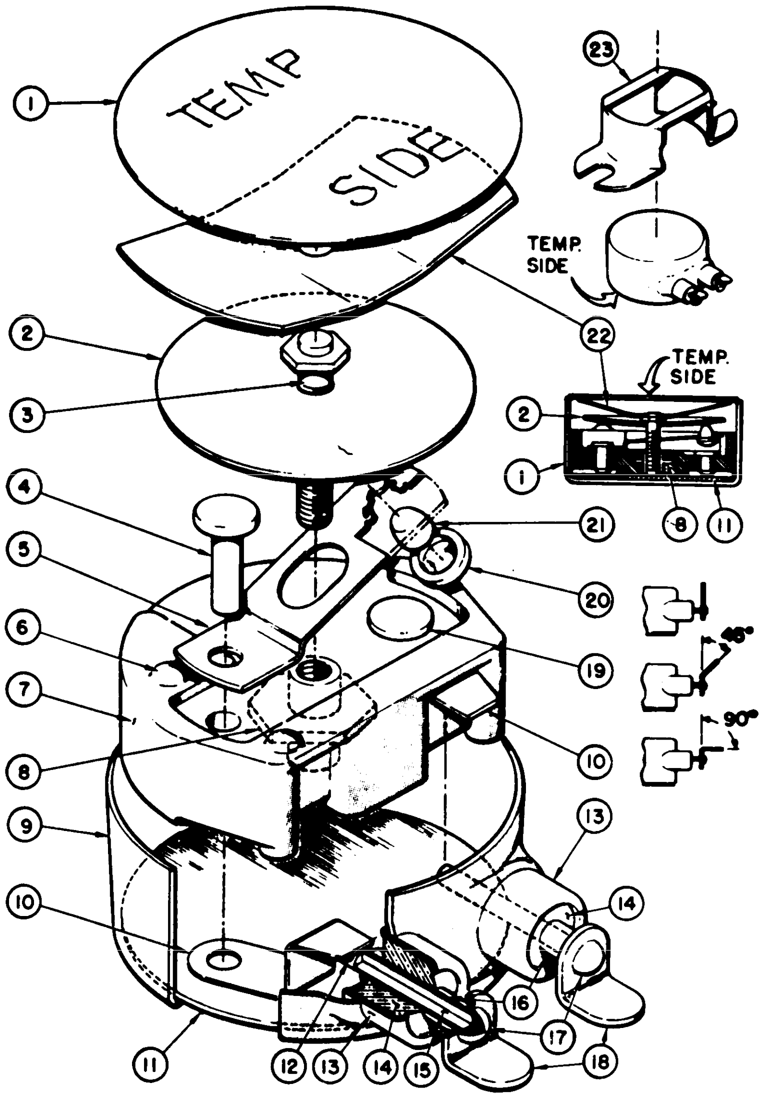


Figure 14-5 Type C thermal switch exploded and cross-sectional views.

suspected, and then 30X magnification (maximum) may be used to verify product integrity for the following:

a. Header glass seals. The glass seals of the header shall be in compliance with MIL-H-28719.

b. Protective finish and Plating.

1. There shall be no unplated areas or discontinuities of protective finish.

2. The finish shall be smooth and free from chips, blisters, peeling, or rough spots.

3. There shall be no evidence of plating flaking off.

4. There shall be no evidence of inadequate protection against corrosion.

5. The case shall be free from distortion and dents.

c. Marking. Marking shall be per MIL-STD-1285.

d) Terminals.

1. There shall be no bent or broken terminals.

2. Thermal switch terminals shall be in accordance with the detailed specification and shall be free from burrs and malformations.

3. Screw threads, tapped holes, and threaded inserts shall be of the size shown on the detailed specification, and shall be in accordance with FED-STD-H28, unless otherwise specified. No malformed threads shall be accepted. A minimum of three full threads of engagement shall be provided.

4. Clearance holes and hardware such as nuts, washers, etc. shall be of the size shown on the detailed specification, and shall be free of burrs and malformations.

5. Studs, flanges, brackets, etc. shall be securely fastened to the thermal switch case.

14.2.1.3 Residual Gas Analysis. The thermal switches shall be submitted for residual gas analysis (RGA) to a laboratory approved by the qualifying activity of the detailed specification. Thermal switches shall be preheated for 15 minutes (minimum) at 100 degrees C immediately prior to being punctured for RGA. The method of sampling the backfill gas from the thermal switch (i.e., puncturing the thermal switch can) shall not cause damage to the internal parts of the thermal switch nor shall it introduce contaminants into the thermal switch. Immediately after removal from the test chamber, the puncture hole shall be covered with a noncontaminating adhesive tape to prevent the introduction of foreign particles. The composition of gases found shall be in agreement with the supplier's baseline (approved) processes and gases for backfilling the thermal switches. The moisture (H_20) content detected shall not exceed 1000 ppm.

14.2.1.4 Suggested Sectioning CAUTIONLrrux: The introduction of foreign particles during opening can result in unacceptable conditions during the micro-clean inspection of 14.2.1.5. When possible, the micro-clean inspection should be performed through the RGA puncture hole prior to opening the thermal switch can. To avoid damage or deformation of the thermal switch, the use of holding devices such as wire, clamps, or pliers is prohibited. Remove all adjunct sealants for thermal switch headers prior to opening and then do the following:

a. Place temperature-sensing side on a flat grinding surface and apply a steady firm pressure by hand. The grinding operation must not penetrate the case, but should only remove sufficient wall material thickness so the remaining wall thickness (approximately 10 percent) can be readily cut through with a sharp cutting instrument such as an Exacto knife blade.

b. During grinding, vacuum off the affected areas continually or as often as possible in order to remove loose metallic particles that could disrupt later examinations. To avoid damage to the thermal switch enclosure, it should be firmly held by hand during each step of the opening procedure.

NOTE : DO NOT ATTEMPT TO MAKE THE FINAL OPENING OF THE THERMAL SWITCH IN A SHOP AREA.

c. Take the thermal switch to the clean room area where the final micro-clean inspection (14.2.1.5) is to occur. NOTE : A specially cleaned area should be dedicated to the micro-clean inspection.

Personnel traffic shall be limited to those involved in the inspection. An enclosed Class 100 laminar flow bench is typically required to maintain cleanliness. All equipment and material such as microscopes, filters, containers, tweezers, etc. shall be thoroughly cleaned prior to entering the area.

d. Using adhesive tape and a vacuum remove all loose (or potentially loose) particles from around the machined surfaces. Examine the affected areas at 30X magnification to verify that no loose particles are present.

e. Once it has been verified at 30X magnification that the thermal switch exterior is free of particles, do not handle it without using finger cots or lint-free rubber gloves.

14.2.1.5 Micro-clean Inspection.

a. Prior to opening the thermal switch can, the materials and equipment necessary to perform the micro-clean inspection should be set up.

1. A "particle free" source of Freon is required. This may be achieved by obtaining the highest grade purity Freon available and then cycling it several times through 1.2-micron filters. A quantity of this Freon should be placed in a pressure-rinser that is also equipped with its own 1.2-micron filter (use a 25 millimeter diameter filter).

NOTE : Gelman Model No. 7074 and David J. Tripp Associates Model No. 4743 are typical pressure-rinsers.

2. The pressure-rinser with its Freon shall be pressurized from a clean, dry air (or nitrogen) source.

3. Obtain a clean 1.2-micron filter (use a 47 millimeter diameter filter). Verify its initial cleanliness by examining it at 30X magnification.

4. Place the clean filter across the orifice of a flask through which a vacuum can be pulled (see Figure 14-6).

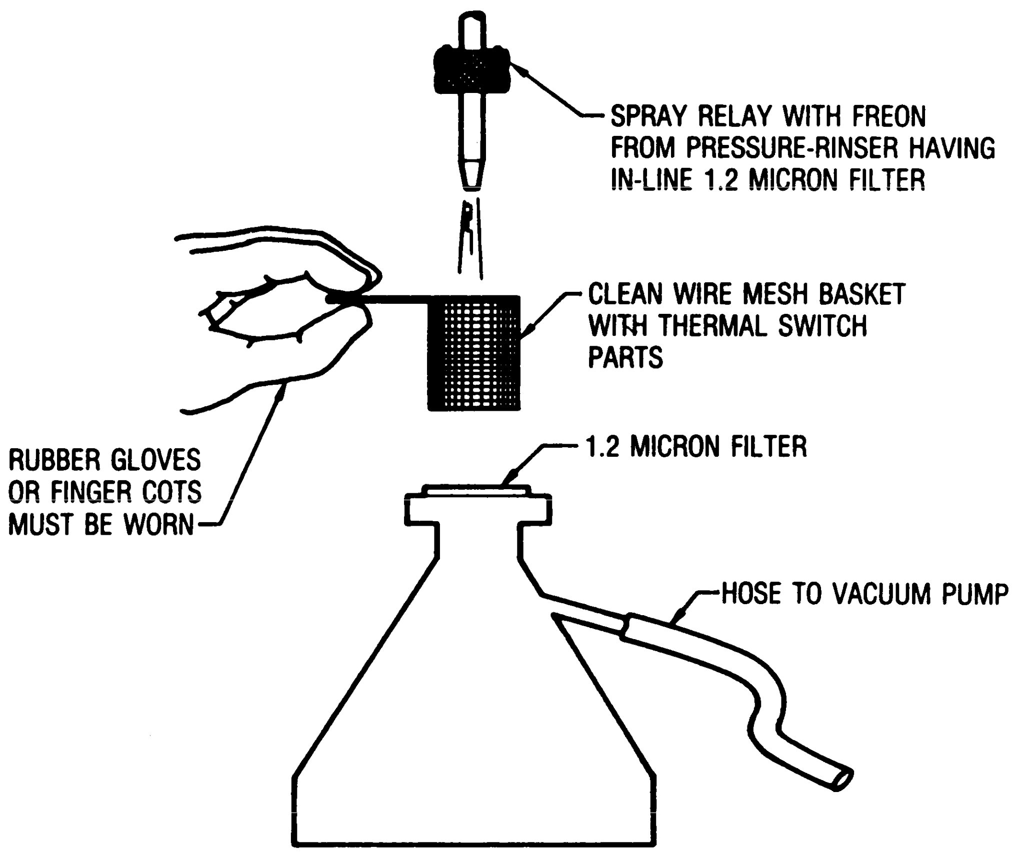


Figure 14-6. Micro-clean inspection of a thermal switch.

