November 25, 1977

Final Report

Design and Quality Standards for Custom Hybrid Microcircuits

Contract NAS8-32610

DCN 1-7-EC-07661 (1F)

Prepared for

George C. Marshall Space Flight Center
National Aeronautics & Space Administration
Marshall Space Flight Center, Alabama 35812

Prepared by

Robert V. Allen
Microsystems Technology, Inc.
11527 So. Memorial Pkwy., Suite B
Huntsville, Alabama 35803

TABLE OF CONTENTS

SUMMARY

Under contract NAS8-32610, "Design and Quality Standards for Custom Hybrid Microcircuits", issued by George C. Marshall Space Flight Center, Microsystems Technology, Inc. has successfully completed a practical hybrid microcircuit standard which will gain wide usage throughout the hybrid industry. This new standard, MSFC-STD-587 (formerly 85M03926A) was prepared after a thorough review of applicable NASA, military, industry, and technical society specifications and standards and compilation of comments from technical reviewers throughout the hybrid industry. The draft of the standard submitted to the technical reviewers, the comments from the reviewers, and the completed standard were thoroughly reviewed with Messrs. Salvadore V. Caruso and George L. Filip.

The tasks performed under the contract were divided into four phases as described below.

Phase I

- Review with MSFC.
- Review of 85M03926A, MIL-STD-883A, MIL-M-38510C, industry and technical society specifications and standards.

Phase II

- Compile findings of reviews in Phase I.
- Prepare preliminary draft.
- Review with MSFC.

Phase III

- Prepare list of reviewers.
- Finalize draft incorporating comments from MSFC review of Phase II.
- Mail draft to reviewers.

Phase III (continued)

- o Compile reviewers comments.
- o Review with MSFC.

Phase IV

- o Complete final standard.
- o Review with MSFC.
- o Complete final report.

This four phase approach adequately depicted the logical progression of the effort performed under the contract to prepare the new standard. This approach incorporated industry and Government review, insured a close and continual interface with MSFC, included addition of state-of-the-art processes and techniques and provided information relating to industry trends in specifications and standards utilization.

SUMMARY OF TECHNICAL REVIEW

A preliminary draft of MSFC standard MSFC-STD-587, "Design and Quality Standard for Hybrid Microcircuits," was submitted to ten technical reviewers throughout the hybrid industry. Each of the reviewers are employed by corporations who are presently supplying hybrid microcircuits to NASA. In addition, Mr. Caruso coordinated a review of the draft within NASA. Seven of the ten reviewers listed in Microsystems Technology, Inc. memorandum 1077-418, addressed to Mr. Harley R. Hope, contract administrator, responded and each offered significant constructive comments. A listing of the reviewers and notation of whether or not they responded is given below.

Reviewers offering comments

- Robert B. Golightly, Aerojet ElectroSystems
- Richard P. Himmel, Hughes Aircraft
- James C. Lawson, Sperry Flight Systems
- Raj Patel, Applied Technology
- David T. Somerville, Rockwell International
- John Weinstein, Circuit Technology
- Daniel D. Zimmerman, Applied Physics Laboratory

Reviewers not responding

- Charles A. Harper, Westinghouse
- Sam S. Hartin, Martin-Marietta
- Carl E. Peckinpaugh, E-Systems

The majority of the comments were significant and constructive and in most cases the comments were incorporated into the final standard. One general comment offered by all reviewers was praise for MSFC in taking the lead to produce a useful and practical standard. The comments indicated that

such a standard is critically needed in the hybrid industry. Also, the unique structure and style of the standard, which tabulates the acceptable and not acceptable requirements by quality class level, received favorable comment from all reviewers. The most significant comments are summarized below.

- o A paragraph on manufacturer certification should be added under the product assurance requirements. The draft contains a statement that hybrid devices supplied in accordance with this standard should be manufactured on certified lines, but there is no reference as to what constitutes a certified line.

- o The requirements for application of discrete devices should be expanded to include carrier mounted inductors, MOS capacitors, and tantalum chip capacitors.

- o Use of solder for attachment of discrete devices should be permitted for all classes. The standard permits use of solder for sealing for classes B and C and for attachment of substrates for all classes, but only permits use of solder for attachment of discrete devices for class C.

- o Not permitting delidding of sealed hybrid devices for any reason is very restrictive and costly. This requirement should be relaxed to permit delidding of class B and C hybrid devices.

- o Solder sealing requirements should be expanded to include class A hybrid devices in addition to class B and C which are presently specified.

