GSFC PREFERRED PARTS LIST
PPL-17

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This document was prepared by the Parts Branch of the Goddard Space Flight Center and the Preferred Parts Mission of the Sperry Corp.

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Parts Branch

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PREFACE

PURPOSE

This document contains a listing of preferred parts, part upgrading procedures, part derating guidelines, and part screening procedures to be used in the selection, procurement, and application of parts for GSFC space systems and ground support equipment.

AUTHORITY

The GSFC PPL is authorized and invoked by Goddard Management Instructions (GMI) 5330.6, Implementation of the Goddard Space Flight Center Parts Program.

STANDARDIZATION

MIL-STD-975, the NASA Standard (EEE) Parts List (NSPL), is the prime reference document for preferred electronic parts for NASA. The GSFC Preferred Parts List (PPL-17), complements MIL-STD-975 by listing additional part types and part categories not included in MIL-STD-975. Parts or styles listed in MIL-STD-975 are identified in PPL-17 as a convenience to users. Several part types listed in MIL-STD-975 are not identified in PPL-17. They are considered to be nonstandard, and are so noted in the PPL. Where conflicts exist between the NSPL and PPL-17, PPL-17 takes precedence.

All parts not specifically identified in the current issues of MIL-STD-975 or the GSFC PPL or which are not procured to the specification given in MIL-STD 975 or PPL are non-standard. These parts shall be used only, with the approval of the GSFC Project Office, if needs cannot be satisfied with a standard part.

QUALITY LEVELS

Consistent with MIL-STD-975, PPL-17 specifies two levels of quality. Grade 1 parts are higher quality, government-specification-controlled parts intended for critical applications. Grade 2 parts are high quality government-specification-controlled parts for use in applications where grade 1 parts are not required.

The parts listed in this document meet the requirements of a Military or NASA specification. When a PPL listed part is purchased, the specification listed for the part and the recommended manufacturer(s) or the manufacturers on the QPL for the part must be referenced in the procurement request.

All specifications listed in the PPL are maintained on file in the Parts Branch for reference purposes. GSFC personnel can obtain copies of specifications through their division offices from the Parts Branch Library, code 310.1, telephone (301) 344-7240. Contractors, approved domestic and foreign experimenters, and international cooperative project working groups can obtain copies.
of the PPL and copies of referenced documents, except MIL specifications, by a written request via the cognizant project office. All others may obtain copies of the PPL through the National Technical Information Service (NTIS), Springfield, VA 22161 or the GIDEP data bank. Requests for Military Specifications should be directed to:

Commanding Officer
Naval Publications and Forms Center, Code 3015
5801 Tabor Avenue
Philadelphia, PA 19120

REVISIONS

The PPL will be reissued during 1986. Portions may be changed and updated prior to that date, as required. Parts not now listed, for which a substantial or critical usage is anticipated, should be brought to the attention of the Parts Branch so that those parts may be considered as candidates for evaluation and possible future listing in MIL-STD-975 or the GSFC PPL. Call (301) 344-8923 or (301) 344-6485.

PART CHARACTERISTICS

Electrical characteristics are specified at 25°C ambient, unless otherwise noted.

CRITERIA FOR LISTING PARTS

Parts are listed in the PPL based on the following criteria:
(1) they can be procured to a high reliability military or NASA specification;
(2) they have complied with an approved series of qualifying criteria;
(3) they are judged by the GSFC Parts Branch to be available and not redundant to other parts in the GSFC PPL or MIL-STD-975.

USER RESPONSIBILITY

MIL-STD-975 and the PPL serve the Center covering both Flight and Ground Support Equipment applications and needs. It is the responsibility of the user, the product assurance engineer, and flight assurance manager to insure that the proper grade level parts are selected from MIL-STD-975 and the PPL commensurate with the criticality of the application.
PARTS APPLICATIONS

MIL-HDBK-978, NASA Parts Application Handbook, is intended to maintain a parts technology baseline for NASA centers and NASA contractors and to maximize standard parts usage. It is an integral part of the NASA standard parts program.

Those part categories covered in MIL-HDBK-978 that are also found in PPL-17 are: Microcircuits (Microelectronic Devices), Transistors, Diodes, Capacitors, Resistors, Connectors, Filters, Protective Devices, Relays, Transformers and Inductors. Some other features found in the handbook are: Cost Factors, Definitions, Construction Details, Operating Characteristics, Failure Mechanisms, Screening Techniques, Environmental Considerations, Selection Criteria, Circuit Application, Failure Rates and Radiation Effects.

PARTS UPGRADING

For some types of parts listed in MIL-STD-975 and the PPL, Grade 1 parts are not listed. Appendix A gives guidelines for upgrading a Grade 2 part for use in a Grade 1 application. In all cases, upgrading must be approved by submission of a non-standard part approval request. This additional testing does not provide a part that is equivalent to the Grade 1 part. Subsequent testing never can duplicate design and processing controls that are imposed during manufacturing.