5. Spray a small amount of Freon from the pressure–rinser through the filter with the vacuum pump on.

6. Reexamine the filter at 30X magnification to verify cleanliness of the Freon. If particles are observed, repeat step (a) above to obtain clean Freon.

b. The thermal switch whose external cleanliness has been verified may now be opened in the specially cleaned area where the pressure-rinser, filter, and vacuum assembly have been set up. It should be possible to cut through the final wall thickness with an Exacto knife. This operation should be done at 30X magnification with observance for the creation of particles. It may even be necessary to do additional grinding. Any cutting or grinding which is done after the exterior of the thermal switch has been cleaned requires that the cleaning procedures be repeated.

NOTE : To this point all activity has been performed to open the part without introducing particles, to ensure that there are no loose particles on the part's exterior and to provide an inspection system which is itself "particle–free" The importance of not introducing erroneous results cannot be over-emphasized.

c. Place the opened thermal switch can on the table with the opening facing up so that particles (if present) are not dropped out and the switch piece parts are not yet disassembled. Be sure that nothing falls into the can after it has been opened.

d. Use the Freon from the pressure-rinser and wash the thermal switch assembly through the filter with the vacuum on in one of the following ways.

1. Place the thermal switch piece parts into a cleaned wire mesh basket and wash the Freon through the basket over the filter (see Figure 14-6).

2. Pour the Freon into the thermal switch and then empty the Freon through the filter. This process should be repeated three times prior to examining the filter.

e. Examine the filter at 30X magnification. Characterize any particles seen, e.g., metallic or nonmetallic; spherical, thread-like or oblong; glass-like or plastic. Nonmetallic particles greater than 0.025 millimeters (0.001 inches) in any dimension and metallic particles greater than 0.125 millimeters (0.005 inches) in any dimension are unacceptable.

14.2.1.6 Internal Examination Refer to Figures 14-2 through 14-5 for illustrations of thermal switch constructions. All exposed inner surfaces of the device shall be examined for the following characteristics at 20X minimum magnification:

a. Loose particles (conductive or nonconductive), not caused by opening, within the switch or cover that can be detected by 20X magnification, and which were not detected in 14.2.1.5, are unacceptable.

b. Loose, broken, or misaligned components not caused by opening are unacceptable.

c. Evidence of contamination film that can be detected by 20X magnification is unacceptable.

d. Corrosion or peeling of plating or finish is unacceptable.

e. For Type C thermal switches only: Loctite on adjustment screw area other than adjacent to nut, where it is normally applied to secure adjustment screw, is unacceptable. (Loctite is not applicable to Types A and B thermal switches).

f. All materials shall be per the approved supplier's baseline material list. Verification can normally be accomplished by visual examination and comparison with previous DPA samples or qualification samples. If a material's composition is questionable, scanning electron microscope (SEM), X-ray analysis, chemical analysis, or other analytical means may be used to determine material composition.

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SECTION 15

DETAILED REQUIREMENTS FOR THERMISTORS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used thermistors. These requirements supplement the general requirements in Section 4. An example of a typical configuration is depicted in Figure 15–1. When applicable, specification numbers or types are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

15.1 THERMISTOR. GLASS BODIED. HERMETIC (MIL-T-23648).

15.1.1 Method.

15.1.1.1 Exteral Visual. Examin<thermistor at 20X minimum magnification for defects in the glass, construction, marking, leads, and dimensions.

15.1.1.2 Hermeticity Conduct seal tests on all samples in accordance with requirements of the procurement specification.

15.1.1.3 Terminal Strength. Perform a lead pull strength test on all parts (two parts minimum) in accordance with applicable specification.

15.1.1.4 Sample Prepsration. Parts shall be cleaned, encapsulated, and sectioned along the longitudinal axis to a depth that exposes the center of the leads.

15.1.1.5 Internal Visual. Examine sectioned parts under 30X minimum magnification for configuration compliance and compliance with specification requirements and good workmanship.

15.1.2 Data Records. DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

15.1.3 Evalation Criteria When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples exhibit any of the defects listed below (as applicable to the type of part being examined):

a. Cracks in the body

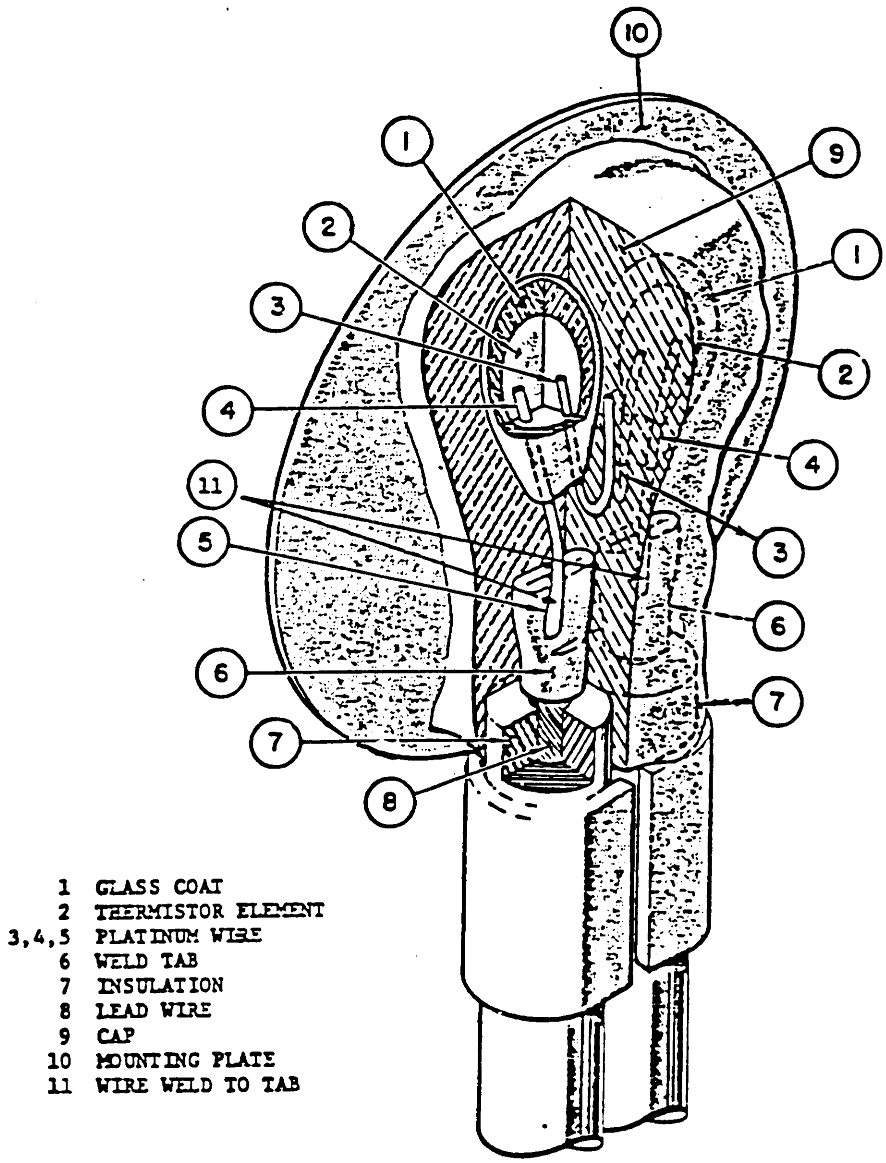

Figure 15-1. Thermistor, Glass Body (Typical).

b. Cracks in the semiconductor material

co Discoloration or distortion of body or semiconductor material

d. Contamination

e. Wire-to-tab weld showing cracks or inadequate weld indentation

f. Broken wire, or dents in the wire greater than l/6th the wire diameter

15.2 THERMISTOR. DISC AND BEAD ENCAPSULATED (MIL-T-23648)

15.2.1 Method.

15.2.1.1 External Visual Perform visual inspection at 20X minimum magnification as in para. 5.1.1.1.

15.2.1.2 Terminal Strength. Conduct terminal strength test (pull test only) on all samples in accordance with the

15.2.1.3 Sample Preparation. Strip plastic coating or case from one-half of the samples, using a suitable solution which exposes but does not attack the thermistor body and lead terminations. The remaining half shall be encapsulated and sectioned along the longitudinal axis to a depth that exposes the center leads.

15.2.1.4 Internal Visual. Examine depotted and axially sectioned samples at 20X minimum magnification for configuration compliance, uniformity, cracks in the body, evidence of metallization on body of disc between lead attachment surfaces, lead insulation, and solder connections. Encapsulated units must be sectioned in a plane such that the connections between the lead and thermistor element are exposed.

15.2.2 Data Records DPA findings that deviate from the specified configuration or other requirements shall be documented as defects.

15.2.3 Evaluation Criteria. When the DPA is being conducted as a Lot Conformance Test, the associated production lot shall be rejected if one or more of the DPA samples exhibit any of the following defects:

a. Cracked body.

b. Evidence of metallization on body of disc between lead and attachment surfaces.

c. Cold solder or loose solder attachment of leads on disc.

d. Lead insulation not mechanically secured to prevent stress on soldered terminations.

e. During terminal strength test, leads shall withstand an 11 Newton (2.5 pound) pull test when tested per MIL-STD-202, Method 211, Test Condition A.

f. Discoloration or contamination on body of disc.

SECTION 16

DETAILED REQUIREMENTS FOR TRANSISTORS

This section describes detailed requirements for a destructive physical analysis (DPA) of commonly used transistors. These requirements supplement the general requirements in Section 4. Examples of typical configuration sketches are included. When applicable, specification numbers or type numbers are referenced to assist in identification. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing and are therefore not addressed.

16.1 TRANSISTORS (MIL-S-19500)

16.1.1 Method.

16.1.1.1 X-ray Examination. X-ray undisturbed samples in two views 90 degrees apart (x and y directions) and note any anomalies. Stud-mounted and axial-leaded devices shall also be X-rayed in both x and y directions.