- o Screening, quality conformance, and qualification of hybrid devices as presently listed should be deleted in its entirety and substituted with a reference to the use of MIL-STD-883B, Method 5008, which was issued with an effective date of August 31, 1977.

- o Constant acceleration testing for screening, quality conformance, and qualification should be deleted as the G levels required to adequately evaluate wire bonds and attachment of discrete devices would cause the hybrid package or lid to rupture.

If required, the detailed contact reports with each reviewer can be supplied to MSFC. However, the major comments are all listed above.

MSFC-STD-587 contains several major features that set it apart from other standards which make it useful and practical and will guarantee its wide usage throughout the industry. The major features of the standard with paragraph and table references in parenthesis include the following.

- Inclusion of a table of contents for quick and easy reference, a feature not found in military specifications, but which has been a common practice for NASA.
- Clear and concise definition of class A, class B, and class C hybrid devices (paragraphs 1.2.1 through 1.2.3).
- Definitions of production lot, inspection lot, inspection sublot, rework, procuring activity and qualifying activity (paragraphs 3.1.2 through 3.1.2.6).
- Classification of requirements (paragraph 3.2) for easy reference to product assurance, documentation, design and construction, quality inspection, marking, and workmanship requirements.
- Manufacturer certification requirements by program or project authorized by the procuring activity and qualifying activity (paragraph 3.3.1).
- Modification of screening requirements to include constant acceleration or mechanical shock for class A hybrid devices and addition of partical impact noise detection (PIND) test for both class A and class B hybrid devices (paragraph 3.3.3 and Table I).
- Detail documentation requirements (paragraph 3.4).
- Expanded use of discrete devices to include beam tape carrier dice, bump contact dice, MOS chip capacitors, tantalum chip capacitors, and inductors (paragraph 3.5.4 and Table II).
- Allowance to use gold, gold alloy or palladium silver terminated capacitors, inductors, and resistors (paragraph 3.5.4 and Table II).

- Detailed qualification testing, incoming receiving inspection, and screening testing requirements for discrete devices and requirement for all discrete devices to be procured with detail source control documents (paragraph 5.5.4 and Table III).

- Allowance to use silver epoxy for attachment of discrete devices and substrates (paragraphs 3.5.6 through 3.5.6.5 and Table IV through VIII).

- Expanded sealing requirements to permit solder sealing for class B and class C hybrid devices (paragraph 3.5.8 and Table X).

- Reference of internal visual inspection requirements to MIL-STD-883, Method 2017 (paragraph 3.6.2).

- Reference of rework provisions to MIL-M-38510 (paragraph 3.8.1).

- Definition of destructive and nondestructive tests (paragraphs 4.3.1.2 and 4.3.1.3).

- Incorporation of MIL-STD-883, Method 5008 to specify all screening, quality conformance, and qualification test procedures. This adds internal water vapor content, scanning electron microscope, die shear strength, particle impact noise detection, and physical dimensions tests (paragraph 4.4 and Table I).

The above represents the most significant features of the standard "Design and Quality Standard for Custom Hybrid Microcircuits," MSFC-STD-587, which was completed under the contracted work effort. The complete standard is contained as a section within the final report.

MSFC-STD-587
November 25, 1977

ADVANCE COPY

DESIGN AND QUALITY STANDARD
FOR
CUSTOM HYBRID MICROCIRCUITS

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

TABLE OF CONTENTS

page

LIST OF TABLES

1. SCOPE

1.1 Statement of Scope. This standard established the general requirements for design, fabrication, documentation, and quality assurance of hybrid microcircuits. Additional requirements which are relevant to specific hybrid devices shall be contained in the applicable detail procurement document.

1.2 Classification. This standard covers hybrid microcircuits of three levels of product control as described in paragraphs 1.2.1, 1.2.2, and 1.2.3.

1.2.1 Class A. These hybrid devices shall be of the highest order of reliability and shall be subjected to all constraints and requirements specified in this standard. These hybrid devices shall be intended for use in applications of a degree of criticality relating to mission success or crew safety. These hybrid devices shall also be intended for use where maintenance and replacement are exceedingly difficult.

1.2.2 Class B. These hybrid devices shall be intended for use in applications of a degree of criticality relating to loss of important experiments and losses of equivalent importance. These hybrid devices shall also be intended for use where maintenance and replacement are difficult and expensive.

1.2.3 Class C. These hybrid devices shall be intended for use in applications of a degree of criticality relating to mission delay or degradation of experiment data.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this standard to the extent specified in this standard. Unless otherwise indicated, the issue in effect on the date of invitation for bids or request for proposal shall apply.

