JEDEC PUBLICATION

Obtaining and Accepting Material for Use in Hybrid/MCM Products

JEP142

MAY 2002

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

NOTICE

JEDEC standards and publications contain material that has been prepared, reviewed, and approved through the JEDEC Board of Directors level and subsequently reviewed and approved by the JEDEC legal counsel.

JEDEC standards and publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for use by those other than JEDEC members, whether the standard is to be used either domestically or internationally.

JEDEC standards and publications are adopted without regard to whether or not their adoption may involve patents or articles, materials, or processes. By such action JEDEC does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the JEDEC standards or publications.

The information included in JEDEC standards and publications represents a sound approach to product specification and application, principally from the solid state device manufacturer viewpoint. Within the JEDEC organization there are procedures whereby an JEDEC standard or publication may be further processed and ultimately become an ANSI/EIA standard.

No claims to be in conformance with this standard may be made unless all requirements stated in the standard are met.

Inquiries, comments, and suggestions relative to the content of this JEDEC standard or publication should be addressed to JEDEC Solid State Technology Association, 2500 Wilson Boulevard, Arlington, VA 22201-3834, (703)907-7559 or www.jedec.org

Published by
©JEDEC Solid State Technology Association 2002
2500 Wilson Boulevard
Arlington, VA 22201-3834

PRICE: Please refer to the current
Catalog of JEDEC Engineering Standards and Publications or call Global Engineering Documents, USA and Canada 1-800-854-7179, International (303) 397-7956

PLEASE!

DON'T VIOLATE
THE
LAW!

JEDEC Solid State Technology Association
2500 Wilson Boulevard
Arlington, Virginia 22201-3834
or call (703) 907-7559

GUIDELINE FOR OBTAINING AND ACCEPTING MATERIAL FOR USE IN HYBRID / MCM PRODUCTS

CONTENTS

GUIDELINE FOR OBTAINING AND ACCEPTING MATERIAL FOR USE IN HYBRID / MCM PRODUCTS

CONTENTS

GUIDELINE FOR OBTAINING AND ACCEPTING MATERIAL FOR USE IN HYBRID / MCM PRODUCTS

(From JEDEC Board ballots JCB-01-67A and JCB-02-52, formulated under the cognizance of the JC-13.5 Subcommittee on Hybrid, RF/Microwave, and MCM Technology.)

1 Scope

This document provides guidance regarding design considerations, material assessment techniques, and recommendations for material acceptance prior to use in Hybrid / MCM Products. As part of the risk assessment process, both technical requirements and cost should be carefully considered with regard to testing / evaluating the elements of a hybrid microcircuit or Multi-chip Module (MCM) prior to material release for assembly. The intent of this document is to highlight various options that are available to the Hybrid / MCM manufacturer and provide associated guidance, not to impose a specific set of tests.

2 Applicable documents

The following documents may be used as guidelines for developing test plans or for performing testing. The revision of these referenced documents is that which best satisfies the user's requirements.

2.1 Military / Government documents

MIL-PRF-20, *Capacitor, Fixed Ceramic Dielectric (Temperature Compensating), Established Reliability and Non Established Reliability, General Specification for*

MIL-HDBK-103, *List of Standard Microcircuit Drawings*

MIL-PRF-123, *Capacitors, Fixed, Ceramic Dielectric, (Temperature Stable and General Purpose), High Reliability, General Specification for*

MIL-HDBK-179, *Microcircuit Acquisition Handbook*

MIL-HDBK-199, *Resistors, Selection and Use of*

MIL-STD-202, *Test Methods for Electronic and Electrical Component Parts*

MIL-STD-690, *Failure Rate Sampling Plans and Procedures*

MIL-STD-750, *Test Methods for Semiconductor Devices*

MIL-STD-790, *Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic and Fiber Optic Parts Specifications*

MIL-STD-883, *Test Methods for Microcircuits Devices*

2 Applicable documents (cont'd)

2.1 Military / Government documents (cont'd)

MIL-STD-1686, *Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding electrically initiated explosive devices) (metric)*

MIL-PRF-19500, *Semiconductor Devices, General Specification for*

MIL-PRF-38534, *Hybrid Microcircuits, General Specification for*

MIL-PRF-38535, *Integrated Circuits (Microcircuits), Manufacturing, General Specification for*

MIL-PRF-39001, *Capacitors, Fixed, Mica Dielectric, Established Reliability and - Non-Established Reliability, General Specification for*

MIL-PRF-49470, C*apacitor, Fixed, Ceramic Dielectric, Switch Mode Power Supply (General Purpose and Temperature Stable), General Specification for*

MIL-PRF-55342, *Performance Specification, Resistors, Fixed, Film, Chip Non-Established Reliability, Established Reliability, General Specification for*

MIL-PRF-55365, *Capacitor, Fixed, Electrolytic (Tantalum), Chip, Non-Established Reliability, Established Reliability, General Specification for*

MIL-PRF-55681, *Capacitor, Chip, Multiple Layer, Fixed, Ceramic Dielectric, Established Reliability and Non-Established Reliability, General Specification for*

MIL-PRF-87164, *Capacitors, Fixed, Mica Dielectric, High Reliability, General Specification for*