16.1.1.2 External Visual Examination. Perform an external visual examination at magnification of 15X or greater to adequately resolve the area being examined. Note any change from baseline drawings or any discrepancies. Take one representative photomacrograph of a sample device prior to sectioning and record any evidence of:

a. Damage, corrosion, or contamination.

b. Defects in seal or dents in package.

c. Defects in plating such as flaking, peeling, or blistering.

16.1.1.3 Electrical Tesing. Perform the appropriate Group A electrical tests per the transistor slash sheet or source control drawing. As a minimum, the following tests shall be performed:

Bipolar

I_{CBO}/BV_{CBO}

I_{EBO}/BV_{EBO}

H_{fe}

FET

I_{GSS}/BV_{GSS}

Vp (pinch off)

BVDSS

16.1.1.4 Hermetic Seal The transistors shall be tested according to MIL-TD-750, Method 1071. Fine leak testing shall be according to Condition G or H. The leak rate should be equal to or less than 10^{-7} atm-cc/sec. Gross leak testing shall be according to Condition C, D, or E. No bubbles or fluorescent residue should be present.

16.1.1.5 Suggested Package Delidding. Prior to opening, the height of the header should be determined from the manufacturer's photo expositional drawings or from previous radiographic examination. The lid should be carefully cut with a special can opener device designed specifically for that purpose (any equivalent available device may be used). The cut in the lid should be at a point sufficiently above the header so that the cover can be easily removed by hand. During cutting and removal of the lid, care must be exercised to avoid damage of internal elements or introduction of external contaminants into the internal enclosure area.

16.1.1.6 Internal Visual (decap visual). Each sample device shall be subjected to decap visualal examination, which is in accordance with MIL-STD-750, Method 2072 (reference Figures 16-1 through 16-7):

a. Determination of "as delivered device condition: this examination is a verification that the device sealing process and 100-percent screening have not contaminated or otherwise adversely affected the devices.

b. Verification of pre-seal visual: this examination is a verification of the effectiveness of the pre-seal visual inspection for screening out rejectable devices. For DPA sample devices from inspection lots upon which pre-seal visual inspection has not previously been performed, this examination shall serve as a general assessment of the quality and internal condition of the devices in those particular lots.

c. An evaluation should then be made of the number and types of anomalies to determine if further action should be taken and if corrective action is required. If the lot is suspect, the Parts, Materials, and Processes Control Board shall be notified.

16.1.1.7 Scanning Electron Microscope (sEM) Examination. A quantity of devices, either 1 device or 20 percent of the DPA samples, whichever is larger, from each DPA sample shall be inspected on a scanning electron microscope equipped with X-ray analysis instrumentation. The SEM inspection shall be in accordance with MIL-STD-750, Method 2077. If a fraction of device is calculated using the percentage, then the sample size shall be equal to the next higher integer. Particular attention shall be directed to the items mentioned or referenced in the above paragraphs. In addition, the following items shall be inspected before bond pull:

a. Attached foreign material shall be X-ray analyzed for elemental content. Material suspected of being chemically reactive within the expected life of the component, and hence a latent defect, shall be cause for rejection.

b. Metallization corrosion which is defined as chemical or contaminant interaction with the metal shall be inspected for at 500X minimum magnification. Particular attention should be paid around wire bonds where contamination may be drawn by surface tension during precap cleaning or through hermetic seal leak intrusion. The corrosion shall be X-ray analyzed for chemical content. Metallization corrosion is cause for rejection.

c. Wire bonds, both on the chip and package posts, should be inspected at a minimum magnification of l000X for the presence of microcracks or intermetallic compounds 0.0125 millimeters (0.0005 inches) from bond, when applicable. The condition of the bonds should be noted and recorded by photographs if a defect exists, and compared to subsequent bond pull information.

d. The chip die attach area shall be inspected at 400X minimum magnification for the presence of microcracks. The presence of a perimeter microcrack which is a fracture separation in the bonding material along the attachment interface shall not be acceptable.

16.1.1.8 Bond Pull. Each device in the DPA sample shall undergo a destructive bond pull. All internal wire bonds or clip fasteners for each device shall be pulled to destruction according to MIL-STD–750, Method 2037. The maximum allowable pull rate shall be 0.05 Newtons (5 grams) per second. The minimum bond pull strength criteria shall be as specified in MIL-STD-750, Method 2037, Table I; results of the bond pull test shall be recorded in the lot history records.

16.1.1.9 Die Bond Shear Test A die bond shear test shall be the final DPA step and shall be conducted on 20 percent of the devices in each DPA sample rounded to the next higher integer. Die shear testing shall be conducted as specified in MIL–STD-750, Method 2017. The maximum force applied, the location of the shear, and the percentage of the die still attached shall be recorded and entered in the DPA report. In addition, the results of the die bond shear test performed in screening and comparison made between the shears recorded in screening and DPA shall be presented in the DPA report. The inspection lot shall be rejected if any die shears at a force specified in (acceptance criteria) MIL-STD-750, Method 2017. A photograph of each device tested by this method shall be included in the DPA report. The photo shall be taken of the header in such a manner as to evidence the amount of die still attached.

NOTE : In figures 16-9 through 16-25, the numbers in parentheses represent the applicable paragraph numbers in MIL-STD-750, Method 2072.

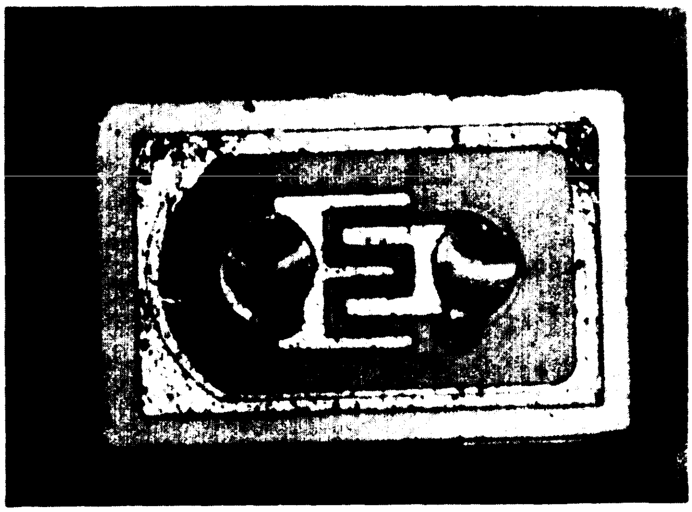

Figure 16-1. Good Die 225X

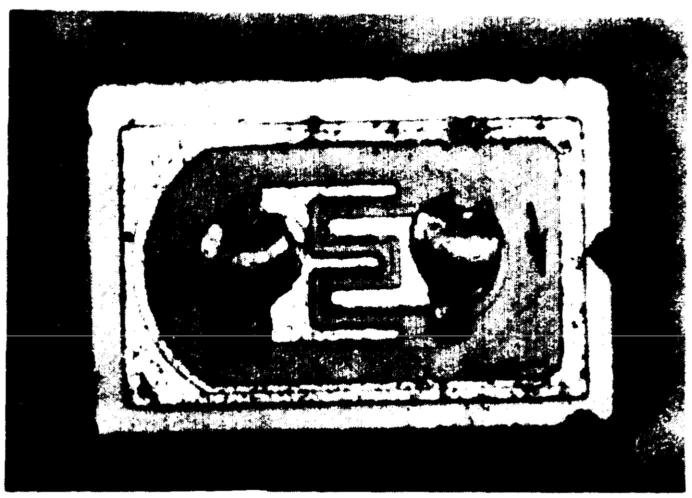

Figure 16-2. Cracked Die in Active Region 225X
(Unacceptable)

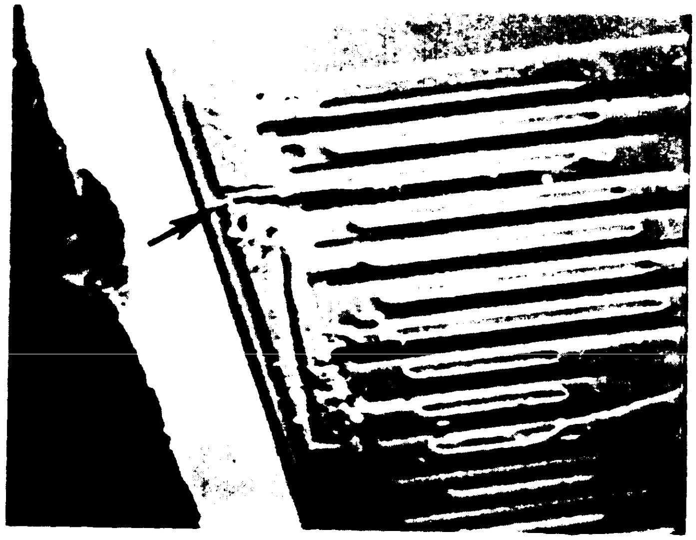

Figure 16-3. Interrupted Metalization 200X Magnification. See Enlargement of Area Depicted by Arrow Below (unacceptable)

Figure 16-4. 500X Magnification of Area Depicted by Arrow

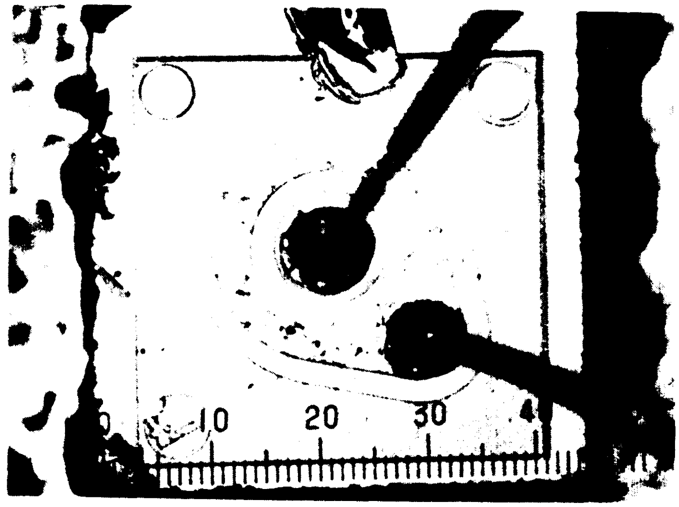

Figure 16-5. Chipped Die, 173X Magnification, (unacceptable)

