The documentation and process conversion measures necessary to comply with this revision shall be completed by 31 December, 1996

INCH-POUND

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PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICES,

GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification establishes the general performance requirements for semiconductor devices. Detail requirements and characteristics are specified in the associated specification. Four quality levels for encapsulated devices are provided for in this specification, differentiated by the prefixes JAN, JANTX, JANTXV, and JANS. Seven radiation hardness assurance (RHA) levels are provided for the JANTXV and JANS quality levels. These are designated by the letters M, D, L, R, F, G, and H following the quality level portion of the prefix. Two quality levels for unencapsulated devices are provided for in this specification, differentiated by the prefixes JANHC and JANKC.

1.2 Description. This specification contains the performance requirement and verification methods for semiconductor devices. The main body specifies the performance requirements and requires the manufacturer to verify that their devices are capable of meeting those performance requirements. Appendix A contains definitions of terms used throughout the specification. Appendix B contains abbreviations and symbols. Appendix C contains the statistical sampling and life test procedures. Appendix D contains the quality system requirements. Appendix E contains the standard verification flow for encapsulated devices. Appendix F contains the certification requirements for Radiation Hardness Assured semiconductor devices. Appendix G contains the standard verification flow for unencapsulated devices. Appendix H contains critical interface and materials for semiconductor devices.

1.3 Identification. The part numbering schemes are as follows:

a. The Part or Identifying Number (PIN) for encapsulated semiconductor devices furnished under this specification is formulated as follows:

JANQQQ	A	XN	YYYY	ZZ
JAN brand and quality level (see 1.3.1)	RHA designator (see 1.3.3)	Component designation (see 1.3.4)	Identification number (see 1.3.5)	Suffix letters (see 1.3.6)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Electronics Supply Center, ATTN: DESC-ELD, 1507 Wilmington Pike, Dayton, OH 45444-5765, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

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b. The PIN for unencapsulated semiconductor devices furnished under this specification is formulated as follows:

JANQC	A	XN	YYYY	ZZ
JAN brand and quality level (see 1.3.2)	RHA designator (see 1.3.3)	Component designation (see 1.3.4)	Identification number (see 1.3.5)	Suffix letters (see 1.3.6)

1.3.1 Quality level for encapsulated devices. The quality levels for encapsulated devices includes the JAN brand and associated modifiers as applicable (denoted by "QQQ" in 1.3). These quality levels from the lowest level to the highest level are JAN, JANTX, JANTXV, and JANS. JANS is intended for space applications.

1.3.2 Quality level for unencapsulated devices. The quality levels for unencapsulated devices includes the JAN brand and associated modifiers as applicable (denoted by "QC" in 1.3). JANKC is intended for space applications and JANHC is intended for standard military applications.

1.3.3 RHA designator. The RHA designator is a letter which identifies the applicable RHA level as defined in appendix F (denoted by "A" in 1.3). The RHA levels from lowest to highest are M, D, L, R, F, G, and H.

1.3.4 Component designation. Semiconductor devices are identified by the prefix "XN". The "X" will usually be a number that is one less than the number of active element terminations.

1.3.5 Identification number. It is recommended that each type of semiconductor device intended for standardization be assigned an identification, serially, by the Joint Electron Device Engineering Council, a council sponsored by the Electronic Industries Association (EIA) and the National Electrical Manufacturers Association. The assignment will provide the component designation and the identification number.

1.3.6 Suffix letters. The following suffix letters may be incorporated in the military type number as applicable.

A, B, C, etc. (except L, M, R, S, U)	Indicates a modified version which is substitutable for the basic numbered (nonsuffix) device.
M	Indicates matching of specified parameters of separate devices.
R	Indicates reverse polarity packaging of the basic numbered device.
L or S	Indicates that the terminal leads are longer or shorter, respectively, than those of the basic numbered device.
U	Indicates unleaded or surface mounted devices.
UR	Indicates unleaded or surface mounted (round end cap diodes).
US	Indicates unleaded or surface mounted (square end cap diodes).
-1	Indicates metallurgical bond.

Suffix letter(s) are used and marked on the device only when specific device types are covered by the applicable associated specification requiring the suffix letters (see 3.10.6).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.1).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

(See supplement 1 for list of associated specifications.)

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-750 - Test Methods for Semiconductor Devices.

MIL-STD-1835 - Microcircuit and Semiconductor Case Outlines.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2 Non-Government standards and other publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.1).

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA-625 - Distributor Requirements for Handling Electrostatic Discharge Sensitive (ESDS) Devices.

JEDEC Publication 109 - General Requirement for Distributors.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Pennsylvania Avenue, Washington, DC 20006.)

(Non-Government standards and other publications are normally available from the organizations which prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General requirements. The individual device requirements shall be as specified herein and in accordance with the applicable associated specification. The general requirements of referenced documents shall also apply. Only devices or die listed or approved for listing on the Qualified Products List (QPL) which meet all the performance requirements of the applicable associated specification for the applicable quality level shall be marked and delivered as appropriate. Any DoD specification or standard referred to in this specification may be replaced by an equivalent commercial standard as determined by the preparing activity and the qualifying activity.

3.2 Associated specifications. The individual item requirements shall be as specified herein and in accordance with the applicable associated specification. In the event of a conflict between the requirements of this specification and the associated specification, the latter shall govern. (If a specific requirement specified herein is not required for an item, it shall be so indicated on the associated specification; for example, Shock, N/A.).

3.3 Performance requirements. It shall be demonstrated that parts delivered to this specification shall be capable of passing the tests and inspections specified in appendix E or appendix G, as required, for the applicable quality level.

3.4 Reference to associated specification. For purposes of this specification, when the term "specified" is used without references to a specific document, the intended reference is to the associated specification.

3.5 Certification. The qualifying activity shall verify that the manufacturer's quality system and device verification system meet 4.1, 4.2, and 4.3, if applicable, and that the manufacturer is producing devices which meet 3.3. Wafer fabrication and assembly operations shall be performed in a facility or facilities certified by the qualifying activity for the applicable technology to the applicable quality level. All testing shall be performed at a facility with MIL-STD-750 laboratory suitability for the applicable method (see appendix D). The reaudit frequency is two years. Reaudits are required to maintain qualification and shall be performed within 24 months of the last review. This validation period may be extended by the qualifying activity if the manufacturer can demonstrate to the qualifying activity adequate controls of their system through Statistical Process Control (SPC), self-assessment, Technology Review Boards (TRB's), etc.

3.6 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see appendix E).

3.7 Certification of conformance and acquisition traceability. Manufacturers who offer the products as described in this specification shall provide written certification signed by the company or corporate official who has management responsibility for the production of the products, (1) that the product being supplied has been manufactured and shall be capable of passing the tests in accordance with this specification and conforms to all of the requirements as specified herein, (2) that all products are as described on the certificate which accompanies the shipment. The responsible official may, by documented authorization, designate other responsible individuals to sign the certificate, but the responsibility for conformance to the facts shall rest with the responsible official. The certification shall be confirmed by documentation to the Government or to users with Government contracts or subcontracts, regardless of whether the products are acquired directly from the manufacturer or from another source such as a distributor. When other sources are involved, their acquisition certification shall be in addition to the certificates of conformance and acquisition traceability provided by the manufacturer and previous distributors. In no case shall the manufacturer's certificate be altered or show signs of alteration. The certificate shall include the following information:

a. Manufacturer documentation:

(1) Manufacturer's name and address.

(2) Customer's or distributor's name and address.

(3) Device type, quality level, and associated specification number.

(4) Lot identification code (including assembly plant code).

(5) Inspection date.

(6) Quantity of devices in shipment from manufacturer.

(7) Statement certifying product conformance and traceability.

(8) Signature and date of transaction.

(9) Solderability reinspection date, if applicable.

b. Distributor documentation for each distributor:

(1) Distributor's name and address.

(2) Name and address of customer.

(3) Quantity of devices in shipment.

(4) Certification that this shipment is a part of the shipment covered by the manufacturer's documentation, and an attached copy of the manufacturer's original certification.

(5) Signature and date of transaction.

(6) Authorized dealers and distributors have handled the products in accordance with the requirements of JEDEC publication 109 and EIA-625.

(7) Solderability reinspection date, if applicable.

3.8 Critical interface and materials. Critical interface and materials for devices furnished under this specification shall be such that the devices meet the performance requirements of 3.3 (see appendix H). For semiconductor case outlines, see MIL-STD-1835.

3.9 Lead and terminal finish. The lead and terminal finish shall be in accordance with appendix H.

3.10 Marking.

3.10.1 Marking on each device. The following marking shall be placed on each encapsulated semiconductor device and shall be legible. Devices having inadequate marking area for all applicable markings shall have as many of the following as possible in the following order of precedence (with "a." being most important).

a. Polarity marking, when applicable (see 3.10.5).

b. PIN (see 3.10.6).

c. Manufacturer's name, trademark, or identification (see 3.10.11) and manufacturer's designating symbol (see 3.10.7).

d. Lot identification code and code for plants (see 3.10.8 and 3.10.8.1).

e. Serial number, if applicable (see 3.10.9).

f. Country of origin (see 3.10.10).

g. Special marking (see 3.10.3). Beryllium oxide identifier (see 3.10.3.2).

h. Electrostatic discharge sensitivity (ESDS) identifier (optional see 3.10.3.1).

3.10.2 Marking on initial container (unit package). All device marking, except for polarity and serial numbers, shall also appear on the unit package used as the initial protection for delivery.

3.10.3 Special marking. If any special marking is used, it shall in no way interfere with or obscure the marking required in 3.10.1.

3.10.3.1 ESDS identifier. When a device's ESDS class is determined by the ESDS classification test (see appendix E), the devices represented by the test may at the option of the manufacturer be marked as follows:

a. Class 1: 1,999 V and below - Δ - single equilateral triangle outline or solid (still acceptable as pin one designator).

b. Class 2: 2,000 V to 3,999 V - $\Delta\Delta$ - double equilateral triangle outline or solid (still acceptable as pin one designator).

c. Class 3: 4,000 V to 15,999 V - no designator.

d. Nonsensitive: Above 15,999 V - no designator.

3.10.3.2 Beryllium oxide package identifier. If a semiconductor package contains beryllium oxide (beryllia), the device shall be marked with the designation 'BeO'.

3.10.4 Marking legibility. Marking shall remain legible. Marking damage caused by mechanical handling shall not be cause for lot rejection. Devices having damaged markings shall be remarked prior to shipment to insure legibility.

3.10.5 Polarity marking of unidirectional diodes and thyristors. The polarity shall be indicated by one of the following methods.

3.10.5.1 Diodes.

a. A diode graphic symbol or arrow with the arrow pointing toward the cathode terminal for forward bias.

b. A single contrasting color band or a minimum of three contrasting color dots spaced around the periphery on the cathode end may be used.

c. An ESD identifier may be used to indicate polarity for sensitive devices.

3.10.5.2 Thyristors. A graphic symbol for a thyristor with the arrow pointing toward the cathode terminal (for stud-mounted thyristors only).

3.10.6 PIN. Each semiconductor device shall be marked with the type designation which shall be formulated as shown in 1.3. If the device size does not allow the complete PIN to be marked on the device, the component designation portion (see 1.3.4) shall be omitted first followed by the quality level.

3.10.6.1 JAN branded prefix. The type number of all semiconductor devices acquired to and meeting the requirements of this specification and the applicable associated specification shall bear the applicable prefix. In the case of small size semiconductor devices, the abbreviated prefix J, JX, JV, JVM, JVD, JVL, JVR, JVG, JVF, JVH, JS, JSM, JSD, JSL, JSR, JVF, JVG, or JSH may be used.

3.10.6.1.1 JAN and J marking. The United States Government has adopted, and is exercising legitimate control over the certification marks "JAN" and "J", respectively, to indicate that items so marked or identified are manufactured to, and meet all the requirements of the applicable specification. Accordingly, items acquired to, and meeting all of the criteria specified herein and in applicable specifications shall bear the certification mark "JAN" except that items too small to bear the certification marked "JAN" shall bear the letter "J". The "JAN" or "J" shall be placed immediately before the PIN except that if such location would place a hardship on the manufacturer in connection with such marking, the "JAN" or "J" may be located on the first line above or below the PIN. Items furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein or in applicable specifications shall not bear "JAN" or "J". In the event an item fails to meet the requirements of this specification and the applicable associated specifications, the manufacturer shall remove completely the military PIN and the "JAN" or the "J" from the sample tested and also from all items represented by the sample. The "JAN" or "J" certification mark shall not be used on products acquired to contractor drawings or specifications (see 6.1.1). The United States Government has obtained Certificate of Registration Number 504,860 for the certification mark "JAN" and Registration Number 1,586,261 for the certification mark "J".

3.10.7 Manufacturer's designating symbol. The manufacturer's designating symbol shall be as listed in the QPL and assigned by the qualifying activity. The symbol shall be used only by the manufacturer to whom it has been assigned and only on those devices manufactured at that manufacturer's plant. In the case of small devices, the manufacturer's designating symbol may be abbreviated by omitting the first "C" in the series of letters.

3.10.8 Lot identification code. Semiconductor devices shall be marked by a code indicating the last week of sealing for the inspection lot accumulation period. The first two numbers in the code shall be the last two digits of the number of the year. The third and fourth numbers shall be two digits indicating the calendar week of the year. When the number of the week is a single digit, it shall be preceded by a zero. Reading from left to right or top to bottom, the code number shall designate the year and week. When more than one lot of a device type sealed within the same 6-week period is submitted for conformance inspection, a lot identification suffix letter shall be chosen, consisting of a single capital letter, and shall appear on each semiconductor device immediately following the date code. This letter shall be chosen by the manufacturer so that each inspection lot is uniquely identified by the lot identification code and by the lot identification suffix letter, if one is required. The lot identification code shall not be omitted from the marking on DO-35 packages.

3.10.8.1 Code for plants. If the devices are assembled or fabricated at a plant other than the basic plant, the lot identification code shall include a single letter which uniquely identifies the plant or country where the plant is located. This plant designator shall appear immediately preceding and adjacent to the date code. The plant designator will be listed with the addresses in the QPL.

3.10.9 Serialization. JANS devices and, when specified, other device levels shall be marked with a unique serial number assigned consecutively within the inspection lot. JANS devices shall be marked with the serial number prior to the first electrical test in screening, and inspection lot records shall be maintained to provide traceability from the serial number to the specific wafer inspection lot from which the devices originated. For small devices with insufficient area for serialization, lead or body tags may be used.

3.10.10 Country of origin. The manufacturer shall indicate the country of origin of the device. At the option of the manufacturer the country of origin marking may be omitted from the body of the device but shall be retained on the initial container.

3.10.11 Manufacturer's name, abbreviation, or trademark. At the manufacturer's option, devices supplied to this specification may be marked with the device manufacturer's name, abbreviation, or trademark in place of the designating symbol described in 3.10.7, except for a manufacturer with multiple facility locations. The identification of the equipment manufacturer may appear on the device only if the equipment manufacturer is also the device manufacturer. The name or trademark of only the original manufacturer shall appear on the device or initial container. Alteration of name or trademark shall not be permitted.

3.10.12 Marking option. Except for serialization, the manufacturer has the option of marking the entire lot or only the sample devices prior to inspection. If the manufacturer exercises the option to mark only the sample devices, the procedure shall be as follows:

a. The sample devices shall be marked prior to performance of conformance or qualification inspection.

b. At the completion of inspection, the marking of the sample devices shall be inspected for conformance with the requirements of 3.10.1 and 3.10.4.

c. The inspection lot represented by a conforming inspection sample shall then be marked and any specified visual and mechanical inspection performed.

d. The marking materials and processing applied to the inspection lot shall be to the same specification as those used for the inspection sample.

3.11 Solderability. All parts shall be capable of passing the solderability test in accordance with MIL-STD-750, test method 2026, on delivery.

3.12 ESD control. Semiconductors shall be handled in accordance with EIA-625 or other industry standard practice, to safeguard against discharge damage, as applicable.

3.13 Traceability. All devices delivered to this specification shall be identified (see 3.7 and 3.10.1) such that they shall be traceable through the lot identification code and inspection lot records. In addition, JANS devices shall have a lot control system from wafer processing through screening which provides wafer lot identification, operation (machine), date of operation, operator(s) identification, quantity, and serial numbers of devices processed.

4. VERIFICATION

4.1 Quality system. The manufacturer shall implement and maintain a quality system. This system shall assist the manufacturer in producing devices which meet 3.1. See appendix D for the quality system requirements.

4.2 Device verification. The manufacturer shall implement and maintain a verification program which demonstrates that devices meet 3.1. Appendix E is the standard verification flow for encapsulated devices, appendix G is the standard verification flow for unencapsulated devices.

4.2.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see appendix E).

b. Screening (see appendix E).

c. Conformance inspection (CI)(see appendix E).

4.3 RHA program. Manufacturer's producing RHA qualified devices shall implement and maintain a RHA program which demonstrates device compliance with 3.1. Appendix F shall be used in developing this program.

4.4 Test modification, reduction, or elimination. Tests and inspections may be modified, reduced, or eliminated with the approval of the preparing activity and the qualifying activity. When a manufacturer modifies, reduces, or eliminates a test or inspection, the manufacturer is only relieved of the responsibility of performing that test or inspection. The manufacturer is still responsible for providing product which meets 3.1.

4.5 ESDS. ESDS testing shall be done in accordance with test method 1020 of MIL-STD-750 and the associated specification. Unless otherwise specified, tests shall be performed for initial qualification and product redesign as a minimum.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.1). When actual packaging of material is to be performed by DOD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contracting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1).

c. Packaging requirements (see 5.1).

d. PIN (see 1.3).

e. Number of the applicable associated specification (see 3.4 and supplement 1 of this document). For additional information on PINs not included in supplement 1, contact the Defense Electronics Supply Center, DESC-ELD, Dayton, OH 45444.

f. Lead formation, length, finish, if other than that specified, or when a choice is required by the device application.

g. Data requirements, when applicable.

h. Specify point of shipment.

i. PIND screening when required.

j. Date code and specification revision letter must not be restricted by the acquisition documents.

6.1.1 Purchase order requirements. The JAN brand or the abbreviations must not be used on any semiconductor device acquired under contracts which permit or require any changes to this specification or the applicable associated specification, except for:

a. Lead length.

b. Finish.

c. PIND testing. PIND screening to requirements beyond those specified herein may be performed only when imposed by the acquisition document upon the component manufacturer. A new PIN will be created in accordance with 1.3 and 3.10.3. Devices which pass such screens may be JAN branded or may retain the JAN brand if already marked. All devices failing such screens must not be JAN branded or, if already marked must have the JAN brand removed or the device destroyed.

d. Lead forming. The forming of leads must not be performed except for specific customer purchase orders where the lot is controlled throughout processing by specific lot travelers. The bend must not be closer than .050 inch (1.27 mm) to the glass seal. If lead forming is performed, a hermeticity test must be performed in accordance with table IV, screen 7.

6.2 Supersession information. Devices covered by associated specifications are substitutable for the manufacturer's and user's PIN's. This information in no way implies that manufacturer's PINs are suitable as a substitute for the military PIN. The table below is an example of the type of cross reference data that should be available in the associated specifications.

Supersession and cross reference data.

Military PIN	Manufacturer's CAGE code	Manufacturer's and user's PIN

6.3 Qualification. With respect to products requiring qualification, awards will also be made only for products which are, at the time of award of a contract, qualified for inclusion in QPL, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orderfor the products covered by this specification. The information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center, DESC-ELS, Dayton, OH 45444.

6.4 Subject term (key word) listing:

Double plug construction
Electrostatic discharge sensitivity (ESD)
Failure analysis (FA)
Metallurgical bond
Qualification
Qualified products listing (QPL)
Quality assurance (QA)
Radiation hardness assurance (RHA)
Statistical process control (SPC)
Thermal match
Thermal response

APPENDIX A

DEFINITIONS

A.1 SCOPE

A.1.1 Scope. This appendix contains the definitions of terms used with semiconductor devices. This appendix is not mandatory.

A.2 APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

A.3 SEMICONDUCTOR COMMON DEFINITIONS

A.3.1 Absolute maximum ratings. The values specified for "ratings", "maximum ratings", or "absolute maximum ratings" are based on the "absolute system" and unless otherwise required for a specific test method are not to be exceeded under any service or test conditions. These ratings are limiting values beyond which the serviceability of any individual semiconductor device may be impaired. Unless otherwise specified, the voltage, current, and power ratings are based on continuous dc power conditions at free air ambient temperature of +25°C. For pulsed or other conditions or operation of similar nature, the current, voltage, and power dissipation ratings are a function of time and duty cycle. In order not to exceed absolute ratings, the equipment designer has the responsibility of determining an average design value, for each rating, below the absolute value of that rating by a safety factor, so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

A.3.2 Ambient temperature. Ambient temperature is the air temperature measured below a semiconductor device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces.

A.3.3 Anode. The electrode from which the forward current flows within the device.

A.3.4 Associated specification. Since this specification covers the general requirements and tests for semiconductor devices, the details of performance of the semiconductor device must be specified in the associated specification. Items listed below should be covered in the associated specification:

a. PIN (see 1.3)

b. Generic design, construction, and material (see appendix H).

c. The marking to be omitted if any (see 3.10). The order of precedence for marking is as listed in 3.10.1.

d. Classification of inspection.

   (1) Examination and tests to be performed under qualification inspection.

   (2) Examination and tests to be performed under CI.

   (3) Examination and tests to be performed under screening inspection.

e. End-point measurements to be made for group B, C, D, and E inspections (see appendix E).

f. Quality levels covered.

g. Device level and screening procedure if other than table II.

h. Sequence of test, test method, test condition, limit, cycles, temperature, or axis; when not specified, or if other than specified herein.

i. Interim (pre- and post-burn-in) electrical parameters.

j. Burn-in test condition and burn-in test circuit.

k. Delta parameter measurements or provisions for PDA including procedures for traceability, where applicable.

l. Final electrical measurements.

m. Requirements for data recording and reporting, where applicable.

A.3.4.1 MIL-STD-750 details. In addition to the items as specified in A.3.4, the applicable details required by MIL-STD-750 should be listed in the associated specification.

A.3.5 Blocking. A term describing the state of a semiconductor device or junction which eventually prevents the flow of current.

A.3.6 Breakdown voltage. The breakdown voltage is the maximum instantaneous voltage, including repetitive and nonrepetitive transients, which can be applied across a junction in the reverse direction without an external means (circuit) of limiting the current. It is also the instantaneous value of reverse voltage at which a transition commences from a region of high small-signal impedance to a region of substantially lower small-signal impedance.

A.3.7 Case mount. A type of package (outline) which provides a method of readily attaching one surface of the semiconductor device to a heat dissipator to achieve thermal management of the case temperature (example: TO-3, DO-4).

A.3.8 Case temperature. Case temperature is that temperature measured at a specified point on the case of a semiconductor device.

A.3.9 Cathode. The electrode to which the forward current flows within the device.

A.3.10 Characteristic. An inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electromagnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values usually shown in graphical form.

A.3.11 Constant current source. A current source shall be considered constant if halving the generator impedance does not produce a change in the parameter being measured that is greater than the required precision of the measurement.

A.3.12 Constant voltage source. A voltage source shall be considered constant if doubling the generator impedance does not produce a change in the parameter being measured that is greater than the required precision of the measurement.

A.3.13 Disc type. A type of package (outline) for very high power devices which provides two parallel surfaces for mounting into a specialized heat dissipator capable of applying a specified compressive force to the device.

A.3.14 Forward bias. The bias which tends to produce current flow in the forward direction (p type semiconductor region at a positive potential relative to n type region).

A.3.15 Metallurgical bond, diode construction, and thermal matching. Metallurgical bonds as used in JAN-brand semiconductor devices will be identified by one of the following categories. The listing of the three types of metallurgical bonds is for clarification and may not necessarily be listed in order of merit.

A.3.15.1 Double plug construction. Double plug construction is one where the terminal plugs have equal nominal diameters. Plug contact with the semiconductor die may be achieved either through direct contact with the die metallization materials or via brazing or solder prefrom metallization. The use of a point contact whisker or other wire conductors is not allowed.

A.3.15.2 Dash-one construction. Dash-one diodes shall be of double plug construction utilizing high temperature metallurgical bonding between both sides of the silicon die and attach preform or terminal pins.

A.3.15.3 Category I metallurgical bond. A category I metallurgical bond is formed when the bond between the semiconductor element (such as silicon or germanium.) and the package consists of a phase which melts during the bonding process and which includes in the solidified melt both a portion of the semiconductor element and a portion of the metallization layer which is on the package mounting surface. Category I bonds between adjacent semiconductor elements (as in stacks) shall include portions of both semiconductor elements in the solidified melt. Unless otherwise specified in the associated specification, category I metallurgical bonds are typically required for all axial leaded diodes, equal to and greater than 1 watt or 1 amp.

A.3.15.4 Category II metallurgical bond. A category II metallurgical bond is formed utilizing a brazing or soldering alloy which melts during the bonding process and bonds to a metallization layer on each of the surfaces being joined. Dissolution of the semiconductor element or any of the wetted surface layers is not required.

A.3.15.5 Category III metallurgical bond. A category III metallurgical bond is formed when the surfaces to be bonded are brought together under conditions of temperature and pressure such that a diffusion bond is formed between the outermost metallization layer of the elements being joined. This bond is characterized by having species from both sides of the original interface diffused across the interface without any molten phase having been present.

A.3.15.6 Non-cavity double plug diode. Double plug construction where the package glass is in intimate contact with the semiconductor die isolating the anode and cathode regions, and insuring immunity from particle related failures. Voids may be present provided isolation (to prevent arcing) and particle immunity are insured.

A.3.15.7 Thermally matched axial leaded diodes. Diode construction within the coefficients of thermal expansion of the die, plug, and package materials shall be thermally matched such that the diodes are immune to intermittent opens by design. Axial-leaded diode critical interfaces which comply with this definition must utilize tungsten or molybdenum plugs.

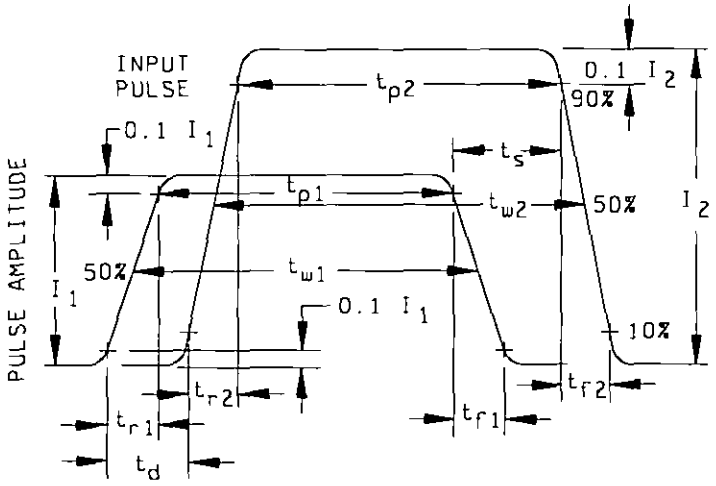
A.3.15.8 Metallurgically bonded-thermally matched-noncavity-double plug construction. Axial-leaded diodes meeting this definition must be of double plug construction utilizing tungsten or molybdenum plugs. Both sides of the diode chip (die) must be bonded to the corresponding plug by a category I metallurgical bond. The package must be thermally matched, non-cavity construction (see A.3.14.1 through A.3.14.7). The plate silver button contact design is not permitted.

A.3.16 Noise figure. At a selected input frequency, the noise figure is the ratio of the total noise power per unit bandwidth (at a corresponding output frequency) delivered to the output termination, to the portion thereof contributed at the input frequency by the input termination, whose noise temperature is standard (293°K) at all frequencies.

A.3.17 Open circuit. A circuit shall be considered as open circuited if halving the magnitude of the terminating impedance does not produce a change in the parameter being measured greater than the specified accuracy of the measurement.

A.3.18 Package type. A package type is a package which has the same case outline, configuration, materials (including bonding, wire, or ribbon and die attach) piece parts (excluding preforms which differ only in size) and assembly processes.

A.3.19 Pulse. A pulse is a flow of electrical energy of short duration. See figure 1 for illustrations of the characteristics defined in A.3.19 to A.3.24, inclusive.



t_r = Pulse rise time.

t_d = Pulse delay time.

t_p = Pulse time.

t_s = Pulse storage time.

t_f = Pulse fall time.

t_w = Pulse average time.

I = Pulse amplitude.

NOTES:
1. Subscript 2 denotes output.
2. Subscript 1 denotes input.

FIGURE 1. Pulse measurements.

A.3.20 Pulse average time. The average pulse time of a pulse is the time duration from a point on the leading edge which is 50 percent of the maximum amplitude to a point on the trailing edge which is 50 percent of the maximum amplitude.

A.3.21 Pulse delay time. The delay time of a pulse is the time interval from a point at which the leading edge of the input pulse has risen to 10 percent of its maximum amplitude to a point at which the leading edge of the output pulse has risen to 10 percent of its maximum amplitude.

A.3.22 Pulse fall time. The fall time of a pulse is that time duration during which the amplitude of its trailing edge is decreasing from 90 to 10 percent of the maximum amplitude.

A.3.23 Pulse rise time. The rise time of a pulse is that time duration during which the amplitude of its leading edge is increasing from 10 to 90 percent of the maximum amplitude.

A.3.24 Pulse storage time. The storage time of a pulse is the time interval from a point 10 percent down from the maximum amplitude on the trailing edge of the input pulse to a point 10 percent down from the maximum amplitude on the trailing edge of the output pulse.

A.3.25 Pulse time. The pulse time of a pulse is the time interval from the point on the leading edge which is 90 percent of the maximum amplitude, to the point on the trailing edge which is 90 percent of the maximum amplitude.

A.3.26 Radiation failures. A radiation failure is defined at the lowest radiation level when either any device parameter exceeds its specified post irradiation parameter limits (PIPL) or the device fails any functional test in accordance with stated test conditions.

A.3.27 Radiation hardness assurance (RHA). That portion of performance verification testing that assures that parts meet the radiation response characteristics as specified in this specification and the associated specification.

A.3.28 Rating. The nominal value of any electrical, thermal, mechanical, or environmental quantity assigned to define the operating conditions under which a component, machine, apparatus, or electronic device is expected to give satisfactory service.

A.3.29 Reverse bias. The bias which tends to produce current flow in the reverse direction (n type semiconductor region at a positive potential relative to the p type region).

A.3.30 Semiconductor devices. Electronic device in which the characteristic distinguishing electronic conduction takes place within a semiconductor.

A.3.31 Semiconductor diode. A semiconductor device having two terminals and exhibiting a nonlinear voltage-current characteristic.

A.3.32 Semiconductor junction. A region of transition between semiconductor regions of different electrical properties (e.g., n-n+, p-n, p-p+ semiconductors) or between a metal and a semiconductor.

A.3.33 Short circuit. A circuit shall be considered short-circuited if doubling the magnitude of the terminating impedance does not produce a change in the parameter being measured that is greater than the specified accuracy of the measurement.

A.3.34 Small signal. A signal shall be considered small if doubling its magnitude does not produce a change in the parameter being measured that is greater than the specified accuracy of the measurement.

A.3.35 Storage temperature. Storage temperature is a temperature at which the device may be stored without any power being applied.

A.3.36 Temperature coefficient. The ratio of the change in a parameter to the change in temperature.

A.3.37 Thermal compression bond. A bond achieved when pressure and temperature are present regardless of how the temperature rise was achieved except without ultrasonic assist.

A.3.38 Thermal equilibrium. Thermal equilibrium is reached when doubling the test time interval does not produce a change, due to thermal effects, in the parameter being measured that is greater than the specified accuracy of the measurement.