2.2 Industry documents

JESD9, *Metal Package Specification for Microelectronic Packages and Covers*

JESD22-A104, *Temperature Cycling*

JESD22-A106, *Thermal Shock*

JESD22-A107, *Salt Atmosphere*

JESD22-A108, *Temperature, Bias, and Operating Life*

JESD22-A109, *Hermeticity*

JESD22-B102, *Solderability*

JESD22-B104, *Mechanical Shock*

JESD22-B107, *Marking permanency*

2 Applicable documents (cont'd)

2.2 Industry documents (cont'd)

JESD22-B116, *Wire Bond Shear Test*

JESD49, *Procurement Standard for Known Good Die*

EIA557, *Statistical Process Control System*

JESD27, *Ceramic Package Specification for Microelectronic Packages*

JEP135, *Guideline for Supplier Management*

JEP132, *Process Characterization Guideline*

JEP133, *Guide For the Production and Acquisition of Radiation-Hardness Assured Multichip Modules and Hybrid Microcircuits*

ANSI/EIA-469, *Standard Test Method for Destructive Physical Analysis (DPA) of Ceramic Monolithic Capacitors*

2.3 Internet reference locations

Defense Supply Center Columbus (DSCC), www.dscccols.com/offices/sourcing_and_qualification/

JEDEC Solid State Technology Association (JEDEC), www.jedec.org/

3 Terms and definitions

This section intentionally left blank.

4 Microcircuits and semiconductor die

4.1 Guidelines for establishing a procurement/acceptance plan for microcircuit and semiconductor die

The following guidelines should be considered when evaluating microcircuit and semiconductor die.

4.1.1 Built-in test

Fault testing (complex ASIC) devices have tests that are typically performed at the probe level that verify die performance.

4.1 Guidelines for establishing a procurement/acceptance plan for microcircuit and semiconductor die (cont'd)

4.1.2 Yield data

Wafer/wafer lot yield (electrical /mechanical / visual) may be used to determine product/manufacturing maturity thereby establishing inspection / test levels for new material lots. However, wafer/wafer lot yield data may be considered proprietary by the die manufacturer and therefore may not be obtainable.

4.1.3 Electrical test following assembly

a) Sample testing in monolithic form:

Electrical Testing – A sample of die may be packaged and subjected to electrical testing over temperature extremes. Burn-in, temperature cycling, mechanical shock or other testing may be performed to increase the manufacturer's confidence level of accepting the die for the intended functions.

Electrical components should not be operated outside of the component manufacturer recommended operating conditions.

b) Sample testing in production hardware:

A sample of die may be assembled into the Hybrid / MCM product. Validation that sample die meet electrical performance requirements in production hardware should increase the manufacturers confidence in the inspection lot of die and therefore the remaining die may not require additional element evaluation at the die level.

4.1.4 Die complexity

The level of testing for any particular die should consider the level of complexity required to fabricate the die and the user's expectations of the end item part.

4.1.5 Construction and dimensions

a) Visual inspection

Visual Criteria – MIL-STD-883 Method 2010 and MIL-STD-750 Methods 2073 and 2072 may be used for visual inspection criteria for microcircuits, diodes, and transistors respectively.

Suppliers may utilize visual inspection criteria developed internally. When procuring die, the visual inspection criteria should be identified.

b) Dimensions

Dimension verifications may be used where space limitations are critical. A lot to lot change in dimensions could be an indicator of nonconformances, i.e., wrong die, mask changes, etc. However, typically die of the same design from the same manufacturer are highly consistent regarding dimensions. Where die thickness is critical to the process, die thickness should be specified.

4.1 Guidelines for establishing a procurement/acceptance plan for microcircuit and semiconductor die (cont'd)

4.1.5 Construction and dimensions (cont'd)

c) SEM analysis

SEM Analysis may be utilized to observe various junctions, mask alignment or other characteristics typical of the die fabrication process. SEM Analysis is recommended for Class "K" Hybrid Applications. SEM Analysis may be used to detect thin metallization or critical junction characteristics. MIL-STD-883 Method 2018 or MIL-STD-750 Method 2077 may be used as a guide.

4.1.6 Radiation hardness (Also see 10.4)

a) Neutron / Irradiation Testing may be performed using MIL-STD-883 Method 1017 or MIL-STD-750 Method 1017 as a guide.

b) Ionizing Radiation Testing may be performed using MIL-STD-883 Method 1019 or MIL-STD-750 Method 1019 as a guide.

4.1.7 Bondability

a) Wire bond evaluation

Sample bonding may be performed on die bond pads for each lot of received devices. Use wire bonding equipment and profiles that simulate end item use.

b) Wire bonding strength testing

This test may be performed on wire bondable elements in accordance with MIL-STD-883 Method 2011. Accelerated Wire Bond Stress Testing may be performed by heating the bonding sample to 300°C for one hour in either air or an inert atmosphere prior to performing the wire bond strength test. Exposing the bond to 300 degrees centigrade for one hour tends to accelerate the interaction of intermetallics, thereby revealing corrosion and weak bond problems. When wires are subjected to the exposure described above, destructive pull force values should be reduced in accordance with MIL-PRF-38534.

c) Plasma cleaning

Plasma cleaning may be used on certain die to remove organic materials prior to wire bonding.