SPECIFICATIONS

Military

MIL-M-38510	Microcircuit, General Specification for
MIL-M-55565	Microcircuits, Packaging of

STANDARDS

Military

MIL-STD-883	Test Methods and Procedures for Microelectronics

STANDARDS (continued)

George C. Marshall Space Flight Center

MSFC-STD-586	Specification for the Selection and Use of Organic Adhesives in Hybrid Microcircuits

3. REQUIREMENTS

3.1 General. Hybrid microcircuits supplied to this standard shall conform to the requirements specified in paragraphs 3.3 through 3.8.1 for the particular hybrid device class and to the requirements specified in the applicable detail procurement document.

3.1.1 Conflicting Requirements. In the event of conflict between the requirements of this standard and other requirements of the applicable procurement document, the following order of precedence shall prevail.

a. Individual procurement document.

b. This standard.

c. MSFC documents specified in this standard.

d. Other documents specified in this standard.

3.1.2 Terms, Definitions, and Symbols. Unless otherwise specified, terms, definitions, and symbols shall be defined in MIL-M-38510 and MIL-STD-883.

3.1.2.1 Production Lot. A production lot shall consist of devices manufactured on the same production line by means of the same production technique, materials, controls and design. Where a production lot identification is terminated upon completion of substrate processing, or at any later point prior to hybrid device sealing, it shall be permissible to process more than a single hybrid device type in a single production lot provided traceability is maintained by assembling hybrid devices into inspection lots, as defined in this standard, at the point where production lot identification is terminated.

3.1.2.2 Inspection Lot. An inspection lot shall consist of hybrid devices submitted at one time for inspection to determine compliance with the applicable requirements and acceptance criteria. Each inspection lot shall consist of hybrid devices of a single type or may consist of a collection of inspection sublots. Inspection lot identification shall be maintained from the time the lot is assembled to the time it is accepted.

3.1.2.3 Inspection Sublot. An inspection sublot shall consist of hybrid devices of a single type contained on a single detail specification, manufactured through final seal by the same production techniques, same device design requirements, the same package, the same material requirements, and the same sealing period not exceeding six weeks.

3.1.2.4 Rework. Any processing or reprocessing operation, other than testing, applied to an individual hybrid device, or part thereof, and performed subsequent to the prescribed nonrepairing manufacturing operations which are applicable to all hybrid devices of that type.

3.1.2.5 Procuring Activity. The organizational element of the government which contracts for articles, supplies or services; or it may be a contractor or subcontractor when the organizational element of the government has given specific written authorization to such contractor or subcontractor to serve as agent of the procuring activity. A contractor or subcontractor serving as agent of the procuring activity shall not have the authority to grant waivers, deviations or exceptions to this specification unless specific written authorization to do so has also been given by the government organization.

3.1.2.6 Qualifying Activity. The organizational element of the government grants certification, and qualification for the specific associated hybrid device in accordance with this specification and the applicable procurement document; or it may be a contractor or subcontractor when the organizational element of the government has given specific written authorization to such contractor or subcontractor to serve as agent of the activity. A contractor or subcontractor serving as agent of the activity shall not have the authority to grant waivers, deviations or exceptions to this specification unless specific written authorization to do so has also been given by the government organization.

3.2 Classification of Requirements. The requirements and reference paragraphs for hybrid microcircuits classified in this standard are as follows.

Requirement	Paragraph
Product Assurance Requirements	3.3
Manufacturer Certification	3.3.1
Qualification	3.3.2
Screening	3.3.3
Documentation Requirements	3.4
Design and Construction	3.5
Package Construction	3.5.1
External Metal Surfaces	3.5.2
External and Internal Materials	3.5.3
Discrete Devices	3.5.4
Layout and Design Requirements	3.5.5
Mounting and Attachment Requirements	3.5.6
Active Devices	3.5.6.1
Capacitors	3.5.6.2
Inductors	3.5.6.3
Resistors	3.5.6.4
Substrates	3.5.6.5

3.2 Classification of Requirements (continued).

Requirement	Paragraph
Electrical Interconnection Requirements	3.5.7
Sealing Requirements	3.5.8
Production Changes	3.5.9
Quality Inspection	3.6
Discrete Devices Inspection	3.6.1
Incoming Receiving Inspection	3.6.1.1
Qualification	3.6.1.2
Screening	3.6.1.3
Internal Visual Inspection	3.6.2
Marking	3.7
Workmanship	3.8
Rework Provisions	3.8.1

3.3 Product Assurance Requirements.

3.3.1 Manufacturer Certification. Manufacturers supplying hybrid microcircuits produced in accordance with this standard shall be certified by the applicable procuring activity and qualifying activity.