A.3.39 Thermal resistance. Thermal resistance is the temperature rise, per unit power dissipation, of a junction above the temperature of a stated external reference point under conditions of thermal equilibrium.

A.3.40 Thyristor. A bi-stable semiconductor device that comprises three or more junctions and can be switched from the off state or on state to the opposite state.

A.3.41 Transistor. An active semiconductor device capable of providing power amplification and having three or more terminals.

A.3.42 Expanded metallization. Expanded metallization is metallization that increases in area (example, metal line to bond pad area) (see figure 2).

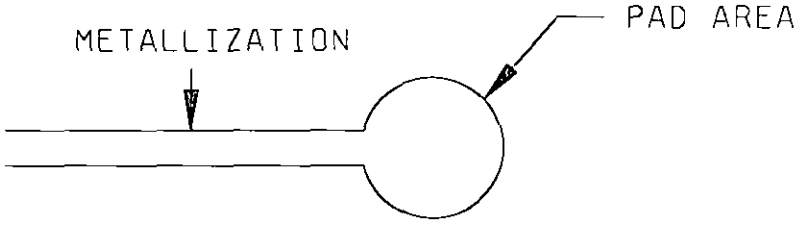


FIGURE 2. Example of expanded metallization.

A.3.43 Impulse waveform. A pulse with a defined virtual front and impulse duration for either a voltage or current amplitude of unidirectional polarity.

A.3.44 Virtual front duration. The pulse time as defined by 1.67 times time for voltage to increase from 30 percent to 90 percent of crest (peak value) or 1.25 times time for current to increase from 10 percent to 90 percent of crest.

A.3.45 Impulse duration. The time required for an impulse waveform to decay to 50 percent of the peak value measured from the start of the virtual front duration of zero crossover.

A.3.46 Line. A collection of similar wafer fabrication flows, or similar package assembly flows used to manufacture semiconductors in accordance with a specified process flow.

A.4 TRANSISTOR DEFINITIONS

A.4.1 Junction transistors, multijunction types.

A.4.1.1 Base. A region which lies between an emitter and collector of a transistor and into which minority carriers are injected.

A.4.1.2 Collector. A region through which a primary flow of charge carriers leaves the base.

A.4.1.3 Cutoff current. The cutoff current is the measured value of dc current when a transistor is reverse biased by a voltage less than the breakdown voltage.

A.4.1.4 Emitter. A region from which charge carriers that are minority carriers in the base are injected into the base.

A.4.1.5 Junction, collector. A semiconductor junction, normally biased in the reverse direction, the current through which can be controlled by the introduction of minority carriers into the base.

A.4.1.6 Junction, emitter. A semiconductor junction normally biased in the forward direction to inject minority carriers into the base.

A.4.1.7 Saturation. A base current and a collector current condition resulting in a forward-biased collector junction.

A.4.2 Unijunction transistors.

A.4.2.1 Peak point. The point on the emitter current-voltage characteristic corresponding to the lowest current at which the change in emitter base voltage with respect to emitter current equals zero.

A.4.2.2 Unijunction transistor. A three-terminal semiconductor device having one junction and a stable negative-resistance characteristic over a wide temperature range.

A.4.2.3 Valley point. The point on the emitter current-voltage characteristic corresponding to the second lowest current at which the change in emitter base voltage with respect to emitter current equals zero.

A.4.3 FETs.

A.4.3.1 Depletion-mode operation. The operation of a FET such that changing the gate to source voltage from zero to a finite value decreases the magnitude of the drain current.

A.4.3.2 Depletion-type-FET. A FET having appreciable channel conductivity for zero gate to source voltage. The channel conductivity may be increased or decreased according to the polarity of the applied gate to source voltage.

A.4.3.3 Drain. A region into which majority carriers flow from the channel.

A.4.3.4 Enhancement-mode operation. The operation of a FET such that changing the gate to source voltage from zero to a finite value increases the magnitude of the drain current.

A.4.3.5 Enhancement-mode FET. A FET having substantially zero channel conductivity for zero gate to source voltage. The channel conductivity may be increased by the application of a gate to source voltage of appropriate polarity.

A.4.3.6 FET. A transistor in which the conduction is due entirely to the flow of majority carriers through a conduction channel controlled by an electric field arising from a voltage applied between the gate and source terminals.

A.4.3.7 Gate. The electrode associated with the region in which the electric field due to the control voltage is effective.

A.4.3.8 Insulated-gate FET. A FET having one or more gate electrodes which are electrically insulated from the channel.

A.4.3.9 Junction-gate FET. A FET that uses one or more gate regions to form p-n junction(s) with the channel.

A.4.3.10 MOSFET. An insulated gate FET in which the insulating layer between each gate electrode and the channel is oxide material.

A.4.3.11 N-channel FET. A FET that has an n type conduction channel.

A.4.3.12 P-channel FET. A FET that has a p type conduction channel.

A.4.3.13 Source. A region from which majority carriers flow into the channel.

A.5 DIODE AND RECTIFIER DEFINITIONS

A.5.1 Signal diodes and rectifier diodes.

A.5.1.1 Semiconductor rectifier diode. A device having an asymmetrical voltage-current characteristic used for rectification.

A.5.1.2 Semiconductor signal diode. A device having an asymmetrical voltage-current characteristic and used for signal detection.

A.5.2 Microwave diodes.

A.5.2.1 Detector diode. A device which converts rf energy into dc or video output.

A.5.2.2 Gunn diode. A microwave diode that exhibits negative resistance arising from the bulk negative differential conductivity occurring in several compound semiconductors such as gallium arsenide, and that operates at a frequency determined by the transit time of charge bunches formed by this negative differential conductivity.

A.5.2.3 IMPATT diode (impact, avalanche and transit time diode). A semiconductor microwave diode that, when its junction is biased into avalanche, exhibits a negative resistance over a frequency range determined by the transit time of charge carriers through the depletion region.

A.5.2.4 LSA diode (limited space-charge accumulation diode). A microwave diode similar to the Gunn diode except that it achieves higher output power at frequencies, determined by the microwave cavity, that are several times greater than the transit-time frequency by avoiding the formation of charge bunches or domains.

A.5.2.5 Matched pair. A pair of diodes identical in outline dimensions and with matched electrical characteristics. The two diodes may both be forward polarity, or one forward and one reverse polarity, or both reverse polarity.

A.5.2.6 Microwave diode. A two terminal device that is responsive in the microwave region of the electromagnetic spectrum, commonly regarded as extending from 1 to 300 GHz.

A.5.2.7 Mixer diode. A microwave diode that combines rf signals at two frequencies to generate an rf signal at a third frequency.

A.5.2.8 TRAPATT diode (trapped plasma avalanche transit time diode). A microwave diode that, when its junction is biased into avalanche, exhibits a negative resistance at frequencies below the transit time frequency range of the diode due to generation and dissipation of trapped electron-hole plasma resulting from the intimate interaction between the diode and a multiresonant microwave cavity.

A.5.3 Tunnel diodes.

A.5.3.1 Tunnel diodes. A device in which quantum-mechanical tunneling leads to a region of negative slope in the forward direction of the current-voltage characteristic.

A.5.3.2 Backward diode. A device in which quantum-mechanical tunneling leads to a current-voltage characteristic with a reverse current greater than the forward current, for equal and opposite applied voltages.

A.5.4 Voltage-regulator and voltage-reference diodes.

A.5.4.1 Voltage-reference diode. A diode which is normally biased to operate in the breakdown region of its voltage-current characteristic and which develops across its terminals a reference voltage of specified accuracy, when biased to operate throughout a specified current and temperature range.

A.5.4.2 Voltage-regulator diode. A diode which is normally biased to operate in the breakdown region of its voltage-current characteristic and which develops across its terminals an essentially constant voltage throughout a specified current range.

A.5.5 Current-regulator diodes.

A.5.5.1 Current-regulator diode. A diode which limits current to an essentially constant value over a specified voltage range.

A.5.6 Varactor diodes.

A.5.6.1 Varactor diode. A two terminal semiconductor device in which use is made of the property that its capacitance varies with the applied voltage.

A.5.6.2 Tuning diode. A varactor diode used for rf tuning including functions such as automatic frequency control (AFC) and automatic fine tuning (AFT).

A.5.7 Transient voltage suppressors.

A.5.7.1 Varistor. A transient voltage suppressor that is a nonlinear resistor with symmetrical characteristics.

A.5.7.2 Avalanche-junction. A transient voltage suppressor that is a semiconductor diode that can operate in either the forward or reverse direction of its voltage-current characteristic to limit voltage transients.

A.5.7.3 Clamping voltage. The voltage in a region of low differential resistance that serves to limit the transient voltage across the device terminals.

A.5.7.4 Clamping factor. The ratio of clamping voltage to breakdown voltage.

A.5.7.5 Peak impulse current. The peak current for a series of essentially identical impulses.

A.5.7.6 Standby current. The dc current through a transient voltage suppressor at rated standoff voltage.

A.5.7.7 Repetitive peak pulse power. The peak power dissipation resulting from the peak impulse current I_{pp}.

A.5.7.8 Response time. The time interval between the point on the impulse waveform at which the amplitude exceeds the clamping voltage level and the peak of the voltage overshoot.

A.5.7.9 Voltage overshoot. The excess voltage over the clamping voltage that occurs when a current impulse having short virtual front duration is applied.

A.5.7.10 Forward surge current. The peak current for a single impulse for forward biased diode.

A.5.7.11 Working peak voltage. The peak voltage, excluding all transient voltage, usually referred to as standoff voltage.

A.6 CLASSES OF THYRISTORS

A.6.1 Thyristor. A bi-stable semiconductor device that comprises three or more junctions and can be switched between conducting and nonconducting status.

A.6.1.1 Bidirectional diode thyristor. A two terminal thyristor having substantially the same switching behavior in the first and third quadrants of the principal voltage-current characteristic.

A.6.1.2 Bidirectional triode thyristor. An n-gate or p-gate thyristor having substantially the same switching behavior in the first and third quadrants of the principal voltage-current characteristic.

A.6.1.3 N-gate thyristor. A three-terminal thyristor in which the gate terminal is connected to the n-region adjacent to the region to which the anode terminal is connected and that is normally switched to the on-state by applying a negative signal between gate and anode terminals.

A.6.1.4 P-gate thyristor. A three-terminal thyristor in which the gate terminal is connected to the p-region adjacent to the region to which the cathode terminal is connected and that is normally switched to the on-state by applying a positive signal between gate and cathode terminals.

A.6.1.5 Reverse blocking diode thyristor. A two-terminal thyristor that switches only for positive anode to cathode voltages and exhibits a reverse blocking state for negative anode to cathode voltages.

A.6.1.6 Reverse blocking triode thyristor. An n-gate or p-gate thyristor that switches only for positive anode to cathode voltages and exhibits a reverse blocking state for negative anode to cathode voltages.

A.6.1.7 Reverse conducting diode thyristor. A two terminal thyristor that switches only for positive anode to cathode voltages and conducts large currents at negative anode to cathode voltages comparable in magnitude to the on-state voltage.

A.6.1.8 Reverse conducting triode thyristor. An n-gate or p-gate thyristor that switches only for positive anode to cathode voltages and conducts large currents at negative anode to cathode voltages comparable in magnitude to the on-state voltages.

A.6.1.9 Turn off thyristor. A thyristor that can be switched between conducting and nonconducting states by applying control signals of appropriate polarities to the gate terminal, with the ratio of triggering power to triggered power appreciably less than one.

A.6.2 Physical structure terms.

A.6.2.1 Gate. An electrode connected to one of the semiconductor regions for introducing control current.

A.6.2.2 Main terminals. The two terminals through which the principal current flows.

A.6.3 Electrical characteristic and rating terms.

A.6.3.1 Anode to cathode voltage-current characteristic (anode characteristic). A function, usually represented graphically, relating the anode to cathode voltage to the principal current, with gate current where applicable, as a parameter.

A.6.3.2 Breakover point. Any point on the principal voltage-current characteristic for which the differential resistance is zero and where the principal voltage reaches a maximum value.

A.6.3.3 Negative differential resistance region. Any portion of the principal voltage-current characteristic in the switching quadrant within which the differential resistance is negative.

A.6.3.4 Off impedance. The differential impedance between the terminals through which the principal current flows when the thyristor is in the off state.

A.6.3.5 Off state. The condition of a thyristor corresponding to the high resistance low current portion of the principal voltage-current characteristic between the origin and the breakover point in the switching quadrant.

A.6.3.6 On impedance. The differential impedance between the terminals through which the principal current flows when the thyristor is in the on state.

A.6.3.7 On state. The condition of a thyristor corresponding to the low resistance, low voltage portion of the principal voltage-current characteristic in the switching quadrant.

A.6.3.8 Principal current. A generic term for the current through the device excluding gate current.

A.6.3.9 Principal voltage. The voltage between the main terminals.

A.6.3.10 Principal voltage-current characteristic (principal characteristic). A function, usually represented graphically, relating the principal voltage to the principal current, with gate current where applicable, as a parameter.

A.6.3.11 Reverse blocking impedance. The differential impedance between the two terminals through which the principal current flows when the thyristor is in the reverse blocking state at a stated operating point.

A.6.3.12 Reverse blocking state. The condition of a reverse blocking thyristor corresponding to the portion of the anode to cathode voltage-current characteristic for which the reverse currents are of lower magnitude than the reverse breakdown current.

A.6.3.13 Switching quadrant. A quadrant of the principal voltage-current characteristic in which a device is intended to switch between an off state and an on state.

A.7 OPTOELECTRONIC DEVICE DEFINITIONS

A.7.1 Optoelectronic device. A device that is responsive to or that emits or modifies electromagnetic radiation in the visible, infrared, or ultraviolet spectral regions; or a device that utilizes such electromagnetic radiation for its internal operation.

A.7.1.1 Conversion efficiency. The ratio of maximum available power output resulting from photovoltaic operation to total incident radiant flux.

A.7.1.2 Dark condition. The condition attained when the electrical parameter under consideration approaches a value which cannot be altered by further irradiation shielding.

A.7.1.3 Dark current. The current that flows through a photosensitive device in the dark condition.

A.7.1.4 Light current. The current that flows through a photosensitive device when it is exposed to radiant energy.

A.7.1.5 Photoconductive diode. A photodiode that is intended to be used as a photoconductive transducer.

A.7.1.6 Photocurrent. The difference in magnitude between light current and dark current.

A.7.1.7 Photodiode. A diode that is intended to be responsive to radiant energy.

A.7.1.8 Photodiode, avalanche. A photodiode that is intended to take advantage of avalanche multiplication of photocurrent.

A.7.1.9 Photoemitter. A device that emits electromagnetic radiation in the visible, infrared, or ultraviolet spectral regions.

A.7.1.10 Photosensitive device. A device that is responsive to electromagnetic radiation in the visible, infrared, or ultraviolet spectral regions.

A.7.1.11 Photothyristor. A thyristor that is intended to be responsive to radiant energy for controlling its operation as a thyristor.

A.7.1.12 Phototransistor. A transistor that is intended to be responsive to radiant energy.

A.7.1.13 Photovoltaic diode. A photodiode that is intended to generate a terminal voltage in response to radiant energy.

A.7.2 Photoemitting devices.

A.7.2.1 Avalanche luminescent diode. A light emitting diode that emits luminous energy when a controlled reverse current in the breakdown region is applied.

A.7.2.2 Infrared emitting diode. A diode capable of emitting radiant energy in the infrared region of the spectrum resulting from the recombination of electrons and holes.

A.7.2.3 Light emitting diode. A diode capable of emitting luminous energy resulting from the recombination of electrons and holes.

A.7.2.4 Radiant efficiency. The ratio of the total radiant flux emitted to the total input power.

A.7.3 Opto-couplers.

A.7.3.1 Photodarlington coupler. An opto-coupler in which the photo-sensitive element is a darlington connected phototransistor.

A.7.3.2 Photodiode coupler. An opto-coupler in which the photosensitive element is a photodiode.

A.7.3.3 Photothyristor coupler. An opto-coupler in which the photosensitive element is a photothyristor.

A.7.3.4 Phototransistor coupler. An opto-coupler in which the photosensitive element is a phototransistor.

A.8 ELECTRICAL AND ENVIRONMENTAL STRESS SCREENING DEFINITIONS.

A.8.1 Electrical and environmental stress screening.

a. Electrical stressing near maximum rating of semiconductor devices is performed to remove devices within a given lot which are subject to early life failures due to improper processing.

b. Determine if wear-out mechanisms are present in a given lot which will shorten the time to failure (life tests).

A.8.2 Power burn-in. A generic term describing a screening test which operates the device by internally dissipating sufficient power to significantly heat the device junction for a specified time.

A.8.2.1 Rectifying ac power burn-in. Power burn-in whereby junction heating is accomplished through the alternate application every half cycle of forward current and reverse voltage.

A.8.2.2 Steady-state dc power burn-in. Power burn-in whereby junction heating is accomplished through the application of steady-state forward current, reverse current, or forward power for diodes (including rectifiers), zeners, and transistor respectively.

A.8.3 High temperature reverse bias. A generic term describing a screening test which applies a blocking voltage and is normally performed at T_A = +150°C through the external application of heat.

A.8.3.1 Steady-state dc high temperature reverse bias. High temperature reverse bias which applies steady-state dc blocking voltage.

A.8.3.2 Half-wave high temperature reverse bias. High temperature reverse bias which applies half-wave blocking voltage.

A.8.3.3 Full-wave high temperature blocking bias. High temperature reverse bias which applies full-wave blocking voltage; sometimes applicable to symmetrical thyristors or transient voltage suppressors.

A.8.4 Operating life. A generic term describing a sample test which operates and internally heats a device junction for an extended time to verify lot integrity. This is generally an extension of power burn-in.

A.8.4.1 Rectifying ac operating life. Operating life whereby heating is accomplished through the alternate application of forward current and reverse voltage.

A.8.4.2 Steady-state dc operating life. Operating life whereby heating is accomplished through the application of steady-state forward current, reverse current, or forward power for diodes (including rectifiers), zeners, and transistors respectively.

A.8.4.3 Intermittent operating life. Operating life whereby T_J and T_C is cycled through a specified temperature range by a heating current or power and a cooling period, when current or power is removed.

A.8.4.3.1 Rectifying ac intermittent operating life. Intermittent operating life whereby the device is subjected to forward current and reverse voltage, during the heating period.

A.8.4.3.2 DC intermittent operating life. Intermittent operating life whereby the device is subjected to steady-state forward current or equivalent half sine forward current, during the heating period. This test is also known as power cycling or thermal fatigue.

A.8.5 Blocking life. A generic term describing a sample test which applies a blocking voltage and is normally performed at a specified high ambient or case temperature through the external application of heat.

A.8.5.1 Steady-state dc blocking life. Blocking life which applies steady-state dc blocking voltage.

A.8.5.2 Half-wave blocking life. Blocking life which applies half-wave blocking voltage.

A.8.5.3 Full-wave blocking life. Blocking life which applies full-wave blocking voltage.

A.8.6 Temperature cycling (air to air). Temperature cycling at device's case temperature through a specified range by the external heating and cooling of the device in an air to air environment.

A.8.7 Thermal shock (liquid to liquid). Thermal shock cycling at device's case temperature through a specified range by the external heating and cooling of the device in a liquid to liquid environment.

A.8.8 Thermal response. Thermal response for the purpose of this specification is the application of an electrical stress sufficient to pass heat through the interface of dissimilar materials, primarily to determine the quality of attachment by measuring the electrical characteristics of the temperature sensitive parameter.

A.8.9 Surge. Surge is the application of a high peak current ten times (minimum) the device average current maximum rating applied for a short pulse width appropriate to determine processing defects (e.g., wire bond integrity, micro cracks, and bond voids).

APPENDIX B

ABBREVIATIONS AND SYMBOLS

B.1 SCOPE

B.1.1 Scope. This appendix covers the abbreviations and symbols for use with semiconductor devices. This appendix is not mandatory.

B.2 APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

B.3 GENERAL SEMICONDUCTOR ABBREVIATIONS AND SYMBOLS.

B.3.1 Abbreviations.

ACF	Automatic frequency control
AFT	Automatic fine tuning
BIST	Backward instability shock test
CI	Conformance inspection
ESD	Electrostatic discharge
ESDS	Electrostatic discharge sensitive
FET	Field-effect transistor
FIST	Forward instability shock test
GaAs	Gallium arsenide
HTRB	High temperature reverse bias
IGBT	Insulated gate bipolar transistor
IMPATT	Impact, avalanche, and transit time diode
LSA	Limited space-charge accumulation
MOSFETS	Metal oxide semiconductor field-effect transistors
OEM	Original equipment manufacturer
PDA	Percent defective allowed
PIN	Part or identifying number
PIND	Particle impact noise detector
PIPL	Post-irradiation parameter limits
PPM	Parts per million
QPL	Qualified products list
RHA	Radiation hardness assurance
RHAPM	Radiation hardness assurance part managers

RMS	Root means square	
SEM	Scanning electron microscope	
SOA	Safe operating area	
SPC	Statistical process control	
TP	True position	
TRAPATT	Trapped plasma avalanche transit time diode	
UHF	Ultra high frequency	

B.3.2 Symbols.

		Old symbol
F	Spot noise figure	(NF)
$\bar{F}$	Average noise figure	
R_θ	Thermal resistance	(θ)
$R_{\theta CA}$	Thermal resistance, case to ambient	
$R_{\theta JA}$	Thermal resistance, junction to ambient	(θ_{J-A})
$R_{\theta JC}$	Thermal resistance, junction to case	(θ_{J-C})
$R_{\theta JL}$	Thermal resistance, junction to lead	
$R_{\theta JR}$	Thermal resistance, junction to reference	
T_A	Ambient or free air temperature	
T_C	Case temperature	
TEC	End cap temperature	
T_J	Junction temperature	
TL	Lead temperature	
T_{op}	Operating temperature	
T_{STG}	Storage temperature	
t_d	Delay time	
t_f	Fall time	
t_{off}	Turn off time	
t_{on}	Turn on time	
t_p	Pulse time	
t_r	Rise time	

t_s	Storage time	
t_w	Pulse average time	
$V_{(BR)}$	Breakdown voltage	(BV)

B.4 TRANSISTORS SYMBOLS

B.4.1 Junction transistors, multijunction type symbols.

C_{ibo}, C_{ieo}	Input capacitance, (common base, common emitter) collector open circuited for ac
ibs, C_{ies}	Input capacitance, (common base, common emitter) collector short-circuited to reference terminal for ac
C_{obo}, C_{oeo}	Output capacitance, (common base, common emitter) input open circuited to ac
C_{obs}, C_{oes}	Output capacitance, (common base, common emitter) input short-circuited to reference terminal for ac
f_{hfb}, f_{hfc}, f_{hfe}	Small signal, short-circuit forward current transfer ratio cutoff frequency (common base, common collector, common emitter)
f_{max}	Maximum frequency of oscillation
f_T	Extrapolated unity gain frequency
g_{MB}, g_{MC}, g_{ME}	Static transconductance (common base, common collector, common emitter)
g_{mb}, g_{mc}, g_{me}	Small signal transconductance (common base, common collector, common emitter)
G_{pB}, G_{pC}, G_{pE}	Large signal insertion power gain (common base, common collector, common emitter)
G_{pb}, G_{pc}, G_{pe}	Small signal insertion power gain (common base, common collector, common emitter)
h_{FB}, h_{FC}, h_{FE}	Static forward current transfer ratio (common base, common collector, common emitter)
h_{fb}, h_{fc}, h_{fe} -8YC	Small signal short circuit forward current transfer ratio (common base, common collector, common emitter)
$\|h_{fe}\|$	Magnitude of common emitter small signal short circuit forward current transfer ratio
h_{IB}, h_{IC}, h_{IE}	Static input resistance (common base, common collector, common emitter)
h_{ib}, h_{ic}, h_{ie}	Small signal short circuit input impedance (common base, common collector, common emitter)
h_{ob}, h_{oc}, h_{oe}	Small signal open circuit output admittance (common base, common collector, common emitter)

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h_{rb}, h_{rc}, h_{re}	Small signal open circ702X base, common collector, common emitter)
I_B	Base current (dc)
I_C	Collector current (dc)
I_E	Emitter current (dc)
i_B	Base current (instantaneous total value)
i_C	Collector current (instantaneous total value)
i_E	Emitter current (instantaneous total value)
I_{CBO}	Collector cutoff current (dc) emitter open
I_{CEO}	Collector cutoff current (dc) base open
I_{CER}	Collector cutoff current (dc) with specified resistance between base and emitter
I_{CES}	Collector cutoff current (dc) base short circuited to emitter
$_{CEV}$	Collector cutoff current (dc) with specified voltage between base and emitter
I_{CEX}	Collector cutoff current (dc) with specified circuit between base and emitter
I_{EBO}	Emitter cutoff current (dc) collector open
I_{ECS}	Emitter cutoff current (dc) base short-circuited to collector
I_S	Collector efficiency
P_C	Collector power dissipation
P_T	Total power dissipation, all terminals
R_B	External base resistance
r_b	Base spreading resistance
rb'cc	Collector-base time constant
R_C	External collector resistance
$r_{CE(sat)}$	Collector to emitter saturation resistance
R_E	External emitter resistance
r_{iep}	Small signal short circuit parallel input resistance (common emitter)
t_c	t_{OFF} crossover time (the time interval during which the collector voltage decreases from 10 percent of its peak off-state value and the collector current decreases to 10 percent of its peak on state value)

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V_{BB}	Base supply voltage
V_{BE}	Base to emitter voltage (dc)
$V_{BE(sat)}$	Base to emitter saturation voltage
$V_{(BR)CBO}$	Breakdown voltage collector to base, emitter open
$V_{(BR)CEO}$	Breakdown voltage collector to emitter, base open
$V_{(BR)CER}$	Breakdown voltage collector to emitter, with specified resistance between base and emitter
$V_{(BR)CES}$	Breakdown voltage collector to emitter, with base short-circuited to emitter
$V_{(BR)CEX}$	Breakdown voltage collector to emitter, with specified circuit between base and emitter
$V_{(BR)EBO}$	Breakdown voltage emitter to base, collector open
V_{CB}	Collector to base voltage (dc)
V_{CBF}	DC open circuit voltage (floating potential) between the collector and base, with the emitter biased in the reverse direction with respect to the base
V_{CBO}	Collector to base voltage (static), emitter open
V_{CC}	Collector supply voltage
V_{CE}	Collector to emitter voltage (dc)
V_{ce}	Collector to emitter voltage (rms)
v_{ce}	Collector to emitter voltage (instantaneous)
$V_{CE(sat)}$	Collector to emitter saturation voltage
V_{CEO}	Collector to emitter voltage (static) base open
$V_{CEO(sus)}$	Breakdown voltage, collector to emitter, sustained
V_{CER}	Collector to emitter voltage (dc), with specified resistance between base and emitter
V_{CES}	Collector to emitter voltage (dc), base short-circuited to emitter
V_{EB}	Emitter to base voltage (dc)
V_{eb}	Emitter to base voltage (rms)
v_{eb}	Emitter to base voltage (instantaneous)
V_{EBF}	DC open circuit voltage (floating potential) between the emitter and base, with the collector biased in the reverse direction with respect to the base

$V_{(BR)CEV}$ - - - - - - - - - - - - - - Breakdown voltage collector to emitter, with specified voltage between base and emitter

V_{EBO} - - - - - - - - - - - - - - - - Emitter to base voltage (static) collector open

V_{EC} - - - - - - - - - - - - - - - - - Emitter to collector voltage (dc)

V_{ECF} - - - - - - - - - - - - - - - - DC open circuit voltage (floating potential) between the emitter and collector, with the base biased in the reverse direction with respect to the collector

V_{EE} - - - - - - - - - - - - - - - - - Emitter supply voltage

V_{RT} - - - - - - - - - - - - - - - - - Reach through voltage

B.4.2 FET symbols.

b_{is} - - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, input susceptance

b_{os} - - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, output susceptance

b_{fs} - - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, forward transfer susceptance

b_{rs} - - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, reverse transfer susceptance

C_{ds} - - - - - - - - - - - - - - - - - Small-signal drain to source capacitance

C_{du} - - - - - - - - - - - - - - - - - Small-signal drain to substrate capacitance

C_{iss} - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, input capacitance

C_{oss} - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, output capacitance

C_{rss} - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, reverse transfer capacitance

D, d - - - - - - - - - - - - - - - - - - Drain terminal

E_{AR} - - - - - - - - - - - - - - - - - Repetitive avalanche energy capability

E_{AS} - - - - - - - - - - - - - - - - - Single pulse avalanche energy capability

G, g - - - - - - - - - - - - - - - - - - Gate terminal

g_{fs} - - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, forward transfer conductance

g_{is} - - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, input conductance

g_{os} - - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, output conductance

G_{pg} - - - - - - - - - - - - - - - - - Small-signal, common-gate insertion power gain

G_{ps} - - - - - - - - - - - - - - - - - Small-signal, common-source insertion power gain

g_{rs} - - - - - - - - - - - - - - - - - Small-signal, common-source, short-circuit, reverse transfer conductance

G_{tg}	Small-signal, common-gate, transducer power gain
G_{ts}	Small-signal, common-source transducer power gain
I_D	Drain current
I_{AR}	Rated avalanche current (repetitive and nonrepetitive)
$I_{D(on)}$	On-state drain current
$I_{D(off)}$	Drain cutoff current
I_{DSS}	Zero-gate-voltage drain current
I_G	Gate current
I_{GF}	Forward gate current
I_{GR}	Reverse gate current
I_{GSS}	Reverse gate current with all other terminals short-circuited to source (junction-gate)
I_{GSSF}	Forward gate current with all other terminals short-circuited to source (insulated-gate)
I_{GSSR}	Reverse gate current with all other terminals short-circuited to source (insulated-gate)
I_S	Source current through drain diode (forward biased V_{SD})
$I_{S(off)}$	Source cutoff current
I_{SDS}	Zero-gate-voltage source current
$I_{(ISO)}$	Source pin to case isolation current
$Q_g(th)$	Gate charge that must be supplied to reach minimum specified gate-source threshold voltage
$Q_{g(on)}$	Gate charge that must be supplied to reach the gate-source voltage specified for the device $r_{DS(on)}$ measurement
$Q_{gm(on)}$	Gate charge that must be supplied to the device to reach the maximum rated gate-source voltage
Q_{gs}	Charge required by C_{GS} to reach a specified I_D
Q_{gd}	Charge supplied to the drain from the gate to change the drain voltage under constant drain current conditions
$r_{ds(on)}$	Small-signal, drain to source on-state resistance
$r_{DS(on)}$	Static drain to source on-state resistance
S, s	Source terminal
$t_{d(off)}$	Turn-off delay time
$t_{d(on)}$	Turn-on delay time

U, u	Substrate (bulk) (terminal, when substrate is externally terminated)
$V_{(BR)GSS}$	Gate to source breakdown voltage, all other terminals short-circuited to source (junction-gate)
$V_{(BR)DSS}$	Drain to source breakdown voltage, all other terminals short-circuited to source (junction-gate)
$V_{(BR)GSSF}$	Forward gate to source breakdown voltage
$V_{(BR)GSSR}$	Reverse gate to source breakdown voltage
V_{DD}	Drain supply voltage
V_{DG}	Drain to gate voltage
V_{DS}	Drain to source voltage
$V_{DS(on)}$	On-state drain to source voltage
V_{DU}	Drain to substrate voltage
V_{GG}	Gate supply voltage
V_{GP}	Gate plateau voltage
V_{GS}	Gate to source voltage
V_{GSF}	Forward gate to source voltage
V_{GSR}	Reverse gate to source voltage
$V_{GS(off)}$	Gate to source cutoff voltage
$V_{GS(th)}$	Gate to source threshold voltage
V_{GU}	Gate to substrate voltage
V_{ISO}	Source pin to case isolation voltage
V_{SS}	Source supply voltage
V_{SU}	Source to substrate voltage
Y_{fs}	Magnitude of small-signal common-source short-circuit forward transfer admittance
Y_{is}	Magnitude of small-signal common-source short-circuit input admittance
Y_{rs}	Magnitude of small-signal common-source short-circuit reverse transfer admittance

B.4.3 Unijunction transistor symbols.