4.1.8 Attachability

a) Sample die shear:

Backside metal requirements – Considerations should be made for the types of attach that will be performed at the next level of assembly. Backside roughness and metallization material considerations should be determined for epoxy or eutectic attach. For epoxy attach a conductive or non-conductive epoxy should be selected based on the die operating characteristics. For eutectic attach, the backside die metallization should be suitable for the material the die is being attached to as

4.1 Guidelines for establishing a procurement/acceptance plan for microcircuit and semiconductor die (cont'd)

4.1.8 Attachability (cont'd)

well as the preform (if used) and the attach method. Also, the inherent die strength should be considered before selecting the assessment techniques. GaAs die, for example are extremely brittle and considerations (due to die fracture) invalidate die shear test results. Testing may be performed using MIL-STD-883 Method 2019 as a guide.

b) Mechanical shock or constant acceleration

Mechanical shock or constant acceleration may be used to verify the mechanical integrity of the elements being attached. Suggested test methods are MIL-STD-883 Method 2002, Condition B, Y1 direction or Method 2001, 3000G, Y1 direction. Consideration should be given to the die attach metallization.

c) Substrate attach strength

Substrate attach strength may be performed in accordance with MIL-STD-883 Method 2027 to evaluate the die attach strength to the package or substrate.

4.1.9 Design and procurement

a) Traceability – Die traceabilty is usually provided by the supplier to the wafer lot. Adequate tracking of die during Hybrid manufacturing is valuable for failure analysis. Lot evaluation may be required for each wafer lot.

b) Mask control – Die topography may change at the die manufacturer without notice. Auto bonders may not recognize new bond pad layouts or functions of pads may change. Inspection to specific die topographies may be of value.

c) Responsibility for test and inspection – The responsibility for test and inspection should be clearly identified in design and procurement specifications.

d) Packaging – Die may be packaged in waffle packages or gel packages. Die orientation, when required, should be specified in procurement requirements. Protection against possible ESD damage should be considered during shipping and handling.

e) Air bridges – unique structures in microcircuit die such as air bridges should be understood prior to procurement. Packaging and removal of die from packaging requires advanced planning to avoid die damage.

f) Tape and reel – procurement should consider the advantages of tape and reel.

g) Sawn on tape – procurement should consider the advantages of die sawn on tape.

h) Storage – die should be properly stored at the suppliers facility prior to use.

i) Radiation – radiation requirements may invoke traceability to a wafer within a wafer lot.

4.1 Guidelines for establishing a procurement/acceptance plan for microcircuit and semiconductor die (cont'd)

4.1.10 Precautions

a) Assembly technique - Consideration should be given to the intended assembly process when selecting an evaluation technique.

4.1.11 Mask changes

Should check at least one die per lot to assure compatibility with assembly. Considering the fact that die topography can change without prior notification by the die manufacturer, a simple/quick inspection of a sample die for any die markings and/or topography changes will help to prevent downstream problems during assembly.

4.2 Items to evaluate

The following methods may be considered in the selection of microcircuits and semiconductor die:

4.2.1 Semiconductor element evaluation options

a) JANHC (for use in Military hybrids or Class H, MIL-PRF-38534 hybrids) and JANKC (for use in Space hybrids, or Class K, MIL-PRF-38534 hybrids) semiconductor die

   If JANKC or JANHC semiconductor die are purchased, then the purchaser may not need to perform Element Evaluation in accordance with Space Hybrid Guidelines in Table 1. The die supplied as JANKC or JANHC die are manufactured on a QML semiconductor fabrication line and processed through a series of inspections and tests defined in MIL-PRF-19500. Therefore the die may not need be subjected to element evaluation at the purchaser's incoming inspection.

   To purchase JANHC or JANKC die, use a MIL-PRF-19500 Performance Specification Sheet, sometimes referred to as a slash (/) sheet, as the procurement vehicle. Lists of MIL-PRF-19500 Performance Specification Sheets and QPL-19500 are available at the DSCC web site. Also, see MIL-PRF-19500 Part Marking, or the performance specification sheet, for information on part coding for Class level, Radiation hardness, and die form vs. packaged.

   If susceptibility to failures due to radiation (Radiation-Hardness) is a concern, then the appropriate RHA designator should be selected in the part number following the class designator. See MIL-PRF-19500 to determine the appropriate designator and to determine if the RAD-Hard testing performed is adequate to the application.

   It is recommended as a minimum that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

   Purchaser may require additional data as required which may include evaluation flow, attributes, test data, SEM data, flow traveler, Rad-Hard, C of C, etc.

4.2 Items to evaluate (cont'd)

4.2.1 Semiconductor element evaluation options (cont'd)

b) Semiconductor die (for use in Military or Space hybrids, or Class H, or K MIL-PRF-38534 hybrids) where element evaluation is performed

Any level of die (Space grade, commercial, etc.) may be purchased. The die manufacturer, distributor, or third party (test lab or purchaser), or any combination of the parties perform the 100% visual inspection (to the applicable class level) and electrical test. The sample testing, listed in Table 1, is then performed by the die supplier, the die distributor or a third party (such as the purchaser or a test lab.)

These semiconductor die may not be tested for their susceptibility to failures due to radiation (RAD-Hard testing.) If this is an issue for the end environment then Rad-Hard testing should be specified and performed.

It is recommended, as a minimum, that the purchaser perform a sample visual inspection and dimensional as incoming inspections.