PARTS DERATING

Conservative application stresses are an important design tool for decreasing part degradation, improving failure rates, and prolonging the useful life of parts. For guidance, recommended part derating factors are tabulated in Appendix B.

PARTS SCREENING

Screening is designed to eliminate quality defects that will prevent a part from meeting its intended performance requirements. Screening is not a substitute for the design and processing controls that can be applied to a part during manufacturing to improve its reliability. Appendix C gives screening guidelines that should be used when a nonstandard part must be procured because no standard part is available.

PARTS RADIATION EFFECTS

Space radiation can present a hazard to electronic parts on space missions. Appendix D gives information on radiation effects on electronic parts.

REFERENCED SPECIFICATIONS

Unless noted otherwise, all specifications referenced in the PPL are the issue in effect on the date of PPL issue.
**PARTS INFORMATION DIRECTORY**

Assistance in the selection of parts, parts specifications, manufacturers surveys, incoming inspection, screening evaluation tests and failure analysis services for all parts are available from the Parts Branch of the Product Assurance Division.

For assistance on electronic parts problems and questions in direct support of specific projects, users should contact the cognizant parts specialist assigned to the respective project. If unknown, the identity can be determined by contacting the project office.

For general evaluation information of electronic parts, part specifications, and part qualifications, users may contact a specialist in the particular part category, as listed below:

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Additional services in support of the GSFC parts program are:

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</table>

**NOTES:**
1. CKR styles are to be limited to maximum capacitance values as follows:
   - CKR05—33,000 pf
   - CKR11—4,700 pf
   - CKR14—47,000 pf
   - CKR06—333,000 pf
   - CKR12—10,000 pf
   - CKR15—180,000 pf

2. CKR styles shall be purchased to revision C of MIL-C-39014.

3. A non-standard parts approval is needed if the requirements of notes 1 and 2 are to be waived.

4. The CLR79 style wet slug tantalum capacitors shall be subjected to an acid indicator leak test in accordance with paragraphs III and IV of GSFC screening procedure SP01.23.

5. EFFECTIVE SERIES RESISTANCE SEEN BY CSR STYLE CAPACITORS SHOULD BE EQUAL TO OR GREATER THAN ONE OHM/VOLT. AS NOTED IN MIL-STD-975, THE CSR STYLE OF CAPACITOR IS NOT RECOMMENDED FOR USE IN APPLICATIONS LESS THAN ONE OHM/VOLT, AS IN POWER SUPPLY FILTERS.

6. Surge current testing shall be performed on CSR style capacitors for all Grade 1 applications per MIL-STD-975.
### MIL-C-23269, CAPACITORS
**Fixed, Glass Dielectric, Established Reliability**

Part Number example:

M23269 /XX XXXX

- **M-Number** - identifies "CYR" fixed, glass dielectric, established reliability capacitors conforming to MIL-C-23269.
- **/XX** - identifies the appropriate military specification sheet that uniquely specifies the capacitor family.
- **XXXX** - uniquely specifies the nominal capacitance value, capacitance tolerance, rated dc voltage, and failure rate level (%/1000 hours).

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Style</th>
<th>See Page</th>
<th>Capacitance Range (pF)</th>
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<th>Rated Voltage (volts, dc)</th>
<th>Temperature Range °C</th>
<th>Coefficient (ppm/°C)</th>
<th>Minimum Insulation Resistance (megohms)</th>
<th>Case Type</th>
<th>Lead Type</th>
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<td>3,4</td>
<td>0.5-300</td>
<td>0.7, 0.3, 0.1</td>
<td>300, 500</td>
<td>0°C to +125°C</td>
<td>105 ±25</td>
<td>500 K @ 25°C</td>
<td>Rectangular, hermetic</td>
<td>Axial or Radial</td>
<td>R</td>
<td>P</td>
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<td>Radial</td>
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**NOTES:**
1. No Grade 1 parts are available at the present time.
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<th>Dissipation Factor (%)</th>
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### Fixed, Glass Dielectric, Established Reliability

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- 47
- 51
- 56
- 62
- 68
- 75
- 82
- 91
- 100
- 110

**Tolerance (± %)**
- 2
- 5
- 1
- 2
- 5
- 1
- 2
- 5
- 1
- 2
- 5

**Dissipation Factor (%)**
- 0.1

**Rated Voltage (volts, dc)**
- 500

**Part Number**
- M23269/05-
## M23269/09, STYLE CYR41
### Fixed, Glass Dielectric, Established Reliability

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September, 1984

01-5 PPL 17
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## Capacitance and Dissipation Factor Table