$I_{B2(mod)}$	Interbase modulated current
I_{EB20}	Emitter reverse current
I_P	Peak point current
I_V	Valley point current

r_{BB}	Interbase resistance
V_{B2B1}	Interbase voltage
$V_{EB1(sat)}$	Emitter saturation voltage
V_{OB1}	Base - 1 peak voltage
V_p	Peak point voltage
V_v	Valley point voltage
η	Intrinsic standoff ratio

B.5 DIODES AND RECTIFIERS SYMBOLS

B.5.1 Diodes and rectifier symbols.

C_J	Junction capacitance
$I_{F(RMS)}$, I_f, I_F, $I_{F(AV)}$, i_F, I_{FM}	Forward current
I_{FSM}	Forward current, surge peak
$I_{F(OV)}$	Forward current, overload
I_O	Average forward current, 180° conduction angle, 60 Hz, half sine wave
$I_{R(RMS)}$, I_r, I_R, $I_{R(AV)}$, i_R, I_{RM}	Reverse current
$i_{R(REC)}$, $I_{RM(REC)}$	Reverse recovery current
I_{RRM}	Reverse current, repetitive peak
I_{RSM}	Reverse current, surge peak
P_F, $P_{F(AV)}$, P_F, P_{FM}	Forward power dissipation
P_R, $P_{R(AV)}$, P_R, P_{RM}	Reverse power dissipation
Q_S	Stored charge
t_{fr}	Forward recovery time
t_{rr}	Reverse recovery time
$V_{(BR)}$, $v_{(BR)}$	Breakdown voltage (dc, instantaneous total value)
$V_{F(RMS)}$, V_f, V_F, $V_{F(AV)}$, v_F, V_{FM}	Forward voltage
$V_{R(RMS)}$, V_r, V_R, $V_{r(AV)}$, v_R, V_{RM}	Reverse voltage
V_{RWM}	Working peak reverse voltage
V_{RRM}	Repetitive peak reverse voltage
V_{RSM}	Nonrepetitive peak reverse voltage

B.5.1.1 Letter symbol table (diodes and rectifiers).

	Total RMS value	RMS value of alternating component	DC value no alternating component	DC value with alternating component	Instantaneous total value	Maximum (peak) total value
Forward current	$I_{F(RMS)}$	I_F	I_F	$I_{F(AV)}$	i_F	I_{FM}
Forward current, average, 180° conduction angle 60 Hz, half sine wave				I_O		
Forward current, repetitive peak						I_{FRM}
Forward current, surge peak						I_{FSM}
Forward current, overload						$I_{F(OV)}$
Reverse current	$I_{R(RMS)}$	I_F	I_R	$I_{R(AV)}$	i_R	I_{RM}
Reverse recovery current					$i_{R(REC)}$	$I_{RM(REC)}$
Forward power dissipation			P_F	$P_{F(A)}$	P_F	P_{FM}
Reverse power dissipation			P_R	$P_{R(A)}$	P_R	P_{RM}
Forward voltage	$V_{F(RMS)}$	V_f	V_F	$V_{F(A)}$	V_F	V_{FM}
Reverse voltage	$V_{R(RMS)}$	V_r	V_R	$V_{R(A)}$	V_R	R_{RM}
Reverse voltage working peak						V_{RWM}
Reverse voltage repetitive peak						V_{RRM}
Reverse voltage nonrepetitive peak						V_{RRM}
Breakdown voltage			$V_{(BR)}$		$V_{(BR)}$	

B.5.2 Microwave diode symbols.

$\overline{F_o}$	Overall average noise figure (of a mixer diode)
$\overline{F_{os}}$	Standard overall average noise figure (of a mixer diode)
L_c	Conversion loss
M	Figure of merit (of a detector diode)
N_r	Output noise ratio
TSS	Tangential signal sensitivity
VSWR	Voltage standing wave ratio
z_{if}	Impedance, intermediate-frequency
z_{rf}	Impedance, radio-frequency
z_m	Impedance, modulator-frequency load
z_v	Video impedance

B.5.3 Tunnel diodes and backward diode symbols.

I_I	Inflection point current
I_P	Peak point current
I_V	Valley point current
r_i	Dynamic resistance at inflection point
V_{PP}	Projected peak point voltage
V_I	Inflection point voltage
V_P	Peak point voltage
V_V	Valley point voltage

B.5.4 Voltage regulator and voltage-reference diode symbols.

I_F	Forward current, dc
I_R	Reverse current, dc
I_Z, I_{ZK}, I_{ZM}, I_{ZSM}	Regulator current, reference current (dc, dc near breakdown knee, dc maximum rated current, dc maximum rated surge current)
V_F	Forward voltage, dc
V_R	Reverse voltage, dc
V_Z, V_{ZM}	Regulator voltage, reference voltage (dc, dc at maximum rated current)
z_z, z_{zk}, z_{zm}	Regulator impedance, reference impedance (small-signal, at I_Z, at I_{ZK}, at I_{ZM})
α_{VZ}	Temperature coefficient of regulator voltage, temperature coefficient of reference voltage

B.5.5 Current regulator diode symbols.

I_L	Limiting current
I_S	Regulator current
V_K	Knee voltage
V_L	Limiting voltage
ΔI_S	Regulator current variation
V_S	Regulator voltage
z_k	Knee impedance
z_s	Regulator impedance
α_{IS}	Temperature coefficient of regulator current

B.5.6 Varactor diode symbols.

C_c	Case capacitance
C_j	Junction capacitance
C_t	Total capacitance
$\frac{C_{t1}}{C_{t2}}$	Capacitance ratio
f_{co}	Cut-off frequency
L_s	Series inductance
Q	Figure of merit
r_s	Series resistance, small-signal
α_C	Temperature coefficient of capacitance
η	Efficiency

B.5.7 Transient voltage suppressor symbols.

CF	Clamping factor
I_D	Standby current
I_{FS}	Forward surge current
I_{FSM}	Rated forward surge current
I_{PP}	Peak impulse current
I_{PPM}	Rated peak impulse current
I_S	Surge peak transient current
I_{SM}	Rated surge peak transient current

$P_{(A)}$	Average power dissipation
$P_{M(A)}$	Rated average power dissipation
P_{PP}	Repetitive peak pulse power dissipation
P_{PPM}	Rated repetitive peak pulse power dissipation
t_{os}	Overshoot duration
t_{res}	Response time
$V_{(BR)}$	Breakdown voltage
V_C	Clamping voltage
W_W	Working peak voltage, also standoff voltage
$W_{WM(RMS)}$	Working rms voltage
V_{WM}	Rated working peak voltage
V_{CS}	Voltage overshoot
$\alpha V(BR)$	Temperature coefficient of breakdown voltage

B.6 THYRISTORS SYMBOLS

B.6.1 Thyristor symbols.

dv/dt	Critical rate of rise of off-state voltage
$I_{(BO)}$, $i_{(BO)}$	Breakover current
$I_{(BR)}$, $i_{(BR)}$	Reverse breakdown current (of a reverse-blocking thyristor)
$I_{D(RMS)}$, I_D, $I_{D(A)}$, i_D, I_{DM}	Off-state current
I_{DRM}	Repetitive peak off-state current
I_G, $I_{G(A)}$, i_G, I_{GM}	Gate current
I_{GD}, i_{GD}, I_{GDM}	Gate nontrigger current
I_{GQ}, i_{GQ}, I_{GQM}	Gate turn-off current (of a turn-off thyristor)
I_{GT}, i_{GT}, I_{GTM}	Gate trigger current
I_H, i_H	Holding current
I_L, i_L	Latching current
$I_{R(RSM)}$, I_R, $I_{R(A)}$, i_R, I_{RM}	Reverse current (of a reverse-blocking or reverse-conducting thyristor)
I_{RRM}	Repetitive peak reverse current (of a reverse-blocking thyristor)
I_{RSM}	Nonrepetitive peak reverse current (of a reverse-blocking thyristor)
$I_{T(RMS)}$, I_T, $I_{T(A)}$, i_T, I_{TM}	On-state current
I_{TRM}	Repetitive peak on-state current

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I_{TSM}	Nonrepetitive peak on-state current
P_G, $P_{G(A)}$, p_G, P_{GM}	Gate power dissipation
P_R, $P_{R(A)}$, p_R, P_{RM}	Reverse power dissipation
t_{gd}	Gate-controlled delay time
t_{gq}	Gate-controlled turn-off time (of a turn-off thyristor)
t_{gt}	Gate-controlled turn-on time
t_q	Circuit-commutated turn-off time
$V_{(BO)}$, $v_{(BO)}$	Breakover voltage
$V_{(BR)}$, $v_{(BR)}$	Reverse breakdown voltage (of a reverse-blocking thyristor)
$V_{D(RMS)}$, V_D, $V_{D(A)}$, v_D, V_{DM}	Off-state voltage
V_{DRM}	Repetitive peak off-state voltage
V_{DSM}	Nonrepetitive peak off-state voltage
V_{DWM}	Working peak off-state voltage
V_G, $V_{G(A)}$, v_G, V_{GM}	Gate voltage
V_{GD}, v_{GD}, V_{GDM}	Gate nontrigger voltage
V_{GQ}, v_{GQ}, V_{GQM}	Gate turn-off voltage (of a turn-off thyristor)
V_{GT}, v_{GT}, V_{GTM}	Gate trigger voltage (of a reverse-blocking thyristor
V_{RRM}	Repetitive peak reverse voltage (of a reverse-blocking thyristor)
V_{RSM}	Nonrepetitive peak reverse voltage (of a reverse-blocking thyristor)
V_{RWM}	Working peak reverse voltage (of a reverse-blocking thyristor)
$V_{T(RMS)}$, V_T, $V_{T(A)}$, v_T, V_{TM}	On-state voltage
$V_{T(MIN)}$	Minimum on-state voltage

B.6.1.1 Letter symbol table (thyristors).

	Total RMS value	DC value no alternating component	DC value with alternating component	Instantaneous total value	Maximum (peak) total value
On state current	$I_{T(RMS)}$	I_T	$I_{T(A)}$	i_T	I_{TM}
Repetitive peak, on-state current					I_{TRM}
Surge (nonrepetitive) on-state current					I_{TSM}
Overload on-state current					$I_{T(OV)}$
Breakover current		$I_{(BO)}$		$i_{(BO)}$	
Off-state current	$I_{D(RMS)}$	I_D	$I_{D(A)}$	i_D	I_{DM}
Repetitive peak, off-state current					I_{DRM}
Reverse current	$I_{R(RMS)}$	I_R	$I_{R(A)}$	i_R	I_{RM}
Repetitive peak, reverse current					I_{RRM}
Reverse breakdown current		$I_{(BR)R}$		$i_{(BR)R}$	
On-state voltage	$V_{T(RMS)}$	V_T	$V_{T(A)}$	v_T	V_{TM}
Breakover voltage		$V_{(BO)}$		$v_{(BO)}$	
Off-state voltage	$V_{D(RMS)}$	V_D	$V_{D(A)}$	v_D	V_{DM}
Minimum on-state voltage		$V_{T(MIN)}$			
Working peak, off-state voltage					V_{DWM}
Repetitive peak, off-state voltage					V_{DRM}

B.6.1.1 Letter symbol table (thyristors) - Continued.

	Total RMS value	DC value no alternating component	DC value with alternating component	Instantaneous total value	Maximum (peak) total value
Nonrepetitive, off-state voltage					V_{DSM}
Reverse voltage	$V_{R(RMS)}$	V_R	$V_{R(A)}$	v_R	V_{RM}
Working peak, reverse voltage					V_{RWM}
Repetitive peak, reverse voltage					V_{RRM}
Nonrepetitive peak, reverse voltage					V_{RSM}
Reverse breakdown voltage		$V_{(BR)R}$		$v_{(BR)R}$	
Holding current		I_H		i_H	
Latching current		I_L		i_L	
Gate current		I_G	$I_{G(A)}$	i_G	I_{GM}
Gate trigger current		I_{GT}		i_{GT}	I_{GTM}
Gate nontrigger current		I_{GD}		i_{GD}	I_{GDM}
Gate turn-off current		I_{GQ}		i_{GQ}	I_{GQM}
Gate voltage		V_G	$V_{G(A)}$	v_G	V_{GM}
Gate trigger voltage		V_{GT}		v_{GT}	V_{GTM}
Gate nontrigger current		V_{GD}		v_{GD}	V_{GDM}
Gate turn-off voltage		V_{GQ}		v_{GQ}	V_{GQM}
Gate power dissipation		P_G	$P_{G(A)}$	p_G	P_{GM}

B.7 OPTOELECTRONIC DEVICES SYMBOLS

B.7.1 Optoelectronic device symbols.

Q, (Q_e)	Radiant energy
Q, (Q_v)	Luminous energy
t_d	Delay time
t_f	Fall time
t_{off}	Turn-off time
t_{on}	Turn-on time
t_r	Rise time
t_s	Storage time
τ	Time constant
ϕ	Luminous flux, radiant flux

B.7.2 Photosensitive device symbols.

A_D	Area, detector
E	Illuminance (illumination); irradiance
f_{mod}	Modulation frequency
I_n	Detector noise
I_S, I_s	Detector signal current (dc; rms value of ac component)
P_n	Noise equivalent power
V_n	Detector noise voltage
V_S, V_s	Detector signal voltage (dc; rms value of ac component)
μf	Noise equivalent bandwidth

B.7.3 Photoemitting device symbols.

I	Luminous intensity; radiant intensity
L	Luminance; radiance
t_f	Radiant-pulse fall time
t_r	Radiant-pulse rise time
w	Luminous density; radiant density
$\Delta\lambda$	Spectral bandwidth
λ_p	Peak wavelength

B.7.4 Optocoupler (photocoupler, opto-isolator) symbols.

C_{io} - - - - - - - - - - - - - - - - -	Input-to-output internal capacitance; transcapacitance
h_F - - - - - - - - - - - - - - - - - -	Current transfer ratio
I_{IO} - - - - - - - - - - - - - - - - -	DC input-to-output current; isolation current
r_{IO} - - - - - - - - - - - - - - - - -	Isolation resistance
V_{IO} - - - - - - - - - - - - - - - - -	DC input-to-output voltage; isolation voltage

APPENDIX C

STATISTICAL SAMPLING AND LIFE TEST PROCEDURES

C.1 SCOPE

C.1.1 Scope. This appendix contains statistical sampling, life test, and qualification procedures used with semiconductor devices. This appendix is not mandatory.

C.2 APPLICABLE DOCUMENT

C.2.1 General. The documents listed in this section are specified in sections C.3 and C.4 of this specification. This section does not include documents cited in other sections of this appendix or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections C.3 and C.4 herein, whether or not they are listed.

C.2.2 Government documents.

C.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.1).

HANDBOOK

MILITARY

MIL-HDBK-53-1 - Guide for Attribute Lot Sampling Inspection.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

C.2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

C.3 GENERAL

C.3.1 Definitions. The following definitions shall apply for all statistical sampling procedures:

a. Sample plan series: The sample plan series is defined as the following decreasing series of sample plan values - 50, 30, 20, 15, 10, 7, 5, 3, 2, 1.5, 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1.

b. Tightened inspection: Tightened inspection is defined as inspection performed using the next sample plan value in the sample plan series lower than that specified.

c. Acceptance number (c): The acceptance number is defined as an integral number associated with the selected sample size which determines the maximum number of defectives permitted for that sample size.

d. Rejection number (r): Rejection number is defined as one plus the acceptance number.

C.3.2 Symbols. The following symbols shall apply for all statistical sampling procedures:

a. c - Acceptance number

b. r - Rejection number

c. n - Sample size

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C.4 STATISTICAL SAMPLING PROCEDURES AND TABLE

C.4.1 General. Statistical sampling shall be conducted using the sample plan method herein. The sample plan method as specified herein is a double sample plan which provides a high degree of assurance that a lot having a proportion defective equal to or greater than the specified sample plan value will not be accepted. The choice of any one procedure is optional. The procedures specified herein are suitable for all qualification or quality conformance requirements, but are not suitable if the objective of the inspection is to determine that the proportion defective in the lot represented is greater than the specified sample plan value since the assurance for that purpose is normally only 10 percent.

C.4.1.1 Selection of samples. Samples shall be randomly selected from the inspection lot or inspection sublots (For an explanation of random sampling, see MIL-HDBK-53-1, section 13).

C.4.1.2 Failures. Failure of a unit for one or more tests of a subgroup shall be charged as a single failure.

C.4.2 Single-lot sampling method. CI information (sample sizes and number of observed defectives) shall be accumulated from a single inspection lot to demonstrate conformance to the individual subgroup criteria.

C.4.2.1 Sample size. The sample size for each subgroup shall be determined from table I and shall meet the specified sample plan. The manufacturer may, at his option, select a sample size greater than that required; however, the number of failures permitted shall not exceed the acceptance number associated with the required sample size in table I.

C.4.2.2 Acceptance procedure. For the first sampling, an acceptance number shall be chosen and the associated number of sampling devices for the specified sample plan selected and tested (see C.4.2.1). If the observed number of defectives from the first sample is less than or equal to the preselected acceptance number, the lot shall be accepted. If the observed number of defectives exceeds the preselected acceptance number, an additional sample may be chosen such that the total sample complies with C.4.2.3.

C.4.2.3 Additional sample. The manufacturer may add an additional quantity to the initial sample, but this may be done only once for any subgroup and the added samples shall be subjected to all the tests within the subgroup. The total sample size (initial and added samples) shall be determined by a new acceptance number selected from table I.

C.4.2.4 Multiple criteria. Except where otherwise specified, when a subgroup contains more than one acceptance criterion, the entire sample for a subgroup shall be used for all criteria within the subgroup. In table I, the acceptance number shall be that one associated with the largest sample size in the appropriate sample plan column which is less than or equal to the sample size used.

C.4.2.5 One-hundred percent inspection. Inspection of 100 percent of the lot shall be allowed, at the option of the manufacturer for any or all subgroups other than those which are considered "destructive." The maximum observed percent defective for the inspection lot shall not exceed the specified sample plan value. Devices that fail any test shall be removed from the lot.

C.4.2.6 Disposition of failed lot. A lot that fails CI may, at the option of the manufacturer, be screened for defectives or reworked and resubmitted for reinspection (see appendix E)

C.5 LIFE TEST

C.5.1 General. Life tests shall be conducted in accordance with the procedures in this section. Life tests performed on devices at or within their maximum ratings shall be considered nondestructive. If a lot is made up of a collection of sublots, each sublot shall pass all applicable electrical end-points as specified.

C.5.2 Selection of samples. Samples for life tests shall be selected at random from the inspection lot (see C.4.1.1). The sample size for a 1,000-hour test shall be chosen by the manufacturer from table I from the column under the specified lambda (λ). The acceptance number shall be the one associated with the particular sample size chosen.

C.5.3 Failures. A semiconductor device which exceeds one or more of the end-point limits specified for life test at any specified or other reading interval shall be considered a failure and shall not be considered acceptable at any subsequent reading interval. For the purpose of computing device hours, the test-time hours credited to a failed device shall not exceed the test time associated with the last measurement time that the device was observed to be within the specified end-point limits. If the sample size fails, the test may be terminated at the discretion of the manufacturer.

C.5.4 Life-test time and sample size. When a lambda (λ) is specified, the life-test time shall be 1,000 hours initially. Once a lot has passed the 1,000-hour tests, life tests with minimums of 340 hours and maximums of 2,000 hours may be initiated for new lots provided that 365 days have not elapsed since a 1,000-hour life tests on the same device type on the same structurally identical group (see appendix E). If 365 days have elapsed, the new lot shall pass a 1,000-hour life test. The sample size for a life-test time other than 1,000 hours shall be chosen according to the relationship of inverse proportionality between test time and sample size, such that the total unit test hours accumulated (sample sizes multiplied by test hours) equal the amount that would have been chosen for the 1,000-hour life test, had it been performed. The acceptance number shall also be determined from the sample size associated with the same 1,000-hour test, had it been performed. The lot shall be accepted if the number of failures at the end of the test period does not exceed the acceptance number.

C.5.5 Procedure to be used if number of observed failures exceeds the acceptance number. In the event that the number of failures observed on life test exceeds the acceptance number, the manufacturer shall choose one of the following options: (1) discontinue the life test, screen or rework, and resubmit in accordance with C.4.2.6, (2) add additional samples in accordance with C.5.5.1, or (3) extend the test time to 1,000 hour in accordance with C.5.5.2, if a test time less than 1,000 hours was originally chosen. Only one of these options shall be used for a given submission, and this option shall be used only once.

C.5.5.1 Additional samples. When this option is chosen, a new total sample size (initial plus added) shall be chosen by the manufacturer from table I from the column under the specified λ. A quantity of additional units sufficient to increase the sample to the newly chosen total sample size shall be selected from the lot. A new acceptance number shall be determined and shall be the one associated with the new total sample size chosen. The added sample shall be subjected to the same life-test conditions and time period as the initial sample. If the total observed number of defectives (initial plus added) does not exceed the acceptance number for the total sample, the lot shall be accepted. If the observed number of defectives exceeds this acceptance number, the lot shall not be accepted but may be resubmitted (see C.4.2.6).

C.5.5.2 Extension of life-test period. If a life-test time period less than 1,000 hours is being used and the number of failures observed in the initial sample exceeds the acceptance number, the manufacturer may in lieu of adding additional samples, choose to extend the test time of the entire initial sample to 1,000 hours and determine a new acceptance number from table I. The new acceptance number shall be that one associated with the largest sample size in the specified column which is less than or equal to the sample size on test. A device which is a failure at the initial reading interval shall not be considered acceptable at the 1,000-hour reading interval. If the observed number of defectives at 1,000 hours does not exceed the new acceptance number, the lot shall be accepted. If the observed number of defectives exceeds this acceptance number, the lot shall not be accepted, but may be resubmitted (see C.4.2.6).

C.5.5.3 Failure of life test. If a lot fails to meet life-test requirements (including submission in accordance with C.4.2.6, if elected) such that it is eliminated or withdrawn from further conformance inspection consideration, then a 1,000-hour life test shall be required for the failed subgroup until three successive lots have passed. If group B or C (see appendix E) does not require 1,000-hour testing, then the specified life test, if other than 1,000 hours, shall be required for three successive lots.

TABLE I. Sample plans. 1/ 2/
Minimum size of sample to be tested to assure, with a 90 percent confidence, that a lot having percent-defective equal to the specified sample plan will not be accepted (single sample).

Maximum percent defective or λ	50	30	20	15	10	7	5	3	2	1.5	1	0.7	0.5	0.3	0.2	0.15	0.1
Acceptance number (c) (r = c + 1)	Minimum sample sizes (For device-hours required for life test, multiply by 1,000)																
0	5 (1.03)	8 (0.64)	11 (0.46)	15 (0.34)	22 (0.23)	32 (0.16)	45 (0.11)	76 (0.07)	116 (0.04)	153 (0.03)	231 (0.02)	328 (0.02)	461 (0.01)	767 (0.007)	1152 (0.005)	1534 (0.003)	2303 (0.002)
1	8 (4.4)	13 (2.7)	18 (2.0)	25 (1.4)	38 (0.94)	55 (0.65)	77 (0.46)	129 (0.28)	195 (0.18)	258 (0.14)	390 (0.09)	555 (0.06)	778 (0.045)	1296 (0.027)	1946 (0.018)	2592 (0.013)	3891 (0.009)

1/ Sample sizes are based upon the Poisson exponential binomial limit.
2/ The minimum quality (approximate AQL required to accept on the average) 19 of 20 lots is shown in parentheses for information only.

APPENDIX D

QUALITY SYSTEM PROGRAM

D.1 SCOPE

D.1.1 Scope. This appendix contains details of the quality system program for JAN, JANTX, JANTXV, and JANS semiconductor devices. The program measures and evaluates the manufacturer's manufacturing process against a baseline for that process. This baseline can include innovative and improved processes that result in an equivalent or higher quality product, provided that the process used to evaluate and document these changes has been reviewed and approved by the qualifying activity. Changes to the process baseline can be made by the manufacturer after achieving approval with documented reliability and quality data. The approach outlined in this appendix is a proven baseline which contains details of a quality system including best commercial practices. This appendix is not mandatory. However manufacturers must demonstrate to the qualifying activity a quality system that achieves at least the same level of quality as could be achieved by complying with this appendix. Certification is provided by the qualifying activity upon approval by the preparing activity (for equivalent quality systems) and qualifying activity.

D.2 APPLICABLE DOCUMENTS.

D.2.1 Non-Government standards and other publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.1).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/NCSL-Z540-1-1994 - Calibration Systems Requirements.

(Application for copies should be addressed to the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA-554	-	Assessment of Outgoing Nonconforming Levels in Part Per Million (PPM) (DOD adopted).
EIA-557	-	Statistical Process Control Systems.
JEDEC Publication 114	-	Analysis of Component PIND Test Failures.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Pennsylvania Avenue, Washington, DC 20006.)

(Non-Government standards and other publications are normally available from the organizations which prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

D.3 Quality system program. Devices furnished under this specification shall comply with the performance requirements of 3. herein, and shall be prepared for delivery in accordance with 5. herein. The verification program shall assure that the design, processing, assembly, inspection, and testing of semiconductor devices comply with this specification and the associated specification.

D.3.1 Management responsibility.

D.3.1.1 Management responsibility. Management shall provide sufficient resources, personnel, and authority necessary for performing all applicable verification and manufacturing certification requirements specified herein.

D.3.1.2 Organization. A functional block organization chart shall be included in the quality system program which shows the lines of responsibility and authority for organization, approval, and implementation of all aspects of the quality program. A management representative shall be identified who has defined responsibility and authority to ensure that the requirements of this specification are met.

D.3.1.3 Responsibility and authority.

D.3.1.3.1 Definition of a QPL manufacturer. For guidance on specific business scenarios, details of QPL implementation, financial commitment to this program, or interpretation of criteria herein, contact the qualifying activity. The QPL manufacturer is the basic plant (see H.3.1)

D.3.1.3.1.1 Basic plant. The basic plant is where wafer fabrication or device assembly is performed. The basic plant has the responsibility for device critical interfaces, performance, quality, and reliability. The manufacturer's designating symbol of the basic plant shall appear on the finished product. Total ownership of the basic plant is required for listing on the QPL and JAN Branding. The basic plant shall be certified and qualified by the qualifying activity. A QPL manufacturer may have multiple basic plants. Unless otherwise approved by the qualifying activity, however, only one device design per PIN, per basic plant will be allowed. Contractors shall ensure their subcontractors meet the requirements of MIL-PRF-19500.

D.3.1.3.1.2 Contracted plant. The basic plant may contract assembly or wafer fabrication provided control of the contracted plant is demonstrated to the qualifying activity. A written agreement between a basic plant and a contracted plant is necessary for all contracting scenarios. This agreement shall establish who is the basic plant. For any device type a basic plant may not contract both assembly and wafer fabrication. The contracted plant shall be certified by the qualifying activity. Qualification of assembled devices or wafers will be the responsibility of the basic plant. QPL manufacturers may offer their certified line services to each other. The address of the contracted assembly or wafer fabrication plant will be included on the QPL.

D.3.1.3.1.3 Contracted wafer fabrication. JANHC die evaluation in accordance with MIL-PRF-19500 or equivalent shall be performed whenever a contracted wafer fabrication plant is utilized by the basic assembly plant. This die evaluation may be performed by either the contracted wafer plant or the basic assembly plant and is applicable to JAN, JANTX, and JANTXV. (For JANS devices, JANKC die evaluation applies.)

D.3.1.3.1.4 Wafer fabrication. The wafer fabrication plant (basic wafer fabrication plant or contracted wafer fabrication plant) may contract any or all of the following special processes to specialty laboratories:

a. epitaxial layer

b. ion implantation

c. irradiation (for carrier lifetime suppression)

D.3.1.3.2 Responsibility of the manufacturer. The manufacturer is responsible for the performance of all inspection requirements as specified herein, and in the associated specification. The manufacturer may use their own or other suitable facilities which have been approved and granted laboratory suitability by the qualifying activity for the performance of the inspection requirements specified herein. The Government or acquiring activity reserves the right to witness or perform any of these inspections set forth herein or in the associated specification and to audit the data resulting from the manufacturer's performance of these specifications.

D.3.1.3.3 Incoming, in-process, and outgoing inventory control. The manufacturer shall employ procedures to control storage and handling of incoming materials, work in-process, warehoused and outgoing product in order to (a) achieve such factors as age control of limited-life materials; and (b) prevent inadvertent mixing of conforming and nonconforming materials, work in process, finished product, resubmitted lots, or customer returns.

D.3.1.3.4 Personnel. Personnel performing quality functions shall have sufficient well-defined responsibility, authority, and the organizational freedom to identify and evaluate quality problems and to initiate, recommend, or provide solutions.

D.3.1.4 Resources. The manufacturer shall identify requirements and provide adequate resources for management, performance of work, verification activities, and internal audits. For the purpose of this document, resources shall include, but not be limited to, materials, equipment, training, and personnel.

D.3.1.5 Management representative. The manufacturer shall appoint a member of his management who has the authority and responsibility for development and implementation of the program plan of this appendix. This individual shall insure that the quality system is maintained and shall periodically report to the manufacturers management on the performance of the system and opportunities to improve it. The qualifying activity shall be informed whenever there is a change in the management representative.

D.3.1.6 Management review. The manufacturers management shall maintain an ongoing cognizance of the status of the quality system to ensure it's continuous suitability and effectiveness in satisfying the requirements herein through periodic reviews of the quality system.

D.3.2 Quality system.

D.3.2.1 Quality system requirements. A quality system shall be established by each manufacturer which implements all requirements of this appendix. The current revision shall serve to demonstrate to the qualifying activity that the manufacturer's system is adequate to assure compliance with the applicable specifications and quality standards. Proprietary documents shall be clearly identified by category in the system.

D.3.2.2 Process flows. The system includes process flows for each distinct product family. As a minimum, flows shall include wafer fabrication, assembly, processing and CI, and shall indicate which CI option has been selected.

D.3.2.3 Quality system procedures. The manufacturer shall implement the approved system. The range and detail of the procedures shall ensure compliance with this system.

D.3.2.4 Quality planning. The manufacturer shall define how the requirements for quality will be met. Quality planning shall be consistent with all other requirements of the manufacturer's quality system. The manufacturer shall give consideration to the following activities, as appropriate, in meeting the specified requirements for products.

a. The preparation of quality plans may be in the form of a reference to the appropriate procedures that form an integral part of the manufacturer's quality system.

b. The identification and acquisition of any controls, processes, equipment (including inspection and test equipment), fixtures, resources, and skills that may be needed to achieve the required quality.

c. Ensuring the compatibility of the design, production process, inspection, and test procedures.

d. The updating, as necessary, of quality control, inspection, and testing techniques, including the development of new instrumentation.

e. The identification of any measurement requirement involving capability that exceeds the known state of the art, in sufficient time for the needed capability to be developed.

f. The identification of suitable verification at appropriate stages in the realization of product.

g. The clarification of standards of acceptability for all features and requirements, including those which contain a subjective element.