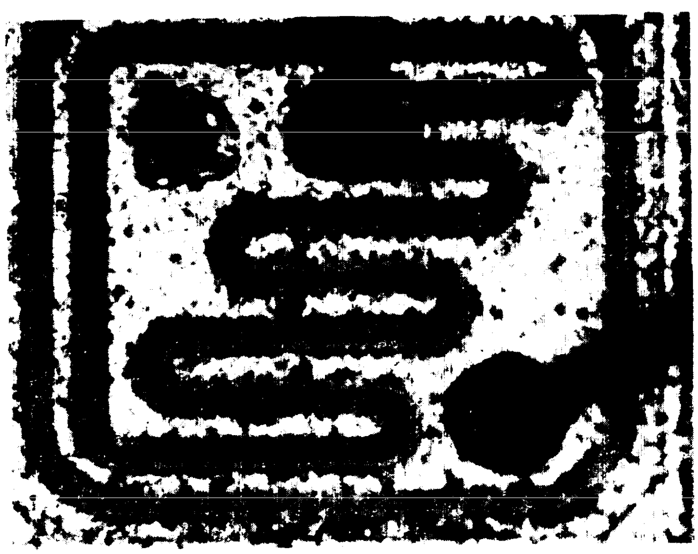

Figure 16-6. Bond Lift-off at Die (unacceptable)

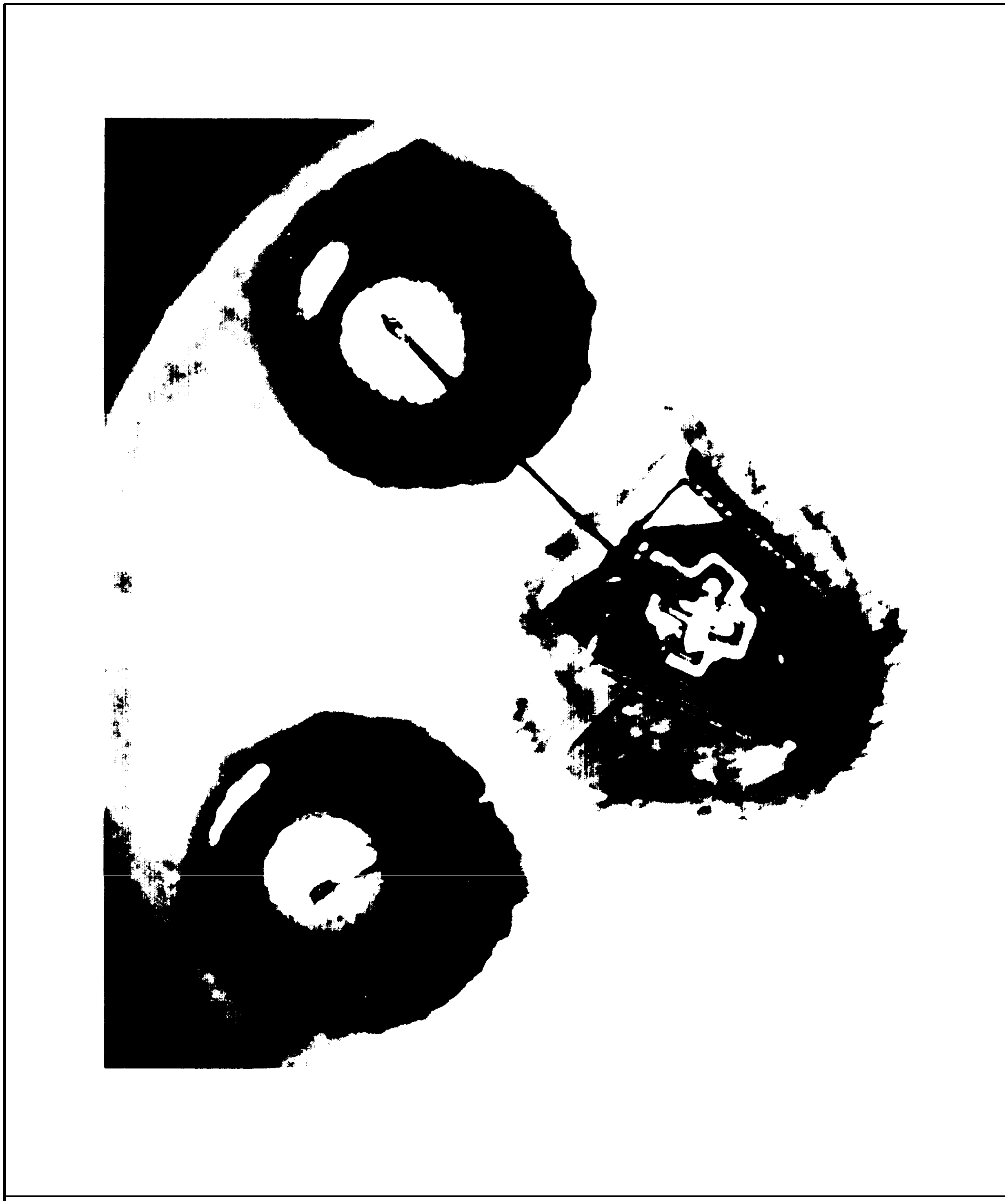

Figure 16-7. Die Fracture (unacceptable)

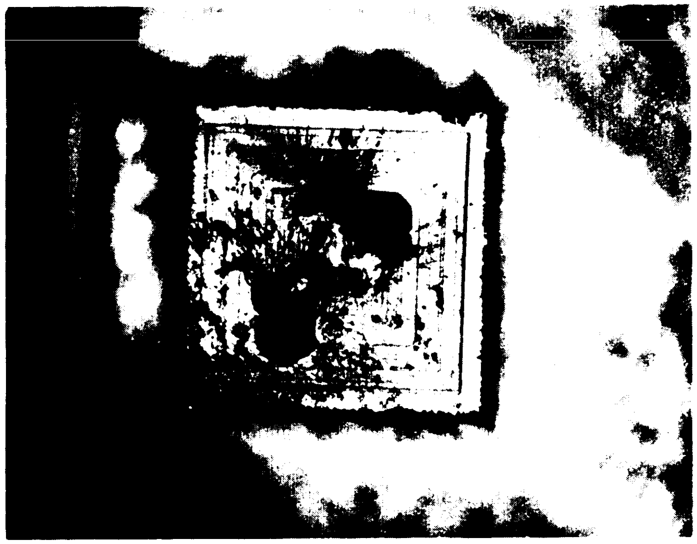

Figure 16-8. Base to Collector Short (unacceptable)

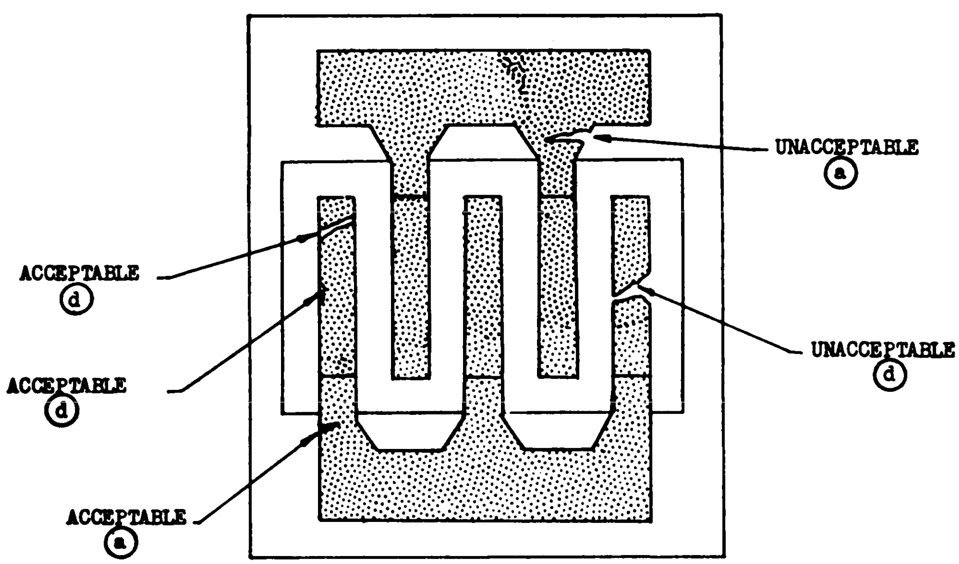

Figure 16-9. (Para 3.1.1.1)

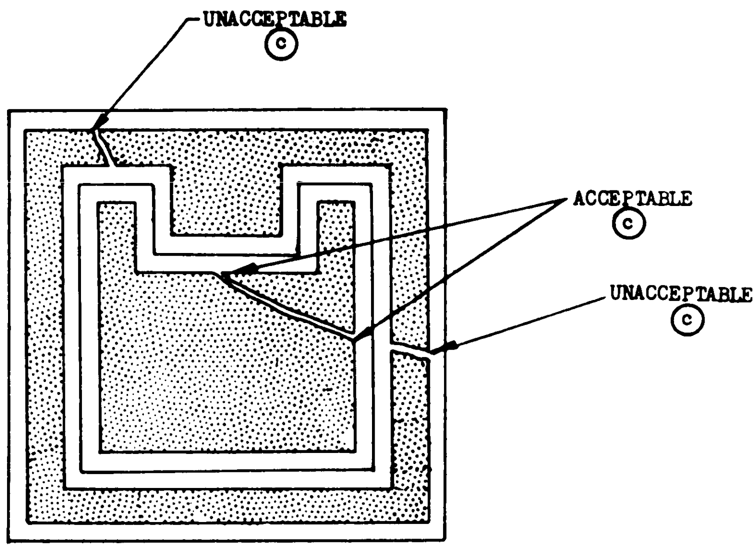

Figure 16-10. (Para. 3.1.1.1)