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<th>Capacitance Value (pF)</th>
<th>Tolerance (± %)</th>
<th>Dissipation Factor (%)</th>
<th>Rated Voltage (volts, dc)</th>
<th>Part Number M23269/09- Grade 2 FRL = P(0.1)</th>
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<tbody>
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01-6 PPL 17  
September, 1984
# M23269/09, STYLE CYR43

**Fixed, Glass Dielectric, Established Reliability**

<table>
<thead>
<tr>
<th>Capacitance Value (pF)</th>
<th>Tolerance (± %)</th>
<th>Rated Voltage (volts, dc)</th>
<th>Part Number M23269/09-Grade 2 FRL = P(0.1)</th>
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<th>Tolerance (± %)</th>
<th>Rated Voltage (volts, dc)</th>
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**NOTE:**
1. Dissipation factor = 0.1%
# Index of Preferred Connectors

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<th>Specification</th>
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<td>Power Connectors, Solder Contacts (sub-miniature)</td>
<td>GSFC S-311-P-10</td>
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</tr>
<tr>
<td>311P409</td>
<td>Power Connectors, Crimp Removable Contacts (sub-miniature)</td>
<td>GSFC S-311-P-4/9</td>
<td>Page 02-3</td>
</tr>
<tr>
<td>311P407</td>
<td>Power connectors, Crimp Removable Contacts</td>
<td>GSFC S311P-4/7</td>
<td>Page 02-4</td>
</tr>
<tr>
<td>NLS</td>
<td>High Density, Miniature</td>
<td>MSFC 40 M38277</td>
<td>MIL-STD-975</td>
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<td>Miniature (200°C)</td>
<td>MSFC 40 M39569</td>
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<td>Electrical, Miniature, Circular (200°C)</td>
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**NOTES:**
1. OTHER PARTS ARE LISTED IN MIL-STD-975, BUT GSFC CONSIDERS ONLY THE ONES LISTED ABOVE AS STANDARD PARTS.
## POWER CONNECTORS

### Rack and Panel, Sub-Miniature, Solder Contacts

<table>
<thead>
<tr>
<th>Construction</th>
<th>Qty.</th>
<th>Type</th>
<th>For Use With Wire Size</th>
<th>Grade 1 &amp; Grade 2</th>
<th>Remarks</th>
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<tbody>
<tr>
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<td>Socket</td>
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<td>ITT Cannon Electric</td>
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<td>AWG #20 max.</td>
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<td>G311P10-5P-C-15</td>
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**NOTES:**

1. C = 20 gamma residual magnetism level; other levels B = 200 and D = 2 gamma are available.

All GSFC type connectors: "-15" in type indicates 0.154 inch (0.39 mm) dia. mounting hole, 0.120 inch (0.31 mm) dia. is available; indicated by "-12."
# POWER CONNECTORS
Rack and Panel, Sub-Miniature, Crimp Removable Contacts

<table>
<thead>
<tr>
<th>Construction</th>
<th>Contacts</th>
<th>Qty</th>
<th>Type</th>
<th>For Use With Wire Size</th>
<th>Grade 1 &amp; Grade 2</th>
<th>Remarks</th>
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**NOTES:**
1. $\theta = 200$ gamma residual magnetism level. Other levels are available; if required, consult the parts specialist.

*September, 1984*
# POWER CONNECTORS

Rack and Panel, Sub-Miniature, High Density, Crimp Removable Contacts

<table>
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<th>Construction</th>
<th>Qty.</th>
<th>Type</th>
<th>For Use With Wire Size</th>
<th>Grade 1 &amp; Grade 2</th>
<th>Remarks</th>
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</table>

NOTES:

1. B = 200 gamma residual magnetism level. No other residual magnetism levels are available for this type of connector.

All GSFC type connectors: 
"-15" type indicates 0.154 inch (0.39 mm) dia. mounting hole, 0.120 inch (0.31 mm) dia. is available; indicated by "-12."
# Index of Preferred Filters

<table>
<thead>
<tr>
<th>Style</th>
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<th>Specification</th>
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<td>MIL-F-28861/1</td>
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<td>FS50</td>
<td>Electromagnetic Interference Suppression</td>
<td>MIL-F-28861/5</td>
<td>MIL-STD-975</td>
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</table>

**NOTES:**

1. MIL-STD-975 LISTS THE MIL-F-18327 BAND PASS FILTER. GSFC CONSIDERS ONLY THE ONES LISTED ABOVE AS STANDARD PARTS.

2. Presently, there are no Grade 1 filters. Non-standard part approval and up-grading are required for intended use of the Grade 2 devices in a Grade 1 program. See Appendix A for recommended up-grading procedures.