Purchaser may require additional data as required which may include evaluation flow, attributes, test data, SEM data, flow traveler, Rad-Hard C of C, etc.

c) Semiconductor die (for use in Military or Space hybrids, or Class H, or K MIL-PRF-38534 hybrids) where element evaluation has been reduced or eliminated

Based on the die manufacturer, die distributor or hybrid history for a given die e.g., reduced inspections and test, skip lot, elimination of inspections) may be used. In such cases, sufficient data/rational for the existing acceptance plan should be maintained. A Technology Review Board or equivalent is recommended for establishing these alternate acceptance Plans.

d) Commercial semiconductor die where the die supplier or distributor perform element evaluation

Commercial semiconductor die may be purchased where the die manufacturer or die distributor will perform the commercial element evaluation in accordance with Table 1.

It is recommended as a minimum that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

e) Commercial semiconductor die where element acceptance is performed according to purchaser's procedure.

Commercial die may be accepted based on the purchaser's internal procedures for incoming element evaluation. Additional requirements may be specified on the purchase order.

It is recommended as a minimum that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

4.3 Microcircuit element evaluation options

a) Classes Q (for Military, and Class H hybrids) and V (for Space, and Class K Hybrids) microcircuit die

When Class V or Q Microcircuit die (MIL-PRF-38535) are purchased, the purchaser may not need to perform Element Evaluation in accordance with Table 1. The Class V or Q die is manufactured on a MIL-PRF-38535 certified QML wafer fabrication line. Appropriate monitoring, and testing is performed by the die supplier, to ensure the die meet the quality assurance level of V or Q.

To purchase Class V or Q die use a Standard Microcircuit Drawing (SMDs) as the procurement vehicle. The digit "9" must appear after the class designator in the part number to get the bare die instead of a packaged microcircuit. MIL-HDBK-103, *List of Standard Microcircuit Drawings*; MIL-HDBK-179, *Microcircuit Acquisition Handbook*; and QML-38535 are available at the DSCC website.

Die can also be purchased from a QML-38535 supplier by specifying the Class Level on the Purchase Order as well as stating "Die must be fabricated on the QML-38535 line." A Certificate of Compliance should be required that states that the Die was fabricated on the QML-38535 line. Additionally, the purchaser should require traceability to the specific manufacturer's wafer line and wafer lot. This method does not offer the change control (notification) that would have been inherent with the SMD.

If susceptibility to failures due to radiation (Rad-Hard) is a concern, then the appropriate RHA designator should be selected in the part number following the stock class "5962". If this is an issue for the end environment the testing will have to be specified and performed. See MIL-PRF-38535 to determine the appropriate designator and to determine if the RAD-Hard testing performed is adequate to the application.

It is recommended, as a minimum, that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

Purchaser may require additional data as required which may include evaluation flow, attributes, test data, SEM data, flow traveler, Rad-Hard C of C, etc.

b) Known Good Die (KGD) (for use in space or military hybrids)

When KGD die are purchased, then the purchaser may not be required to perform Element Evaluation in accordance with Table 1. The die supplied as KGD are manufactured in accordance with JESD49 with a high degree of confidence and therefore may not require element evaluation at the purchasers incoming element evaluation process.

KGD die may not be Rad-Hard and may require Rad-Hard testing to meet the end item use application.

It is recommended as a minimum that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

Purchaser may require additional data as required which may include evaluation flow, attributes, test data, SEM data, flow traveler, Rad-Hard C of C, etc.

4.3 Microcircuit element evaluation options (cont'd)

c) Microcircuit die (for use in Military or Space hybrids, or Class H, or K MIL-PRF-38534 hybrids) where element evaluation is performed

Any level of die (Space grade, commercial, etc.) may be purchased. The die manufacturer, die distributor or a third party (test lab or purchaser) or a combination of these parties perform the 100% visual inspection and electrical test and the sample testing per Table 1.

The semiconductor die may not be tested for their susceptibility to failures due to radiation (Rad-Hard testing.) If this is an issue for the end environment the testing will have to be specified and performed.

It is recommended as a minimum that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

Purchaser may require additional data as required which may include evaluation flow, attributes, test data, SEM data, flow traveler, Rad-Hard C of C, etc.

d) Microcircuit die for class h or k hybrids where element evaluation has been reduced or eliminated

Based on the die manufacturer, die distributor, hybrid history of a given die or alternate methods (e.g., reduced inspections and test, skip lot, elimination of inspections) may be used. In such cases, sufficient data/rational for the existing acceptance plan should be maintained. A Technology Review Board or equivalent is recommended for establishing these alternate acceptance plans.

e) Commercial microcircuit die where element evaluation is performed

Commercial microcircuit die may be purchased where the die manufacturer or die distributor will perform the commercial element evaluation in accordance with Table 1.

It is recommended as a minimum that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

f) Commercial microcircuit die where element acceptance is performed according to purchaser's procedure

Commercial die may be accepted based on the purchasers' internal procedures for incoming element evaluation. Additional requirements may be specified on the purchase order.