D.3.3 Conversion of associated specification requirements. The manufacturer shall have a system to convert associated specification requirements to in-house, procedures, methods, and specifications. The system shall include revision and distribution controls. The manufacturer's system ensures review of purchase requirements received from their customer. The review shall insure that the purchase order does not violate this specification for JAN product of any level and that any special instructions are accounted for. The system shall provide objective evidence of this review. Additionally, any modifications shall also be reviewed

D.3.4 Critical interface control.

D.3.4.1 Design, materials, and processing documentation. Each product design shall be fully specified such that all aspects of design, verification testing, processing, and materials are described. In addition, each manufacturer shall have a flow chart, traveler and a design and construction form for each certified product line (see qualifying activity).

D.3.4.2 Change of qualified product. After qualification, the manufacturer shall notify the qualifying activity prior to the release and shipment (for JANS prior to line implementation except for evaluation samples) of product which undergoes any change in the product or verification program which affects performance, quality, appearance, reliability or interchangeability (see appendix E). The changes shall be approved by the Qualifying Activity prior to release and shipment of product. Changes in design, materials, or processes for any device must be processed in accordance with established change control procedures for all affected documents (see D.3.4.1 and D.3.5). Such notification shall include a thorough description of the proposed change and a test plan designed to demonstrate that the change will not adversely affect performance, quality, reliability, or interchangeability and that the changed product will continue to meet the specification requirements. The completed test results shall be approved by the qualifying activity. After approval of the design change, all product inventory of the old design must be submitted to CI within 6 months, unless authorization is extended by the qualifying agency. Unless the design change has been required to correct or eliminate a verified design defect, finished devices manufactured to the previously approved design which are in inventory or in process of testing (i.e., inspection lot identification code assigned) will remain qualified only until that inventory is depleted.

D.3.5 Document control.

D.3.5.1 Document control. The manufacturer shall establish and maintain procedures to control all documents that relate to the requirements of this specification. This includes, to the extent applicable, military and industry specifications and standards.

D.3.5.2 Document approval and issue. Documents shall be reviewed and approved for adequacy by authorized personnel prior to issue. A procedure shall be established to ensure that the pertinent issues of appropriate documents are available at all required locations, that invalid or obsolete documents are promptly removed from all points of issue, and that any obsolete documents which are retained are suitably identified.

D.3.5.3 Document changes. Unless designated otherwise, changes to documents shall be reviewed and approved by the same functions/organizations that performed the original review and approval.

D.3.6 Purchasing.

D.3.6.1 Acquisition documentation. A system for the acquisition of supplies and approval of suppliers shall be established.

D.3.7 Control of customer supplied material. The manufacturer shall establish and maintain procedures for the control, verification, maintenance and storage, as applicable, of customer supplied materials and equipment. Any material which is lost or becomes unsuitable for use shall be recorded and reported to the customer.

D.3.8 Product identification and traceability. All devices delivered to this specification shall be traceable through the lot identification code and inspection lot records, and identified as in 3.7 and 3.10). In addition, JANS devices shall have a lot control system from wafer processing through screening which provides wafer lot identification; operation (machine); date of operation, operator(s) identification, quantity; and serial numbers (after step 8 of table IV) of devices processed.

APPENDIX D

D.3.9 Process control. The manufacturer shall assure that all manufacturing operations are carried out to insure continued process capability. Operations shall be controlled as to the manner of production, requirements for monitoring and control, and output product characteristics. Where necessary, due to the complexity or sensitivity of operation parameters, the process shall consider working environment, workmanship criteria, equipment set-up and the need for special operator certification or continuous monitoring of critical parameters.

D.3.9.1 Control during manufacturing and assembly. The relative humidity, temperature, and particle count for each applicable critical process step (e.g., wafer fabrication, assembly) shall be specified, controlled, and recorded. The procedures and techniques for measuring these environmental parameters and limits shall be documented. The procedures shall contain corrective actions for out-of-tolerance environmental conditions. Unsealed parts shall be handled in such a way as to minimize the introduction of foreign material into the sealed cavity. The purity of water shall be specified, measured, controlled, and recorded in terms of minimum resistivity at +25°C (resistivity meters and cells shall be calibrated), maximum total solids, maximum organic impurities, and maximum bacteria count. In addition, spittle protection is required in applicable critical areas.

D.3.9.2 Process monitor programs. Process monitor programs shall be established as referenced below, for processes performed by the manufacturer. A fully implemented and approved SPC program (in accordance with D.3.20) may replace all or portions of the process monitor programs with the approval of the qualifying activity. These programs shall be documented and made available to the certification team for review. The implementing procedures shall provide for frequency, sample size, reject criteria, allowable rework, and disposition of failed product/lots. Investigative and corrective actions shall be established which address noted deficiencies. With the exception of the particle detection monitor, a procedure is required for the traceability, recovery, and disposition of all units monitored since the last successful test. As with all monitors, the particle detection procedure shall provide for continual process improvement. Records of these monitors shall be available to any (Government or military user) audit team for review. As a minimum, the process monitors shall include the following, or equivalent as approved by the qualifying activity:

a. Die attachment. The type of die mounting method, die material, die mounting material, package material, and mounting configuration shall be documented. The time, temperature, pressure, scrubbing, cleanliness, and environment shall also be specified. The manufacturer shall monitor the die attach integrity for all silicon transistors and case mounted diodes in accordance with test method 2017 or thermal response methods 3101, 3161, 3131, 3103, and 3104 of MIL-STD-750 using the manufacturer's documented procedure. This procedure shall be performed at each equipment set up as a minimum for JANTX and JANTXV and may, at the manufacturers option, consider other related factors. This test shall be conducted on a minimum of two devices from each die attach station at the start and finish of operator change, package type change, die size change and after every two hours of production for JANS. A different method of process control may be implemented, with the approval of the qualifying activity, if an appropriate thermal response method is performed in 100 percent screening. In the event that the die shear is less than the value of table I of method 2017, or the test leaves less than 75 percent silicon remaining of die-to-header bond surface, the output of the die attach station shall not be used until tests show that satisfactory operation has been re-established. A procedure for the traceability, recovery, and disposition of all units bonded since the last successful die attach integrity test is required. This procedure shall provide for sample size, reject criteria, and disposition of failed lots. This test may be conducted on the same samples used for the wire bond strength test.

b. Wire bonding or interconnection. The bonding techniques, type of bond wire, and lead material used in connecting the die to the package leads shall be documented and comply with this specification and the applicable associated specifications. The temperature, pressure, dwell time, control of condition of capillary or electrode, ultrasonic power, composition of metals, lead dress, thickness to width ratio of bond, and environment shall be specified. The manufacturer shall monitor the wire bond strength in accordance with test method 2037 of MIL-STD-750 using the manufacturer's documented procedure. This procedure shall be performed at each equipment setup as a minimum for JANTX and JANTXV and may, at the manufacturer's option consider change of operators, lot size, shift start and stop, and other related factors. As a minimum for JANS each operator/wire bonding station shall have two device samples taken at the start and end of each shift, after each two hours of production, and after changing operators, spools, shifts, packages, wire size, and maintenance of equipment. When more than one lot is processed for JANS in a two-hour period, samples shall be tested from each lot. Pull strength data shall be read and recorded and shall be control charted and maintained in accordance with the specified requirements. Data shall include the force, in grams, required for failure, the physical location of the point of failure, and the nature of the failure. In event that any bond strength is less than the pre-seal value given in table I, method 2037, of MIL-STD-750, the bonder shall be inactivated immediately and not returned to production until tests show that satisfactory operation has been re-established. When the system at the die surface is bimetallic and the lead wires are less than 5 mils in diameter, the lead shall be pulled to destruction and if the chip bond lifts before the wire breaks, the lot shall be rejected. A procedure for the traceability, recovery, and disposition of all units bonded since the last successful bond strength test is required. This procedure shall provide for sample size, number of bonds and device to be tested, reject criteria, and disposition of failed lots.

c. Glass-to-lead seals on clear glass diodes. Visual inspection procedures shall specify inspection criteria, the use of visual aids, and shall comply with the requirements of methods 2069, 2070, 2072 or 2073 (die visual), and 2074 of MIL-STD-750. In addition, the manufacturer shall monitor the lead-to-glass seal following final plating operation for all JANTX, JANTXV, and JANS clear glass diodes constructed with borated seal, using the manufacturer's documented procedure. The procedures shall specify criteria and visual aids and shall be capable of detecting significant loss of glass-to-lead seal. (JANS and JANTXV only).

d. Lid seal. The moisture content of the sealing environment shall be controlled. The internal moisture content of device packages with an internal cavity greater than .01 cc shall not exceed 5,000 PPM when tested in accordance with method 1018 at +100°C. All manufacturers shall exercise package internal moisture content monitors at key locations in the manufacturing flow. The internal water-vapor content test may be performed at the option of the manufacturers. When the internal water-vapor content test is performed, the samples shall have been subjected to screen 3 of table II, or equivalent; not required for devices which are inactive for new design. All devices not utilizing a eutectic die attach shall have the internal oxygen content of the sealing environment controlled. The internal oxygen content of the device package shall not exceed 2,000 PPM at +100°C. The internal oxygen content test may be performed at the option of the manufacturers. When the internal content test is performed, the samples shall have been subjected to screen 3 of table IV or equivalent; not required for devices which are inactive for new design.

e. Particle contamination. The manufacturer shall establish a particle detection monitoring program which assesses the source of particle contamination of sealed cavity devices on an individual manufacturing line basis. The monitor shall use the test set-up as specified in method 2052 of MIL-STD-750. JEDEC Publication 114, "Guidelines for Particle Impact Noise Detection (PIND) Testing, Operator Training, and Certification" may be used as a guideline. Unless otherwise exempt herein, this monitor is applicable to all metal or ceramic cavity package outlines. This monitor shall be performed at the assembly location, or locations, to ensure the most effective feedback loop for corrective action.

f. Application of final lead finish: (see appendix H)

D.3.9.3 Wafer lot inspection (JANS only). The methods and procedures which are used to specify sample size, criteria for control of the wafer thickness, cleanliness, junction and surface preparation, metal deposition and thickness, etching, and alloying shall be documented.

APPENDIX D

D.3.10 Inspection and testing.

D.3.10.1 Inspection of purchased materials. The manufacturer is responsible for assuring that all supplies and services procured from suppliers conform to the purchase contract. The manufacturer shall have a system which controls inspection, storage, and handling of incoming materials, and periodic evaluation of material received. The system may include verification of chemical, physical, and functional characteristics required by manufacturer drawings and specifications. The manufacturer may utilize a certified supplier program to reduce or eliminate receiving inspection.

D.3.10.1.1 Certified supplier program. The capability of supplied material may be validated through a supplier certification system. This program selects and monitors suppliers in order to guarantee that the supplied material will meet and maintain required capability levels (e.g., Cpk, PPM, etc.).

D.3.10.2 In-process quality control. The manufacturer shall perform in-process inspections to the extent necessary to assure product conformance to the end item specification. This shall include inspections and tests which assure that the processes manufacturing are in a state of control as indicated in section D.3.9.1 herein.

D.3.10.2.1 Manufacturer imposed tests. Any manufacturer imposed test(s) (e.g., gross and fine leak) conducted prior to any qualification or CI, are to be performed on all subsequent lots until requalified. If any manufacturer imposed tests detect a problem, the manufacturer shall submit all devices in the lot to those tests to eliminate rejects and shall take steps to determine and eliminate the cause of failure (e.g., rough handling which has produced gross leaks).

D.3.10.3 Testing and screening operations. Testing and screening operations may only be performed in a facility which has received laboratory suitability approval from the Qualifying Activity for each MIL-STD-750 test method to be employed. The environmental conditions where testing and screening are performed shall be maintained to assure compliance with the requirements of MIL-STD-750.

D.3.10.4 Final inspection and testing.

D.3.10.4.1 Qualification and conformance inspection. Qualification and conformance inspection shall be performed as required by the associated specification and herein at a facility which has received laboratory suitability approval from the Qualifying Activity. Procedures shall exist to maintain product lot identification until the successful completion of Qualification or CI testing. The results of testing shall be reviewed and approved.

D.3.10.5 Inspection and test verification. The manufacturer shall verify that all inspection and testing required by this specification and their Quality plan has been accomplished as specified. Verification shall clearly show whether the product passed or failed any requirement and shall contain sufficient detail to allow traceability to a specific operator, test date, and program.

D.3.11 Control of inspection measuring and test equipment.

D.3.11.1 Test programs and setups. The test programs and setups used to sort, classify, and test for MIL-PRF-19500 requirements are required to be traceable through each document control system to insure the correct revision was used when testing MIL-PRF-19500 devices.

D.3.11.2 Test equipment maintenance and calibration system. Maintenance and calibration systems and the frequency of scheduled actions, for gauges and test equipment, shall be established. The system may use ANSI/NCSL Z540-1-1994, or equivalent, as a guideline.

D.3.11.3 Conditions and methods of test. The general requirements, conditions and methods of test shall be in accordance with MIL-STD-750.

D.3.11.4 Electrical test equipment verification. The manufacturer shall define and utilize a method (e.g., correlation samples, diagnosis routines, etc.) to verify the measurement and operation characteristics of the test equipment when in use. In the event of verification of failure, the manufacturer shall utilize a procedure which will determine the requirements for traceability, recovery, and when retesting is required of all units tested since the last successful verification.

D.3.11.5 Alternative test methods. Other test methods or circuits may be substituted for those specified in MIL-STD-750 provided it is demonstrated to and approved by the qualifying activity that such a substitution in no way relaxes the requirements of this specification. The schematic wiring diagram of the test equipment shall be made available for checking by the qualifying activity.

D.3.12 Inspection and test status.

D.3.12.1 Inspection and test status. A system shall be maintained to insure that products are identified by their test or inspection status. The system shall insure the separation of products that have been tested or inspected from product that has not.

D.3.13 Control of nonconforming product. The manufacturer shall maintain a system which will prevent the shipment or use of nonconforming product. The system shall provide for identification, segregation, and evaluation of product which does not conform to specified requirements at any point in the manufacturing and screening flow

D.3.13.1 Reworked product. Reworked or repaired product shall be re-inspected in accordance with the appropriate procedures.

D.3.13.2 Rework provisions. All rework permitted on devices manufactured under this specification shall be accomplished in accordance with the established procedures. Lots shall not exceed two reworks for any process.

D.3.13.2.1 Wafer rework. For wafers, rework is limited to the following: additional etch to correct a nonconformance to a specification limit; photoresist strip and recoat; additional processing to continue or finish incomplete processing; strip and redeposit of non-junction passivation or backside metallization. For JANS no rework or redeposition of any oxide layer is allowed.

D.3.13.2.2 Rework of assembled devices. No delidding or package opening shall be permitted except for disc packages. Unless otherwise specified, rework of sealed packages is limited to recleaning, rebranding to correct defective marking, and lead straightening, re-plating or re-solder dipping of the leads. After any re-plating, all JANS, JANTXV, and JANTX shall pass as a 100 percent screen the requirements of group A, subgroup 2 and the hermetic seal requirements of screen 7 of table IV herein. Solder dip rework shall be in accordance with appendix H.

D.3.13.3 Rejected lots. Lots with an unscreenable failure mode shall be rejected. Unless the entire inspection lot has seen the same screening, devices which have received PIND screening in accordance with 6.1.1 may not be considered as candidates for this inspection.

D.3.13.3.1 Lots resubmitted for burn-in. Unless otherwise specified, lots may be resubmitted for burn-in one time only and may be resubmitted only when the observed percentage of defectives does not exceed twice the specified PDA or 20 percent whichever is greater. Resubmitted lots shall contain only parts which were in the original lot. Resubmitted lots shall be kept separate from new lots and shall be inspected for all specified characteristics using a tightened inspection PDA of 3 percent. If the percent defective for the resubmitted lot exceeds the tightened inspection PDA, the entire resubmitted lot shall be unacceptable for any quality level.

D.3.14 Corrective and preventative action.

D.3.14.1 Corrective action. The system identifies the responsibility for decisions regarding the necessity for a corrective action as a result of failure, defect analysis, inappropriate performance of inspections/procedures, product trends, inappropriate records and audits. Evaluation and approval of the proposed corrective action shall be made part of the record of the lot(s) involved. If 3 of 10 consecutive lots or if 2 successive lots of a device type or structurally identical types are rejected for the same failure mechanism, corrective action shall be initiated by the manufacturer. Failure to initiate corrective action may result in removal of products from the qualified product list.

D.3.15 Handling, storage, packaging, and delivery.

D.3.15.1 Security of completed devices. Marked devices which have passed all screening and quality conformance requirements shall be retained in a secure area prior to shipment delivery. Device inventory shall be controlled by device type, lot identification code, quantity, product assurance level, and transaction date. This requirement applies to both the manufacturer and the distributor(s).

D.3.15.2 ESDS program. The manufacturer of ESDS class 1 and 2 devices shall institute an ESDS program commensurate with the product classification. The product classification shall be as indicated in appendix E. The requirements of EIA-625 apply but may be tailored for establishing an ESDS program. Justification for the tailoring shall be made available to the qualifying activity for approval upon request.

D.3.16 Quality records. A system shall be in place to track the results of all qualification, screening (attribute data), quality conformance tests (attributes or variable data) and inspections, and any required failure analysis per lot.

D.3.17 Internal quality audits.

D.3.17.1 Internal audit program. The manufacturer shall establish an independent internal audit program which shall be included in the quality system. The internal audit program shall assess compliance with all applicable quality system requirements and shall identify key review areas, their frequency of audit, and describe the corrective action system. The internal audit program shall include any subcontractors used.

D.3.17.1.1 Internal audit checklist. The internal audit checklist shall assure that the quality system is adequate and followed by all personnel in each area.

D.3.17.2 Audit schedules and frequencies. The audit frequency shall in no case exceed one year for each area unless authorized by the qualifying activity. An internal audit shall be conducted and corrective actions completed prior to the initial qualifying activity audit. The qualifying activity may modify the frequency of the internal audit(s) or require additional inspection based on the effectiveness of the manufacturer's internal audit program, and assessment of the internal audit findings.

D.3.17.3 Auditors. The designated auditors shall be independent from the area being audited. If the use of an independent auditor is not practical a second individual should be assigned to participate in the audit or review the results. Auditors shall be trained in the area to be audited, in the applicable military specification requirements and provided with an appropriate checklist for annotating deficiencies. Prior to the audit, the assigned auditor(s) shall review the previous internal audit results to assure corrective actions have been implemented and are effective.

D.3.17.4 Audit deficiencies. All audit deficiencies shall be conveyed to the responsible individual for corrective action(s). All corrective actions shall be agreed to by the management representative. A procedure shall be established to follow up on all audit deficiencies to assure that the corrective actions have been implemented in a timely manner. If recurrent deficiencies are found additional corrective action shall be taken to assure correction of the problem and the Qualifying Activity shall be notified. The internal audit team shall perform a 6-month follow-up verification of corrective actions to assure that they are adequate.

D.3.18 Training.

D.3.18.1 Personnel performing quality operations. All personnel performing an operation affecting quality shall be trained in and familiar with that part of the operation relevant to their function. They shall have sufficient responsibility and authority to inspect and accept or reject product according to the applicable specifications.

D.3.18.2 Training requirements. Work training practices shall be established and utilized in acquiring and maintaining job skills as required in critical work areas.

D.3.19 Servicing. Not applicable to this document.

APPENDIX D

D.3.20 Statistical techniques.

D.3.20.1 SPC program. The manufacturers Statistical Method Program which is used to achieve continuous improvement and process control in their manufacturing line. The manufacturer's SPC program shall be included as part of the quality system. The manufacturer shall use SPC techniques in the manufacturing process for parts covered by this specification.

The SPC program shall be in accordance with all the requirements of EIA-557. A minimum program shall include training, definition of critical operations, installation of statistical control techniques, a control action system and FMEA. The manufacturer shall perform the following assessment of their products:

a. Identify the failure modes for the device.

b. List the contributing failure mechanisms for each failure mode.

c. Identify the manner in which the risk of shipping product with the inherent defect is mitigated, for each failure mechanism. Examples:

(1) Design.

(2) Material control.

(3) Process control.

(4) Screening.

(5) CI.

A planned SPC milestone schedule and progress reporting system shall be developed and made available for review. The SPC program plan and milestone shall be maintained as part of the overall verification program plan as specified herein. The progress reporting system shall be updated on a quarterly basis and be made available to the Qualifying Activity upon request.

D.3.20.2 Process control requirements for all diodes, rectifiers, and zeners. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for engineering evaluation and disposition.

D.3.20.2.1 Thermal impedance measurements. Thermal impedance measurement shall be performed in accordance with the applicable MIL-STD-750 thermal methods. The screening limit shall be derived by each vendor by means of statistical techniques, once the process has exhibited control and capability. The capability data shall be used to establish this screening limit. The maximum limit shall not exceed the group A, subgroup 2 limit of the associated specification. In addition to screening, once a fixed limit has been established, monitor each die attach production lots using a random five piece sample (minimum) from each die attach production lot to be plotted on the applicable X, R chart. Unless otherwise justified by engineering evaluation, a Cpk of 1.33 minimum, and pass/fail limits of ±3 sigma are expected.

D.3.20.2.2 Leakage current measurements. Leakage current measurements shall be performed in accordance with the applicable MIL-STD-750 leakage currents methods. The screening limit shall be derived by each vendor by means of statistical techniques, once the process has exhibited control and capability. The capability data shall be used to establish this screening limit. The maximum limit shall not exceed the group A, subgroup 2 limit of the associated specification. In addition to screening, once a fixed limit has been established, monitor all wafer lots using a random five piece sample (minimum) from each wafer lot to be plotted on the applicable X, R chart. Unless otherwise justified by engineering evaluation, a Cpk of 1.33 minimum and pass/fail of ±3 sigma are expected. (This requirement is not applicable for leakage currents of 10 nA and below.)

D.3.20.3 Parts per million (PPM) verification. The manufacturer shall establish a system for collecting and reporting defect levels in PPM. Data collected from the tests of group A, subgroups 2, 3, and 4 shall be used for PPM calculations in accordance with EIA 554. The maximum delivered defect level shall be 100 PPM. For the purpose of PPM calculations data from devices from structurally identical groupings may be combined. The contractor is responsible for establishing a quality system to verify the PPM defect level of lots that are subjected to subgroup tests of the group A inspections. The PPM defect level shall be based on a 6-month moving average. In the event that the contractor (component manufacture) meets or exceeds 100 PPM for PPM-2 groupings the manufacturer shall identify the problem device type(s) and problem subgroup which caused the grouping to exceed 100 PPM. In the event that a device type or structurally identical device types are of insufficient volume for PPM evaluation, manufacturers may create their own groupings with the following guidelines:

a. Similar package styles.

b. Similar construction, materials, and processing.

D.3.20.3.1 PPM quality levels. The quality of lots that have been subjected to and have passed the 100 percent screening inspections of table IV (or unscreened devices at the option of the manufacturer) shall be established and maintained in accordance with D.3.20.2.2 below and EIA-554. Individual PPM levels for PPM-2 shall be computed for table V, subgroups 2, 3, and 4. The sum of these equate to the overall PPM-5 defect level.

D.3.20.3.2 Group A, subgroup 2, 3, and 4 tests (PPM categories). Test results from subgroup 2, 3, and 4 shall be used for subsequent PPM calculations in accordance with EIA-554. PPM calculations shall be based on the results of the first submission and shall be based on the semiconductor grouping defined as structurally identical (see appendix E), or as defined in D.3.20.2.3 and PPM calculation, shall not use data on resubmitted lots. Calculation and data exclusion shall be in accordance with EIA-554. Larger samples may be inspected by the contractor in order to calculate PPM, however rejection of the lot shall be based only on subgroup sample testing.

D.3.20.3.3 Device groupings. When production of any device or structurally identical group is insufficient to allow accurate calculation of PPM's, the manufacturer, at his option, may increase the tested sample size, or may create expanded groupings based on similarity of package, process, construction, or specialized materials. If an increased sample size is used, rejection of lots will be based on the required subgroup sample testing. Expanded groupings, and any change to the expanded groupings must be approved by the Qualifying Activity.

D.3.20.3.4 Lots exceeding 100 PPM. When failure in a lot sample causes a six-month rolling average to exceed 100 PPM, the manufacturer shall determine the cause of the failure(s). A corrective action plan shall be developed, and implemented.

D.3.20.3.5 PPM customer correlation. The manufacturer shall establish a feedback loop with all customers who request participation to correlate the customer's test results with those of the manufacturer.

APPENDIX E

STANDARD VERIFICATION FLOW FOR ENCAPSULATED DEVICES

E.1 SCOPE

E.1.1 Scope. This appendix contains the standard test flow which, when performed in its entirety, assures that the product will meet the performance requirements. The QPL program measures and evaluates the manufacturer's manufacturing process against a baseline for that process. This baseline can include innovative and improved processes that result in an equivalent or higher quality product, provided that the process used to evaluate and document these changes have been reviewed and approved. Changes to the process baseline can be made by the manufacturer after achieving approval with documented reliability and quality data. The approach outlined in this appendix is a proven baseline which contains details of the screening and CI procedures. Compliance with this appendix is not mandatory. However, manufacturers must demonstrate to the qualifying activity a system that achieves at least the same level of quality as could be achieved by complying with this appendix.

E.2 APPLICABLE DOCUMENT

E.2.1 General. The documents listed in this section are specified in sections E.3 and E.4 of this specification. This section does not include documents cited in other sections of this appendix or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections E.3 and E.4 herein, whether or not they are listed.

E.2.3 Non-Government standards and other publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.1).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/NCSL-Z540-1-1994 - Calibration Systems Requirements.

(Application for copies should be addressed to the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA-557 - Statistical Process Control Systems.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Pennsylvania Avenue, Washington, DC 20006.)

(Non-Government standards and other publications are normally available from the organizations which prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

E.2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

APPENDIX E

E.3 GENERAL TEST AND INSPECTION INFORMATION

E.3.1 CI or 100 percent screen reduction or elimination. If a manufacturer elects to eliminate or reduce all or any CI step or 100 percent screen operation by substituting a process monitor or SPC procedure (when approved by the preparing activity and the qualifying activity), the manufacturer is only relieved of the responsibility of performing the CI or 100 percent screen operation. The manufacturer is still responsible for providing product which meets all of the performance, quality, and reliability requirements herein. A manufacturers reliability program may be used in lieu of all or any screening step or any CI, when equivalent to or compliant with E.6.1.1 and D.3.2 herein. The following are the minimum guidelines for a manufacturer to eliminate or reduce testing in either CI or 100 percent screening:

a. The manufacturer shall demonstrate that a Failure Mode Effects Analysis (FMEA) or equivalent study has been performed to identify potential device failure modes activated by the test which is intended to be changed or eliminated.

b. The manufacturer shall demonstrate that an SPC program is in place to ensure that the defect level from each of the identified failure modes is controlled at less than 500 PPM measured at a 99 percent confidence level. (Beta = .05 at 600 ppm)

c. The manufacturer shall demonstrate that end of life or step stress to failure limits have been identified for any product intended for a test flow change.

d. The manufacturer shall demonstrate through a design of experiment or equivalent method that devices tested under the proposed change in the test flow are equivalent in quality to those produced under the previous flow. Devices must be equivalent in end of life capability, not just capable of meeting the specification requirements.

E.3.2 Formation of inspection lots. The product shall be assembled into an identifiable inspection lot or collection of inspection sublots. Each inspection lot shall be identified by a unique lot identification code (see 3.10.8).

E.3.2.1 JAN, JANTX, and JANTXV inspection lot. The total number of devices that the manufacturer submits at any one time for qualification or CI shall constitute an inspection lot. The maximum small inspection lot size shall be 2,500 devices. The inspection lot is submitted to determine compliance with the requirements of the associated specification. Each inspection lot shall consist of devices of a single device type or consist of a collection of sublots of structurally identical devices contained on one or more associated specifications manufactured on the same production line(s) within a single plant through final seal by the same production technique and to the same device design with the same material requirements and sealed within the same 6-week period. Lot identification shall be maintained from the time the lot is assembled to the time it is accepted or rejected.

E.3.2.2 Inspection sublot. An inspection sublot shall consist of a single device type contained on a single associated specification manufactured on the same production line(s) through final seal by the same fabrication technique and to the same device design with the same material requirements and within the same 6-week period.

E.3.2.3 JANS inspection lot.

E.3.2.3.1 Wafer lot. A wafer lot shall consist of only semiconductor wafers subjected to each and every process step such as masking, etching, deposition, diffusion, or metallization as a group. Each wafer lot shall be assigned a unique identifier which provides traceability to all wafer processing steps. Wafer lot records shall identify all JANS device inspection lots formed from the wafer lot.

E.3.2.3.2 Wafer lot acceptance. Wafer lot acceptance is required for selected die designs such as overlay structure devices and devices with metallization path to bond pad crossing any junction covered by passivation or glassivation where the bonding pad is not on the active area of the device. This acceptance shall be performed in accordance with method 5001 of MIL-STD-750 for each of these lots.

E.3.2.3.3 Device inspection lot. The total number of devices that the manufacturer submits at any one time for JANS qualification or CI shall constitute a device inspection lot and shall conform to the following criteria:

a. Small lots shall not exceed 500 pieces. Sampling inspection for large or small lots shall be in accordance with table VIB.

b. All devices shall be of a single device type.

c. All devices shall be from a single wafer lot.

d. All devices shall be assembled on the same production line with the same technique from die attach through final seal, within 21 working days not to exceed 31 calendar days.

E.3.2.4 Structurally identical device types. Structurally identical device types are devices manufactured on the same production line(s) through final seal, by the same fabrication technique within the same package family and to the same device design with the same material requirements and differ only electrically or by dimensional proportions. Examples of such structurally identical device types are as follows:

a. Rectifiers, diodes, or thyristors grouped into different voltage ratings. Rectifiers and diodes with identical design rules (same passivation and device structure) which differ only in die size and package size are considered structurally identical. Initially, Group B and C shall be performed on each device construction in every associated specification. On subsequent lots, the die sizes/package styles which receive group B and C inspection shall be rotated on every lot thus assuring that all die/package styles receive groups B and C inspection.

b. Transistors grouped for gain limits and voltage ratings. Transistors (> 4 watts) with similar die structures that vary only in die size are considered structurally identical if the following criteria are met.

   (1) Die must have the same generic design rules and vary only in size. Channel stop, voltage enhancement, and emitter ballasting techniques, epi-base, diffused base, expanded contacts and metal interconnects over oxide steps must be similar. The process sequence in the diffusion and photolithographic areas must be the same. Transistors must have similar peak frequency responses and V ratings that do not vary more than two to one (3 MHz to 6 MHz, 60 V dc to 120 V dc). Darlington transistors cannot be grouped with standard transistors.

   (2) Overall construction must be the same. The number and size of wires can change as is needed to handle the power rating, but the die attach, wire attach and encapsulation method must be identical.

c. Power MOSFETs grouped for r_{DS}(on) and voltage ratings. Power MOSFETs of the same voltage types with identical design rules (field termination and cell density) and which differ only in die size are considered structural identical. Initially, groups B and C shall be performed on the largest die size available within each structurally identical voltage grouping. The die sizes which receive groups B and C inspection shall be rotated on a periodic basis thus assuring that all die sizes receive groups B and C inspection.

E.3.3 Disposal of samples. Devices subjected to destructive tests or which fail any test shall not be shipped. Sample devices from lots which have passed CI and which have been subjected to mechanical or environmental tests specified in groups B and C inspection and not classified as destructive, may be shipped provided each of the devices subsequently passes group A, subgroup 2 inspection.