3. a. THE TORQUE USED IN MOUNTING THESE FILTERS IS CRITICAL. EXCESSIVE TORQUE CAN DAMAGE THE INTERNAL CAPACITOR. USE THE MINIMUM TORQUE NECESSARY FOR THE MECHANICAL CONNECTION TO CREATE A GOOD ELECTRICAL CONNECTION TO GROUND. IN NO CASE SHOULD THE TORQUE EXCEED THE LIMIT GIVEN IN THE DETAIL SPECIFICATION. FOR MORE INFORMATION, CONSULT THE PARTS SPECIALIST.

b. THE FILTERS MUST BE TREATED AS BEING HEAT SENSITIVE. HEAT SINK THE DEVICE WHEN SOLDERING TO THE FILTER.
# Index Of Preferred Fuses

<table>
<thead>
<tr>
<th>Style</th>
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<th>Specification</th>
<th>Refer To</th>
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<tr>
<td>FM04A</td>
<td>Fuse, Subminiature</td>
<td>MIL-F-23419</td>
<td>Page 04-2</td>
</tr>
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<td>FM08A</td>
<td>Fuse, Subminiature</td>
<td>MIL-F-23419</td>
<td>Page 04-2</td>
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</tbody>
</table>
## Fuse Specifications

**Subminiature**

### Current Rating
- **Grade 1**: 1/8, 1/4, 3/8, 1/2, 3/4, 1, 1-1/2, 2, 2-1/2, 3, 4, 5, 7, 10, 15 Amperes
- **Grade 2**: 1/8, 1/4, 3/8, 1/2, 3/4, 1, 1-1/2, 2, 2-1/2, 3, 4, 5, 7, 10, 15 Amperes

### Rated Voltage
- **Grade 1**: 125 Volts
- **Grade 2**: 125 Volts

### Maximum Short Circuit Current
- **Grade 1**: 300 Amperes
- **Grade 2**: 300 Amperes

### Voltage Drop @ Rated Current
- **Grade 1**: Min-Max
- **Grade 2**: Min-Max

### Maximum Cold Resistance
- **Grade 1**: ohms
- **Grade 2**: ohms

### Mil Part Number
- **Grade 1**: FM08A125V
- **Grade 2**: FM04A125V

### Manufacturer
- **Grade 1**: QPL-23419
- **Grade 2**: QPL-23419

### Notes:
1. GSFC requires additional screening for Grade 1 applications per Appendix C, Table 04.
2. GSFC requires additional screening for Grade 2 applications per Appendix C, Table 04.
3. Refer to Appendix B, Table 04 for Fuse Derating outline for all applications.
4. GSFC recommends the use of redundant circuits for critical flight applications.
5. No Grade 2 part exists at the present time. Use the listed Grade 1 part.
6. THE FLIGHT USE OF FUSES RATED ½ AMPERE AND LESS REQUIRES APPLICATION APPROVAL BY THE APPLICABLE GSFC PROJECT OFFICE. EVIDENCE OF ACTUAL CURRENT LEVELS (INCLUDING STEADY-STATE, REPETITIVE PULSES AND TRANSIENTS) MUST BE SUBMITTED WITH THE APPROVAL REQUEST.
7. Subminiature fuses are not mechanically rugged and are susceptible to handling and assembly damage. Use special handling and soldering for these heat sensitive parts.

---

**September, 1984**
### Index of Preferred Inductors

<table>
<thead>
<tr>
<th>Style</th>
<th>Description</th>
<th>Specification</th>
<th>Refer To</th>
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<td>Audio Frequency, High Q</td>
<td>MIL-T-27</td>
<td>MIL-STD-975</td>
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<td>MIL-STD-975</td>
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<td>MIL-C-39010/01</td>
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<td>MIL-STD-975</td>
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<td>MIL-C-39010/02</td>
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<td>MIL-STD-975</td>
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<tr>
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<td>MIL-C-39010/07</td>
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**NOTES:**
1. MIL-C-15305 PARTS ARE NOT SCREENED AND ARE CONSIDERED TO BE NON-STANDARD PARTS. FOR SPACE FLIGHT USE THEY MUST BE SCREENED AS OUTLINED IN APPENDIX C, TABLE 05.

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September, 1984
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**NOTES:**

1. These military styles are limited to Grade 2 applications. For Grade 1 applications, use equivalent GSFC part numbers (refer to pages 06-2 and 06-3).

2. These styles listed in MIL-STD-975 are limited to Grade 2 applications. No equivalent Grade 1 parts are currently available.

3. FOR ALL GRADE 2 PARTS LISTED HERE OR IN MIL-STD-975, THE FOLLOWING SHALL APPLY:
   A. THE PURCHASE ORDER SHALL SPECIFY THAT THE PARTS SHALL BE SUPPLIED WITH UNPAINTED ENCLOSURES, AND NO CADMIUM OR ZINC PLATING (INTERNAL OR EXTERNAL) SHALL BE USED.
   B. A DPA SHALL BE PERFORMED PER GSFC S-311-70 (REFER TO APPENDIX A, PAGE A-1 FOR SAMPLING PLAN).