3.3.2 Qualification. Hybrid microcircuits manufactured in accordance with this standard and the applicable procurement document shall be products which are qualified for listing on the approved products list of the applicable program or project.

3.3.3 Screening. Hybrid microcircuits manufactured in accordance with this standard and the applicable procurement document shall be subjected to, and passed, all the screening tests detailed in Table I and the applicable screening tests of MIL-STD-883, Method 5008.

3.4 Documentation Requirements. Design, topography, schematic circuit information, process control plan and quality plan for hybrid microcircuits supplied to this standard shall be submitted to the qualifying activity and shall be available for review by the procuring activity and the qualifying activity upon request. This documentation shall be sufficient to depict completely the physical and electrical construction of the hybrid microcircuit supplied in accordance with this standard and shall be traceable to the specified part, drawing, or type number to which it applies, and to the production lot and inspection lot codes under which the hybrid microcircuits are manufactured and tested.

Table I. Screening Requirements for Hybrid Microcircuits

Requirement	Test Method (1)	Quality Level		
		Class A	Class B	Class C
Internal Visual	2017	Required	Required	Required
Stabilization Bake	1008 (2)	Required	Required	Required
Temperature Cycling	1010 (3)	Required	Required	Required
Constant Acceleration or Mechanical Shock	2001 (4) 2002 (5)	Required	--------	--------
Interim Electrical Test	----	Required	--------	--------
Burn-In Test	1015 (6)	Required	Required	Required
Fine Leak Test	1014	Required	Required	Required
Gross Leak Test	1014	Required	Required	Required
Partical Impact Noise Detection Test	2020	Required	Required	--------
Final Electrical Test	----	Required	Required	Required
External Visual	2009	Required	Required	Required

NOTES: (1) Applicable test method of MIL-STD-883.

(2) Test condition C, 24 hours minimum.

(3) Test condition C, 10 cycles.

(4) Test condition A, Y_1 orientation only.

(5) Test condition B, Y_1 orientation only.

(6) Classes A and B 240 hours, 125°C; class C 168 hours, 125°C.

3.5 Design and Construction. Hybrid microcircuit design and construction shall be in accordance with the requirements specified in this standard and the applicable procurement document.

3.5.1 Package Construction. Unless otherwise specified, all hybrid devices manufactured in accordance with this standard shall be designed with glass or ceramic feed-thru metal hermetically sealed packages.

3.5.2 External Metal Surfaces. External metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion. External lead material and finish shall be per the hybrid device detail specification and shall be capable of meeting the solderability test requirements of MIL-STD-883, Method 2003.

3.5.3 External and Internal Materials. External materials shall be inherently non-nutrient to fungus. Internal and external materials shall not blister, crack, outgas, soften, flow or exhibit defects that adversely affect storage, operation, or environmental capabilities of hybrid microcircuits under the specified test conditions.

3.5.4 Discrete Devices. All active and passive discrete devices utilized in the manufacture of hybrid microcircuits procured with this standard and the applicable procurement document shall conform to the application and requirements specified in Tables I and III.

Table II. Discrete Device Application for Hybrid Microcircuits

Discrete Device Type	Configuration	Quality Level		
		Class A	Class B	Class C
Active	Beam Lead	A	A	A
	Beam Tape Carrier	A	A	A
	Bump Contact Die	N	A	A
	Carrier Mounted Die	A	A	A
	Packaged (leaded)	N	N	A
	Unpackaged Die	A	A	A
Capacitor	Beam Lead	A	A	A
	Ceramic Chip (2)	A	A	A
	MOS Chip	A	A	A
	Packaged (leaded)	N	N	A
	Tantalum Chip (2)	A	A	A
Inductor	Carrier Chip (2)	A	A	A
	Packaged (leaded)	N	N	A
Resistor	Beam Lead	A	A	A
	Packaged (leaded)	N	N	A
	Thick Film Chip (2)	A	A	A
	Thin Film Chip	A	A	A

NOTES: (1) Designations A and N represent acceptable and not acceptable respectively.

(2) Termination metallization shall be gold, gold alloy, or palladium-silver.

Table III. Discrete Device Requirements for Hybrid Microcircuits

Requirement	Reference Paragraph (1)	Quality Level		
		Class A	Class B	Class C
Qualification Testing	3.6.1.2	Required	Required	--------
Source Control Procurement Document	-------	Required	Required	Required
Incoming Receiving Inspection	3.6.1.1	Required	Required	Required
Screening Test	3.6.1.3 (2)	Required	Required	--------

NOTES: (1) Reference paragraph of this standard.