E.3.4 Destructive tests. Unless otherwise demonstrated, the following MIL-STD-750 tests are classified as destructive:

Method number	Test
1017	Neutron irradiation
1019	Steady state total dose irradiation
1020	ESDS classification
1021	Moisture resistance
1036, 1037	Intermittent operation life
1041	Salt atmosphere
1042 (condition D)	Burn-in/life test for power MOSFETs
1046	Salt spray
1056	Thermal shock (glass strain)
2017	Die shear test
2031	Soldering heat
2036	Terminal strength
2037	Post seal bond strength
2075	Decap internal visual design verification
2077	SEM

All other mechanical or environmental tests (other than those listed in E.3.5) shall be considered destructive initially, but may subsequently be considered nondestructive upon accumulation of sufficient evidence to indicate that the test is nondestructive. The accumulation of data from five repetitions of the specified test on the same sample of product, without significant evidence of cumulative degradation in any device in the sample, is considered sufficient evidence that the test is nondestructive for the device of that manufacturer. Any test specified as a 100 percent screen shall be considered nondestructive for the stress level and duration or number of cycles applied as a screen.

E.3.5 Nondestructive tests. Unless otherwise demonstrated, the following MIL-STD-750 tests are classified as nondestructive:

Method number	Test
1038, 1039, 1040	Burn-in screen
1042 (conditions A, B, and C)	Burn-in/life test for power MOSFETs
1051 (100 cycles or less)	Thermal shock (temperature cycling)
1001	Barometric pressure
1022	Resistance to solvents
1026, 1027	Steady-state life

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Method number	Test
1031, 1032	High temperature life (nonoperating)
1071	Hermetic seal tests
2006	Constant acceleration
2016	Shock
2026	Solderability (If the original lead finish is unchanged and if the maximum allowable number of reworks is not exceeded.)
2052	PIND test
2056	Vibration, variable frequency
2066	Physical dimensions
2069, 2070, 2072, 2073, 2074	Internal visual (pre-cap)
2071	External visual
2076	Radiographic inspection
2081	Forward instability shock test (FIST)
2082	Backward instability shock test (BIST)
3101	Thermal impedance testing of diodes
3103	Thermal impedance measurements for IGBTs
3104	Thermal impedance measurements for GaAs
3051, 3052, 3053 (with limited supply voltage)	Safe operating area (SOA) (condition A for method 3053)
3131	Thermal resistance (emitter to base forward voltage, emitter-only switching method)
4066	Surge current
4081	Thermal resistance of lead mounted diode (forward voltage, switching method)

When the junction temperature exceeds the device maximum rated junction temperature for any operation or test (including electrical stress test), these tests shall be considered destructive except under transient surge or nonrepetitive fault conditions or approved accelerated screening when it may be desirable to allow the junction temperature to exceed the rated junction temperature. The feasibility shall be determined on a part by part basis and in the case where it is allowed adequate sample testing shall be performed to provide the proper reliability safeguards.

E.3.6 Resubmitted lots.

E.3.6.1 Resubmitted lots of JANS. Resubmitted lots shall be kept separate from new lots and shall be clearly identified as resubmitted lots. Any failed lot for group B, subgroups 1, 2, 3, 4, 5, 6, and group C may be resubmitted one time only, for the failed subgroup, at double the original sample sized with zero failures. Lots which fail group B, bond strength, die shear, decap internal visual and SEM (when applicable) shall not be resubmitted. For group A, E.3.6.2 shall apply. With the approval of the qualifying activity die shear failures (when determined to be die attach failure mode) may be considered to be screenable utilizing the applicable thermal impedance methods.

E.3.6.2 Resubmitted lots of JANTXV, JANTX, and JAN. Resubmitted lots shall be kept separate from new lots and shall be clearly identified as resubmitted lots. When any lot submitted for qualification or CI fails any applicable subgroup requirement of groups A (for A-2, A-3, and A-4, see footnote 3 of table V), B, C, or E tests, it may be resubmitted once for that particular subgroup at double the original sample size with zero failures. A second submission, using double the original sample size with zero failures, may only be performed if it is determined by analysis of all the failed devices, that the failure mechanism is due to a defect that can be effectively removed by rescreening the entire lot, and that rescreening has been performed.

E.3.6.3 Resubmitted lots of JANSM, JANSD, JANSL, JANSR, JANSF, JANSG, JANSH, JANTXVM, JANTXVD, JANTXVL, JANTXVR, JANTXVF, JANTXVG, and JANTXVH. Lots which fail group D tests may be resubmitted if failure analysis indicates that the defective parts can be effectively removed by screening the entire lot (100 percent) and sample retesting to group D requirements.

E.3.7 Conditions and methods of test. Conditions and methods of test shall be in accordance with MIL-STD-750. The general requirements of MIL-STD-750 apply as specified. A system for control and calibration of test equipment shall be established. ANSI/NCSL Z540-1-1994 may be used as guidance for the calibration system.

E.3.7.1 Alternative test methods. Other test methods or circuits may be substituted for those specified in MIL-STD-750 provided it is demonstrated to and approved by the qualifying activity that such a substitution in no way relaxes the requirements of this specification. The schematic wiring diagram of the test equipment shall be made available for review by the qualifying activity.

E.3.7.2 Procedure in case of test equipment failure or human error. If it is determined through an engineering evaluation that a failed device is the result of test equipment failure or human 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. Failures occurring as a result of operator error, prior to the start of testing, may be replaced by the manufacturer but shall be noted on the lot history. Any ESD failures shall be counted as rejects and not be attributed to equipment/operator error for screening, group A, and end-point electrical tests of MIL-STD-750.

E.3.7.3 Standard mixer diodes and holders. The manufacturer of UHF and microwave mixer diodes shall establish and maintain standard mixer diodes and standard mixer holders for use in qualification and quality conformance testing of UHF and microwave mixer diodes. These standards shall be calibrated at least once in each successive 12-month period or prior to use if over 12 months, at a laboratory acceptable to the Government.

E.3.8 JANS electrical test data retention. Unless otherwise specified in the associated specification, all electrical measurements performed on devices during screening tests and lot acceptance testing shall be recorded.

E.3.8.1 Summary of parts fallout. A summary of the JANS parts fallout during screening tests shall be prepared by the manufacturer in accordance with the requirements of the qualifying activity

E.3.9 Preservation of lot identity. During all screening, inspection, and marking operations, each lot and sublot shall be kept segregated, secure, and traceable.

APPENDIX E

E.4 QUALIFICATION

E.4.1 Qualification inspection. Qualification inspection shall be performed at a facility approved by the qualifying activity and shall be conducted in accordance with the procedures described herein and by the Qualifying Activity. Qualification of a particular device type to a given quality level may be extended by the qualifying activity to any other quality level provided all the groups A, B, C, D, and E requirements of the other level have been met and provided that suitable approved screening facilities are available for the other tests and stress levels. In addition, the requirements of appendix H shall be met. Small lot sampling shall not be used for qualification inspection.

Group D is required for each inspection lot of RHA types as specified in the associated specification. Qualification for RHA shall be for a specific semiconductor die and package type.

An alternate qualification procedure for RHA devices for levels M, L, and D only, are available for devices with demonstrated RHA. These devices must be submitted for qualification inspection and CI, if process or design changes affecting RHA are made. QPL-19500 provides a footnote for devices not requiring RHA qualification or CI testing.

E.4.2 Inspection routine. All samples subjected to groups B, C, D, and E must have been chosen from a lot which has passed the requirements for group A except as modified in E.6.1.6. The following conditions apply:

a. The required sample plan from a sublot of each device type submitted except for series of devices shall be the sample plan of the highest and the lowest voltage types or as the qualifying activity requires, shall be tested for each group A subgroup.

b. A sample from one sublot shall be tested for each group B subgroup. A sample device from each sublot (each device type) shall be submitted to the design verification examination.

c. A sample from one sublot shall be tested for each group C subgroup. At the option of the manufacturer, devices from table IVb, subgroup 3, may be continued on in group C, subgroup 6, to achieve 1,000 hours or 6,000 cycles total, or separate samples may be used.

d. When group D (RHA) qualification extension is granted, the radiation facility shall be approved by the qualifying activity. A sample from a sublot of each device type shall be tested for each group D subgroup.

e. Devices which are constructed using braided leads may be processed through table IV screening and qualification high temperature testing prior to the addition of leads. Qualification testing requiring load current conduction will require that leads be attached.

E.4.2.1 Qualification to ESDS classes. Initial qualification to an ESDS class or requalification after redesign shall consist of qualification to the appropriate quality and reliability level plus ESDS classification in accordance with method 1020 of MIL-STD-750.

ESDS classification levels are defined as follows:

ESDS class designator	Prior designation category	Marking	Electrostatic voltage
1	A	△	0 - 1,999 V
2	B	△ △	2,000 - 3,999 V
3			4,000 - 15,999 V
Nonsensitive			> 15,999 V

a. Although little variation due to case outline is expected, if a device type is available in more than one package type or case outline, ESDS testing and classification shall be applied to at least that one package type shown by experience to be worst case for ESDS. ESDS classification test results shall be submitted to the qualifying activity for all associated specifications for listing on the QPL. Specifications using structurally identical die designs may be classified with data from previously classified types. Any dissimilar designs within a associated specification shall have ESDS classifications for each structurally identical grouping.

b. All power bi-polar transistors and rectifiers except schottkys are considered to be at least class 3 by design. Schottky case mounted rectifiers may be designated class 3, upon successful completion of a 2 ampere reverse energy test. Other schottky rectifier package configurations may be designated class 3, if they pass a reverse energy test which has been demonstrated to correlate with class 3 classification.

c. All zeners, (voltage reference and voltage regulators) and transient suppressors are considered non-sensitive by design.

E.4.2.1.1 ESDS. ESDS classification testing shall be done in accordance with method 1020 of MIL-STD-750 and the applicable associated specification (see 3.10.3.1). Devices shall be handled in accordance with the manufacturer's in-house control documentation. Devices that are classified class 3 or nonsensitive, are not required to be handled as ESD sensitive, and manufacturer's in-house control documentation plan is not required. Handling shall begin at lead clip or wire bond (e.g., for packages which do not have a lead shorting bar or do not have leads shorted together). Guidance for device handling is available in the EIA-625 document.

E.4.2.2 Qualification by extension. Qualification of a structurally identical device or series of devices from the same or different associated specifications may be extended from a previously fully qualified device provided the following information and data are supplied to the qualifying activity:

a. Previously qualified device type, associated specification number, and qualification reference number.

b. Design and construction information on devices covered under different associated specifications.

c. Samples of structurally identical devices with certification that these samples are structurally identical to the previously qualified device.

d. Group A variables data on a sample plan of each structurally identical device type except for series of devices which shall be the sample plan of the highest and the lowest voltage types or as the qualifying activity requires, or as specified in associated specifications covering groups of devices. Test samples of selected devices in a group or portion of a group shall be from the same inspection lot.

e. Results and variables data for each structurally identical device on all group B and C electrical tests not specified in group A, including tests at temperature extremes.

f. All results and variables data on group B and C tests as follows:

(1) Data on any tests not required by the qualified device.

(2) Data that is the result of tests performed at stress levels greater than those required for the qualified device.

(3) Data for any tests requiring more exacting limits than those found for the qualified device.

g. Items E.4.2.3d through E.4.2.3f shall not be required if the qualifying activity can be assured that the previously fully qualified device at least meets all of the conditions and requirements for the proposed structurally identical device type, except for device type marking.

E.4.3 End points. End-point electrical measurements shall be measured and recorded as applicable (e.g., if delta's are required) starting and after completion of all specified tests in the subgroups of groups B, C, and D. Pre-test end point failures shall be replaced by acceptable devices.

E.4.4 Selection of samples. All samples shall be randomly selected from the qualification inspection lot. Sample selection for group D testing shall be in accordance with table VIII and shall be from each wafer or from each inspection lot, as appropriate.

E.4.5 Identification of samples. The manufacturer's management representative may, at his option, mark or authorize the marking of each sample to be subjected to qualification testing in order to distinguish these devices from those not intended for qualification inspection.

E.4.6 Lot release. The lot from which the qualification samples are selected may be offered for delivery under contract after qualification approval has been granted provided screening and quality conformance requirements are satisfied.

E.5 SCREENING

E.5.1 Screening. All JANS, JANTXV, and JANTX semiconductor devices (100 percent) shall have been subjected to and passed, all the applicable screening tests (as specified in table IV) in the sequence shown and the applicable percent defective allowed (PDA) for the type of semiconductor and quality level (device class) specified. Devices which fail any test criteria in the screening flow, shall be identified and controlled until removal from the lot. At the option of the manufacturer, the rejects may continue processing. The lot records shall identify the point of failure and the actual PDA (as applicable). Any rejected devices shall be removed from the lot prior to shipment. Except for JANS, the conditioning and screening tests performed as standard production tests need not be repeated when these are predesignated and acceptable to the Government as being equal to or more severe than specified herein provided the relative process conditioning sequence is maintained. All tests, preconditioning and screening operations which were performed on the devices submitted for qualification inspections specified herein shall be performed on all devices subsequently submitted for CIs (see E.6.). If a manufacturer elects to eliminate all or any screening operation substituting either a process monitor or SPC procedures (when approved by the preparing activity and qualifying activity), the manufacturer is only relieved of the responsibility of performing the screen. The manufacturer still bears full liability for any failure that may result if these tests are performed at a later time. A manufacturers reliability program may be used in lieu of all or any screening step, when equivalent to or compliant with E.6.1.1 and D.3.2 herein.

E.5.2 PDA. Selected electrical parameters shall be designated in the associated specification as interim and end-point measurements for the 100 percent burn-in of screen 12 of table IV. These parameters may also be compared to determine whether the change during burn-in (delta) is indicative of a lot stability problem. All burn-in pre-conditioning failures (on additional burn-in added prior to screen 12) shall be counted as part of the PDA in screen 13. When these parameters are specified, the quantity in the lot which fail these parameters or associated delta limits shall not exceed 10 percent. If the percent defective exceeds 20 percent, the lot shall not be acceptable for any level (see D.3.13.3.1).

E.5.3 JANTX and JANTXV product. The procedure for testing and screening for JANTXV and JANTX devices shall be in accordance with tables IV, V, VIb, VII, figure 3, and as specified in the applicable associated specification.

E.5.3.1 Alternate procedure for screening of JANTX and JANTXV types. JAN types may be processed and marked as JANTX and JANTXV types by the original part manufacturer on his own qualified product provided the following procedures are satisfied:

a. All devices to be proposed for JANTXV processing (except clear glass JANTXV diodes which shall be subjected to internal visual inspection before printing or marking) must have been subjected to and passed JANTXV internal visual 100 percent screening prior to seal.

b. Groups A, B, and C inspection shall have met the JANTX and JANTXV level requirements in accordance with tables V, VIb, VII, figure 4, and the applicable associated specification.

c. Screening shall be conducted in accordance with table IV, figure 4, and the applicable associated specification. All units failing these tests shall be removed from the lot and the quantity removed shall be noted in the lot history.

d. A sample of the screened devices shall be submitted to and pass the requirements of group A-1 and A-2 inspection (see table V) (see table VIb, subgroup 1) subsequent to the 100 percent screening (of the lot or separate portions thereof) as specified in E.5.3.1c, as shown on figure 4.

E.5.3.2 JANTX and JANTXV pre and post burn-in electrical measurements. Alternate methods to variables recording may be used to determine delta end point requirements of JANTX and JANTXV burn-in provided the qualifying activity has granted written approval. When alternate methods to variables recording are used to determine delta end point requirements, devices shall be separated into groups, each of which shall have maximum and minimum limits on the variable parameter(s). The difference in parameter limits for any group shall not exceed the delta requirements for the variable parameter(s).

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E.5.3.3 Alternate procedures for qualification and CI where JAN is not covered by the associated specification. When the JAN quality level is not included in the associated specification, or at the option of the manufacturer, the alternate flow (see figure 4) may be used for qualification and CI. The lot used shall be marked in accordance with 3.10.1, except the "JAN" designating symbol shall be replaced by the letter "Q". Unless they are submitted to the flow that the lot was submitted to, these samples shall not be shipped.

E.5.3.5 Lead forming for JANTX and JANTXV. When lead forming is specified for JANTX and JANTXV devices, it shall be followed by n = 116, c = 0 fine and gross seal tests, group A, subgroup 2, and external visual examination n = 45, c = 0.

E.5.4 JANS product. The procedure for testing and screening of JANS devices shall be in accordance with tables IV, V, VIa, VII, figure 5, and the applicable associated specification.

E.5.4.1 Burn-in acceptance criteria. The PDA for each inspection lot submitted to burn-in and interim (post burn-in) electrical parameters shall be 5 percent (for each burn-in) on all failures in steps 11 and 13a. Delta limits shall be defined in the associated specification. When the PDA applies to delta limits, the delta parameter values measured after burn-in (100 percent screening test) shall be compared with delta parameter values measured prior to that burn-in. Unless otherwise specified, lots which exceed the 5 percent PDA may be resubmitted one time only to the burn-in operation failed. The PDA shall be 3 percent on the resubmitted lot to each failed burn-in (delta endpoint parameter failures). If the combined burn-in PDA's for the first submission exceeds 20 percent or either of the resubmitted burn-in exceed the 3 percent PDA, the entire lot shall be unacceptable for any quality level.

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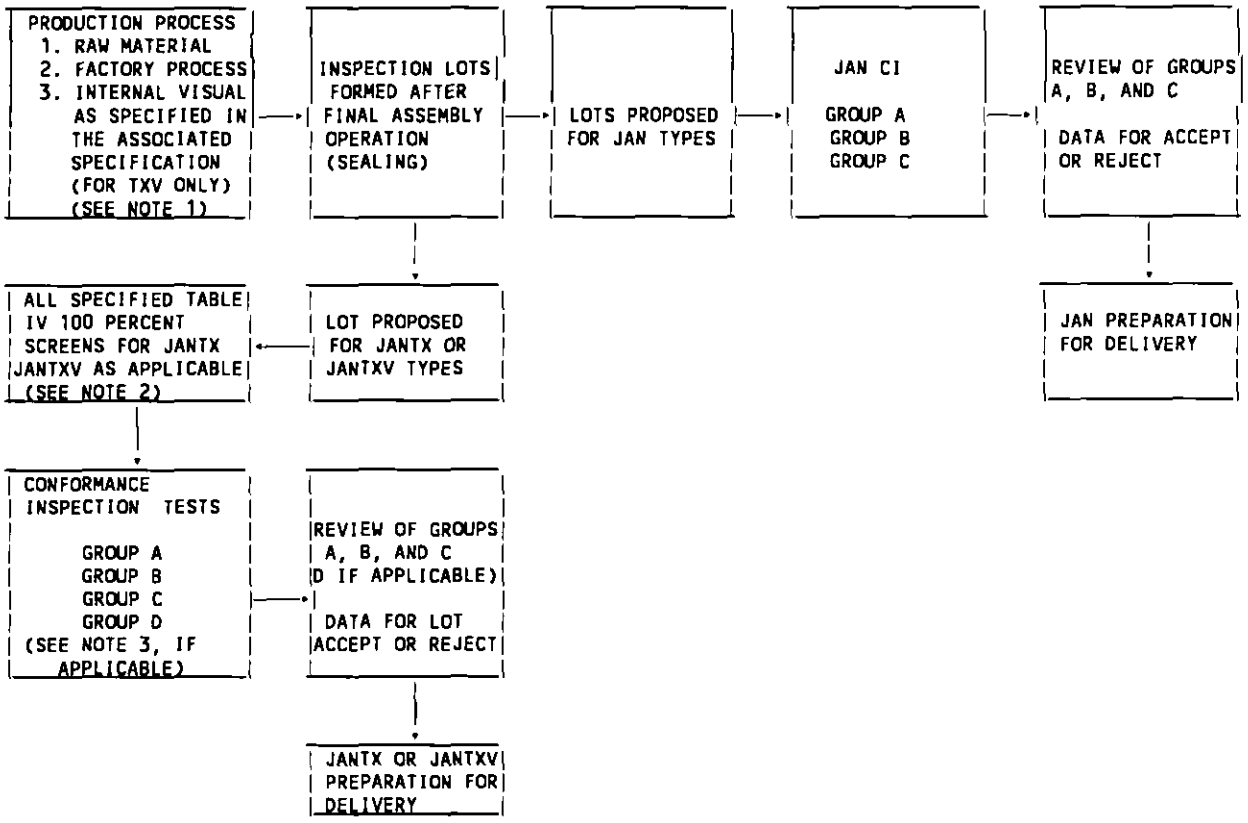

NOTES:

1. All products to be proposed for JANTXV processing must have been subjected to and passed JANTXV internal visual 100 percent screening at this step (except for clear glass JANTXV diodes which shall be subjected to internal visual inspection prior to painting and marking).
2. Order of the tests shall be performed as specified in table IV.
3. Group D inspection may be performed at any point following the production process.

FIGURE 3. Order of procedure diagram for JAN, JANTX, and JANTXV device types.

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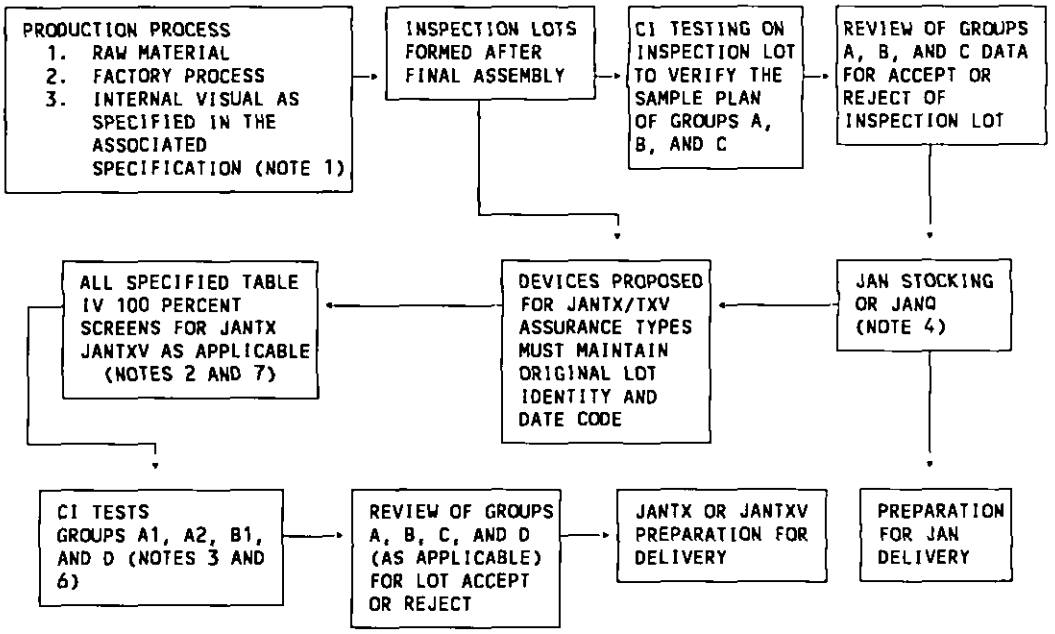

NOTES:

1. All product proposed for JANTXV processing must have been subjected to and passed JANTXV internal visual 100 percent screening in accordance with table II herein at this step (except for clear glass JANTXV diodes which shall be subjected to internal visual prior to body paint or mark).
2. The order of all screening tests shall be performed as specified in table IV.
3. B1 may be performed simultaneously with A. Steam age is not required for solderability testing at this step only.
4. JANQ product must be screened and receive the appropriate CI testing prior to shipping (see E.5.4.3).
5. Parallel processing of JANTX/TXV material with the JAN inspection lot is allowed.
6. If a JAN inspection lot is not processed in parallel with the material designated for JANTX and JANTXV, all group A, B, C, and D testing must be performed on a JANTX or JANTXV inspection lot.
7. Groups A, B, C, and D testing for lot acceptance may be initiated immediately prior to screen 1 or between screens 11 and 12.

FIGURE 4. Alternate order of procedure diagram for JAN, JANTX, and JANTXV device types.

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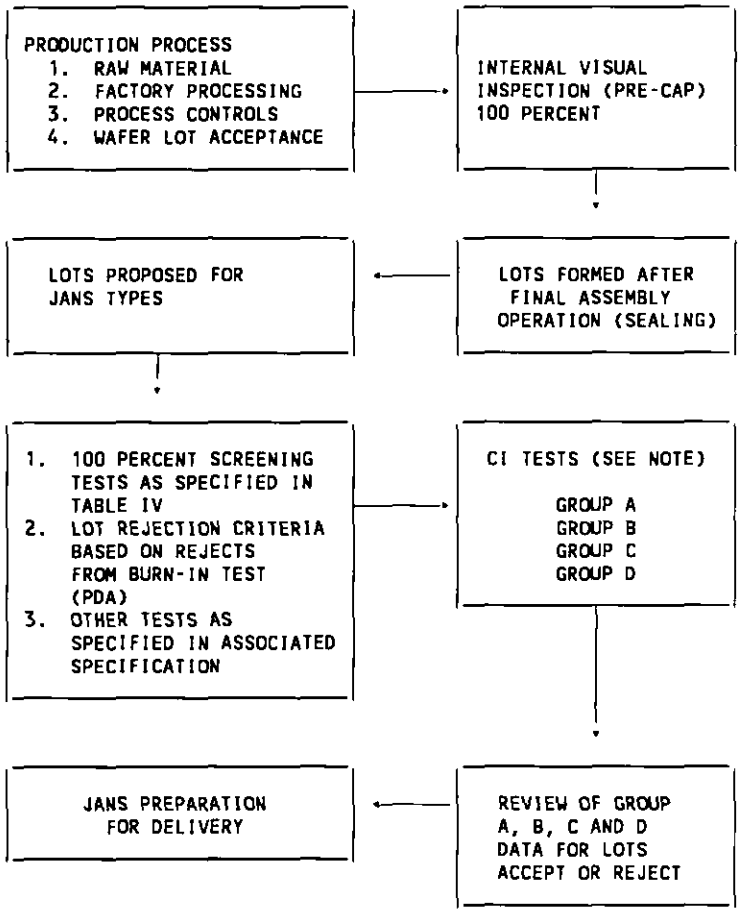
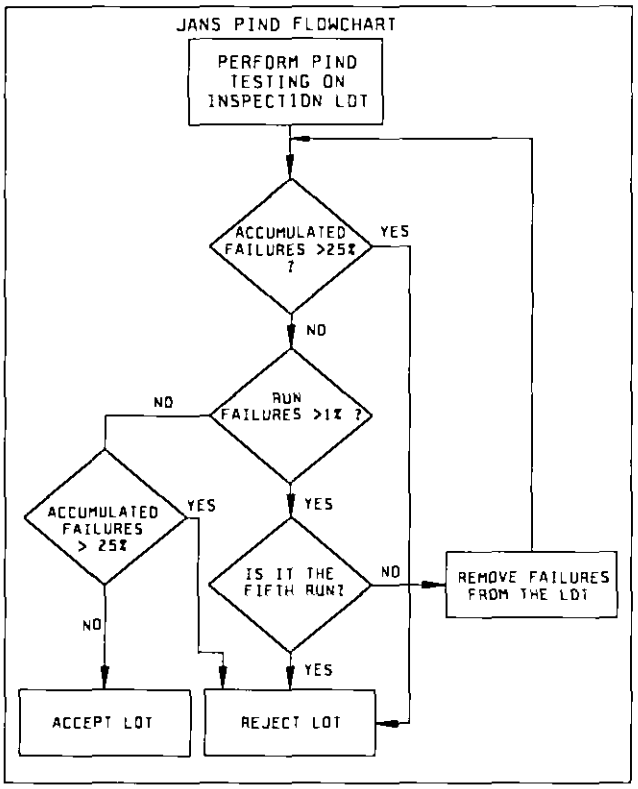


NOTES:
1. Group D testing may be performed at any point following the production process (see E.6.1.10).
2. Groups B, C, and D testing for lot acceptance may be initiated immediately prior to screen 15.

FIGURE 5. Order of procedure diagram for JANS.

E.5.4.2 PIND test for JANS devices. The inspection lot (or sublots) shall be submitted to 100 percent PIND testing a maximum of five times in accordance with method 2052 of MIL-STD-750, test condition A. PIND prescreening shall not be performed. The lot may be accepted on any of the five runs if the percentage of defective devices is less than one percent (zero failures allowed for lots of less than 50 devices). All defective devices shall be removed after each run. Lots which do not meet the one percent PDA on the fifth run, or exceed 25 percent defectives cumulative, shall be rejected and resubmission is not allowed. These parts shall not be shipped as any other quality level. When calculating numbers of allowed failures using percentages, fractional values shall be increased to the next whole integer.



E.5.4.3 Lead forming for JANS. When lead forming is specified for JANS devices, it shall be followed by 100 percent fine and gross seal tests, group A, subgroup 2, and external visual examination.

E.5.4.4 Burn-in socket verification for JANS. The electrical continuity between each device and the socket shall be verified prior to initiating burn-in (see MIL-STD-750 for details).

E.5.5 Failure evaluation for JANS. Failures that occur during JANS screening shall be evaluated to determine if failure mode is the result of a latent (time dependent) defect, workmanship, or design weakness. This information shall be retained and presented to the qualifying activity, when requested, for review and determination if a failure trend is developing that needs corrective action.

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E.6 CONFORMANCE INSPECTION (CI)

E.6.1 CI. CI shall be conducted in accordance with the requirements of groups A, B, and C for the specified quality level as well as group D to the applicable RHA level. If a lot is withdrawn in a state of failing to meet conformance requirements and is not resubmitted, it shall be considered a failed lot and reported as such. Each lot shall be subjected to group A and B inspection. Successful completion of group C conformance for a given quality level shall satisfy the group C requirements for the tested level or any quality level and devices represented by the structurally identical group. The grouping of structurally identical devices shall be as agreed between the manufacturer and the qualifying activity. JANS devices shall not be used to represent the other quality levels. If a manufacturer elects to eliminate all or any CI step substituting either a process monitor or SPC procedures (when approved by the preparing activity and qualifying activity), the manufacturer is only relieved of the responsibility of performing the CI (see 4.5). The manufacturer still bears full liability for any failure that may result if these tests are performed at a later time. A manufacturers reliability program may be used in lieu of all or any CI when equivalent to or compliant with E.6.1.1 and D.3.2 herein.

E.6.1.1 Reliability and ongoing reliability (continuous improvement program) guidance criteria. With the approval of the qualifying activity and preparing activity, this program or an equivalent program may be used as an alternative to the conformance inspection.

E.6.1.2 General elements of an ongoing reliability program (continuous improvement program). A ongoing reliability program is designed to create a closed loop feedback system which will generate continuous improvement. Existing production lines are constantly sampled and tested. This proves the critical interfaces and manufacturing process are stable and repeatable, as well as providing a mechanism for failures to be evaluated and the process improved. The ongoing reliability program shall include, as a minimum, the following:

a. Program will formalize the routine reliability testing and tie failures to a specific manufacturing process.

b. Program will integrate FMEA with reliability surveillance.

c. Effort will restructure surveillance program by "root technologies", rather than by individual part numbers.

d. All ongoing reliability testing will continue routinely.

e. Large samples will be tested weekly in key environmental test, i.e., HTRB, Solder Dip, and Thermal Shock.

f. Failures will be reviewed and tracked to a specific manufacturing process.

g. The ongoing reliability program will record type of failure, manufacturing process, and root cause/corrective action.