---

*September, 1984*
## Relays, Nonlatching

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<th>Pick-up Max (vdc)</th>
<th>Nominal dc Coil Resistance (ohms)</th>
<th>Contact Form(^3)</th>
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### Notes:

1. GSFC part number is for 1.500 inch min. lead/length, whereas the corresponding MIL part number is for 0.500 inch min. lead length.
2. For contact rating for other types of loads (inductive, capacitive, lamp, motor), contact parts specialist.
3. Refer to NARM Engineers' Relay Handbook for definition of forms (example: form C = single pole, double throw, break before make).
4. Contacts also suitable for low level applications.
5. 15.5 mm x 15.5 mm x 8.1 mm high (.610" x .610" x .320”).
6. For Grade 2 parts, see requirements on page 06-1.

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<th>Nominal dc Coil Resistance (ohms)</th>
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<th>Package Type</th>
<th>Terminal Type</th>
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**NOTES:**
1. See Note 1 on Page 06-2.
2. See Note 2 on Page 06-2.
3. See Note 3 on Page 06-2.
4. See Note 4 on Page 06-2.
5. See Note 5 on Page 06-2.
6. Use Grade 1 parts.
7. FOR GRADE 2 PARTS, SEE REQUIREMENTS ON PAGE 06-1.

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September, 1984
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### NOTES:

1. GSFC considers RCR styles at the "S" failure rate suitable for both Grade 1 and Grade 2 applications.

2. GSFC does not consider type "C" terminal material to be readily weldable, and recommends using type "N" in welding applications. Type "C" and "R" may be used in soldering applications. Styles 75 and 90 are available only with type "C" terminal material.

3. GSFC considers RZO styles listed in MIL-STD-975 acceptable for use in Grade 2 applications. For Grade 1 applications, consult the Parts Specialist.
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### NOTES:
1. When no JANS diode is listed on the QPL, a Grade 2 diode may be upgraded for use in Grade 1 applications in accordance with Appendix A. A non-standard part approval is required.
2. JANTXV diodes must be subjected to the screening verification tests of Appendix E.
3. Refer to Appendix D for information on radiation effects.
## Index of Preferred Diodes\(^1\) (continued)

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\(^1\) MIL-STD-975, Page 08-5

September, 1984
### DIODES
**Switching, Silicon**

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<th>Manufacturer</th>
<th>Maximum Forward Voltage (Vdc)</th>
<th>Forward Current (mA)</th>
<th>Maximum Reverse Current (μA)</th>
<th>Reverse Voltage (Vdc)</th>
<th>Reverse Recovery Time (t_{rr}) (nsec)</th>
<th>Capacitance (pF)</th>
<th>Case Dwg.</th>
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**NOTES:**
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 08-1.
3. See Note 2 on Page 08-1.
4. This case does not meet the dimensional criteria for any JEDEC outline. See MIL-S-19500 detail specification for case outline dimensions.
5. 11.30 mm x 4.37 mm x 7.62 mm.
6. 11.30 mm x 4.37 mm x 12.45 mm.

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## DIODES
Voltage Reference, Silicon

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<th>Zener Current (mAdc)</th>
<th>Voltage Change (Vdc) over Temperature Range</th>
<th>Impedance (ohms)</th>
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**NOTES:**
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 08-1.
3. See Note 2 on Page 08-1.
## DIODES (Page 1 of 2)

### Voltage Regulator, Silicon

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### Notes:

1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 08-1.
3. See Note 2 on Page 08-1.

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**Voltage Regulator, Silicon**

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<th>Manufacturer</th>
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<th>Max. Impedance $Z_z$ (Ohms)</th>
<th>Max Diss. TL = 75°C (W)</th>
<th>Voltage Temp. Coefficient (%/°C)</th>
<th>Max. Storage Temp. (°C)</th>
<th>Case Dwg.</th>
<th>Remarks</th>
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<tr>
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<td>Type Designation JANTXV</td>
<td>MIL-S-19500</td>
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### NOTES:

1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 08-1.
3. See Note 2 on Page 08-1.
4. Microminiature, solid glass, non-cavity construction with dimensions 2.3mm ODX 5mm long.
5. Lead temperature ($T_L$) at 3/8 inch from diode case.