(2) Lot sampling plan per MIL-M-38510, Appendix B.

3.5.5 Layout and Design Requirements. The manufacturer's layout and design guidelines used to produce hybrid microcircuits in accordance with this standard and the applicable procurement document shall be available for review by the applicable qualifying and procuring activity upon request.

3.5.6 Mounting and Attachment Requirements. Mounting and attachment requirements for discrete devices and substrates shall conform to the requirements specified in paragraphs 3.5.6.1 through 3.5.6.5.

3.5.6.1 Active Devices. Mounting and attachment requirements for active devices shall conform to those specified in Table IV.

Table IV. Mounting and Attachment Requirements for Active Devices

Part Type	Mounting Technique	Quality Level		
		Class A	Class B	Class C
Beam Lead	Thermocompression	A	A	A
	Compliant Bond	A	A	A
	Wobble Bonder	A	A	A
Unpackaged Die	Eutectic (3) (4)	A	A	A
	Conductive Epoxy (2)	A	A	A
	Nonconductive Epoxy (2)	A	A	A
Carrier Mounted Die	Eutectic (3) (4)	N	N	A
	Solder	N	N	A
	Conductive Epoxy (2)	N	A	A
	Nonconductive Epoxy (2)(3)	A	A	A
Bump Contact Die	Thermocompression	N	A	A
	Solder	N	N	A
Packaged (leaded)	Solder	N	N	A
Beam Tape Carrier	Thermocompression	A	A	A
	Conductive Epoxy (2)	A	A	A
	Solder (3)	N	N	A

NOTES: (1) Designations A and N represent acceptable and not acceptable, respectively.

(2) Conductive and nonconductive epoxies shall conform to MSFC-STD-586. Conductive epoxy shall be gold or silver.

(3) Applicable to non-inverted mounting condition only.

(4) Eutectic shall be gold alloy.

3.5.6.2 Capacitors. Mounting and attachment requirements for capacitors shall conform to the requirements specified in Table V.

Tab' V. Mounting and Attachment Requirements for Capacitors

Part Type	Mounting Technique	Quality Level		
		Class A	Class B	Class C
Beam Lead	Thermocompression	A	A	A
	Compliant Bond	A	A	A
	Wobble Bond	A	A	A
Ceramic Chip	Conductive Epoxy (2)	A	A	A
	Nonconductive Epoxy (2)	A	A	A
	Solder or Eutectic (3)	N	N	A
MOS Chip	Eutectic (3)	A	A	A
	Conductive Epoxy (2)	A	A	A
	Nonconductive Epoxy (2)	A	A	A
Packaged (leaded)	Solder	N	N	A
Tantalum Chip	Conductive Epoxy (2)	A	A	A
	Nonconductive Epoxy (2)	A	A	A
	Solder or Eutectic (3)	N	N	A

NOTES: (1) Designations A and N represent acceptable and not acceptable, respectively.

(2) Conductive and nonconductive epoxies shall conform to MSFC-STD-586. Conductive epoxy shall be gold or silver.

(3) Eutectic shall be gold alloy.

3.5.6.3 Inductors. Mounting and attachment requirements for inductors shall conform to the requirements specified in Table VI.

Table VI. Mounting and Attachment Requirements for Inductors

Part Type	Mounting Technique	Quality Level		
		Class A	Class B	Class C
Carrier Mounted Chip	Conductive Epoxy (2)	A	A	A
	Nonconductive Epoxy (2)	A	A	A
	Solder or Eutectic (3)	N	N	A
Packaged (leaded)	Solder	N	N	A

NOTES: (1) Designations A and N represent acceptable and not acceptable, respectively.

(2) Conductive and nonconductive epoxies shall conform to MSFC-STD-586. Conductive epoxy shall be gold or silver.

(3) Eutectic shall be gold alloy.

3.5.6.4 Resistors. Mounting and attachment requirements for resistors shall conform to the requirements specified in Table VII.

Table VII. Mounting and Attachment Requirements for Resistors

Part Type	Mounting Technique	Quality Level		
		Class A	Class B	Class C
Beam Lead	Thermocompression	A	A	A
	Compliant Bond	A	A	A
	Wobble Bond	A	A	A
Thin Film Chip	Nonconductive Epoxy (2)	A	A	A
	Conductive Epoxy (2)	A	A	A
	Solder	N	N	N
Thick Film Chip	Nonconductive Epoxy (2)	A	A	A
	Conductive Epoxy (2)	A	A	A
	Solder	N	N	N
Packaged (leaded)	Solder	N	N	A

NOTES: (1) Designations A and N represent acceptable and not acceptable, respectively.