E.6.1.3 General elements of a reliability program. A reliability program is a qualification of the design and the manufacturing process, more commonly referred to as Product Design Qualification (PDQ), and Product Manufacturing Qualification (PMQ). These tests are usually performed as part of the Quality design process for determining the long term reliability of the design and the manufacturing process. Once performed and acceptable these tests are not repeated unless a major design change is made which would require a new PDQ and PMQ reliability program.

a. Smart testing: Avoid unnecessary or redundant testing. Use variable frequency of tests versus fixed frequency of performance tests.

b. Product failures: Do step stress testing in order to generate failures, not produce the absence of failures.

c. Failure analysis: Once failure occurs, perform failure analysis (if needed) to ascertain the mechanisms and failure rates or time to wearout.

d. Engineering evaluations: Evaluate to constantly improve the final product quality and reliability.

e. Failure mechanism identification: Identify and focus on failure mechanisms typical for the technology (assembly, packages, and die-level failures).

f. Publish results: Open up raw and summary data to customers engaged in correlation testing with customers and provide other customers with exchange of data bases.

g. Data base: Build a data base over time and track long term and short term reliability information. Use data base as a foundation for system.

h. Feedback loop: Results from Statistical Process Control (SPC) data shall be used to chose particular device types, sample sizes, and frequencies for destructive stress testing, and failure analysis results shall be used to correct or improve semiconductor processes or to redesign in order to design out failure mechanisms.

E.6.1.3.1 Detailed elements of a reliability program.

a. Defining a device family: In order to provide acceptable coverage during representative reliability assessment testing, all devices must first be grouped into their respective device families. Device families may be selected based on characteristics from the following three categories:

(1) Package grouping based on: Thermal resistance, package profile, volume, complexity of package construction, and number of pins or wire bonds.

(2) Overall construction grouping based on: Die attach method, interconnect construction techniques (e.g., spring contact) or category of bond.

(3) Die grouping based on: Overall dimensions, aspect ratio, thickness, number of bonds, voltage, frequency, or power rating.

When selecting device families, consideration must also be given to differences due to the use of different production facilities, variations in fabrication procedures, and differing design techniques. Differences or variations which may influence device reliability imply that a separate device family should be established. Ignoring these factors in creating device families must be justified to the qualifying activity.

b. Identification of worst case devices: Once device families have been established, worst case device types from within those families must be selected which will provide coverage for the reliability assessment of all other devices within the family. Worst case parameters (or combinations of parameters) from within the three categories listed above (i.e., packaging, overall construction, and die) must be identified in order to establish which devices are worst case.

c. Rationale for device groups and worst case devices: A listing of device families, worst case devices within each family, and the rationale for choosing the family groupings and worst case devices must be submitted as part of the reliability assessment program plan to the qualifying activity for approval. QPL-19500 shall indicate which devices are tested in an ongoing reliability program.

d. Material and process characterization: Materials and processes shall be characterized to identify, optimize, and control the characteristics which lead to long life in harsh military environments. Manufacturers will be approved based on this approach.

e. SPC program: An SPC program that contains all of the critical elements of EIA-557 must have been implemented. The program must include but is not limited to the following elements: Management, SPC organization, SPC program plan details, training, self-audits, maintenance, calibration, incoming materials, services, environmental controls, failure analysis, test, fabrication, assembly, and test critical node evaluation.

f. Reliability assessment program: A reliability assessment program shall be established which considers the following stresses (if they apply for the specific device type): High temperature reverse bias, high temperature gate stress, temperature cycling, power cycling, temperature and humidity, alternating current, high temperature reverse bias, operating life, and mechanical shock or vibration.

g. Experiment: Determine activation energies for all predominant failure mechanisms.

E.6.1.4 Approval procedure and criteria.

a. The program plan must also be tailored to focus on relevant failure modes and mechanisms intrinsic to the family chosen above.

b. The qualifying activity will perform a quality and reliability review. The qualifying activity may review the manufacturer's SPC program to assure that the outgoing defect levels are low. The manufacturer must prove that the devices are robust and have a capability well beyond the normal CI testing levels. The manufacturer shall show that the devices are capable of meeting CI testing greater that those normally required (e.g., if 100 temperature cycles are normally required, the devices must be capable of surviving 500 cycles without failure, etc.). No reliability problems shall exist for the device family.

c. The ongoing reliability assurance program plan and its results shall be available from the manufacturer for review by other participating Government agencies and to interested industry users.

d. A joint audit of the manufacturer shall be performed. Participating industry users and other Government agencies may attend.

E.6.1.5 Nonconformance. Lots which fail subgroup requirements of group A, B, or C may be resubmitted in accordance with the provisions of E.3.6 (E.3.6.3 for group D). However, if the lot is not resubmitted or fails resubmission, the lot shall not be shipped and the JAN marking shall be removed within 30 days.

Samples from subsequent lots of the device types in the structurally identical device grouping represented by a failed group C inspection in the case of group C failures, shall then be subjected to all the tests in the subgroup in which the failure occurred, on a lot-by-lot basis until three successive lots pass the failed subgroup. The testing may then return to periodic testing. A device type which fails a group C inspection shall not be accepted until the device type which failed, successfully completes the failed group C subgroup(s). Other device types from the same qualified group represented by the failed device type may be accepted provided group C inspection requirements have been satisfied for those device types. A device type which fails a group D inspection may not be certified as an RHA device at the level tested, but may be used as a non-RHA device or certified at another (lower) level if the device meets the lower level requirements.

E.6.1.6 Group A inspection. Group A inspection shall be performed on each inspection lot and shall consist of visual and mechanical inspection and electrical tests as specified in table V and the associated specification. Group A inspection may be performed in any order. If an inspection lot is made up of a collection of sublots, each sublot shall pass group A inspection as specified. Unless the entire inspection lot has seen the same screening, devices which have received PIND screening in accordance with E.5 may not be considered as candidates for this inspection.

E.6.1.7 Group B inspection. Group B inspection shall be performed on each inspection lot. Group B shall be in accordance with table VIa or VIb as applicable, and the associated specification. Testing of one device type sublot in any subgroup shall be considered as complying with the requirements for that subgroup for all types in the lot. Different device types may be used for each subgroup. All inspections except for life tests shall be applied only to completed and fully marked devices (see E.5.4.3) from lots which have been subjected to and passed the group A requirements. When the final lead finish is solder, or any plating prone to oxidation at high temperature, the samples for life tests (groups B3 and B6 for JX and JV, and groups B4 and B5 for JANS) may be pulled prior to the application of final lead finish. Tests within a subgroup shall be performed in the order specified. When the lead finish is tin plated the test samples may be cleaned prior to the electrical end-point testing. An evaluation shall be performed on all failures to determine if the failure mode is the result of a latent (time dependent) defect, workmanship, or design weakness. Appropriate corrective action shall be performed as a result of the evaluation. All tests within a subgroup shall be performed in the order specified except table VIa, subgroup 2, and table VIb, subgroup 1.

E.6.1.7.1 Lots shipped prior to group B completion. No lots shall be shipped prior to completion of group B without the approval of the qualifying activity.

E.6.1.8 Group C inspection. Group C inspection shall be in accordance with table VII and shall include those tests specified which are performed periodically at 1 year intervals on at least one device type from each structurally identical device grouping (from the same or different associated specification) in which the manufacturer has qualified device types. This inspection shall be applied only to completed and fully marked devices (see E.5.4.3) from lots which have been subjected to and passed the group A requirements. When the final lead finish is solder, the life test subgroup may be pulled prior to the application of final lead finish. All tests within a subgroup shall be performed in the order specified. When the lead finish is tin plated, the test samples may be cleaned prior to the electrical end-point testing. An evaluation shall be performed on all failures to determine if the failure mode is the result of a latent (time dependent) defect, workmanship, or design weakness. Appropriate corrective action shall be performed as a result of the evaluation. Lots with an unscreenable failure mode shall be rejected. Unless all devices intended for manufacturing during that period will receive as a minimum the same screening, devices which have received PIND screening in accordance with E.5 may not be used to qualify the next group C inspection periods.

E.6.1.8.1 Group C sample selection. Samples for subgroups in group C shall be chosen at random from the first lot submitted for CI during the specified group C inspection interval. Testing of one device type for each subgroup shall be considered as complying with the requirements for that subgroup for all types represented (see E.6.1.8) from the same line. A different device type(s) shall be tested at each successive inspection interval until all structurally identical device types qualified on the same or different associated specifications from the same qualified line have been tested, except power MOSFETs grouped by the same voltage as described in E.3.2.4. When none of the inspection lots passing group A of the first lot submitted contain the device type which is due to be tested, the samples for inspection shall be chosen from those types in the inspection lots being tested which have not been used for the longest time for group C inspection. The date code of the lot establishes (begins) the one year group C interval. Groups A and B shall also be completed on the group C inspection lot date code prior to the coverage being valid.

E.6.1.8.2 Lots shipped prior to group C completion. No lots shall be shipped prior to completion of group C without the approval of the qualifying activity.

E.6.1.9 Group D inspection. Group D inspection shall be performed in accordance with table VIII and the requirements of the associated specification. A device type which fails a group D inspection may not be certified as an RHA device at the level test, but may be used as a non RHA device or certified at another (lower) level if the device meets the lower level requirements. At the manufacturer's option, group D samples need not be subjected to all the screening tests, but shall be assembled in its qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package and as a minimum, pass group A, subgroup 2 prior to irradiation. CI is not required for a special group of moderately hard semiconductor devices for JANTXV, levels M and D. These devices are so noted in QPL-19500. Devices which have received PIND screening in accordance with E.5, may not be considered as candidates for this inspection unless the entire inspection lot has been subjected to the same screening.

E.6.1.10 Group E inspection. Group E is a workmanship, ruggedness, and critical interface verification inspection. Group E testing need only be performed when the testing requirements have been added to the associated specification. The results of group E testing shall be submitted to the qualifying activity (by all QPL manufacturers prior to the implementation of the associated specification or prior to shipment of product, as applicable). Product redesigns may be subjected to group E testing as required by the qualifying activity.

E.6.1.10.1 Group E testing requirements. Group E shall be performed in accordance with table IX herein and the associated specification. All tests within a subgroup shall be performed in the order specified. An evaluation shall be performed on all failures to determine if the failure mode is the result of a latent (time dependent) defect, workmanship, or design weakness. Appropriate corrective action shall be performed and approved by the qualifying activity.

E.6.1.10.2 Alternate group E testing procedures. Manufacturers may use internal design verification or ongoing reliability assessment programs in lieu of group E, subgroups 1 and 2 only, provided this testing is equivalent to or more stressful than group E and is performed using the same design and construction on file at the qualifying activity. This alternate testing must be approved by the preparing activity and the qualifying activity.

E.6.1.11 Group B, C, D, and E end points. Post test end points specified in the associated specification shall be measured for each device of the sample after completion of all specified tests in the subgroups. Except as specified or otherwise required, all life test (such as operation, storage, blocking) end point measurements shall be performed within 96 hours after sample units have been subjected to and removed from required tests. All other end-point test measurements shall be made within 168 hours, or as specified. Additional measurements may be made at the discretion of the manufacturer.

E.6.1.12 Inspection of packaging. The sampling and inspection of the preservation, packing, container and unit package marking shall be in accordance with the acquisition document.

TABLE II. RHA levels and requirements. 1/

Radiation level		
RHA Designation	Total ionizing dose (RAD(Si)) 2/	Neutron fluence (N/Cm^2) 3/
M	3×10^3	
D	1×10^4	
L	5×10^4	
R	1×10^5	
F	3×10^5	
G	6×10^5	
H	1×10^6	

1/ See 4.3.
2/ Test in accordance with MIL-STD-750, method 1019.
3/ Test in accordance with MIL-STD-750, method 1017. Unless otherwise specified in the associated specification, the minimum neutron fluence shall be 2×10^{12} N/cm^2.

TABLE III. Testing guidelines for changes to a qualified product. 1/ 2/ 3/ 4/ 5/ 6/ 7/

Changes (see appendix D)		Testing, MIL-STD-750, (All electrical parameters as specified in associated specifications)	Samples to be submitted to qualifying activity
a.	Doping material source Concentration Process technique	GRP A and C-6 deltas (variables only when deltas are required)	C-6 (2 samples)
b.	Die structure/topography	Same as a	C-6 (2 samples)
c.	Mask changes affecting die size or active element	Variable GRP A, B-2, and C6, if new die area is smaller/larger in the applicable package than previously qualified	B-2 (2 samples)
	Wafer diameter Final die thickness	GRP A and C-6 GRP B-2 and B-4	C-6 (2 samples) B-2 (2 samples)
d.	Passivation/glassivation or die coating	GRP A and C-6	C-6 (2 samples)
e.	Metallization changes. Anything that effects density for Schottkys and composition of layers	GRP A, B-2, B-4, and C-6	B-2 (2 samples)
f.	Die attach method	B-2 and C-3	C-3 (2 samples)

See footnotes at end of table.

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TABLE III. Testing guidelines for changes to a qualified product 1/ 2/ 3/ 4/ 5/ 6/ 7/ - Continued.

	Changes (see appendix D)	Testing, MIL-STD-750, (all electrical parameters as specified in associated specifications)	Samples to be submitted to qualifying activity
g.	Bond process	B-4 and C-3	C-3 (2 samples)
h.	Bond wire material, doping dimensions	B-4 and C-3	C-3 (2 samples)
i.	Package or lid structure	B-1, B-2, and C-3	C-3 (2 samples)
	Package or lid material	B-1, B-2, and C-3	C-3 (2 samples)
	Package or lid dimension	B-1, B-2, and C-3	C-3 (2 samples)
j.	Sealing technique	B-1, B-2, and C-3	C-3 (2 samples)
k.	Sealing environment	B-1, B-2, and C-3	C-3 (2 samples)
l.	Implementation of test methods	Notify qualifying activity (may involve test demonstration)	As required
m.	Changes in flow chart	Same as l	As required
n.	Fab move	Quality conformance test report (summary data) group A (read and record)	One test sample each subgroup (B and C)
o.	Assembly move	Same as L	Same as L
p.	Test facility move	Notify qualifying activity	As required
q.	Scribe/die separation	B-2 and C-3	B-2 (2 samples)
r.	Qualification/CI procedures	Notify qualifying activity	As required

1/ Acceptable supporting data may be submitted to reduce or eliminate required testing.
2/ When variable data is required for applicable groups A and C testing, data histograms providing acceptable parameter data summaries may be submitted in place of variables.
3/ If changes involve more than one device type from the same certified line, contact the qualifying activity to determine appropriate selection of device type(s) to be selected for testing.
4/ The qualifying activity may add or reduce testing if warranted by associated specification requirements or unique design or process circumstances after notification of the manufacturer.
5/ All groups and subgroups referenced herein apply to JANTX and JANTXV only. Test requirements for sample submittals for design changes to JANS level qualified product are to be determined by the qualifying activity.
6/ Additional testing and evaluation in accordance with group E to establish confidence in the proposed change shall be performed as required by the qualifying activity (see E.6.1.10).
7/ New die design requires full qualification.

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TABLE IV. Screening requirements.

Screen	MIL-STD-750 method	Condition	JANS requirements	JANTXV requirements	JANTX requirements
1a. Die visual for diodes 1/	2073	Die form prior to assembly	100 percent	When specified	N/A
1b. Internal visual (pre-cap) inspection			100 percent	100 percent	N/A
For diodes	2074				
For POWERFETs	2069				
For microwave transistors	2070				
For transistors	2072				
2. High temperature life Nonoperating life (stabilization bake)	1032	$T_{STG} \leq +175°C$ t = as specified	optional	optional	optional
3a. Temperature cycling	1051	No dwell is required at +25°C. Test condition C, or maximum storage temperature, whichever is less, 20 cycles, t(extremes) ≥ 10 minutes.	100 percent	100 percent	100 percent
3b. Surge (as specified) 2/	4066	Condition B, as specified	100 percent	100 percent	100 percent
3c. Thermal response 2/ (as specified)		As specified	100 percent	100 percent	100 percent
Transistors, POWERFETs	3161				
Bipolar	3131				
Diodes	3101				
IGBT	3103				
GaAs FET	3104				
4. Constant acceleration	2006	Y_1 direction at 20,000 G min except at 10,000 G minimum for devices with power rating of ≥ ten watts at T_C = +25°C. The 1 minute hold time requirement shall not apply.	100 percent except not required for metallurgically bond diodes	Optional 3/	Optional 3/

See footnotes at end of table.

APPENDIX E

TABLE IV. Screening requirements - Continued.

Screen	MIL-STD-750 method	Condition	JANS requirements	JANTXV requirements	JANTX requirements
5. PIND 4/	2052	Condition A.	100 percent see 50.4.2		
6. Instability shock test (axial lead diodes only) 5/					
a. FIST	2081		100 percent		
b. BIST	2082		100 percent		
7. Hermetic seal 6/					
a. Fine	1071	Omit for double plug diodes. Test condition G or H, maximum leak rate = 5 x 10^{-8} atm cc/s except 5 x 10^{-7} atm cc/s for devices with internal cavity > 0.3 cc. Maximum leak rate = 5 x 10^{-6} atm cc/s for cavities 3-40 cc.	optional 12/	100 7/ percent	100 7/ percent
b. Gross				100 7/ percent	100 7/ percent
8. Serialization		See 3.10.9.	100 percent		
9. Interim electrical parameters		As specified.	100 percent (Read and record)	For case mounted rectifiers as specified	For case mounted rectifiers as specified
10. High temperature reverse bias (HTRB)					
a. For transistors	1039	Test condition A. 80 percent (minimum) of rated V_{CB} (bipolar), V_{GS}(FET) or V_{DS}(FET), as applicable.	100 percent	100 percent	100 percent

See footnotes at end of table.

APPENDIX E

TABLE IV. Screening requirements - Continued.

Screen	MIL-STD-750 method	Condition	JANS requirements	JANTXV requirements	JANTX requirements
10. High temperature reverse bias (HTRB) - Continued					
b. For Powerfets	1042	Test condition B. 80 percent (minimum) of rated V_{GS}.	100 percent	100 percent	100 percent
c. For diodes and rectifiers	1038	c. Test condition A. Diodes (not required for LEDs, case mounted rectifiers and zeners) 80 percent minimum of rated V_R or V_{RWM} when dc conditions are specified. 95 - 100 percent of V_{RWM}, when half sine condition is specified.	100 percent	100 percent	100 percent
11. Interim electrical and delta parameters for PDA (see 50.2) for JANTX and JANTXV and 50.4.1 for JANS		As specified but including all delta parameters as a minimum. When HTRB is performed leakage current shall be measured on each device before any other specified parametric test is made.	100 percent (Measure all specified parameters within 16 hours after removal of applied voltage in HTRB. Record those parameters which have a delta limit.)(See screen 13.)	100 percent (Measure all specified parameters within 24 hours after removal of applied voltage in HTRB. Record those parameters which have a delta limit.)(See screen 13.)	100 percent (Measure all specified parameters within 24 hours after removal of applied voltage in HTRB. Record those parameters which have a delta limit.)(See screen 13.)
12. Burn-in		As specified.	100 percent	100 percent	100 percent
a. For bipolar transistors	1039	a. Test condition B.	240 hours (minimum)	160 hours (minimum)	160 hours (minimum)
b. For Powerfets	1042	b. Test condition A.	240 hours (minimum)	160 hours 8/ (minimum)	160 hours 8/ (minimum)

See footnotes at end of table.

TABLE IV. Screening requirements - Continued.

Screen	MIL-STD-750 method	Condition	JANS requirements	JANTXV requirements	JANTX requirements
12. Burn-in - Continued		As specified.	100 percent	100 percent	100 percent
c. For diodes, zeners, and rectifiers	1038	c. Test condition B.	240 hours 9/ (minimum)	96 hours (minimum)	96 hours (minimum)
For case mount rectifiers		Condition A, JANTX and JANTXV only.	N/A	48 hours (minimum)	48 hours (minimum)
		Condition B, for JANS	240 hours (minimum)	N/A	N/A
d. For thyristors 10/	1040		240 hours (minimum)	96 hours (minimum)	96 hours (minimum)
13. Final electrical test (see 50.and 50.5)		As specified.	100 percent	100 percent	100 percent
a. Interim electrical and delta parameters for PDA (see 50.2 or 50.4.1)			Interim electrical and delta parameters as a minimum. (Read and record.)	Interim electrical and delta parameters as a minimum. (Read and record.) (See E.5.3.2.)	Interim electrical and delta parameters as a minimum. (Read and record.) (See E.5.3.2.)
b. Other electrical parameters 11/			Group A, subgroups 2 and 3.	Group A, subgroup 2.	Group A, subgroup 2.
14. Hermetic seal 6/ a. Fine b. Gross	1071	(Same as 7 above) 12/	100 percent	optional 7/	optional 7/

See footnotes at end of table.

APPENDIX E

TABLE IV. Screening requirements - Continued.

Screen	MIL-STD-750 method	Condition	JANS requirements	JANTXV requirements	JANTX requirements
15. Radiography	2076	13/	100 percent	N/A	N/A
16. External visual examination	2071	To be performed after complete marking and prior to lot acceptance	100 percent	N/A	N/A

1/ Visual inspection (method 2074) on clear glass diodes shall be performed any time prior to screen 8.
2/ Shall be performed any time before screen 13. Surge shall precede thermal response when both tests are performed. Surge and thermal impedance are applicable only when specified in the screening table of the associated specification.
3/ Constant acceleration shall be performed on gold bond devices.
4/ PIND is not applicable to any device with external and internal pressure contacts (die to electrical contacts) optical coupled isolators, and double plug diodes. PIND screening may be performed any time after screen 4 when imposed by contract or purchase order (see E.5).
5/ Omit BIST and FIST tests for double plug or case-mounted diodes. Omit FIST test for temperature compensated referenced diodes.
6/ Non-transparent glass encased double plug noncavity axial lead diodes only may use method 2068 in lieu of 1071.
7/ Fine and gross seal leak test for JANTX and JANTXV shall be performed in either screen 7 or screen 14.
8/ Optional accelerated HTRB for POWERFETs in accordance with method 1042, condition A, shall be 48 hours minimum at T_A = +175°C minimum. Initial use of this option is contingent upon subsequent completion of a one time 1,000 hour qualification in accordance with method 1042, and as specified on group E of the individual associated specification, condition A to be submitted with the initial qualification report.
9/ For JANS only, zener diodes shall be subjected to high temperature reverse bias at 80 - 85 percent of nominal V_Z for V_Z > 10 V. Omit test for devices with $V_Z \leq 10$ V. For JANS case mounted rectifiers condition A is required.
10/ For JANTX and JANTXV levels full wave-blocking test shall replace power burn-in for all thyristors.
11/ Tests previously performed 100 percent (i.e., surge, thermal impedance) need not be repeated in screen 13.
12/ Hermetic seal screens for JANS may be performed in any order following final electrical test. Glass diodes shall not be painted until after seal tests. When hermetic seal testing is performed in screen 7 it does not have to be performed again in screen 14 for double plug diode construction.
13/ The radiographic screen for JANS may be performed in any sequence after screen 8.

APPENDIX E

TABLE V. Group A inspection.

Subgroups	JANS 1/ sample plan (n/c)	JAN, JANTX, JANTXV sample plan 1/
Subgroup 1 Visual and mechanical inspection (MIL-STD-750, method 2071)	15 devices c = 0	45 devices c = 0
Subgroup 2 (PPM-2) DC (static) tests at +25°C	116 devices c = 0	116 devices 2/3/ c = 0
Subgroup 3 (PPM-2) DC (static) tests at maximum rated and minimum rated operating temperatures	2/ 4/	116 devices 2/3/ c = 0
Subgroup 4 (PPM-2) Dynamic tests at +25°C		116 devices 2/3/ c = 0
Subgroup 5 Safe operating area test (for power transistors only): a. DC b. Clamped inductive c. Unclamped inductive End-point electrical measurement	5/ 45 devices c = 0	45 devices c = 0
Subgroup 6 Surge current (for diodes/rectifiers only) End-point electrical measurements		22 devices c = 0
Subgroup 7 Selected static and dynamic tests		22 devices c = 0

1/ The specific parameters to be included for tests in each subgroup shall be as specified in the applicable associated specification. Where no parameters have been specified in a particular subgroup or test within a subgroup, no group A testing is required for that subgroup or test to satisfy group A requirements. A single sample may be used for all subgroup testing. These tests are considered nondestructive and devices may be shipped.

2/ If a device in the sample fails one or more test(s) in the subgroup(s) being sampled, each device in the (sub)lot represented by the sample may be screened for the test(s) for which the sample failed. An alternate temperature electrical screen necessary to remove the failure mode may be used after an Engineering evaluation is performed. A second sample shall be tested to the failed parameter. If the second sample fails, the same subgroup 100 percent rescreen of the failed subgroup shall be performed or the lot shall be rejected.

3/ For small lot sampling plan, n = 45.

4/ All devices required by the specified sample plan shall be subjected to subgroups 2, 3, and 4 combined.

5/ All devices required by the specified sample plan shall be randomly selected from the devices subjected to subgroups 2, 3, and 4, and shall be subjected to subgroups 5, 6, and 7 combined.

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TABLE VIa. Group B inspections for JANS devices.

Inspections	MIL-STD-750 method	MIL-STD-750 condition	Qualification and large lot quality conformance inspection sample plan	Small lot CI n/c
Subgroup 1 1/			22 devices c = 0	8 devices, c = 0
Physical dimensions	2066	Dimensions in accordance with case outline specified in MIL-STD-1835 and associated specifications.		
Subgroup 2 1/		Separate samples may be used for each test.	15 leads c = 0	6 leads, c = 0
Solderability	2026	The sample plan applies to the number of leads inspected. A minimum of 3 devices shall be tested.		
Resistance to solvents	1022	Not required if marking is etched into the device.	15 devices c = 0	15 devices, c = 0
Subgroup 3			22 devices c = 0	6 devices, c = 0
Temperature cycling (air-to-air) (except for axial lead glass diodes)	1051	No dwell is required at +25°C. Test condition C, (100 cycles) or maximum storage temperature whichever is less.		
Thermal shock (liquid-to-liquid) (For axial lead glass diodes only)	1056	25 cycles, condition A		
Surge	4066	As specified.		
Hermetic seal 2/	1071			
a. Fine		Not required for double plug diodes. Test condition G or H, maximum leak rate = 5×10^{-8} atm cc/s, except 5×10^{-7} atm cc/s for devices with internal cavity > 0.3 cc. Maximum leak rate = 5×10^{-6} atm cc/s for cavities 3-40 cc		
b. Gross				
Electrical measurements		As specified.		

See footnotes at end of table.

APPENDIX E

TABLE VIa. Group B inspections for JANS devices - Continued.

Inspections	MIL-STD-750 method	MIL-STD-750 condition	Qualification and large lot quality conformance inspection sample plan	Small lot Cl n/c
Subgroup 3 - Continued				
Decap-internal visual (design verification) 3/	2075	Visual criteria in accordance with qualified design and internal visual precap criteria.	6 devices c = 0	
Bond strength (wire or clip bonded devices only)	2037		22 wires or 11 devices c = 0 (Whichever requires the smaller number of devices)	
SEM (when specified) 4/	2077		6 devices c = 0	
Die shear (excluding axial leaded devices)	2017	The same number of devices used for bond strength will also be used for die shear (minimum of six die)		
Subgroup 4			22 devices c = 0	8 devices, c = 0
Intermittent operation life	1037	2,000 cycles		
	1042	As specified. Condition D.		
Electrical measurements		Thermal response and other electrical measurements as specified.		
Subgroup 5			22 devices c = 0	12 devices, c = 0
Accelerated steady-state operation life		Bias conditions as specified.		
Eutectic die attached semiconductors	1027	T_J = +275°C minimum (for 96 hours minimum)		
Soft solder die attached power semiconductors	1027	T_J = +225°C minimum (for 168 hours minimum)		
Electrical measurements		As specified		

See footnotes at end of table.

APPENDIX E

TABLE VIa. Group B inspections for JANS devices - Continued.

Inspections	MIL-STD-750 method	MIL-STD-750 condition	Qualification and large lot quality conformance inspection sample plan	Small lot CI n/c
Subgroup 5 - Continued				
Schottky diodes	1038	T_J = rated T_J maximum (for 240 hours minimum)		
Electrical measurements		As specified		
Accelerated steady-state reverse bias power MOSFETS	1042	Condition A, V_{DS} = rated, T_A = +175°C, t = 120 hours and as specified		
Electrical measurements		As specified		
Accelerated steady-state gate stress power MOSFETS	1042	Condition B, V_{GS} = rated, T_A = +175°C, t = 24 hours		
Electrical measurements		As specified		
Bond strength (Al-Au die-interconnect only)	2037	As specified. Bond strength samples shall have passed accelerated steady-state operation life.	20 wires c = 0	20 wires, c = 0
Subgroup 6			22 devices c = 0	8 devices c = 0
Thermal resistance		As specified.		
Diodes	3101			
Transistors (bipolar)	3131			
Transistors (POWERFETS)	3161			
Thyristors	3181			
IGBT	3103			
GaAs FET	3104			

1/ Electrical reject devices from the same inspection lot, may be used for all subgroups, when electrical end-point measurements are not required. Other non-catastrophic rejected devices (i.e., PIND, X-ray) may be utilized for all subgroups. For subgroups with end-point measurements, the devices shall be screened to table IV through block 13.

2/ Non-transparent glass encased double plug noncavity axial lead diodes only may use method 2068 in lieu of 1071.

3/ Verification of metallurgical bond as defined in appendix A in its entirety shall be documented.

4/ This test may be performed at any time prior to lot formation.

APPENDIX E

TABLE VIb. Group B inspections for JAN, JANTX, and JANTXV devices.

Inspections	MIL-STD-750		Sample plan	Small lot quality conformance inspection n/c
	Method	Condition		
Subgroup 1 1/			15 leads c = 0	4 leads c = 0
Solderability	2026	Separate samples may be used for each test. The sample plan applies to the number of leads inspected. A minimum of 3 devices shall be tested.		
Resistance to solvents	1022	Not required if marking is etched into the device		
Subgroup 2			22 devices c = 0	6 devices c = 0
Temperature cycling (air-to-air) except for axial lead glass diode	1051	No dwell is required at +25°C. Test condition C, or maximum storage temperature whichever is less, (45 cycles, including screening)		
Thermal shock (liquid-to-liquid) (For axial lead glass diodes only)	1056	10 cycles, condition A		
Surge	4066	As specified.		
Hermetic seal 2/				
a. Fine leak	1071	Not required for double plug diode. Test condition G or H, maximum leak rate = 5×10^{-8} atm cc/s, except 5×10^{-7} atm cc/s for devices with internal cavity > 0.3 cc. Maximum leak rate = 5×10^{-6} atm cc/s for cavities 3-40 cc		
b. Gross leak				
Electrical measurements 3/		As specified.		
Subgroup 3 4/			45 devices c = 0	12 devices c = 0
Steady-state-operation life or intermittent operation life 5/	1027 1037 1042	Bias conditions as specified, 340 hours (minimum) 2,000 cycles (minimum) Condition D, 2,000 cycles (minimum)		
Electrical measurements		As specified.		
Bond strength (wire or clip bonded devices only)	2037	The sample shall include a minimum of 3 devices and shall include all wire sizes.	11 wires c = 0	11 wires c = 0

See footnotes at end of table.

APPENDIX E

TABLE VIb. Group B inspections for JAN, JANTX, and JANTXV devices - Continued.

Inspections	MIL-STD-750		Sample plan	Small lot quality conformance inspection n/c
	Method	Condition		
Subgroup 4 1/			1 device c = 0	1 device c = 0
Decap internal visual (design verification)	2075	Visual criteria in accordance with qualified design.		
SEM (when specified)	2077		6 devices c = 0	6 devices c = 0
Subgroup 5			15 devices c = 0	6 devices c = 0
Thermal resistance:		As specified. Thermal resistance may be performed on group E frequency whenever 100 percent thermal impedance is performed.		
Diodes	3101 or 4081			
Transistors (bipolar)	3131			
Transistors (POWERFETS)	3161			
Thyristors	3181			
IGBT	3103			
GaAs FET	3104			
Subgroup 6 6/			32 devices c = 0	12 devices c = 0
High-temperature life (nonoperating)	1032	340 hours minimum, $T_{STG(max)} = T_A$		
Electrical measurements		As specified.		