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September, 1984
<table>
<thead>
<tr>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Specification</th>
<th>Manufacturer</th>
<th>( I_D ) ((\text{Ardc}))</th>
<th>( V_{RM} ) ((\text{wkg}))</th>
<th>Reverse Recovery Time ((\text{trr}))</th>
<th>Maximum Reverse Current ((\mu\text{Ardc}))</th>
<th>Reverse Voltage ((\text{Vdc}))</th>
<th>( I_{FSM} ) ((1/120\text{sec}))</th>
<th>Case Dwg.</th>
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<tbody>
<tr>
<td>JANS</td>
<td>JANTXV</td>
<td>MIL-S-19500</td>
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<td>1.0 ( @T_A = 55^\circ\text{C} )</td>
<td>200 | 150</td>
<td>0.85 | 0.85 | 1.3 | 1.3 | 2.0</td>
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**Notes:**
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 08-1.
3. See Note 2 on Page 08-1.
4. This case does not meet the dimensional criteria for any JEDEC outline. See MIL-S-19500 detail specification for case outline dimensions.
## DIODES
### Power, Silicon

<table>
<thead>
<tr>
<th>Grade 1²</th>
<th>Grade 2³</th>
<th>Specification MIL-S-19500</th>
<th>Manufacturer</th>
<th>Maximum Forward Voltage [V (pk)]</th>
<th>Forward Current [A (pk)]</th>
<th>Maximum Reverse Current</th>
<th>Reverse Recovery Time ( t_{rr} ) (( \mu \text{sec} ))</th>
<th>Case Dwg.</th>
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### Voltage Variable Capacitor, Silicon

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<th>Grade 1²</th>
<th>Grade 2³</th>
<th>Specification MIL-S-19500</th>
<th>Manufacturer</th>
<th>Nominal Cap. @( V_R = 4 \text{Vdc} ) (pF)</th>
<th>Cap. Ratio ( V_R = 4 \text{v to 60v} ) (times)</th>
<th>Max. Cont. Work. Volts ( V_R ) (volts)</th>
<th>Min. Q @( f = 50 \text{MHz} ) ( V_R = 4 \text{vdc} )</th>
<th>Max. Diss. (W) ( TA = 25°C )</th>
<th>Max. Temp. (°C)</th>
<th>Case Dwg.</th>
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</thead>
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**NOTES:**
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 08-1.
3. See Note 2 on Page 08-1.
## DIODES
Switching, Silicon, Arrays

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type Designation</th>
<th>Specification</th>
<th>Manufacturer</th>
<th>Maximum Forward Voltage (Vdc)</th>
<th>Forward Current (mA)</th>
<th>Maximum Reverse Current (mA)</th>
<th>Reverse Voltage (Vdc)</th>
<th>Reverse Recovery Time (t_{rr}) (nsec)</th>
<th>Capacitance (pF)</th>
<th>Case Dwg.</th>
<th>Remarks</th>
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<td>Monolithic</td>
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**NOTES:**
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 08-1.
3. See Note 2 on Page 08-1.
4. Package is 16-pin ceramic dual in-line package (DIP).
## Index of Preferred Transistors

<table>
<thead>
<tr>
<th>Grade 1 Type Designation</th>
<th>Grade 2 Type Designation</th>
<th>Description</th>
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<td>2N1613</td>
<td>JANS</td>
<td>Medium Power—NPN</td>
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<td>2N2900</td>
<td>JANS</td>
<td>Low Power—NPN</td>
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<td>2N2219AL</td>
<td>JANTS</td>
<td>Medium Power—NPN</td>
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<td>2N3669A</td>
<td>JANTS</td>
<td>Lower Power—NPN</td>
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<td>Chopper—NPN</td>
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<td>Low Power—NPN</td>
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NOTES:
1. When no JANS transistor is listed on the QPL, a Grade 2 transistor may be upgraded for use in Grade 1 applications in accordance with Appendix A. A non-standard part approval is required.
2. JANTXV transistors must be subjected to the screening verification of Appendix E.
3. Refer to Appendix D for information on radiation effects.
<table>
<thead>
<tr>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Specification</th>
<th>Manufacturer</th>
<th>$h_{FE}$ (min/max)</th>
<th>$I_{CB}(nA/dc)$</th>
<th>$V_{CE}(V_{dc})$</th>
<th>$V_{CE(SAT)}(V_{dc})$</th>
<th>$I_C(mA/dc)$</th>
<th>$I_B(mA/dc)$</th>
<th>$BV_{CEO}(V_{dc})$</th>
<th>$P_T@T_A=25^\circ C$ (mW)</th>
<th>Case Dwg.</th>
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<tbody>
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<td>150</td>
<td>15</td>
<td>75</td>
<td>500</td>
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**NOTES:**
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 09-1.
3. See Note 2 on Page 09-1.