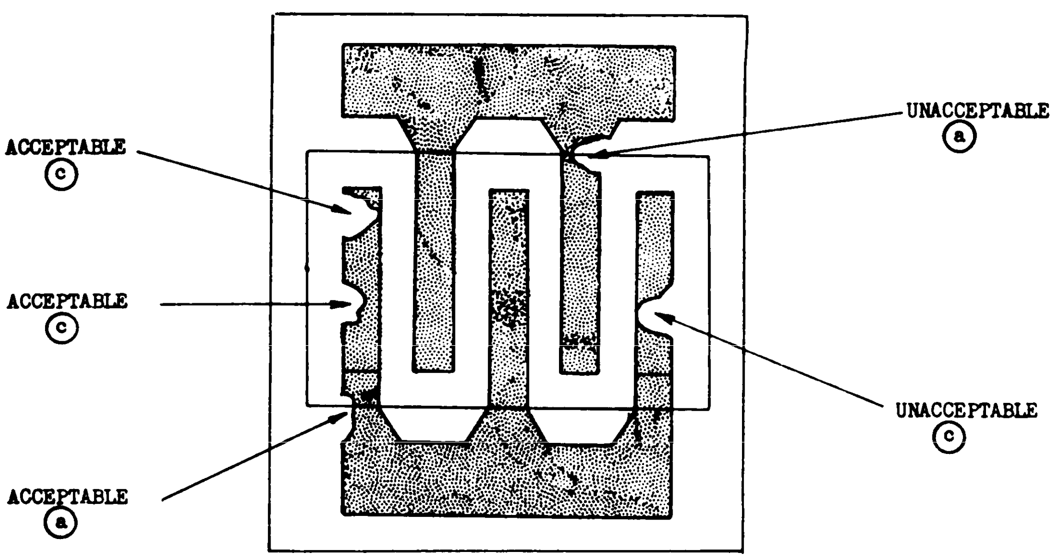

Figure 16-11. (Para. 3.1.1.2)

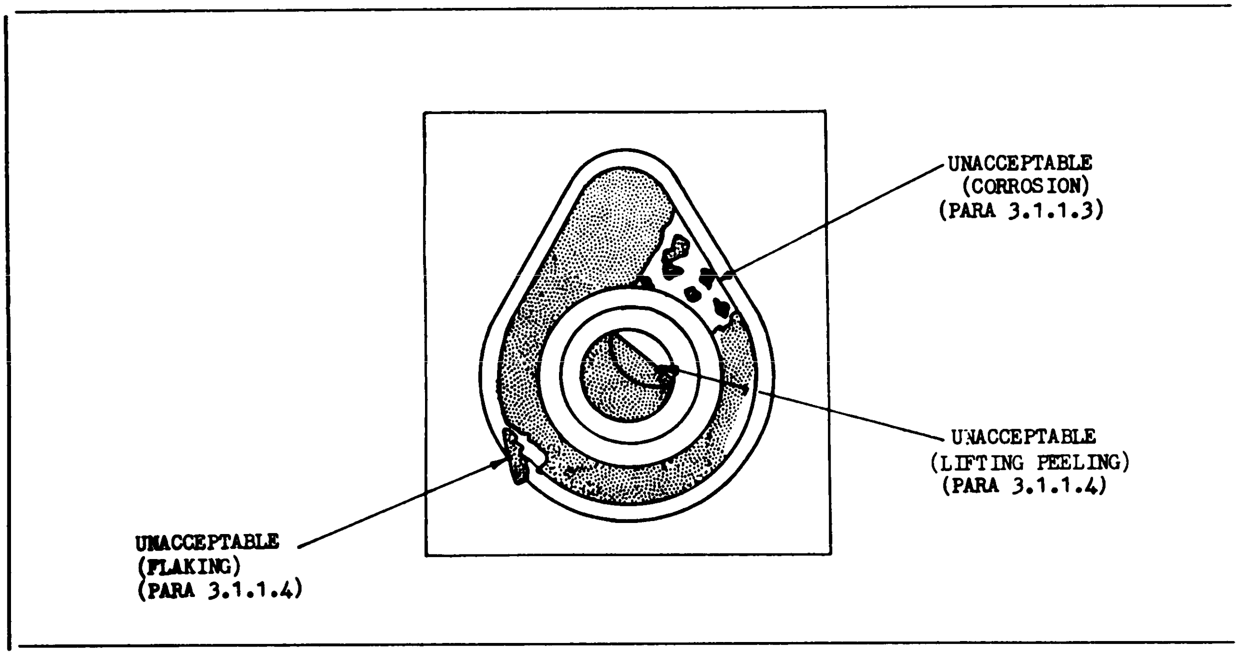

Figure 16-12. (Para. 3.1.1.3 and 3.1.1.4)

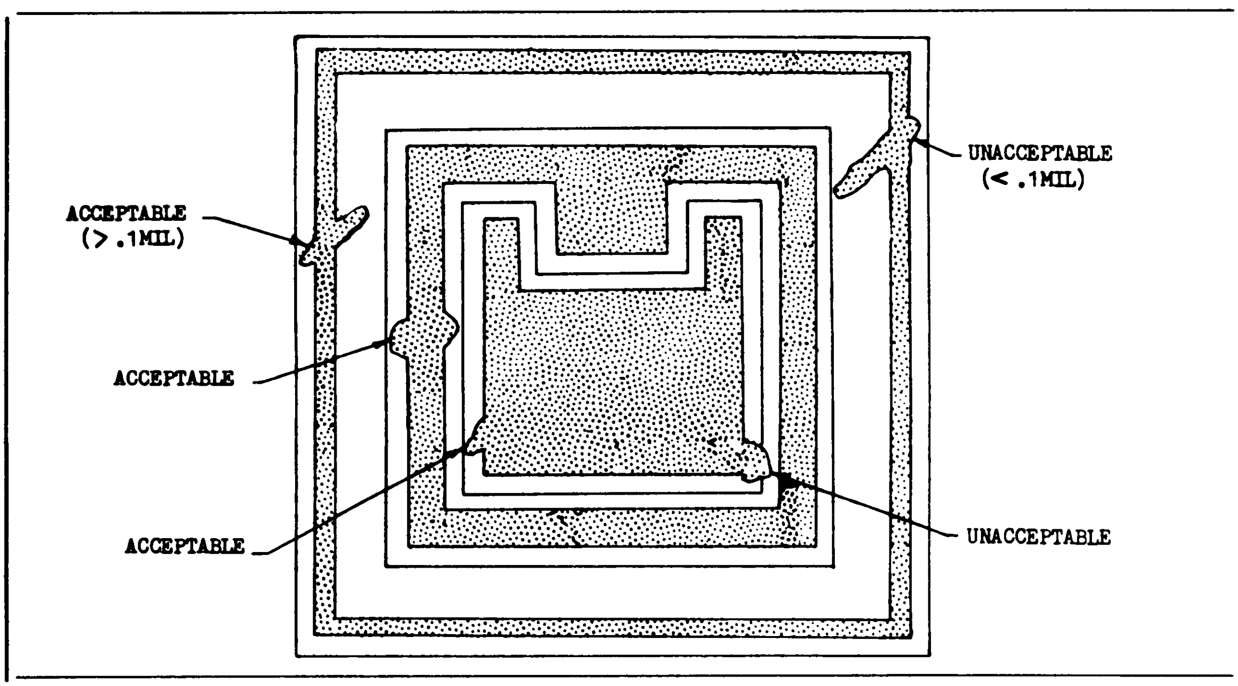

Figure 16-13 (Para. 3.1.1.5)

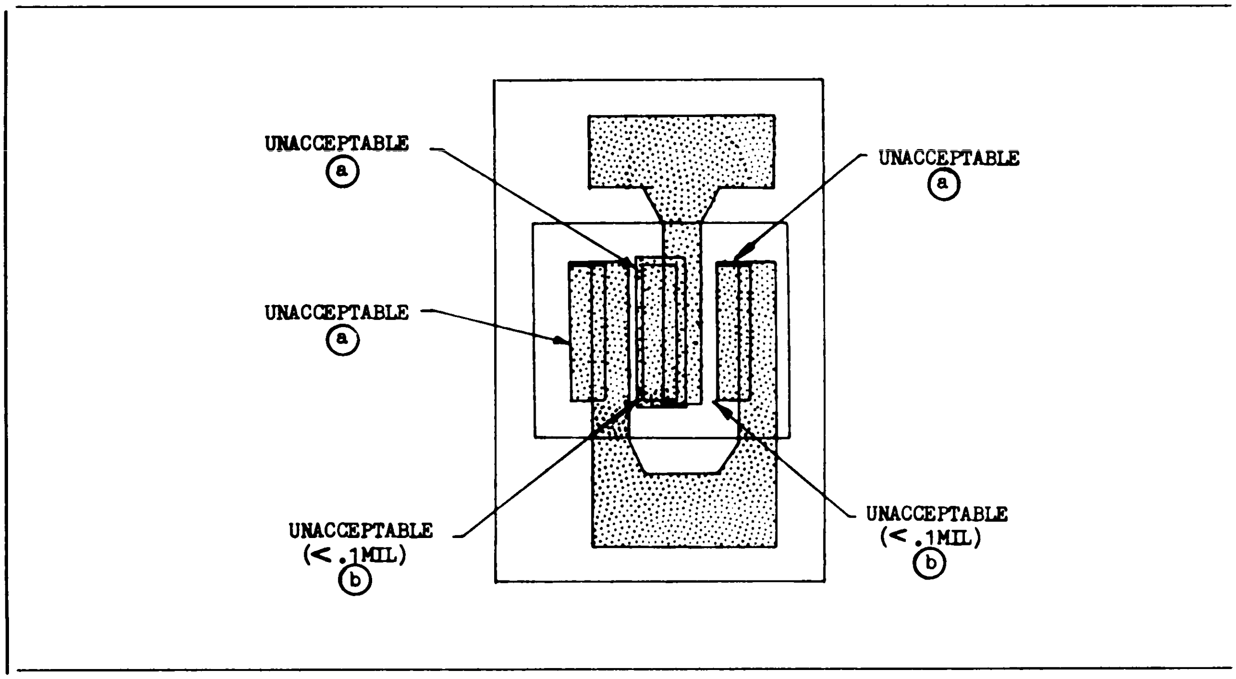

Figure 16-14. (Para. 3.1.1.6)