It is recommended as a minimum that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

4 Microcircuits and semiconductor die (cont'd)

Table 1 — Microcircuit and semiconductor die evaluation guidelines

Subgroup	Class			Test	MIL-STD-883		Commercial Specifications
	Space Hybrids†	Military Hybrids†	Commercial		Method	Condition	
1	*	*	*	Element Electrical	**Method**	**Condition**	
2	*	*	*	Element Visual			
3	*	*		Internal Visual	2010 2072‡ 2073‡		
4	*			Temperature Cycling	2010 2072‡ 2073‡		
	*			Mechanical Shock Or	1010	C	JESD22-A104
				Constant Acceleration	2002	B, Y1 direction	JESD22-B104
	*			Interim Electrical	2001	3000G, Y1 direction	
	*			Burn-In			
	*			Post Burn-In Electrical	1015	240 hours minimum at +125 ºC	
	*			Steady-State Life	1005	1000 hours at +125 ºC	
	*	*		Final Electrical			
5	*	*	*	Wire Bond Evaluation	2011		JESD22-B116
	*	*	*	Die Shear	2019		
6	*			SEM	2018		
7	*			Radiation			
	*			Dose Rate and Latch-Up	1020		
	*			Total Dose	1019		
	*			Neutron Irradiation	1017		

* Recommended tests for hybrid class.

† Test tables for Class H and K hybrids are located in MIL-PRF-38534.

‡ MIL-STD-750 Methods.

5 Passive elements

5.1 Passive element evaluation options

5.1.1 Items to evaluate

The following methods may be used to evaluate passive elements. Passive elements are generally identified as resistors, capacitors and inductors. However, as applicable, packages and substrates may also be tested in this section.

a) Established Reliability (ER) passive components (for use in Military or Space hybrids, or Class H, or K MIL-PRF-38534 hybrids)

When Established Reliability (ER) passive components are purchased, the purchaser may not need to perform Element Evaluation in Table 2 through Table 5. The ER passive components are manufactured on a MIL-STD-690 or MIL-STD-790 certified manufacturing line and then monitored and tested to ensure the failure rate. To purchase Established Reliability (ER) elements the following specifications may be used.

Component Type	Specification	Military	Space	Commercial
Temperature Compensating Capacitors	MIL-PRF-20	Failure rate R or better		Failure rate C
Stacked Capacitors	MIL-PRF-49470	Failure rate R		Failure rate C
Ceramic Capacitors	MIL-PRF-123		approved	
Ceramic Capacitors	MIL-PRF-55681	Failure rate R or better		Failure rate C
Ceramic Resistor	MIL-PRF-55342	Failure rate R or better	Failure rate T	Failure rate C
Mica Capacitors	MIL-PRF-87164		approved	
Mica Capacitors	MIL-PRF-39001	Failure rate R or better		Failure rate C
Tantalum Capacitors	MIL-PRF-55365	Failure rate R or better/ Weibull C or better		Failure rate A

These performance specifications and their related QML/QPL are available at the DSCC web site. MIL-HDBK-198, *Selection and use of capacitors*; and HDBK-199, *Selection and use of Resistors*, are also available.

These passive elements may not be tested for their susceptibility to failures due to radiation (Rad-Hard testing.) If this is an issue for the end item use application the testing will have to be specified and performed.

It is recommended, as a minimum, that the purchaser perform a sample visual and dimensional verification at incoming inspection.

5.1 Passive element evaluation options (cont'd)

5.1.1 Items to evaluate (cont'd)

Purchaser may require additional data including evaluation flow, attributes, test data, flow traveler, Rad-Hard testing results, C of C, etc.

b) Passive elements (for use in Military or Space hybrids, or Class H, or K MIL-PRF-38534 hybrids) where element evaluation is performed

Any level of element (Space grade, commercial, etc.) may be purchased. The element manufacturer, distributor, or third party (purchaser or test lab) or any combination of the parties, perform 100% and sample inspections and tested as prescribed in Table III through VI.

These elements may not be tested for their susceptibility to failures due to radiation (Rad-Hard testing.) If this is an issue for the end environment the testing will have to be specified and performed.

It is recommended, as a minimum, that the purchaser perform a sample visual and dimensional as incoming inspections.

Purchaser may require additional data including evaluation flow, attributes, test data, flow traveler, Rad-Hard, C of C, etc.

c) Passive elements (for use in Military or Space hybrids, or Class H, or K MIL-PRF-38534 hybrids) where evaluation has been reduced or eliminated

Based on the element manufacturer, distributor, or hybrid history, for given component, alternate methods (e.g., reduced inspections and test, skip lot, elimination of inspections) may be used. In such cases, sufficient Data/rational for the existing acceptance plan should be maintained. A Technology Review Board or equivalent is recommended for establishing these alternate acceptance plans

d) Commercial passive elements where element evaluation is performed

Commercial passive elements may be purchased where the element manufacturer or distributor will perform the commercial element evaluation in accordance with Tables III through VI.

It is recommended, as a minimum, that the purchaser perform a sample visual and dimensional as incoming inspections.

e) Commercial passive elements where element acceptance is performed according to purchaser's procedure

Commercial passive elements may be accepted based on the purchaser's internal procedures for incoming element evaluation. Additional requirements based on the appropriate sections of this guideline may be negotiated between the purchaser and the supplier.

It is recommended as a minimum that the purchaser perform a sample visual inspection and dimensional at incoming evaluation.

5.2 Additional guidelines for passive element evaluation

The following additional guidelines should be considered when establishing element evaluation plans for passive elements.

5.2.1 Resistors

Resistors may be checked to verify resistance values. A standardized test procedure is provided by MIL-STD-202 Method 303. Temperature Coefficient of Resistance (TCR) measurement may be performed using MIL-STD-202 Method 304 guide if resistance value versus short term temperature change is important.