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September, 1984
## TRANSISTORS
### NPN, Silicon, Medium Power

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<th>Type</th>
<th>Designation</th>
<th>Specification</th>
<th>Manufacturer</th>
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<th>$I_C$ (mAdc)</th>
<th>$V_C E$ (Vdc)</th>
<th>$I_{CB0}$ (mAdc)</th>
<th>$V_{CE}(SAT)$ (Vdc)</th>
<th>$I_C$ (mAdc)</th>
<th>$I_B$ (mAdc)</th>
<th>$P_T$ @ $T_A = 25^\circ C$ (mW)</th>
<th>Switching Time</th>
<th>Case Dwg.</th>
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<td>40/120</td>
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<td>0.4</td>
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<td>1200</td>
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### TRANSISTORS
### PNP, Chopper, Low Power, Silicon

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type</th>
<th>Designation</th>
<th>Specification</th>
<th>Manufacturer</th>
<th>$h_{FE}$ (min)</th>
<th>$r_e$ (max)</th>
<th>$V_E$ (max)</th>
<th>$I_E$ (mAdc)</th>
<th>$I_B$ (mAdc)</th>
<th>$I_e$ (µA)</th>
<th>$V_E$(ofs) (Vdc)</th>
<th>$I_E$ (mAdc)</th>
<th>$I_B$ (mAdc)</th>
<th>$P_T$ @ $T_A = 25^\circ C$ (mW)</th>
<th>Case Dwg.</th>
</tr>
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<tbody>
<tr>
<td>1</td>
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<td>MIL-S-19500</td>
<td>QPL-19500</td>
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**NOTES:**
1. See MIL-STD-975 for additional types.
2. See Note 2 on Page 09-1.
3. See Note 3 on Page 09-1.
## TRANSISTORS
### NPN, Silicon, High Power

| Grade 1 | Grade 2 | Specification MIL-S-19500 | Manufacturer | hFE (min/max) | @ | ICBO (mADC) @ | VCE (Vdc) | VCE(SAT) (Vdc) | @ | IB (mADC) | BVCEO (Vdc) | PT @TC = 25°C (Watts) | Case Dwg. |
|---------|---------|---------------------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------------|----------|
| JANS    | JANTXV  | QPL-19500                 | OPL-19500    |               | 40/120        | 1             | 5             | 0.0004        | 80            | 0.25         | 1             | 0.1            | 110     | 30@ TC = 125°C | Note 4   |
| 2N2880  |         |                           |              | 30/90         | 20            | 5             | 0.1mADC       | 1.0           | 40            | 4             | 125           | 350     | Note 4         |          |
| 2N5250  |         |                           |              | 40/120        | 0.5           | 5             | 0.0001        | 200           | 0.4           | 1             | 0.1            | 250     | 20@ TC = 125°C | T066     |
| 2N6560  |         |                           |              | 16/30         | 10            | 2             | 1             | 600           | 1.5           | 10            | 2             | 300     | 175            | T03      |

### PNP, Silicon, High Power

| Grade 1 | Grade 2 | Specification MIL-S-19500 | Manufacturer | hFE (min/max) | @ | ICBO (mADC) @ | VCE (Vdc) | VCE(SAT) (Vdc) | @ | IB (mADC) | BVCEO (Vdc) | PT @TC = 25°C (Watts) | Switching Time | Case Dwg. |
|---------|---------|---------------------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------------|---------------|----------|
| JANS    | JANTXV  | QPL-19500                 | OPL-19500    |               | 30/100        | -0.250        | -1            | -0.0001       | -80           | -0.6         | -1            | -0.125       | 25     | 0.4            | 1.0       | T066     |
| 2N3741  |         |                           |              | 50/150        | -1            | -2            | ICES = 1mADC  | VCE = 70Vdc   | -1            | -5            | -0.5         | -80          | 150     | 1.5            | 2.0       | T03      |
| 2N3792  |         |                           |              | 15/60         | -10           | -2            | -1            | -80           | -1            | -10           | -1           | 200     | 1.0            | 3.0       |         |
| 2N5745  |         |                           |              |               |               |               |               |               |               |               |               |               |         |         |

**NOTES:**
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 09-1.
3. See Note 2 on Page 09-1.
4. This case does not meet the dimensional criteria for any JEDEC outline. See MIL-S-19500 detail specification for case outline dimensions.
## TRANSISTORS

Field-Effect, N-Channel, Junction, Silicon

<table>
<thead>
<tr>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Specification MIL-S-19500</th>
<th>Manufacturer</th>
<th>V_{DG} and V_{DS} (max) (Vdc)</th>
<th>V_{GS} (max) (Vdc)</th>
<th>I_{G} (mA)</th>
<th>V_{GS(ohf)} (max, (Vdc)</th>
<th>I_{DSS} (min/max) (mA)</th>
<th>I_{DSS} (Vdc)</th>
<th>V_{DS} (Vdc)</th>
<th>V_{GS} (Vdc)</th>
<th>P_{T} (mW)</th>
<th>Case Dwg.</th>
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</table>

**NOTES:**
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 09-1.
3. See Note 2 on Page 09-1.
# INDEX TO PREFERRED MICROCIRCUITS

## DIGITAL

(Generic Part Numbers Shown)