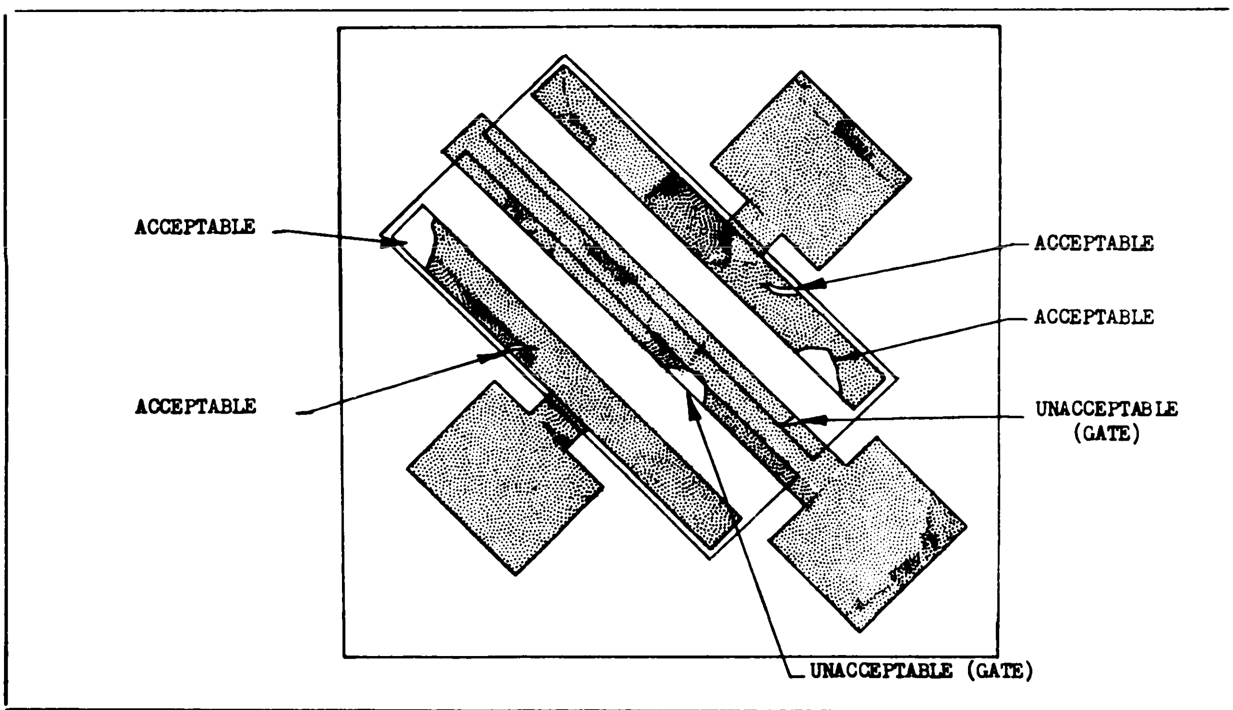

Figure 16-15. (Para. 3.4b)

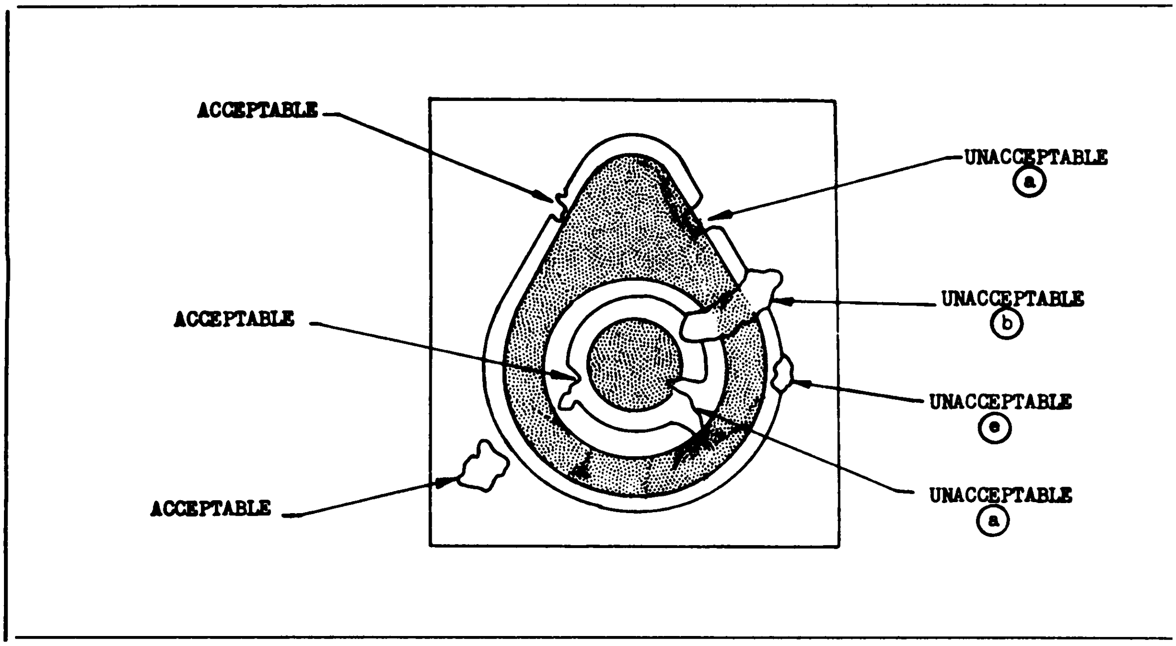

Figure 16-16. (Para 3.1.2)

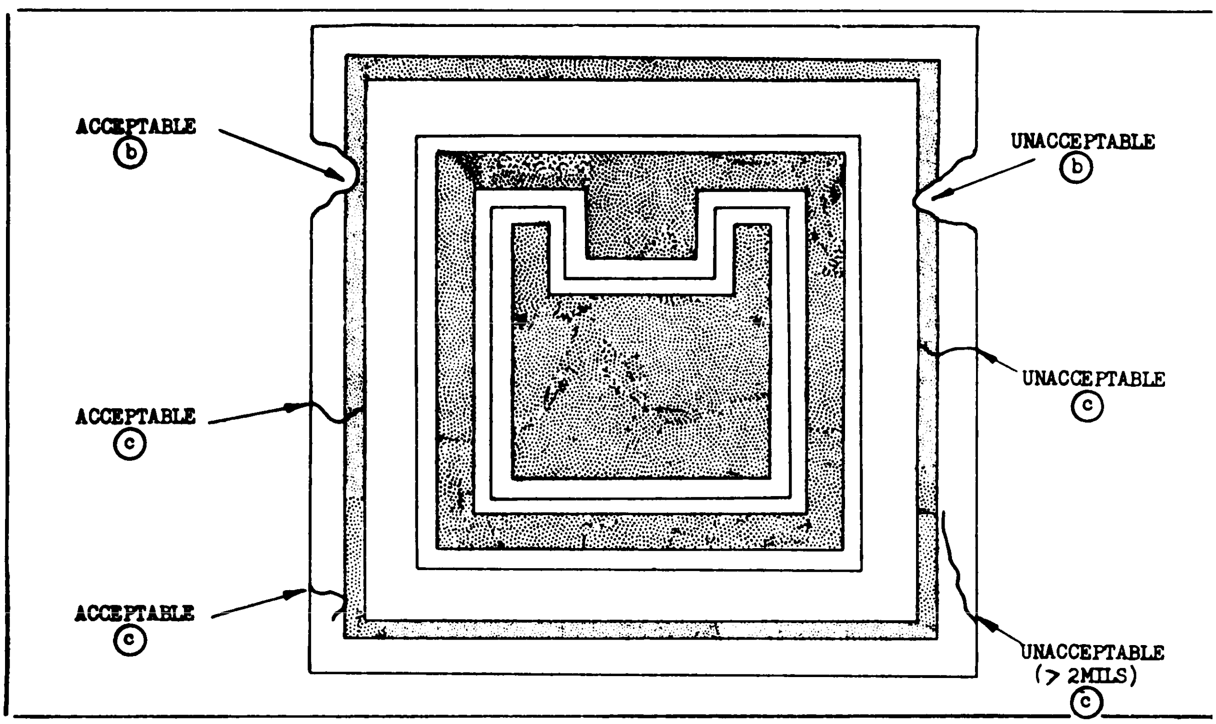

Figure 16-17. (Para. 3.1.3)

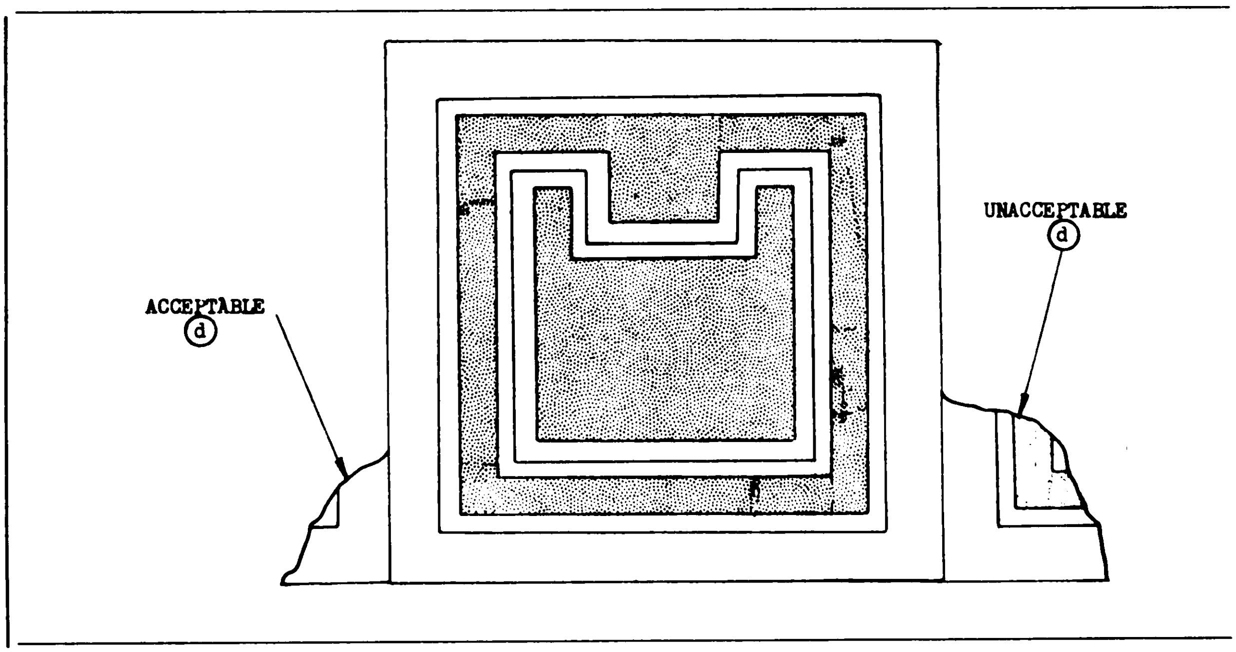

Figure 16-18. (Para. 3.1.3)