5.2.2 Capacitors

Capacitors may be electrically tested to verify capacitance values. A standardized test procedure is provided by MIL-STD-202 Method 305. In addition, the following checks for capacitors may be made when determined to be appropriate by the manufacturer:

a) Ceramic Type – Dielectric withstanding voltage, insulation resistance, and dissipation factor.

b) Tantalum Type – DC leakage current and dissipation factor.

c) Metal Insulation Type – DC leakage current and dielectric withstanding voltage.

5.2.3 Inductors

Inductors may be electrically tested to verify inductance value. In addition, inductors may be electrically tested to verify DC resistance and Q.

5.2.4 Life test

Passive elements may be tested to determine the effect of exposure to the element at elevated temperatures for a specified length of time while the element is performing its operational function. A suggested test method is MIL-STD-202 Method 108.

5.2.5 Construction and dimensions visual inspection

Visual inspection may be used on a 100 percent or sample basis to evaluate lot acceptability. A guide to visual inspection is MIL-STD-883 Method 2032.

5.2 Additional guidelines for passive element evaluation (cont'd)

5.2.6 Bondability

a) Wire Bond Evaluation may be performed on sample bonds on die bond pads for each lot of received devices. Use wire bonding equipment and profiles that simulate end item use.

b) Wire Bonding Strength Testing may be performed on wire bondable elements in accordance with MIL-STD-883 Method 2011. Accelerated Wire Bond Stress Testing may be performed by heating the bonding sample to 300°C for one hour in either air or an inert atmosphere prior to performing the wire bond strength test. Exposing the bond to 300 degrees centigrade for one hour tends to accelerate the interaction of intermetallics, thereby revealing corrosion and weak bond problems. When wires are subjected to the exposure described above, destructive pull force values should be reduced in accordance with MIL-PRF-38534.

c) Plasma Cleaning – Plasma cleaning may be used on certain die to remove organic material prior to wire bonding.

5.2.7 Attachability

a) Mechanical Shock or Constant Acceleration

Mechanical shock or constant acceleration may be used to verify the mechanical integrity of the passive elements being attached. Suggested test methods are MIL-STD-883 Method 2002, Condition B, Y1 direction or Method 2001, 3000G, Y1 direction. Consideration should be given to the die attach metallization. Typically end metallized die have lower attachment strength.

b) Sample Die Shear:

Backside Metal Requirements – Considerations should be made for the type of attach that will be performed at the next level of assembly. Backside roughness and metallization material considerations should be determined for epoxy or eutectic attach. For epoxy attach a conductive or non-conductive epoxy should be selected based on the die operating characteristics. For eutectic attach, the backside die metallization should be suitable for the material the die is being attached to as well as the preform (if used) and the attach method. Also, the inherent die strength must be considered before selecting the assessment techniques. Testing may be performed using MIL-STD-883 Method 2019 as a guide.

5.2.8 Ceramic Capacitors

Ceramic Capacitors that contain state of the art design (small footprint, high metal plate density, minimum ceramic clearance around the metal plates, large blocks of ceramic, stacked capacitors, high capacitance values, etc.) and ceramic capacitors that are manufactured by a new vendor are recommended to be evaluated prior to use. In addition to the guidelines specified herein, the following is recommended to evaluate the ceramic capacitor:

a) Review the manufacturers process flow and capability.

5.2 Additional guidelines for passive element evaluation (cont'd)

5.2.8 Ceramic Capacitors (cont'd)

b) Hybrid manufacturer should perform Design of Experiments (DOE) to evaluate the robustness of the ceramic / stacked capacitor design and evaluate in the end item use application. The DOE should include but not be limited to assembly, rework, thermal shock limitations before and after assembly, mechanical integrity and electrical evaluations. DOE visual inspections of both ceramic and stacked capacitors may include examination for delamination, voiding, cracking, blistering, solder balls, exposed electrodes, exposed base metal on lead frame that exceeds 5% of the solder area, less than 80% solder termination attach, exposed underlying metal, termination separation, peeling or lifting of termination, pits, stacked capacitor separation, etc which are typical failure modes of ceramic and stacked capacitors.

c) Hybrid manufacturer should perform Design Analysis of the ceramic capacitor to evaluate the construction. The analysis should include visual inspection, ultrasonic inspection (Ref MIL-STD-883 Method), Scanning Electron Microscope Inspections (Ref MIL-STD-883 Method 2018) with cross sectioning of the ceramic capacitors and Destructive Physical Analysis (DPA) OF ceramic Monolithic Capacitors (Ref ANSI/EIA 469).

Table 2 — Passive element evaluation guidelines

Subgroup	Class			Test	MIL-STD-883		Commercial Specification
	Space Hybrids†	Military Hybrids†	Commercial		Method	Condition	
1	*	*	*	Element Electrical			
2	*	*	*	Visual Inspection	2032 2032		
3	*			Temperature Cycling	1010	C	JESD22-A104
	*			Mechanical Shock Or	2002	B, Y1 direction	JESD22-B104
				Constant Acceleration	2001	3000G, Y1 direction	
	*			Voltage Conditioning Or Aging (Capacitors)			
	*			Visual Inspection	2017		
	*	*		Electrical			
4	*	*	*	Wire Bond Evaluation	2011		JESD22-B116

* Recommended tests for hybrid class.

† Test tables for Class H and K hybrids for MIL-PRF-38534 are located in MIL-PRF-38534.

6 Surface Acoustic Wave (SAW)

The following information may be used to evaluate surface acoustic wave devices.