1/ Electrical reject devices from the same inspection lot, may be used for all subgroups when electrical end-point measurements are not required. Other non-catastrophic rejected devices (i.e., PIND, X-ray) may be utilized for all subgroups. For subgroups with end-point measurements, the devices shall be screened to table IV through block 13.

2/ Non-transparent glass encased double plug noncavity axial lead diodes only may use method 2068 in lieu of 1071. This test may be performed after electrical measurements.

3/ Unless otherwise specified, omit delta parameters limits for low current gain (h_{fe}) and leakage measurements included in end-point measurements.

4/ If a given inspection lot undergoing group B inspection has been selected to satisfy group C inspection requirements, the 340-hour or 2,000 cycle life tests may be continued on test to 1,000 hours or 6,000 cycles, as applicable, in order to satisfy the group C life test requirements and bond pull may be performed after group C life test. End-point measurements shall be performed or either group B, subgroup 3 (340 hours or 2,000 cycles, as applicable) to satisfy group B lot acceptance or group C, subgroup 6 (1,000 hours or 6,000 cycles, as applicable) to satisfy group B and C lot acceptance. If group B, subgroup 3, is to be continued to group C, bond strength test may be performed after group C, subgroup 6.

5/ Intermittent operation life shall be performed on all case mounted devices.

6/ Not required for power MOSFETs.

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TABLE VII. Group C periodic inspections (all quality levels).

Inspections	MIL-STD-750		Sample plan	Small lot quality conformance inspection n/c
	Method	Condition		
Subgroup 1			15 devices c = 0	6 devices c = 0
Physical dimensions 1/ (Not required for JANS)	2066	Dimensions in accordance with case outline specified in MIL-STD-1835 and associated specifications.		
Subgroup 2			22 devices c = 0	6 devices c = 0
Thermal shock (glass strain)	1056	Test condition A, except test condition B for devices with power rating of > 10 watts at T_C = +25°C.		
Terminal strength	2036	As specified.		
Hermetic seal 2/				
a. Fine leak	1071	Not required for double plug diodes. Test condition G or H, maximum, leak rate = 5×10^{-8} atm cc/s, except 5×10^{-7} atm cc/s for devices with internal cavity > 0.3 cc. Maximum leak rate = 5×10^{-6} atm cc/s for cavities 3-40 cc.		
b. Gross leak				
Moisture resistance	1021	Omit initial conditioning.		
Electrical measurements		As specified.		
Subgroup 3		Not required for disc packages or metallurgically bonded double plug devices, or stud packaged devices.	22 devices c = 0	6 devices c = 0
Shock	2016	Nonoperating, 1500 g's, 0.5 ms, 5 blows in each orientation: X1, Y1, and Z1 (Y1 only for axial glass diodes).		
Vibration, variable frequency	2056			
Constant acceleration 3/	2006	1 minute minimum in each orientation, X1, Y1, and Z1 at 20,000 g's minimum, except at 10,000 g's minimum for devices with power rating of ≥ 15 watts. T_C = +25°C.		
Electrical measurements		As specified.		

See footnotes at the end of table.

APPENDIX E

TABLE VII. Group C periodic inspections (all quality levels) - Continued.

Inspections	MIL-STD-750		Sampling plan	Small lot quality conformance inspection n/c
	Method	Condition		
Subgroup 4			15 devices c = 0	6 devices c = 0
Salt atmosphere (corrosion) 1/	1041			
Subgroup 5				
Not applicable				
Subgroup 6 4/ 5/ 6/		Not required for disc packages.	22 devices c = 0	12 devices c = 0
Steady-state-operation life or	1026	1,000 hours minimum at maximum operating junction temperature		
Intermittent operation life or	1037	6,000 cycles minimum		
Blocking life	1042 1048	Conditions D, 6,000 cycles minimum		
Electrical measurements		As specified.		

1/ Electrical reject devices from the same inspection lot, may be used for all subgroups when electrical end-point measurements are not required. Other non-catastrophic rejected devices (i.e., PIND, X-ray) may be utilized for all subgroups. For subgroups with end-point measurements, the devices shall be screened to table IV through block 13.

2/ Non-transparent glass encased double plug noncavity axial lead diodes only may use method 2068 in lieu of 1071. This test may be performed after electrical measurements.

3/ Not applicable to any devices with external and internal pressure contacts (die to electrical contacts), optional coupled isolators, and double plug diodes.

4/ If a given inspection lot undergoing group B inspection has been selected to satisfy group C inspection requirements, the 340-hour or 2,000 cycles life tests may be continued on test to 1,000 hours or 6,000 cycles, as applicable, in order to satisfy the group C life test requirements. End-point measurements shall be performed on either table VIa, group B, subgroup 4, or table VIb group B, subgroup 3 (340 hours or 2,000 cycles, as applicable) to satisfy group B (table IVa or table IVb) lot acceptance or group C, subgroup 6 (1,000 hours or 6,000 cycles, as applicable) to satisfy group B and C lot acceptance.

5/ Intermittent operation life shall be performed on all case mounted devices.

6/ The sample size may be increased and the test time decreased so long as the devices are stressed for a total of 22,000 device hours minimum, and the actual time or test is at least 340 hours.

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TABLE VIII. Group D (RHA tests). 1/

Test	MIL-STD-750		JANS		JANTXV	
	Method	Condition	Quantity/ accept number	Notes	Quantity/ accept number	Notes
Subgroup 1 2/						
Neutron irradiation	1017	+25°C				
a. Qualification			(a) 11(0)	3/	(a) 11(0)	4/
b. CI			(b) 11(0)	3/	(b) 11(0)	4/
End-point electrical parameters		As specified in accordance with associated specification.				
Subgroup 2 5/						
Steady-state total dose irradiation	1019	+25°C Maximum supply voltage.				
a. Qualification			(a) 4(0) 2(0) 1(0)	(a) 6/ 8/ 9/	(a) 11(0)	7/
b. CI			(b) 4(0) 2(0) 1(0)	(b) 6/ 8/ 9/	(b) 11(0)	7/
End-point electrical parameters		As specified in accordance with associated specification.				
Subgroup 3 10/						
Power transistor electrical dose rate test	3478	+25°C	11(0)	3/	11(0)	4/
End-point electrical parameters		As specified in accordance with associated specification.				

1/ Parts used for one subgroup test may not be used for other subgroups but may be used for higher levels in the same subgroup. Unless testing is performed within the time limits of the test method, total exposure shall not be considered cumulative. Group D tests may be performed prior to device screening (see E.6.1.10).

2/ Unless by design, waive neutron tests for MOS devices, bipolar elements are an integral part of the device function.

3/ In accordance with wafer lot. If one part fails, seven additional parts may be added to the test sample with no additional failures allowed, 18 devices, c = 1.

4/ In accordance with inspection lot. If one part fails, seven additional parts may be added to the test sample with no additional failures allowed, 18 devices, c = 1.

5/ JANTXV devices shall be inspected using either the JANTXV quantity/accept number criteria as specified, or by using the JANS criteria on each wafer.

6/ For device types with greater than or equal to 4,000 die per wafer, selected from a random location on the wafers.

7/ In accordance with inspection lot. If one part fails, 16 additional parts may be added to the test sample with no additional failures allowed, 27 devices, c = 1. For devices which require more than one bias, the sample size shall be 11(0) for each bias.

8/ For device types with less than or equal to 4,000 die per wafer, selected from a random location on the wafer.

9/ For device types with less than or equal to 500 die per wafer, selected from a random location on the wafers.

10/ Upset testing during qualification on first CI shall be conducted when specified in purchase order or contract. When specified, the same devices may be tested in more than one subgroup.

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TABLE IX. Group E inspections (all quality levels) for qualification only.

Inspections	MIL-STD-750		Sampling plan
	Method	Condition	
Subgroup 1			
Thermal shock or Electrical measurements	1056	100 cycles or as specified	As specified
Temperature cycling Electrical measurements	1051	500 cycles minimum or as specified.	
Subgroup 2		As specified.	
Intermittent operating life	1037		As specified
Life test Electrical measurements or	1042		
Steady-state operating life Electrical measurements or	1026		
Blocking life Electrical measurements	1048		
Subgroup 3 As specified		As specified.	As specified
Destructive physical analysis	2101 2102		
Subgroup 4		As specified.	22 devices c = 0
Thermal resistance			
Transistors,			
POWERFETs	3161		
Bipolar	3131		
Diodes	3101 or 4081		
IGBT	3103		
GaAs FET	3104		
Subgroup 5		As specified.	15 devices c = 0
Barometric pressure (reduced) (required only on all devices with rated voltage > 200 V)	1001		

TABLE X. Data guidance for JANS devices.

Data	
Wafer lot acceptance (see E.3.2.3)	1. SEM photographs (when applicable)
Screening (see E.5.)	2. Electrical data
	3. Radiographs
	4. Screening data
Quality conformance (see E.6.)	5. Electrical data
	6. SEM photographs (when applicable)
	7. Bond pull limits (when applicable)
	8. Lot rejection report
	9. CI data (groups A, B, C, and D)

APPENDIX F

CERTIFICATION REQUIREMENTS FOR RADIATION HARDNESS
ASSURED SEMICONDUCTOR DEVICES

F.1 SCOPE

F.1.1 Scope. This appendix presents the requirements for line certification of radiation hardness assured (RHA) semiconductor devices. Compliance with this appendix is not mandatory. However, manufacturers must demonstrate to the qualifying activity a system that achieves at least the same level of quality as could be achieved by complying with this appendix.

F.2 APPLICABLE DOCUMENT. This section is not applicable to this appendix.

F.2.1 General. The documents listed in this section are specified in sections F.3 and F.4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections F.3 and F.4 of this specification, whether or not they are listed.

F.2.2 Government documents.

F.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.1).

HANDBOOKS

DEPARTMENT OF DEFENSE

MIL-HDBK-279 - Total Dose Hardness Assurance Guidelines for Semiconductor Devices.
MIL-HDBK-280 - Neutron Radiation Hardness Assurance Guidelines for Semiconductor Devices and Mircrcircuits.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

F.2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications, specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

F.3 RADIATION HARDNESS PROGRAM

F.3.1 RHA program. The manufacturer shall establish, implement, and maintain a RHA assurance program. The program shall demonstrate and assure that design, manufacture, inspection, and testing of semiconductor devices are adequate to assure compliance with standard, reference documents, and the associated specification for RHA devices. If radiation testing is conducted outside of the manufacturer's facility, it shall be the responsibility of the manufacturer to assure that radiation testing and the associated documents follow the requirements specified herein.

The RHA tasks include but are not limited to:

a. Designation of a RHA manager or a project engineer.

b. Development of a RHA program plan.

c. Development of the RHA design, processing, assembly, testing, and inspection requirements.

d. Development of RHA records.

F.3.2 RHA management. The manufacturer shall identify a person or persons whose responsibility is to implement, control, and coordinate all activities associated with the manufacturing of RHA semiconductor devices.

F.3.3 RHA program plan. The manufacturer shall develop and document a RHA program plan for semiconductor devices which details the tasks to be performed and identifies responsibilities for assuring the tasks are carried out. The program plan shall contain, as a minimum these items:

a. Definition of the responsibilities of the RHA management.

b. Identification of RHA critical factors in design, layout, wafer processing, and assembly of the semiconductor devices.

c. Preparation of manufacturing flow charts showing electrical and radiation testing, quality verification points, and all the documents associated with RHA.

d. Preparation of detailed radiation test procedures to meet the specified RHA requirements.

e. RHA records to be maintained.

F.3.4 RHA design, processing, assembly, testing, and equipment instructions. Device design, processing, assembly, testing, and equipment related to RHA shall include the following items as applicable.

a. Critical layout rules.

b. Circuit design factors.

c. Critical processes.

d. Assembly, packaging, and handling critical to radiation hardness.

F.3.5 Change control, quality control, training, and calibration instructions for RHA. The manufacturer shall have in effect documented instructions covering as a minimum these areas:

a. Procedure for implementation and control of changes in device design, material, and processing which may affect hardness of the device and for making the information available to the certifying activity.

b. RHA quality control and verification operations related to procedures, equipment, action criteria, records, and frequency of use.

c. Training and certification of personnel engaged in radiation testing.

d. The calibration and maintenance procedures of radiation facilities, dosimetry, and equipment used in radiation testing.

e. Traceability of radiation dosimetric devices to National Institute of Standards and Technology (NIST).

F.3.6 Radiation test procedure. The manufacturer shall document a detailed radiation test procedure which complies with the radiation requirements in accordance with group D of MIL-PRF-19500, and in accordance with associated specifications. Guidelines on radiation testing are provided in MIL-HDBK-279 and MIL-HDBK-280.

F.3.6.1 Ionizing radiation test procedure. Ionizing radiation test procedure shall be conducted in accordance with test method 1019 of MIL-STD-750. The procedure shall include:

a. Assembly of the dice using the same procedure of die attach, wire bonding, and packaging method specified for the certified line. The manufacturer shall have available procedures for qualifying each package type.

b. Conducting pre- and post-electrical test in accordance with the associated specification using a certified test program.

c. The manufacturer shall maintain a table or graph showing a monthly correction for the Cobalt-60 source decay and the radiation time required to achieve the specified total dose at the device location. The calibration of the source should be traceable to the NIST.

F.3.6.2 Neutron irradiation test procedure. Neutron irradiation test procedure shall follow the requirements in test method 1017 of MIL-STD-750.

F.3.7 RHA records. The RHA records listed below shall be maintained and be submitted upon request for the review by the certification audit team. Those records shall be retained for a minimum of five years after performance of the inspection. As a minimum, the following records shall be maintained:

a. Records of radiation testing on wafer and wafer lot for JANS or inspection lot for JANTX and JANTXV. The records shall include the information on the test procedure and test results as specified in test methods 1017 and 1019 of MIL-STD-750.

b. Records of failed devices shall identify the device type, the wafer and the wafer lot for JANS or inspection lot for JANTX and JANTXV, and the disposition of the parts. The failed devices shall be data logged and this log shall be made available to the audit team.

c. The manufacturer shall document his RHA control procedure. As a minimum, group D for MIL-PRF-19500 post irradiation electrical parameter shall be read and recorded every six months on representative product from the certified line.

d. Records shall document the initial design, material, processing, and assembly and all changes affecting the hardness of the semiconductor device. Letters of approval by the qualifying activity to the above changes shall be maintained.

e. Records shall cover the scheduled calibration interval for each equipment item, the dates of completion of actual calibration and certification.

f. A traceability system shall be maintained such that RHA semiconductor devices can be traced to a specific wafer for JANS and inspection lot for JANTX and JANTXV, as applicable.

g. Records of personnel training.

F.3.8 Marking. The manufacturer shall show the procedure which assures that only those parts from the wafer for JANS, or from the inspection lot for JANTX and JANTXV which passed the specified radiation level, are marked by the corresponding RHA letter designator.

F.4 RADIATION HARDNESS ASSURANCE PART MANAGER PROGRAM

F.4.1 Radiation hardness assurance part manager (RHAPM). An RHAPM is a certified company (e.g., original equipment manufacturer (OEM)) who establishes a relationship with a component manufacturer for the sole purpose of developing RHA semiconductors and has the responsibility to ensure compliancy of all manufacturing and testing procedures. The certified company shall be listed on the QPL as the manufacturer for the semiconductor device specified. The RHAPM is responsible for setting up a control system to ensure all requirements of the general and associated device specifications are met.

F.4.1.1 Eligibility of participants. To be eligible to qualify a RHA part, a specification for the part must exist. Associated specifications are controlled and modified by the preparing activity. Participants shall be certified on the basis of a facilities survey.

F.4.1.1.1 Preparation of the associated device specification. After the parts selection and prior to a third party agreement with a device manufacturer, the RHAPM must notify the preparing activity of their intent and request that an associated device specification number be assigned. This can be accomplished in writing or by submitting a DD Form 2052 Non-standard Parts Approval Request through the Military Parts Control Advisory Group (MPCAG). In the justification section of this form the RHAPM will indicate a willingness to prepare the associated specification. After the applicable parts control procedures have been followed, the preparing activity will assign a JAN associated specification number or revision letter. The RHAPM will prepare the preliminary draft and submit it to the preparing activity. This preliminary draft does not have to be complete. It may have blank tables, figures, and it may be group D only, but it must be in the correct JAN associated device specification format. A copy of this format is available from any of the technology representatives within the preparing activity (see figure 6).

F.4.1.1.2 Participants preparation for certification. All participants shall comply with the RHAPM management plan and all applicable requirements as specified in sections 3 and 4 of MIL-PRF-19500K, and F.4.3.1 herein. Qualification of RHA devices shall comply with the provisions in appendix E. CI shall comply with the provisions of appendix E and F.4.3.1.

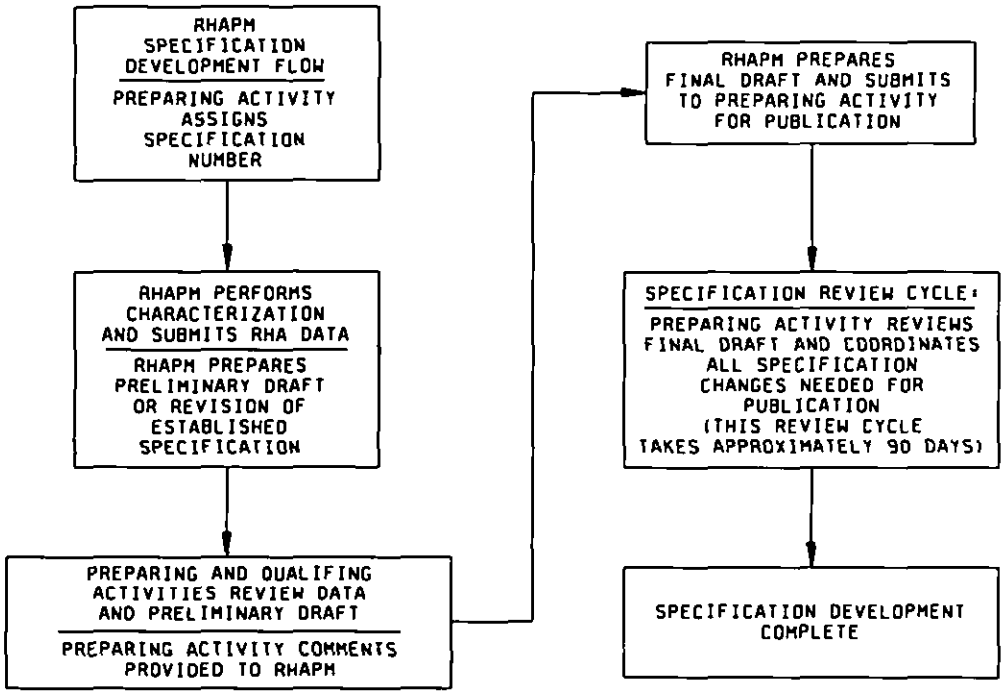


FIGURE 6. Specification development flow.

F.4.2 RHAPM verification requirements. The RHAPM verification program shall assure that the design, processing, assembly, inspection and testing of semiconductor devices comply with this specification and the applicable associated specification. This program shall not require ownership of all manufacturing and testing facilities and establishes additional requirements for the sole purpose of developing a standard RHA product. As a minimum the RHAPM shall document the relationship as follows:

a. Individual responsibilities.

b. Product reliability.

c. Product quality.

d. Traceability.

e. Individual liability.

f. Data support.

g. Part marking.

h. Lot integrity of RHA product.

i. Testing (e.g., certified and qualified to MIL-PRF-19500).

A RHAPM must maintain an active working relationship with the device manufacturer, the preparing and qualifying activities, and the Systems Program Office (SPO). These relationships will constitute a partnership between the RHAPM, the device manufacturer, and the Government to insure the availability of high reliable standard RHA product to be used in more than one Department of Defense (DoD) system.

F.4.2.1 Management review. The RHAPM verification program shall be reviewed at appropriate intervals by responsible management to ensure RHA performance, product reliability, and the effectiveness of the established program. Records of management review shall be maintained covering the following minimum areas:

a. RHA design (when needed).

b. RHA baselines.

c. RHA characterization.

d. Process change control.

e. RHA testing (MIL-STD-750 test methods).

f. RHA Test laboratory suitability (qualifying activity).

g. Development of associated device specifications (preparing activity).

F.4.2.2 Management plan. The management plan shall be established in accordance with appendix D and submitted to the qualifying activity prior to a survey. It shall serve as a basis to demonstrate to the qualifying activity that the RHAPM has an understanding of a complete RHA verification program. The management plan, as exemplified by its documentation system, is adequate to assure compliance with the applicable specifications and quality standards. The management plan shall contain, as a minimum, these items and they shall be available for review at all sites:

a. Functional block diagrams.

b. Manufacturing flow charts by technology.

c. Examples of documentation as required by F.4.2.

d. Examples of records as required by F.4.2.

e. Examples of internal and device manufacturer audit activities.

f. Examples of ppm/spc monitoring.

F.4.3 Certification requirements. Only RHAPM certified companies may develop RHA products and be listed on part II of the QPL (QPL-19500).

F.4.3.1 RHAPM certification. Before an OEM can be considered as a RHAPM, he must demonstrate the capability to control and manage radiation hardened product. This can be accomplished through a pre-certification review and certification audit (see figure 7).

F.4.3.1.1 Pre-certification review. The pre-certification review of the OEM's management plan shall address the following:

a. The interface between the RHAPM and the third parties.

b. The availability of RHA product to other programs.

c. Methods for acquisition, storage, and delivery.

Upon completion of this review the OEM shall receive an authorization to pursue certification as a RHAPM. After receiving authorization the potential RHAPM has one year to establish a qualification plan and develop third party relationships with subcontractors.

F.4.3.1.2 RHAPM certification and laboratory suitability. After the third party relationships have been established the qualifying activity must be notified and qualification milestones, certifications, and laboratory suitabilities, must be established. Laboratory suitability shall be obtained from the qualifying activity for all facilities designated to perform RHA characterization and CI. A list of laboratories being used shall be submitted to the qualifying activity. It will be the responsibility of the RHAPM to insure each RHA test facility maintains suitability. The RHAPM will be responsible for the CI. CI shall be part of the RHA baseline and shall be performed as specified in the general and associated specifications.

F.4.3.1.2.1 Characterization. The RHAPM must be responsible for the performance of all RHA characterization. This includes all known and testable radiation effects. As a minimum characterization shall include the following test methods:

a. Neutron Irradiation (MIL-STD-750, test method 1017).

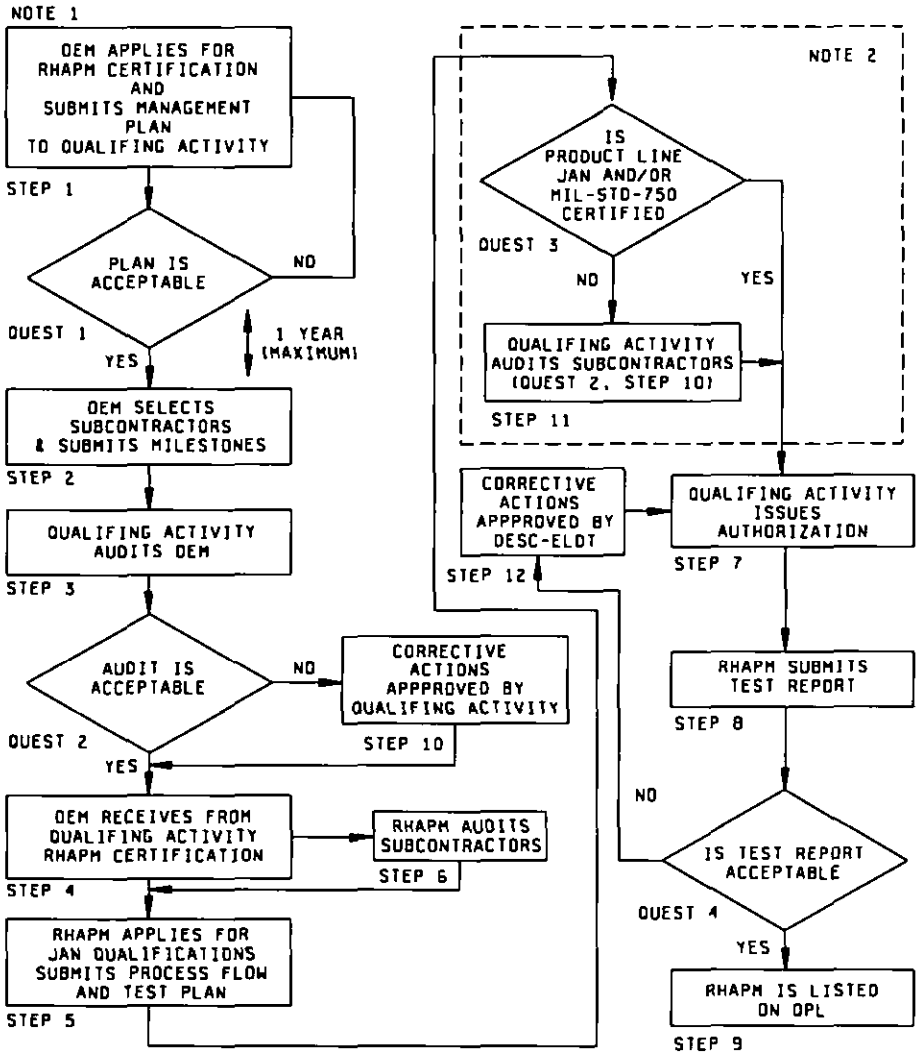
b. Ionizing Radiation (MIL-STD-750, TOTAL DOSE test method 1019).

c. Dose Rate Burnout (MIL-STD-750, test method 3478).

d. Single Event Effects - Gate Rupture.

All characterization shall be to the device capability (not the system capability) under worst case conditions for the device technology and design. Data will be to functional failure or to a level of irradiation which best represents the product capability. From this data, endpoint electrical parameter limits shall be established. The associated device specification shall represent these limits in the appropriate test tables.

F.4.3.1.2.2 Baselines. The RHAPM shall establish the RHA baseline and insure the device manufacturer maintains the manufacturing controls in accordance with this baseline. Any changes to the baseline must be coordinated through the RHAPM and reported to the qualifying activity.



NOTES:

1. The product development flow is as follows:

   Step 1. OEM applies for certification as a RHAPM. At this point the qualifying activity will request a management plan (see F.4.2.2) be formulated and presented to the certifying activity (preparing and qualifying activities).

FIGURE 7. Product development flow.

NOTES - Continued

Question 1. The certifying activity will review the management plan. When all problem areas have been resolved the OEM may be considered as a potential RHAPM. Upon acceptance of the management plan the potential RHAPM will have up to 1 year to accomplish step 2 herein.

Step 2. The potential RHAPM establishes relationships with subcontractors and submits a detailed outline of these relationships (see F.4.1.1.2) to the certifying activity for review. This outline must include qualification milestones.

Step 3. The certifying activity reviews potential RHAPM's verification program, management plan and verifies by auditing the potential RHAPM's procedures to insure compliance to MIL-PRF-19500 and all of appendix F.

Question 2. After reviewing all audit data the certifying activity will issue RHAPM certification. If there are any unresolved issues step 10 must be completed before certification can be issued.

Step 4. The qualifying activity issues RHAPM certification (see F.4.3). The RHAPM's management plan is implemented.

Step 5. Product line, RHA characterization, lab and device manufacturer are selected. The RHAPM is responsible for maintaining compliance to MIL-STD-750 and MIL-PRF-19500 by it's subcontractors. It is also the RHAPM's responsibility to insure that it's subcontractors procedures and documentation meet the baseline established within the RHAPM's management plan (see F.4.2 and F.4.3).

Step 6. RHAPM will prepare preliminary draft specifications for submission to the preparing activity. After the associated device specification has been approved and dated the RHAPM applies for device qualification (see F.4.1.1.1 and figure 6). This application must include a process flow and test report.

Question 3. Before an authorization (step 7) can be issued all device fabrication and assembly must be JAN or MIL-STD-750 certified and all test facilities must have received suitability from the qualifying activity. If not Step 11 must be completed.

Step 7. The qualifying activity issues authorization. The qualification test notification outlines the product to be tested, testing to be performed, sample sizes, and test locations.

Step 8. The qualification data test report is submitted to the qualifying activity for evaluation and review.

Question 4. If all qualification data is in accordance with MIL-PRF-19500, the associated device specification, and the RHAPM's management plan QPL listing is authorized. If not Step 12 must be completed.

Step 9. The RHAPM is listed in the MIL-PRF-19500 QPL as the source of supply for the JAN RHA device.

Steps 10 and 12. If questions 2 and 4 are "NO", the qualifying activity will evaluate proposed correction actions. These corrective actions must be implemented and approved before the next step can be accomplished.

Step 11. All subcontractors must be certified or have received from the qualifying activity laboratory suitability (see F.4.3). If the answer to Question 3 is "NO", the qualifying activity must perform an audit of the facility in question. Any deficiencies requiring corrective action must be implemented and approved prior to granting manufacturer certification or laboratory suitability (see question 2 and step 10).

2. Question 3 may be answered at any time within the certification process, but if the answer is "NO" step 11, question 2 and step 10 must be accomplished before qualification testing can be authorized.

FIGURE 7. Product development flow - Continued.

F.4.3.1.2.3 QPL. In order to be listed as a source, on the QPL, the RHAPM must receive from the qualifying activity the following:

a. Certification: wafer fabrication, assembly, and test.

b. Suitability: test laboratories and radiation facilities.

F.4.3.1.3 Retention for RHAPM. This listing requires that the RHAPM shall maintain the following documentation:

a. Annual retention reports.

b. Self-audits.

c. Annual recertification/resuitability (class S).

APPENDIX G

DISCRETE SEMICONDUCTOR DIE/CHIP LOT ACCEPTANCE

G.1 SCOPE

G.1.1 Scope. The purpose of this appendix is to establish minimum standards for screening, qualification, and sample testing of JANHC and JANKC unencapsulated discrete semiconductor devices (die/chips) for use in semiconductor devices. Except for chips qualified under the provisions of E.4.3.2, JANHC and JANKC qualification is only valid if the manufacturer maintains QPL status for the packaged device. The QPL program measures and evaluates the manufacturer's manufacturing process against a baseline for that process. This baseline can include innovative and improved processes that result in an equivalent or higher quality product, provided that the process used to evaluate and document these changes have been reviewed and approved. Changes to the process baseline can be made by the manufacturer after achieving approval with documented reliability and quality data. The approach outlined in this appendix is a proven baseline which contains details of the standard die verification. This appendix is not mandatory. However, manufacturers must demonstrate to the preparing activity and qualifying activity a process control system that achieves at least the same level of quality as could be achieved by complying with this appendix.

G.2 APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

G.3 DEFINITIONS

G.3.1 Definitions.

G.3.1.1 Date code. Seal week of the CI packaged samples.

G.3.1.2 Die/chips. Unencapsulated discrete semiconductors. The term chip is interchangeable with the term die.

G.3.1.3 Manufacturer. Original wafer fabricator.

G.3.1.4 Identification. See 1.3 for identification.

G.3.1.5 Wafer lot. A wafer lot shall consist of only semiconductor wafers subjected to each and every process step such as masking, etching, deposition, diffusion, or metallization as a group. Each wafer lot shall be assigned a unique identifier which provides traceability to all wafer processing steps. If any portion of the lot is subjected to rework of masking, etching, deposition, diffusion, or related processes, that portion shall be re-identified with a different wafer lot number with identification maintained back to the original lot. Wafer lot records shall identify all JANHC and JANKC device inspection lots formed from the wafer lot.