(2) Conductive and nonconductive epoxies shall conform to MSFC-STD-586. Conductive epoxy shall be gold or silver.

3.5.6.5 Substrates. Mounting and attachment requirements for substrates shall conform to those specified in Table VIII.

Table VIII. Mounting and Attachment Requirements for Substrates

Mounting Technique	Quality Level		
	Class A	Class B	Class C
Eutectic (2)	A	A	A
Solder	A	A	A
Conductive Epoxy (3)	A	A	A
Nonconductive Epoxy (3)	A	A	A

NOTES: (1) Designations A and N represent acceptable and not acceptable, respectively.

(2) Eutectic shall be gold alloy.

(3) Conductive and nonconductive epoxies shall conform to MSFC-STD-586. Conductive epoxy shall be gold or silver.

3.5.7 Electrical Interconnection Requirements. Electrical interconnection requirements for hybrid microcircuits manufactured in accordance with this standard and the applicable procurement document shall conform to the techniques listed in Table IX.

Table IX. Electrical Interconnection Requirements for Hybrid Microcircuits

Material	Bonding Technique	Quality Level		
		Class A	Class B	Class C
Gold Wire or Ribbon	Thermocompression	A	A	A
	Thermosonic	A	A	A
	Ultrasonic	A	A	A
Aluminum Wire	Ultrasonic	A	A	A
	Thermocompression	N	N	A
Beam Lead	Thermocompression	A	A	A
	Compliant Bond	A	A	A
	Wobble Bond	A	A	A
Beam Tape Carrier	Thermocompression	A	A	A
	Conductive Epoxy (2)	A	A	A
	Solder	N	N	A
Solder (3)	Reflow or Manual	N	N	A
Conductive Epoxy (2)	Screen Printed	A	A	A
	Dispensed or Manual	A	A	A

NOTES: (1) Designations A and N represent acceptable and not acceptable, respectively.

(2) Conductive and nonconductive epoxies shall conform to MSFC-STD-586. Conductive epoxy shall be gold or silver.

(3) Packaged (leaded) discrete devices for Class C only.

3.5.8 Sealing Requirements. Sealing requirements for hybrid microcircuits manufactured in accordance with this standard and the applicable procurement document shall conform to the techniques listed in Table X. Prior to sealing, all hybrid circuits for Class A and B shall be subjected to a vacuum bake of 16 hours at 150°C. After the vacuum bake is completed, the hybrid devices shall be maintained in a dry inert atmosphere until sealing.

Table X. Sealing Requirements for Hybrid Microcircuits

Sealing Process	Quality Level		
	Class A	Class B	Class C
Parallel Seam Weld	A	A	A
Solder	N	A	A
Nonconductive Epoxy (2)	N	N	A

NOTES: (1) Designation A and N represent acceptable and not acceptable, respectively.

(2) Nonconductive epoxy shall conform to MSFC-STD-586 and shall be a preform type.

3.5.9 Production Changes. The manufacturer shall not implement any major changes which affect design, performance, quality, or reliability without approval of the qualifying and procurement activities. The manufacturer may implement minor changes which do not affect design, performance, quality or reliability.

a. Major changes

Chip size and geometry; circuit layout pattern design; thermocompression versus ultrasonic bonding; package construction materials or dimensions; and 100 percent versus LTPD or AQL inspection.

b. Minor changes

Variations in processing parameters; variations in manufacturing and test equipment; changes in personnel.

3.6 Quality Inspection. Hybrid microcircuits manufactured in accordance with this standard and the applicable procurement document shall be inspected for quality in accordance with paragraphs 3.6.1 through 3.6.2 of this standard.

3.6.1 Discrete Devices Inspection. All active and discrete devices shall be inspected in accordance with paragraphs 3.6.1.1 through 3.6.1.3 of this standard.

3.6.1.1 Incoming Receiving Inspection. Active and passive discrete devices shall be inspected at incoming and receiving as follows.

a. All active discrete devices shall be 100 percent visually inspected in accordance with MIL-STD-883, Method 2010.

b. All passive discrete devices shall be visually inspected in accordance with MIL-STD-883, Method 2017. Passive discrete devices fabricated by a monolithic process shall be visually inspected in accordance with MIL-STD-883, Method 2010.

c. All active and passive discrete devices shall be functionally tested at extreme operating temperatures in their normal packaged configuration in accordance with lot sampling plan per MIL-M-38510, Appendix B, LTPD 10.