6.1 Design

The following material characteristics may be used as design criteria for selecting SAW devices for specific applications:

Material	Temperature stability	Acoustic coupling constant
Quartz	1	3
Lithium Tantalate	2	2
Lithium Niobate	3	1
Ranking: 1 = Best	2 = Average	3 = Worst

6.2 Process control

The following saw process controls may be monitored to control SAW characteristics:

- Pattern Definition (Line Width and Sharpness)
- Ion Beam Milling Depth (Cuts into SAW crystal)
- Metallization Thickness
- Frequency Trimming
- RIE (Reactive Ion Etch of crystal surface)
- Laser Redeposition (Metal onto crystal surface)

6.3 Test

The following electrical testing may be performed to monitor saw performance:

- Frequency Domain: Frequency; Bandwidth; Insertion Loss; VSWR; Amplitude; and Phase.
- Time Domain: Delay Time; Feedthrough Suppression; Triple Travel Suppression; and Delay Time Variation.

6.4 Statistical process control (SPC)

The following processes may be utilized as statistical process control monitors for saw devices:

- Metal Thickness
- Milling Depth

6 Surface Acoustic Wave (SAW) (cont'd)

Table 3 — SAW element evaluation guidelines

Subgroup	Class			Test	MIL-STD-833		Commercial Specification
	Space Hybrids†	Military Hybrids†	Commercial		Method	Condition	
1	*	*		RF Electrical Probe			
2	*	*	*	Visual Inspection	2032		
3	*	*	*	Wire Bond Evaluation	2011		JESD22-B116

* Recommended tests for hybrid class.

† Test tables for Class H and K hybrids for MIL-PRF-38534 are located in MIL-PRF-38534.

7 Substrate evaluation

7.1 Electrical performance

7.1.1 Resistor stability

Temperature Coefficient of Resistance (TCR) measurements may be required if resistor value versus short term temperature change is important. MIL-STD-202 Method 304 may be used as a guide for performing TCR testing.

7.1.2 Open/Short test

Electrical testing may be utilized for continuity testing prior to the next level of assembly. Open/Short testing is typically performed with a calibrated ohm meter.

7.1.3 Verification of resistor values

Resistance value measurement is typically performed with a calibrated ohm meter. A suggested test method is MIL-STD-202 Method 303.

7.2 Construction and dimensions

7.2.1 Visual inspection

Visual inspection criteria of MIL-STD-883 Method 2032 may be utilized for inspecting substrates.

7.3 Bondability

Bonding on thick film multilayer vias may cause process anomalies due to a higher percentage of glass in these areas.

7 Substrate evaluation (cont'd)

7.4 Adhesion testing

Tape testing has been used as a method of insuring adhesion of deposited conductors to underlying substrate material.

7.5 Attachability

7.5.1 Film adhesion

Tape testing may be used as method for determining film adhesion.

7.5.2 Substrate attach strength

Substrate attach strength may be performed in accordance with MIL-STD-883 Method 2027 to evaluate the substrate attach strength to the package.

7.6 Design and procurement concerns

7.6.1 Substrate material

Alumina / BEO / Duroid / Fused Silica / Z-cut Quartz–Substrate base material should be determined based on the requirements of the circuit function.

CAUTION Caution should be exercised when handling BEO. BEO Substrate breakage/abrasion should be avoided.

7.6.2 Thick film vias / alignment

Multilayer processing and alignment of thick film (screen printed) substrates becomes more critical as line widths are reduced.

7.6.3 Via holes peeling

Via hold size, surface finish and plating technique require analysis to ensure that via holes do not peel. Aspect ratios of holes should be considered.

7.6.4 Furnace profiling

Zone profiling of furnaces (process controls) may be used. Cleanliness of incoming air and other gasses may require monitoring.

7 Substrate evaluation (cont'd)

Table 4 — Substrate evaluation guidelines

Subgroup	Class			Test	MIL-STD-883		Commercial Specification
	Space Hybrids†	Military Hybrids†	Commercial		Method	Condition	
1	*	*		Electrical Testing			
2	*	*		Visual Inspection	2032		
3	*	*		Physical Dimensions	2016		
	*	*	*	Visual Inspection	2032		
	*	*		Electrical			
4	*	*	*	Conductor Thickness Or Conductor Resistivity			
	*	*		Film Adhesion Test			
	*	*		Solderability			JESD22-B102
5	*	*		TCR			
	*	*	*	Wire Bond Evaluation	2011		JESD22-B116
	*	*		Die Shear Evaluation	2019		

* Recommended tests for hybrid class.
† Test tables for Class H and K hybrids for MIL-PRF-38534 are located in MIL-PRF-38534.

8 Package and lid evaluation

Internal use – this guideline section is for metal, glass and ceramic packages. It is not intended for plastic packages.

8.1 Electrical performance

8.1.1 Insulation resistance

Insulation resistance, when required may be performed to MIL-STD-883 method 1003.

8.1.2 Dielectric withstanding voltage

Dielectric withstanding voltage, when required, may be performed to MIL-STD-202 method 301.

8 Package and lid evaluation (cont'd)

8.2 Construction and dimensions

8.2.1 Camber flatness

Flatness of the substrate attach area may be established by dimensional measurement. Excessive camber may reduce substrate attachment strength due to avoiding of the substrate attach material.

8.2.2 Physical dimension

Physical measurement of critical dimensions may be performed to verify conformity to the package drawing.