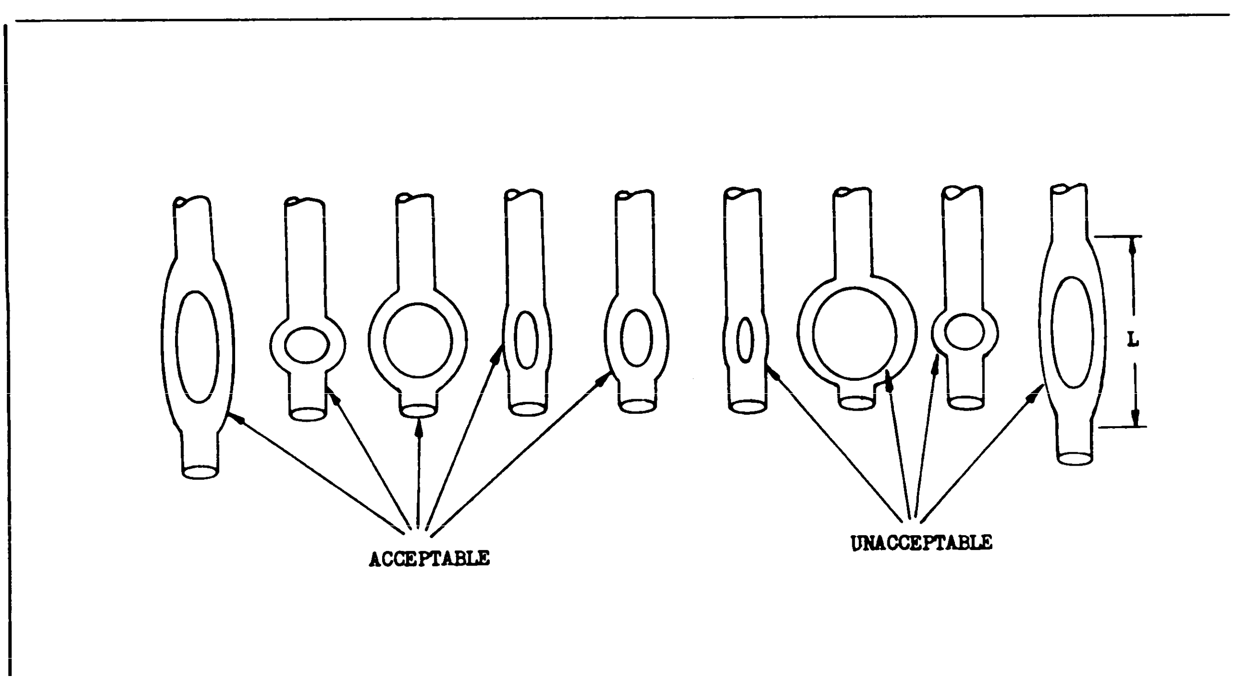

Figure 16-19. (Para. 3.1.4.2a)

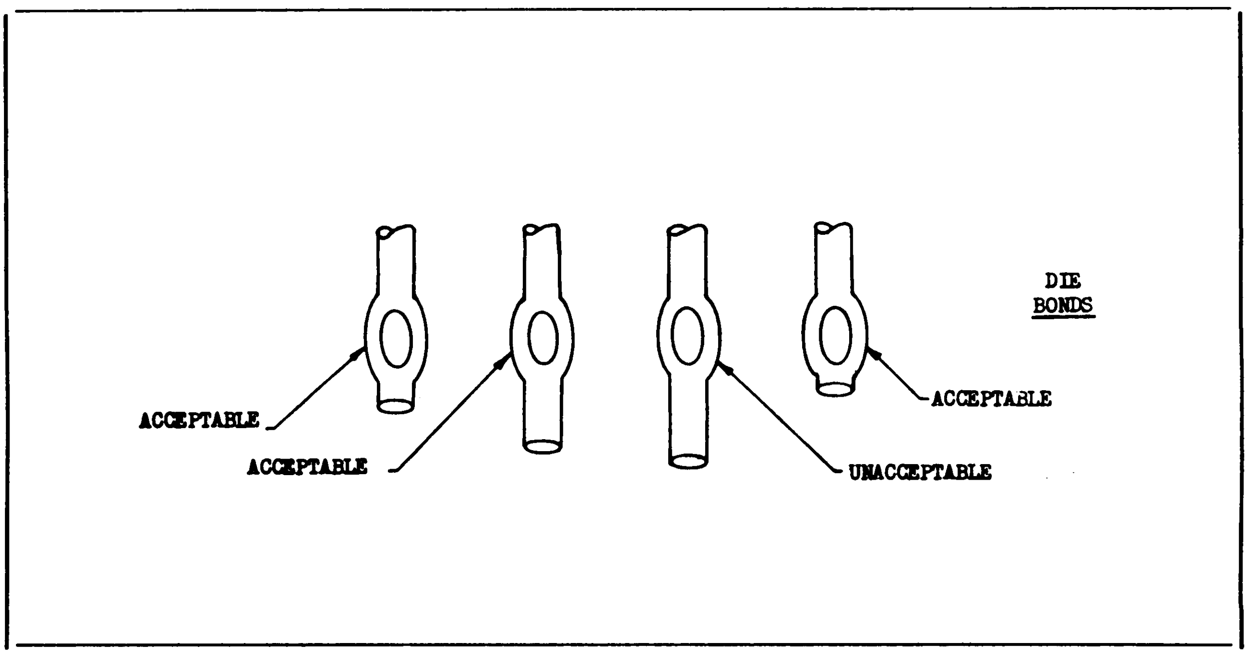

Figure 16-20. (Para. 3.2c)

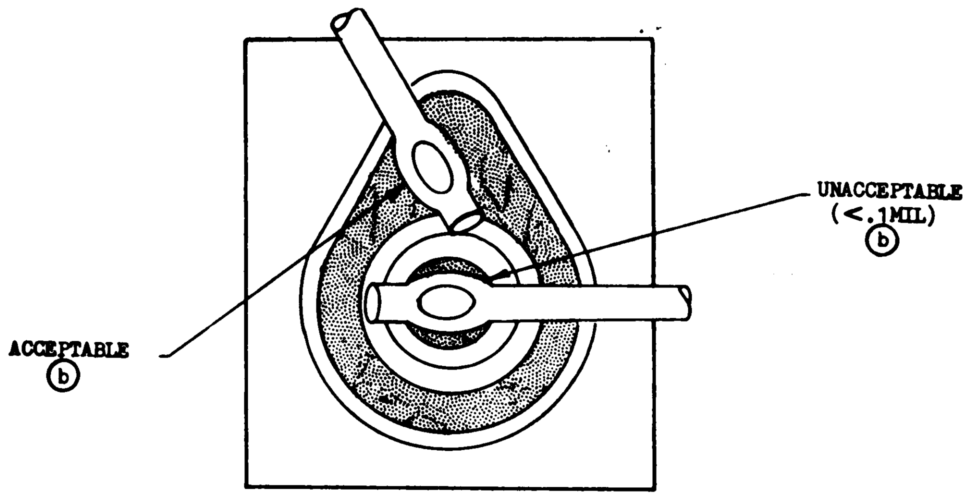

Figure 16-21. (Para. 3.2b)