G.3.1.6 Inspection lot. An inspection lot shall consist of all dice from a single wafer lot which are submitted for CI at one time (see appendix E). The inspection lot may consist of a collection of sublots of different PINs. Only one CI is required for each inspection lot, but each sublot must meet the requirements of table XI, step 1 for JANHC and table XII, step 1 for JANKC.

G.4 REQUIREMENTS (for general flow, see figure 8).

G.4.1 General. Semiconductor die shall conform to the requirements contained herein.

G.4.2 Screening. Semiconductor die shall be 100 percent screened in accordance with G.5.2 prior to qualification, CI, and shipment.

G.4.3 Qualification. Qualification must be performed by the original wafer manufacturer. JANHC qualification will only be granted to a manufacturer who has a MIL-PRF-19500 qualified facility. JANKC qualifications will only be granted to a manufacturer who has been MIL-PRF-19500 qualified to manufacture JANS products.

G.4.3.1 Qualification requirements. Manufacturers who are on the QPL for a JANTX or higher level for a PIN will be granted qualification for the JANHC chip of the same PIN upon successful completion of CI on the first lot of JANHC devices. Manufacturers who are on the QPL for the JANS packaged devices, will be granted qualification to the JANKC and JANHC of the same PIN upon completion of CI on the first lot of JANKC devices.

G.4.3.2 Alternate qualification requirements. Manufacturers who are not on the QPL for the packaged device, but are JANS qualified, will be granted qualification of a JANHC or JANKC part when the requirements of G.4.3.2a through G.4.3.2f are met.

a. The manufacturer must have QPL on a device of similar function and technology. For the purpose of this specification, examples of functions are: signal transistor, zener diode, power transistor, darlington, transient suppressor, or their identifiable circuit function. The term technology will include: DMOS, VMOS, diffused junction, alloy junction, JFET, and all other pertinent technological descriptions of the device critical interface.

b. Qualification testing for JANHC shall consist of CI testing in accordance with table XI and periodic testing as required by G.5.3.5 and table XIII.

c. Qualification testing for JANKC shall consist of CI testing in accordance with table XII and table XIII.

d. Sample devices to be tested for qualification under this option will be assembled in packages which are thermally equivalent to the device package shown on the applicable associated specification.

e. The die are manufactured on JANS qualified wafer fab line.

f. Manufacturers seeking qualification under this option shall submit a design and construction form to the qualifying activity showing the die/package combination which is proposed for qualification and CI testing and data substantiating compliance with the requirements of G.4.3.2a and G.4.3.2d above.

G.4.4 Verification provisions. CI shall be performed on each inspection lot subsequent to qualification.

G.4.4.1 JANHC and JANKC assembly. When a portion of a wafer lot intended for JANHC is assembled, tested, and accepted through CI as JANTX or higher devices, the remainder of the wafer lot shall be qualified for JANHC without further CI testing. When a portion of a wafer lot intended for JANKC is assembled, tested, and accepted through CI as JANS devices, the remainder of the wafer lot shall be qualified for JANKC without further CI testing. This applies only if the following conditions are met: All PDA requirements of table IV, step 11, and step 13a were met on the first submission; the group A sample plan of subgroups 2, 3, and 4 passed on the first submission; the JANC die is identical to the packaged die in all respects; and the assembled lot contains only dice from the JANHC or JANKC intended wafer lot. While awaiting the results of the assembled CI lot, the remaining portion of the wafer lot intended for JANHC or JANKC shall be stored in accordance with G.5.4.

G.4.4.2 Alternate flow. When no dice from a JANHC or JANKC inspection lot are assembled as JAN branded packaged devices, or the JANHC and JANKC dice are configured differently from the dice in the JAN branded packaged devices (e.g., different metallization), then CI of the JANHC and JANKC inspection lot in accordance with G.5.3 is required.

G.4.4.3 JANHC multiple sublots. When the JANHC die lot is divided into multiple sublots which differ only in the metallization schemes, samples from all sublots must conform to step 1 of table XI and G.5.3.2 through G.5.3.4 herein. Conformance to the requirements of G.5.3 herein may be demonstrated with a sample from a single sublot.

G.4.5 Performance characteristics. The electrical performance characteristics of semiconductor die shall be as specified in the associated specification.

G.4.6 Critical interfaces. The critical interfaces and physical dimensions of the semiconductor die shall be in accordance with the requirements of MIL-PRF-19500 and with G.4.6.1 through G.4.6.3 and shall be identical to the qualified die except that metallization may be varied to suit various bonding and die attach methods. A completed design and construction form and die topography, including dimensions, pad locations, and metallization descriptions (die map) shall be made available for inspection to the qualifying activity prior to qualification. A unique critical interface identifier as part of the PIN shall be assigned based on any of the following differences:

a. Die size, height, width, and length.

b. Bond pad size.

c. Bond pad location.

d. Bond pad metal.

e. Backside metal.

G.4.6.1 Bonding pad. The bonding pad size, location, and electrical function shall be in accordance with the applicable associated specification. Unless approved by the qualifying activity, the minimum bond pad dimensions shall be 3 mils.

G.4.6.1.1 Metallization integrity. The bonding pads shall be metallized and suitable for bonding as specified in the associated specification and shall meet the requirements of G.5.3.2.

G.4.6.2 Backing material. The backing material shall be as described in the associated specification, and meet the requirements of G.5.3.4.

G.4.6.3 Glassivation. Glassivation requirements of appendix H apply.

G.5 VERIFICATION PROVISIONS

G.5.1 General. The screening and CI (see G.4.2 and G.4.4) of semiconductor die shall be performed at a facility with MIL-STD-750 laboratory suitability for the applicable test methods.

G.5.1.1 Responsibility for inspection. The supplier shall be responsible for the performance of all inspection requirements as specified herein and in the associated specification.

G.5.1.2 Retention of records. The supplier shall maintain adequate records of all examinations, inspections, and tests accomplished in accordance with the requirements specified herein and in the associated specification. Records, including variables data, shall be retained in accordance with appendix D.

G.5.2 Screening. The die/chip screening shall be performed prior to CI of G.5.3 and shall consist of the following.

G.5.2.1 Electrical probe test. Probe tests shall be performed on 100 percent of the semiconductor die. Test limits and conditions shall be chosen by the supplier to demonstrate that there is compliance with all the electrical characteristics specified by the associated specification. This allows the supplier to assign test values or test details which differ from the associated specification requirements.

G.5.2.2 Visual inspection. All CI samples shall be visually inspected in die form prior to submittal for assembly of the quality conformance testing samples. The remainder of the inspection lot shall be 100 percent visually inspected at any time prior to shipment. All visual inspections shall be performed in accordance with the applicable methods specified in MIL-STD-750.

G.5.2.3 JANKC wafer lot inspection. For JANKC, wafer lot inspection requirements of appendix E shall apply.

G.5.3 Conformance inspection.

TABLE XI. Electrical sampling for JANHC.

Step	Inspection	Associated specification reference	Sample plan
1.	Electrical tests 1/ 2/	Group A, subgroups 2, 3, 4, and 7	n = 10, c = 0
2.	Burn-in	Step 12 of JANTX screening table	
3.	End-points 2/	Group A, subgroup 2	n = 10, c = 0

1/ MIL-PRF-19500, group A table. Group A test conditions and limits shall be as specified in the associated specification.
2/ Data from steps 1 and 3 shall be read and recorded.

TABLE XII. Electrical sampling for JANKC.

Step	Inspection	Associated specification reference (JANS)	Sample plan
1.	Electrical tests 1/ 2/	Group A, subgroups 2, 3, 4, 5, 6, and 7	n = 10, c = 0
2.	HTRB	Step 10 of screening table	
3.	DC test 2/ 3/	Step 11 of screening table	n = 10, c = 0
4.	Burn-in	Step 12 of screening table	
5.	End-points and delta calculation 2/ 3/	Step 13 of screening table	n = 10, c = 0

1/ MIL-PRF-19500, group A table. Group A test conditions and limits shall be as specified in the associated specification.
2/ Data steps 1, 3, and 5 shall be read and recorded.
3/ Deltas shall be required when specified in the screening table of the applicable associated specification.

TABLE XIII. Periodic tests and continuation of JANKC CI.

Step	Inspection	Associated specification reference	Sample plan
1-1	Temperature cycling	Group B, subgroup 3 (S level)	
1-2	Surge	Group B, subgroup 3 (S level)	
1-3	Electrical measurements	Group A, subgroups 2, 3, 4, and 7	n = 10, c = 0
2	Thermal resistance	Group B, subgroup 6	n = 10, c = 0
3-1	Operating life 1/	Step 12 of screening table. (S level) t = 1,000 hours	n = 10, c = 0
3-2	Electrical measurements at 1,000 hours	Step 13 of screening table. (S level) 2/	n = 10, c = 0

1/ Devices from step 4 of table XI may be continued to 1,000 hours to fulfill this requirement.
2/ Omit $Z_{\theta JX}$.

TABLE XIV. Storage life verification tests. 1/

Inspection
a. Electrical tests at +25°C, group A, subgroup 2, n = 10, c = 0
b. Bond pull (see G.5.3.2) 1/ n = 10, c = 0
c. Die shear (see G.5.3.4) 1/ n = 5, c = 0

1/ Separate samples may be used for steps b and c.

If the devices pass the above criteria, then the lot has passed the storage life verification tests.

G.5.3.1 Packaged sample tests. A random sample shall be selected from each inspection lot. The manufacturer may, at his option, perform evaluation of the wafer lot prior to submitting for CI. The evaluation samples may not be used for any CI requirements or test. For JANKC, at least 2 die from each wafer and at least 10 die from each wafer lot shall be selected, to build the packaged samples.

G.5.3.1.1 Pre-cap visual. A pre-cap visual inspection in accordance with the applicable methods specified in MIL-STD-750 shall be performed to remove assembly induced defects.

G.5.3.1.2 Packaged sample identification. The packaged sample shall be marked or labeled in accordance with the following priority:

a. Serial numbers, if required for delta measurement unit identification.

b. Device PIN.

c. Inspection lot number or date code.

G.5.3.1.3 Sample acceptance. The specified sample size shall be processed through the test sequence specified in table XI for JANHC and tables XII and XIII for JANKC. If the test sample fails the criteria of the applicable table, the lot shall be rejected. If a failure is attributed to packaging or handling defects, ESD, equipment malfunction, or operator error, these samples shall be verified by visual inspection or failure analysis. Upon verification of such defects, the test sample may be replaced in accordance with appendix E. In addition, all conformance inspections lots must complete the tests of G.5.3.2 through G.5.3.4.

G.5.3.2 Bond pull. Wire bond pull shall be performed according to MIL-STD-750, method 2037, condition A. Wire bond samples must have been baked to any of the conditions listed in table XV. Five devices minimum with 10 wires shall be tested with zero rejects allowed. If one reject is found, resubmittal is allowed using 10 devices minimum and 20 wires with zero rejects. Failures which are not related to the integrity of the die do not constitute failure of the lot and such failures may be replaced with additional packaged devices and resubmitted for bond pull after verification. It is permissible, but not required, to use devices from tables X and XI.

G.5.3.3 Temperature cycling. Temperature cycling shall be performed in accordance with MIL-STD-750, method 1051, condition C. Sample size shall be 10 pieces. Failure criteria shall be group A, subgroup 2, with zero rejects allowed. If one reject is found, resubmittal is allowed using double the sample size with zero rejects. Failures which are not related to the integrity of the die do not constitute failure of the lot and such failures may be replaced with additional packaged devices and resubmitted for temperature cycling after verification. It is permissible, but not required, to use devices from table XI or table XII.

G.5.3.4 Die shear. Die shear shall be performed in accordance with MIL-STD-750, method 2017, condition A. Unless the test is for table XIV verification testing, five samples that have completed table XI or table XII and temperature cycling shall be tested with zero rejects. If one reject is found, resubmittal is allowed using 10 devices with zero rejects. Assembly related failures which are not related to the integrity of the die do not constitute failure of the lot and such failures may be replaced with additional packaged devices and resubmitted for die shear after verification.

G.5.3.5 Chip qualification. Chips qualified under the optional procedure of G.4.3.2 must successfully complete the periodic testing shown in table XIII as required by appendix C. For the purpose of this appendix, the requirement stating that the devices be fully marked shall be waived and the requirements of G.5.3.1.2 herein shall apply.

G.5.3.5.1 Periodic testing. All devices tested to table XIII requirements shall have passed step 1 of table XI. Devices which have been subjected to table XI or table XII testing can be used for table XIII testing.

G.5.3.5.2 Separate samples. Separate samples may be used for test groupings 1-1 through 1-3, 2, and 3-1 through 3-2 in table XIII. Samples for each test group must be tested sequentially within the group.

G.5.4 Storage. Prior to acceptance, dice shall be stored in a dry nitrogen atmosphere. After lot acceptance, the inspection lot die may be stored in dry nitrogen or other inert atmosphere. When storage time exceeds 36 months after CI completion, a sample shall be assembled and tested as specified in table XIV. The manufacturer may submit an alternate procedure for storage of semiconductor die for approval by the qualifying agency.

G.6 PACKAGING

G.6.1 Packaging. All semiconductor die shall be packaged in individually lidded containers. For ESD sensitive devices (classes I and II) conductive or anti-static containers shall be required with an external conductive field shielding barrier. Stacking of containers without lids shall not be allowed. The supplier may submit an alternate procedure for packaging of die for approval by the using activity. Protective packaging of ESD shall be mandatory.

APPENDIX G

G.6.2 Container marking. The following information shall be marked on each container of semiconductor die:

a. Type designation.

b. Applicable specification number.

c. Manufacturer's logo or designation symbol.

d. Lot identification code.

e. Quantity.

f. ESD symbol, in accordance with 3.10.3.1.

g. Date code.

h. Verification date code (see G.6.2.1).

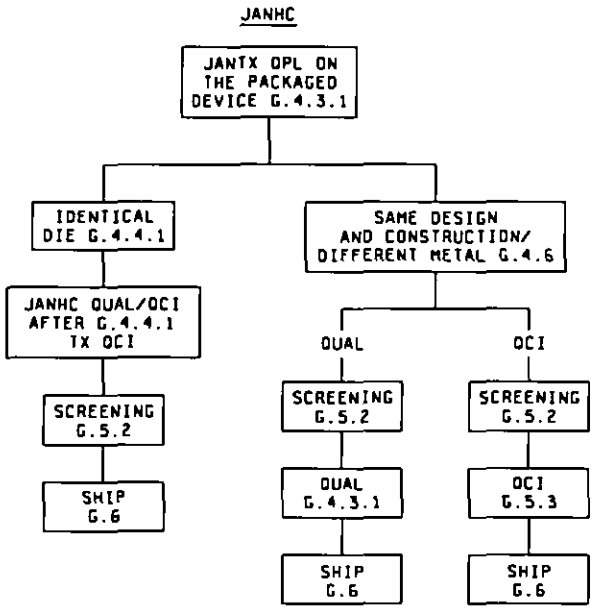
G.6.2.1 Date code for verification. Lots that had storage life verification tests in accordance with table XIV shall have a second date code identifying the date of the verification tests. This date code will be followed by the suffix letter V (identifying verification).

G.6.3 Certificate of conformance. The certificate of conformance shall be in accordance with 3.7 of MIL-PRF-19500.

TABLE XV. Age-time and temperature.

Condition	Minimal time	Temperature 1/
A	1 hour	300°C
B	2.5 hours	275°C
C	8 hours	250°C
D	25 hours	225°C
E	90 hours	200°C
F	400 hours	175°C

1/ +10°C, -5°C.



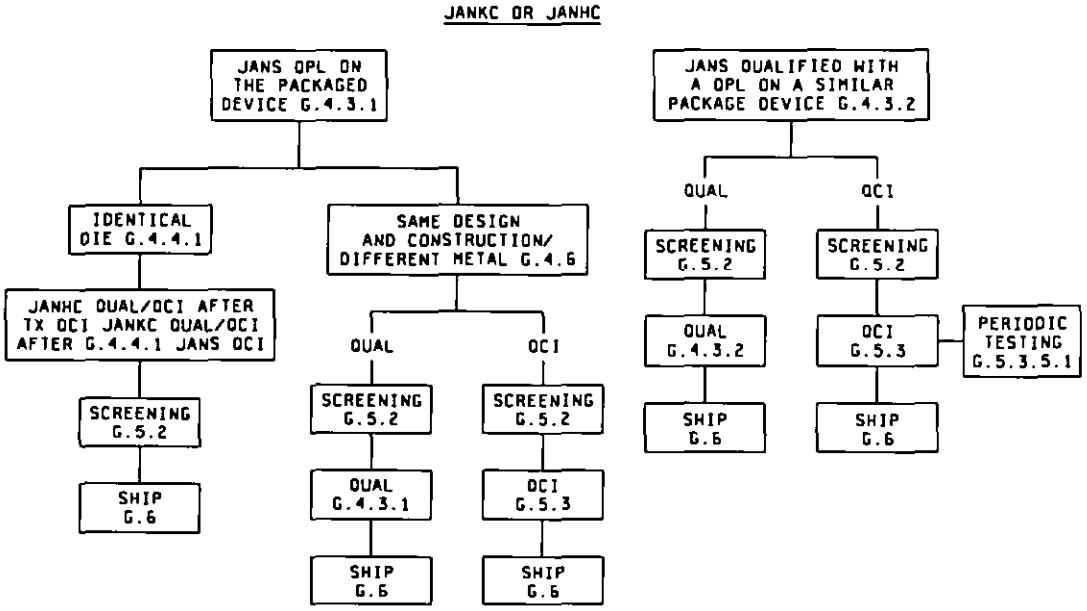


FIGURE 8. MIL-PRF-19500 appendix G flowchart.

APPENDIX H

CRITICAL INTERFACE AND MATERIALS

H.1 SCOPE

H.1.1 Scope. This appendix contains critical interface information which will assist manufacturers in producing devices which meet 3.2. The QPL program measures and evaluates the manufacturer's manufacturing process against a baseline for that process. This baseline can include innovative and improved processes that result in an equivalent or higher quality product, provided that the process used to evaluate and document these changes have been reviewed and approved by the qualifying activity. Changes to the process baseline can be made by the manufacturer after achieving approval with documented reliability and quality data. The approach outlined in this appendix is a proven baseline which contains details of critical interface criteria. This appendix is not mandatory. However manufacturers must demonstrate to the qualifying activity an equivalent system that achieves at least the same level of quality as could be achieved by complying with this appendix.

H.2 APPLICABLE DOCUMENTS

H.2.1 General. The documents listed in this section are specified in sections H.3 and H.4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections H.3 and H.4 of this specification, whether or not they are listed.

H.2.2 Government documents.

H.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.1).

STANDARDS

FEDERAL

FED-STD-H28 - Screw-Thread Standards for Federal Services.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

H.2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications, specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

H.3 CRITICAL INTERFACE AND CONSTRUCTION CRITERIA

H.3.1 Allowable alternate design, materials, and construction. Multiple device designs will be approved by the qualifying activity on a case by case basis for JAN, JANHC, JANKC, JANTX and JANTXV per manufacturer, provided appropriate identification (as a minimum) is provided to ensure traceability . For JANS devices, only one design is allowed per manufacturer, and it may differ from the design of other verification levels. For radiation hardened devices of all levels, only one design is allowed, and it may differ from the design of nonradiation hardened devices. With the approval of the qualifying activity (see D.3.4.2), design material and construction alternatives for qualified device types may be allowed only for a limited time. An alternate design submitted for approval must be definitive of all pertinent construction features. Particular design features are not interchangeable between approved designs. A single inspection lot or sublot, in the case of lots made up of sublots of structurally identical devices, shall contain only one approved design, material and construction so that homogeneity is preserved within a given lot identification code and device type. The qualifying activity shall be notified of the first lot incorporating the change and the last lot of the present existing design and effective date codes for each. If the existing design is to be maintained, the manufacturer shall justify the retention, subject to approval by the qualifying activity. The qualifying activity may periodically identify specific alternate designs by device type and associated specification and request justification for continued retention of that specific alternate design.

H.3.2 Package. All packaged devices supplied under this specification shall be hermetically sealed. No organic or polymeric material shall be used as a package or package seal.

H.3.3 Fungus-resistant material. External parts of the semiconductor device shall be inherently nonnutrient to fungus.

H.3.4 Metals. Internal surfaces shall be capable of resisting progressive degradation within a hermetically sealed package. External metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion. Device package material shall be free of burrs and other potential particle contamination.

H.3.5 Screw threads. Standard screw threads listed in FED-STD-H28 shall be required for all semiconductor devices where screw threads are a mechanical requirement of the device.

H.3.6 Internal conductors. Internal conductors which are in thermal contact with a substrate along their entire lengths (such as metallization strips, contact areas, and bonding interfaces) shall be designed so that no properly fabricated conductor shall experience, at device maximum rated current, a current density in excess of the values shown below for the applicable conductor material including allowances for worst case conductor composition, cross-sectional area, normal production tolerances on critical interface dimensions, and actual thickness at critical areas, such as, steps in the elevation or contact windows:

Conductor material	Maximum allowable continuous current density (RMS for pulse applications)
Aluminum (99.99 percent pure or doped) without glassivation	2×10^5 amps/cm^2
Aluminum (99.99 percent pure or doped) with glassivation	5×10^5 amps/cm^2
Gold	6×10^5 amps/cm^2
All other (unless otherwise specified)	2×10^5 amps/cm^2

H.3.6.1 Wire bonds. Thermocompression wedge bonds shall not be utilized when aluminum wire is used.

H.3.6.2 Die mounting. Pure glass shall not be used for device die mounting.

H.3.7 Silicon transistor metallization protective coating. All silicon transistors with "maximum rating" of less than 4 watts at T_C of +25°C, shall have an inorganic transparent protective overlay material on the active metallization (excluding the bonding pads). For JANS devices, the minimum deposited glassivation thickness shall be 6,000 Å of SiO_2 or 2,000 Å of Si_3N_4. The glassivation shall cover all electrical conductors on the chip except the bonding pads. For JANS devices, a minimum of 0.050 mm (2 mils) distance shall be maintained between all uncoated conducting paths, except where the functional performance parameters of the device require closer spacing.

H.3.8 Critical interface restrictions. Unless it is part of the original design, the external surface of package, header, or flange shall be finished and not have any depression or cavity. External parts, elements, or coatings shall not blister, crack, (excluding glass meniscus), outgas, soften, flow, or exhibit defects that adversely affect storage, operation, or environmental capabilities of semiconductor devices. For JAN, JANTX, and JANTXV the use of silicone or organic material inside the packages, shall be approved by the qualifying activity. Desiccants shall not be used. For JANS devices, silicone or organic materials may only be used when specified by the associated specification. Polymer impregnations (such as backfill) of the packages shall not be permitted.

WARNING: Packages containing beryllium oxide (BeO) shall be marked in accordance with 3.10.3.2 and shall not be ground, machined, sandblasted, or subjected to any mechanical operation which will produce dust containing any beryllium compound. Packages containing any beryllium compound shall not be subjected to any chemical process (such as etching) which will produce fumes containing beryllium or its' compounds.

H.3.9 Metallurgical bond for JANS axial diodes. All JANS diodes (excluding Schottky barrier and point contact ultra high frequency (UHF) devices) shall be metallurgically bonded at the interface of any mechanical connection within the assembly of the device (see appendix A for axial lead diodes).

H.3.10 Requirements for JANS transistor structure.

H.3.10.1 Metallization thickness. The minimum metallization thickness shall be 8,000 A.

H.3.10.2 Internal wire size. The internal wire diameter shall be .0009 inch (0.023 mm) minimum for aluminum and .0007 inch (0.018 mm) minimum for gold wire.

H.3.11 Package element (other than lead or terminal) finish. External metallic package elements other than leads and terminals (e.g., lids, covers, bases, and seal rings) shall meet the applicable environmental requirements without additional finishing of the base materials or else they shall be finished so they meet those requirements using a finish system conforming to one of the combinations listed in table XVIII, and conforming to the thickness and composition requirements of table XVII. The finish system shall also conform to the requirements of H.4.1.1.1 and H.4.1.1.3.

H.4 LEAD AND TERMINAL FINISH

H.4.1 Lead and terminal finish. All leads and applicable terminals shall be solderable in accordance with MIL-STD-750, method 2026, and in accordance with the following proven baseline or as otherwise approved by the qualifying activity.

H.4.1.1 Lead finish and terminal finish baseline. The finish system on all external leads or terminals shall conform to one of the combinations listed in table XVI and to the thickness and composition requirements of table XVII. The finish system shall also conform to the requirements of H.4.1.1.1 and H.4.1.1.3 where applicable. Lead finish requirements are not applicable to specifications which are inactive for new design.

H.4.1.1.1 Hot solder dip. The hot solder dip shall be homogeneous and shall be applied as follows:

a. All outlines with hot solder dip over compliant coating. The hot solder dip shall extend to within .050 inch (1.27 mm) of the seating plate (minimum). For leadless chip carrier devices, the hot solder dip shall cover a minimum of 95 percent of the metallized side castellation or notch and metallized areas above and below the notch, except the index feature if not connected to the castellation. Terminal area intended for device mounting shall be completely covered as required by MIL-STD-750 solderability test. For stud mount the solder shall extend .050 inch (1.27 mm) minimum below the terminal hole.

b. All outlines with hot solder dip over base metal, or noncompliant coating (which are subject to corrosion resulting in lead degradation). The solder shall extend to the package seal or point of emergence of the metallized contact or lead through the package wall. If solder is applied up to the seal, a hermeticity test (MIL-STD-750, method 1071, sample size (116 devices, c = 0)) shall subsequently be performed and passed. An external visual examination (MIL-STD-750, method 2068, sample size (116 devices, c = 0)) may be performed in lieu of the hermeticity test for non-transparent glass encased double plug noncavity axial lead diodes. Alternately, the hot solder dip may extend to within .050 inch (1.27 mm) of the seating plane (minimum), provided a salt atmosphere test method 1041 sample plan 22 devices, c = 0 subsequently be performed and passed. For leadless chip carrier devices, the hot solder dip shall completely cover the metallized side castellation or notch an metallized areas above and below the notch, except the index feature if not connected to the castellation.

H.4.1.1.2 Silver. The lead may be solid silver or the lead finish may be silver clad or silver plated. The silver shall be a minimum of 99.7 percent pure. Silver cladding thickness shall be a minimum of 250 microinches (6.35 µm). A matte or semi-bright plated finish is allowed. The silver plating thickness shall be a minimum of 100 microinches (2.54 µm) and a maximum of 425 microinches (10.80 µm). Silver plating as a final finish, shall not be used directly over copper.

H.4.1.1.3 Tin and tin-lead plate. Pure tin finish shall not be used on any internal or external package or lead surface. Lead finish shall not use pure tin. Tin-lead plate shall contain three percent lead as a minimum (see table XVII). Pure tin finish (including pure tin undercoating) shall be prohibited. For the JAN level only, pure tin is acceptable in accordance with table XVII. herein.

TABLE XVI. Lead finish systems.

Finish	Applied over				Required underplate 1/		
	Base metal	Silver plate	Gold plate	Tin plate	Electroplated nickel	Electroless nickel	None 2/
Hot solder dip 3/	X						X
Hot solder dip 3/							X
Hot solder dip 3/					X		
Hot solder dip 3/						X	
Hot solder dip 3/				X			X
Hot solder dip 3/				X	X		
Hot solder dip 3/				X		X	
Hot solder dip 3/			X		X		
Hot solder dip 3/			X			X	
Hot solder dip 3/		X			X		
Hot solder dip 3/		X				X	
Tin plate	X						X
Tin plate							X
Tin plate					X		
Tin plate						X	
Tin-lead plate	X						X
Tin-lead plate							X
Tin-lead plate					X		
Tin-lead plate						X	
Tin-lead plate				X	X		
Tin-lead plate				X		X	
Gold plate 4/	X						X
Gold plate					X		
Gold plate						X	
Silver plate 5/	X						X
Silver plate					X		
Silver plate						X	

1/ Underplate is the coating that the solder will wet and adhere to.
2/ May include activation systems such as immersion plating of silver or tin.
3/ Hot solder dip shall be applied in accordance with H.4.1.1.1.
4/ Gold plating shall not be used directly over copper.
5/ Silver plating shall not be used directly over copper, however, silver cladding directly over copper is acceptable.

TABLE XVII. Coating thickness and composition requirements.

Coating	Thickness (microinch/micrometer)		Coating composition requirements
	Minimum 1/	Maximum 2/	
Hot solder dip (for round leads) 3/	60/1.52	NS	The solder bath shall have a nominal composition of Sn60 or Sn63. 4/
Hot solder dip (for all shapes other than round leads) 3/ 5/	200/5.08	NS	The solder bath shall have a nominal composition of Sn60 or Sn63. 4/
Tin plate (as plated) 6/	300/7.62	NS	Shall contain no more than 0.12 percent by weight co-deposited organic material measured as elemental carbon. 7/
Tin-lead plate (as plated) 5/ 6/	200/5.08	NS	Shall consist of 3 to 50 percent by weight lead (balance nominally tin) homogeneously co-deposited. Shall contain no more than 0.12 percent by weight co-deposited organic material measured as elemental carbon. 7/
Tin dipping 5/ 6/	100/2.54		
Gold plate	10/.254	225/5.72	Shall contain a minimum of 99.7 percent gold. Only cobalt shall be used as the hardener.
Silver plate	100/2.54	425/10.8	99.7 percent silver minimum.
Nickel plate (electro-plate)	50/1.27	350/8.89	The introduction of organic addition agents to nickel bath is prohibited. Up to 40 percent by weight cobalt is permitted as a co-deposit.
Nickel plate (electroless)	50/1.27	250/6.35	The introduction of organic addition agents to nickel bath is prohibited.
Nickel cladding 8/	50/1.27	350/8.89	

1/ Package elements having noncompliant coatings are permitted provided they are subsequently hot solder dipped in accordance with H.4.1.1.1b.
2/ NS = not specified.
3/ See H.4.1.1.1.
4/ As measured to the center of the flat.
5/ See H.4.1.1.3. For threaded stud packages only, the minimum coating thickness shall be 100 microinches/0.54 micrometers.
6/ The maximum carbon content (and minimum lead content in tin-lead plate) shall be determined by the manufacturer on at least a quarterly basis. The determination of carbon and lead content may be made by any accepted analytical technique (e.g., for carbon: pyrolysis, infrared detection (using an IR212, IR244 infrared detector or equivalent); for lead: x-ray fluorescence, emission spectroscopy) so long as the assay reflects the actual content in the total deposited finish.
7/ The solder Sn concentration in the pot may range between 50 percent Sn to 70 percent Sn.
8/ Maximum nickel applies only to lead material.

APPENDIX H

TABLE XVIII. Package element (other than leads/terminals) finish systems.

Finish	Applied over		Required underplate			
	Gold plate	Tin plate	Electroplated nickel	Electroless nickel 1/	Nickel cladding 1/	None
Tin plate						X
Tin plate			X			
Tin plate				X		
Tin plate					X	
Tin-lead plate						X
Tin-lead plate			X			
Tin-lead plate				X		
Tin-lead plate					X	
Tin-lead plate		X				X
Tin-lead plate		X	X			
Tin-lead plate		X		X		
Tin-lead plate		X			X	
Gold plate			X			
Gold plate				X		
Gold plate					X	
Silver plate			X			
Silver plate				X		
Silver plate					X	
Electroplated nickel 1/						X
Electroless nickel 1/						X
Nickel cladding 1/						X

1/ Combinations of electroplated nickel and electroless nickel and nickel cladding are permitted.

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CONCLUDING MATERIAL

Custodians:
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Navy - EC
Air Force - 17
NASA - NA

Review activities:
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Navy - AS, CG, MC
Air Force - 13, 19, 85, 99
DLA - ES

Preparing activity:
DLA - ES

(Project 5961-1727)