3.6.1.2 Qualification. Qualification of active and passive devices for use in hybrid microcircuits shall as a minimum include the tests specified in Table XI.

Table XI. Discrete Devices Qualification Requirements

Qualification Test	Test Method (1)	Test Condition
Internal Visual		
Active	2010	
Passive	2017 (2)	
Electrical Tests	5005	Group A
Steady State Life	1005	Condition B, 1000 hours at 125°C
Electrical Parameters	5005 (3)	Group A, subgroups 1, 2, 3
Temperature Cycling	1010	Condition C, 100 cycles
Electrical Parameters	5005 (3)	Group A, subgroups 1, 2, 3

NOTES: (1) Applicable test method of MIL-STD-883.

(2) Passive discrete devices fabricated by a monolithic process shall be visually inspected per MIL-STD-883, Method 2010.

3.6.1.3 Screening. Screening of active and passive devices shall as a minimum include the tests specified in Table XI.

Table XII. Discrete Devices Screening Requirements

Screening Test	Test Method (1)	Test Condition
Internal Visual Active Passive	 2010 2017 (2)	
Stabilization Bake	1008	Condition C, 24 hours
Temperature Cycling	1010	Condition C, 10 cycles
Interim Electrical Tests	----	Per applicable device specifications
Burn-In Test	1015	240 hours, 125°C
Final Electrical Tests	----	Per applicable device specification

NOTES: (1) Applicable test method of MIL-STD-883.

(2) Passive discrete devices fabricated by a monolithic process shall be visually inspected per MIL-STD-883, Method 2010.

3.6.2 Internal Visual Inspection. Visual inspection of hybrid microcircuits specified in this standard shall be in accordance with MIL-STD-883, Method 2017.

3.7 Marking. Marking shall be in accordance with MIL-M-38510 and the requirements specified in this standard and shall meet the resistance to solvent requirements of MIL-STD-883, Method 2015. Damage to marking caused by mechanical fixturing shall not be cause for lot rejection. The following marking shall be placed on each hybrid device unless otherwise indicated.

a. Index Point (Color Dot)

b. Part Number

c. Serial Number

d. Date Code

e. Manufacturer Code

3.8 Workmanship. Hybrid devices shall be manufactured, processed and tested in a careful and workmanlike manner, in accordance with this standard. Production processes, workmanship instructions, inspection and test procedures, and training aids shall comply with the intent of the product assurance program of MIL-M-38510.

3.8.1 Rework Provisions. All rework performed on hybrid microcircuits manufactured in accordance with this standard shall comply with the provisions, procedures, and safeguards of MIL-M-38510, paragraphs 3.7.1, 3.7.1.1 and 3.7.1.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 General. The inspection, general procedure for acceptance, classification of inspection, inspection conditions and test methods shall be in accordance with this standard.

4.2 Responsibility for Tests and Inspection. The manufacturer shall be responsible for performance of all tests and inspections specified in this standard. Unless otherwise specified in the applicable procurement document, the manufacturer will use its facilities for the performance of the tests and inspections specified.

4.2.1 Inspection during Manufacture. The manufacturer shall maintain inspection at appropriately located points in the manufacturing process in accordance with the requirements specified in this standard and in accordance with the intent of MIL-M-38510.

4.2.2 Inspection Records. The manufacturer shall maintain adequate records of all examinations, inspections, and tests performed and these records shall be available for review upon request by either the procuring activity or qualifying activity.

4.3 General Inspection Conditions.

4.3.1 Sampling. Statistical sampling for screening quality conformance, and qualification shall be in accordance with MIL-M-38510, Appendix B.

4.3.1.1 Disposal of Samples. Hybrid devices subjected to destructive tests or which fail any test shall not be shipped in fulfillment of the contract or purchase order. Sample hybrid devices from lots which have passed quality conformance inspection and which have been subjected to tests of MIL-STD-883, Method 5008 which are classified as nondestructive may be shipped in fulfillment of the contract or purchase order, provided each of the hybrid devices subsequently passes the final electrical test as defined in the applicable detail procurement document.

4.3.1.2 Destructive Tests. Unless otherwise specified, the following tests referenced in MIL-STD-883, Method 5008, shall be classified as destructive. The test method referenced for each of these tests is contained in MIL-STD-883.