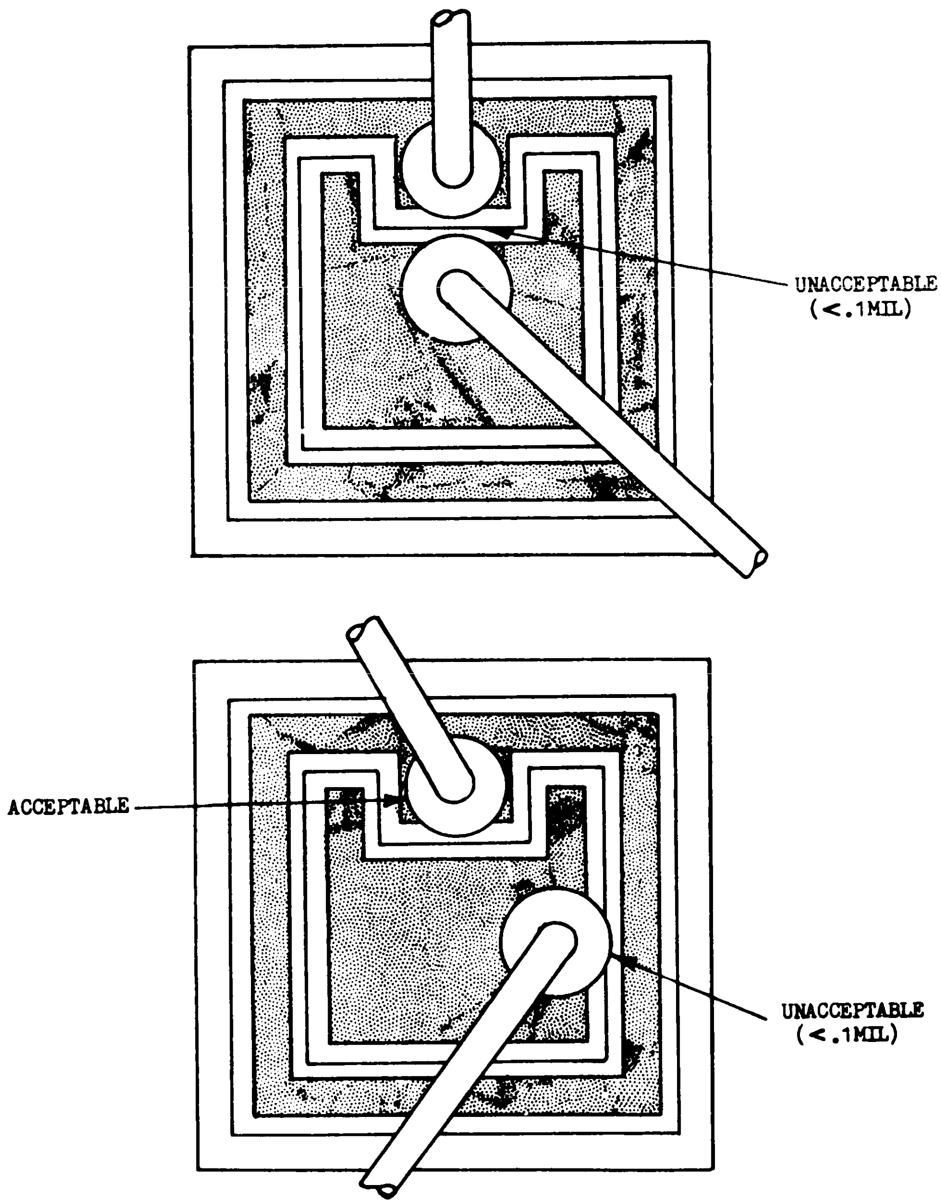

Figure 16-22. (Para. 3.2.6)

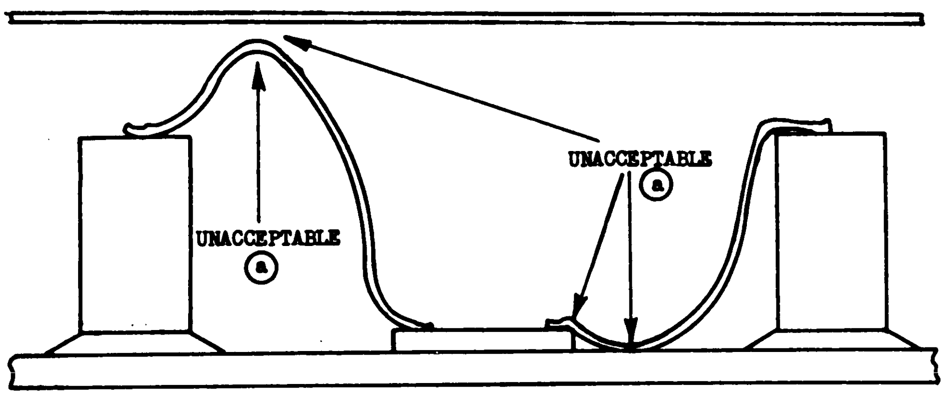

Figure 16-23. (Para. 3.2.2)

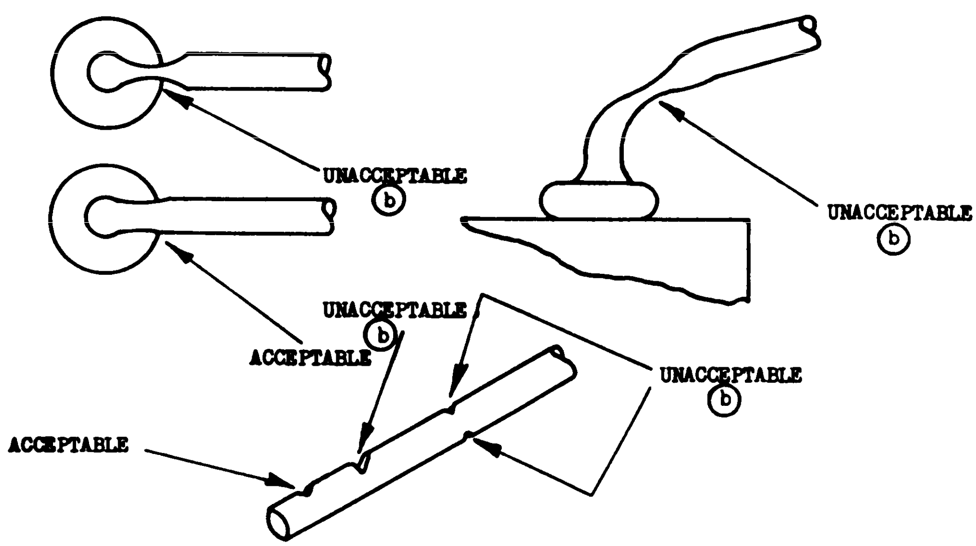

Figure 16-24. (Para. 3.2.2)

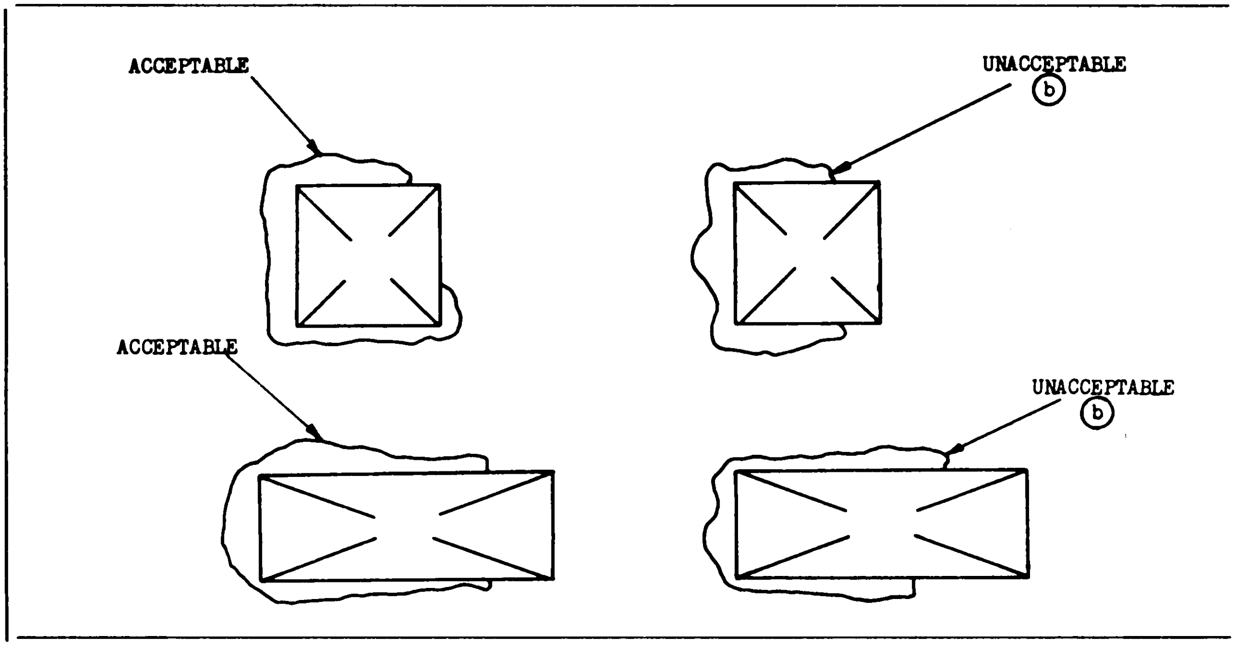

Figure 16-25. (Para. 3.2.3.2)

SECTION 60

NOTES

This Notes section is not a mandatory part of this standard. The contents of this section are intended for use by government acquisition personnel for guidance and information only.

60.1 INTENDED USE

This standard is intended to be referenced, as applicable, in acquisition contracts involving the manufacture of parts or equipment to be used in space and launch vehicles. To ensure the required high quality of the parts, stringent in-process controls must be imposed and a comprehensive test program conducted on the completed parts. A key ingredient of the test program is the assessment of part lot quality based on the destructive examination of samples randomly selected from each production lot. This destructive physical analysis (DPA) is used to verify the internal design, materials, construction, and workmanship of the "as-built" sample parts to preclude installation of parts having patent or latent defects. DPAs can also be used to monitor processes to evaluate supplier production trends and for failure analysis. DPAs can also be used to derive information to aid in defining improvement changes in design, materials, or processes or to aid in dispositioning parts that exhibit anomalies.

60.2 TAILORED APPLICATION

The technical requirements in each contract should be tailored to the needs of that particular acquisition. Military specifications and standards need not be applied in their entirety. Only the minimum requirements needed to provide the basis for achieving the program requirements should be imposed. The cost of imposing each requirement of this standard should be evaluated against the benefits that should be realized. However, the risks and potential costs of not imposing requirements must also be considered. The tailoring should be implemented by the wording used to state the applicable requirements in the specifications or in other contractual documents.

60.3 DOCUMENTATION.

Documents, forms, technical manuals, and data are prepared and distributed in accordance with the Contract Data Requirements List (CDRL) of the applicable contract. The data items discussed in this standard are not deliverable unless invoked by the CDRL or the applicable contract.

60.4 SUBJECT TERM (KEY WORD) LISTING

Analysis
Capacitors
Coils
Connectors
Contacts
Crystals
Decapsulation
Delid
Destructive
Diodes
Filters
Inductors
Inspections
Microcircuits
Particles
Physical
Resistors
Switches
Transformers
Transistors
Thermistors

60.5 CHANGES FROM THE PREVIOUS ISSUE.

This issue of MIL-STD-1580 is a revision that incorporates a large number of changes. The location of these changes from the previous issue are not indicated in the document. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the relationship to the last previous issue.

Custodians
Air Force - 19

Preparing Activity
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(Project No. 1820-F009)
Document 2292b Arch 1421b
Document 2293b Arch 1422b
Document 2294b Arch 1423b

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a. Paragraph Number and Wording:

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