8.2.3 Tolerances

Dimensional tolerances should be established during the design phase in order that the design requirements are satisfied. Early supplier liaison should ensure the manufacturing process is capable of meeting the required tolerances. Consideration should be given to the statistical capability of the equipment used to construct a given dimension. Tolerance stack-up issues should be considered before assigning a tolerance.

8.2.4 Package finish

The package finish should be able to pass the salt and moisture test requirements of MIL-STD-883 Methods 1009 and 1004. The package lead finish should be capable of passing the solderability test requirement of MIL-STD-883 Method 2003.

8.3 Bondability

a) Wire Bond Evaluation may be performed on sample bonds on any bondable surface for each lot of received devices. Use wire bonding equipment and profiles that simulate end item use.

b) Wire Bonding Strength Testing may be performed on wirebonds in accordance with MIL-STD-883 Method 2011. Accelerated Wire Bond Stress Testing may be performed by heating the bonding sample to 300 °C for one hour in either air or an inert atmosphere prior to performing the wire bond strength test. Exposing the bond to 300 °C for one hour tends to accelerate the interaction of intermetallics, thereby revealing corrosion and weak bond problems. When wires are subjected to the exposure described above, destructive pull force values should reduced in accordance with MIL-PRF-38534.

c) Post Bondability – The wire bondability of the package terminal may be tested in accordance with MIL-STD-883 Method 2011. Evidence of lifted plating may indicate an unacceptable level of adhesion to under-plate or base material.

8 Package and lid evaluation (cont'd)

8.4 Attachability

a) Solderability – Solderability testing may be performed to package areas intended to be soldered during assembly. Solderability testing may be performed in a sample basis to determine with a certain degree of confidence if the package leads will be able to accept solder at the end item assembly. See MIL-STD-833 Method 2003 as a guide.

b) Plating Lots (Plating and Thickness) – The definition of a plating lot should be established with the supplier. Parts within a plating lot should be capable of meeting the acceptable plating thickness range as defined by the package drawing. This may be verified by sample measurements using micro-sections or x-ray fluorescent techniques, for example.

Table 5 — Package related test guidelines

Subgroup	Class			Test	MIL-STD-883		Commercial Specification
	Space Hybrids†	Military Hybrids†	Commercial		Method	Condition	
1	*	*		Thermal Shock	1011	C	
	*	*		Stabilization bake	1008	+150 °C, 1 hour	
	*	*		Lead Integrity	2004	B2 (lead fatigue) D (leadless chip carrier)	
	*	*		Pin grid package destructive lead pull test	2028	pin grid array leads and rigid leads	
	*	*	*	Seal:	1014		JESD22-A109
				a) Fine		A or B	
				b) Gross		C or D	
2	*	*		Salt Atmosphere	1009	A	JESD22-A107
3	*	*		Metal package isolation	1003	600 V dc 100 nA maximum	

* Recommended tests for hybrid class.
† Test tables for Class H and K hybrids for MIL-PRF-38534 are located in MIL-PRF-38534.

8.5 Design and procurement concerns

a) Resistance to Solvents – Package marking should withstand common chemicals used during the fabrication of the hybrid as well as chemicals used at the end item application. See MIL-STD-883 Method 2015 as a guide.

b) Hermeticity - Package hermeticity may be tested prior to component installation. See MIL-STD-883 Method 1014 Condition A4 as a guide.

c) Lead Fatigue – Lead fatigue may be used on a sample basis to test the package for end item suitability. See MIL-STD-883 Method 2004 as a guide.

8 Package and lid evaluation (cont'd)

8.5 Design and procurement concerns (cont'd)

d) Thermal Shock Consideration – Thermal shock per MIL-STD-883 Method 1011 may be used as a guide in evaluating structural integrity of packages. Leak testing per MIL-STD-883 Method 1014 Condition A-4 is recommended to verify package integrity after thermal shock.

e) Glass to Metal Seals – The integrity of the glass (or ceramic) to metal seals may be tested for fine leak in accordance with MIL-STD-883 Method 1014. The seals may also be inspected using criteria such as MIL-STD-883 Method 2009.

9 Adhesives

9.1 Adhesive evaluation

The polymeric adhesives used in device applications may be evaluated to the requirements of MIL-STD-883 Method 5011.

10 General guidelines

a) ESD – Suitable handling precautions and grounding procedures need to be taken to protect electrostatic sensitive devices from accidental damage. MIL-STD-1686 may be used as a guide when handling static sensitive devices.

b) SPC information – Improving Confidence Levels – Statistical analysis of the wafer fabrication process, wire bonding evaluation processes, etc., that offer improved confidence in the device.

c) Technology Maturity and Component History / Both Suppliers and Users – Evaluation of the history of the device may give indications of the level of testing required on future lots. Many die/element manufacturers have established process controls and have quantitative data on specific die/element types.

d) JEP133 – Guide for the Production and Acquisition of Radiation-Hardness Assured Multichip Modules and Hybrid Microcircuits.

Annex A (informative)

A.1 Element evaluation summary

Element	Test or Test Method
Microcircuit and semiconductor dice	See Table 1
Passive elements	See Table III
Saw elements	See Table IV
Alternate ICD evaluation	MIL-PRF-38534
Substrates	See Table V
Packages	See Table VI
Adhesives	MIL-STD-883, Method 5011


JEDEC