Moisture Resistance (Method 1004)

Salt Atmosphere (Method 1009)

Internal Water Vapor Content (Method 1018)

Solderability (Method 2003)

Lead Integrity (Method 2004)

Bond Strength (Method 2011)

Internal Visual and Mechanical (Method 2014)

Resistance to Solvents (Method 2015)

Scanning Electron Microscope (SEM) (Method 2018)

Die Shear Strength (Method 2019)

4.3.1.3 Nondestructive Tests. Unless otherwise specified, the following tests referenced in MIL-STD-883, Method 5008 shall be classified as nondestructive. The tests indicated by an asterisk (*) shall be considered destructive when the test temperature exceeds the maximum specified junction temperature for any die in the hybrid.

Steady State Life* (Method 1005)

High Temperature Storage* (Method 1008)

Temperature Cycling* (Method 1010)

Thermal Shock*(Method 1011)

Seal (Method 1014)

Burn-In Test*(Method 1015)

Constant Acceleration (Method 2001)

Mechanical Shock (Method 2002)

External Visual (Method 2009)

Internal Visual (Monolithic) (Method 2010)

Physical Dimensions (Method 2016)

Internal Visual (Hybrid) (Method 2017)

Partical Impact Noise Detection Test (Method 2020)

4.3.2 Formation of Lots. Hybrid devices shall be segregated into identifiable production lots as defined in paragraph 3.1.2 of this standard as required to meet production control and inspection requirements of MIL-M-38510, Appendix A. Hybrid devices shall be assembled into inspection lots as defined in paragraph 3.1.2 of this standard as required to meet the product assurance inspection and test requirements of this standard.

4.3.2.1 Resubmitted Inspection Lots. When applicable, inspection lots which have been screened or reworked and resubmitted for quality conformance inspection shall contain only hybrid devices which were in the original lot, and shall be resubmitted only once for each inspection subgroup (Group B, C or D). For Group A inspection and the subgroups therein, lots may be resubmitted more than once, provided that each resubmission to a given subgroup is at an LTPD one level tighter than the previous submission. Resubmitted inspection lots shall be randomly resampled and inspected for all failed subgroups using tightened inspection. Resubmission for a Group B, C, or D failure shall include reinspection to Group A.

4.3.3 Procedure in Case of Test Equipment Failure or Operator Error. Whenever hybrid devices are believed to have failed as a result of faulty test equipment or operator error, the failure shall be entered in the test record which shall be retained for review along with a complete explanation verifying why the failure is believed to be valid. When it has been established that a failure is due to test equipment failure or operator error, a replacement device from the same inspection lot may be added to the sample. The replacement device shall be subjected to all those tests to which the discarded device was subjected prior to its failure and to any remaining specified tests to which the discarded device was not subjected prior to its failure.

4.3.4 Corrective Action. The manufacturer shall have the responsibility of performing failure analysis on hybrid devices which have failed to perform under reasonable conditions of usage. Upon receipt of such failed hybrid devices, the manufacturer shall prepare a failure analysis and corrective action report to include information as outlined below.

a. Lot identification, date code and size of lot.

b. Device type, identification number or serial number.

c. Failure mode category.

d. Actual mechanism of failure.

e. Photographs.

f. Cause of failure.

g. Corrective action taken or proposed to be taken.

4.3.5 Data. Test data verifying conformance with this standard for each production lot shall be recorded and retained by the manufacturer for a minimum of three years. One copy of a certificate of compliance shall be provided with each shipment of hybrid devices.

4.4 Screening, Quality Conformance, and Qualification Procedures.

Unless otherwise specified in the applicable procurement document, all hybrid devices manufactured in accordance with this standard shall be subjected to the screening, quality conformance, and qualification tests referenced in MIL-STD-883, Method 5008.

5. PREPARATION FOR DELIVERY

5.1 Unit Packaging. Unit packaging and marking of microcircuits shall conform to the applicable requirements of MIL-M-55565.

5.2 Intermediate Packaging. Intermediate packaging, when employed, shall conform to the applicable requirements of MIL-M-55565.

5.3 Exterior Containers. Exterior containers shall conform with applicable requirements of MIL-M-55565.

5.4 Electrostatic Protection. If required, electrostatic protection shall be provided by a container or wrap fabricated from an anti-static material. Cushioning used shall be homogeneously anti-static.

5.5 Marking. Intermediate packaging and exterior containers shall be marked in accordance with MIL-M-55565. In addition, the exterior container shall be marked with the manufacturer's identification, procuring activity part designation, and serial numbers of the microcircuits within the container.

6. NOTES

This standard covers the general requirements and tests for hybrid devices. The specific details of designs, performance, quality, and reliability of hybrid devices manufactured in accordance with this standard shall be specified in the applicable detail procurement document.