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<thead>
<tr>
<th>Low Power Schottky, TTL</th>
<th>CMOS/Bulk</th>
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</thead>
<tbody>
<tr>
<td>54LS00 54LS51 54LS139 54LS241 54LS395</td>
<td>4000A 4019A 4069UB^R</td>
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<tr>
<td>54LS02 54LS54 54LS148 54LS244 54LS490</td>
<td>4002A 4020A 4070B</td>
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<td>54LS03 54LS73 54LS151 54LS245 54LS670</td>
<td>4006A 4021A 4071B</td>
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<td>54LS04 54LS74 54LS153 54LS251</td>
<td>4007A 4022A 4072B</td>
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<td>54LS06 54LS75 54LS156 54LS253</td>
<td>4008A 4023A 4073B</td>
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<td>4009A 4024A 4075B^R</td>
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<td>4011A 4027A 4081B^R</td>
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<td>54LS12 54LS86 54LS161 54LS266</td>
<td>4013A 4031A 4082B^R</td>
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<td>54LS13 54LS90 54LS162 54LS273</td>
<td>4014A 4043A 4085B^R</td>
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<td>54LS14 54LS92 54LS163 54LS279</td>
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<td>54LS22 54LS107 54LS174 54LS295</td>
<td>(Refer to page 10-5)</td>
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<td>54LS47 54LS138 54LS240 54LS393</td>
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### Advanced Low Power Schottky, TTL (Refer to page 10-4)

<table>
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<tr>
<td>506 5425 5472 54145 54180A</td>
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<tr>
<td>507 5450 5477 54150</td>
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<td>516 5453 5482 54154</td>
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### Memory

- Prom, Schottky TTL
- Ram, Schottky TTL
- Ram, NMOS MK2164

### Microprocessor, NMOS

- 8080A 8086 280A 28002
- Microprocessor, ^P^L
- 9989

## Notes:

1. All parts are listed in MIL-STD-975 except as referenced otherwise. The parts must be purchased to the part numbers specified in MIL-M-38510.
2. When no Grade 1 microcircuit is listed, a Grade 2 microcircuit may be upgraded for use in Grade 1 applications in accordance with Appendix A. A non-standard part approval is required.
3. Refer to Appendix D for information on radiation effects.
4. The part types marked with superscripts R and H can be procured as radiation hard parts, hardened to $1 \times 10^5$ rads and $1 \times 10^6$ rads, respectively.

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INDEX TO PREFERRED MICROCIRCUITS 1, 2, 3, 4 (Continued)

LINEAR
BIPOLAR AND BI-FeT

<table>
<thead>
<tr>
<th>Operational Amplifiers</th>
<th>Voltage Regulators</th>
<th>Voltage Comparators</th>
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<td>HA2600 LM101A</td>
<td>LM109</td>
<td>LM111</td>
</tr>
<tr>
<td>HA2101A LM108A</td>
<td>LM723</td>
<td>LM139</td>
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<td>HA2500 LM118</td>
<td>LM120H-05</td>
<td>LM710</td>
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<td>HA2510 LM124</td>
<td>LM120H-12</td>
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<td>LF156A LM1558</td>
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<table>
<thead>
<tr>
<th>Line Drivers</th>
<th>Line Receivers</th>
<th>Precision Timers</th>
<th>DAC</th>
<th>Switches</th>
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<tr>
<td>9614</td>
<td>9615</td>
<td>555</td>
<td>08</td>
<td>155A</td>
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<td>55113</td>
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September, 1984
HYBRID MICROCIRCUITS

Hybrid microcircuits are defined as microcircuits in which the circuits elements are contained on more than one die or chip, as compared to a monolithic microcircuit where all the circuit elements are contained on a single die. A hybrid microcircuit generally contains an insulating substrate or substrates on which are deposited a conductor network and sometimes thick film resistors. Semiconductor dice and sometimes passive elements are attached to the substrate. Additional connections are made between the active and passive elements, the substrate, and the package leads using interconnection wires. Hybrid microcircuits are normally low volume non-standard parts. A non-standard part approval is required for all non-standard types. General requirements for hybrid microcircuits are presented in GSFC specification S-311-200.
<table>
<thead>
<tr>
<th>Commercial Part Number¹</th>
<th>Function</th>
<th>Grade 1</th>
<th>Grade 2</th>
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<td>JANM38510</td>
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<td>NOR, quad 2-input</td>
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<td>54ALS04</td>
<td>Hex Inverter</td>
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<td>/37006BXX</td>
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<tr>
<td>54ALS08</td>
<td>And, quad 2-input</td>
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<td>/37401BXX</td>
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<td>54ALS10</td>
<td>NAND, Triple 3-input</td>
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<td>/37002BXX</td>
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<td>AND, Triple 3-input</td>
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<td>/38303BXX</td>
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<tr>
<td>54ALS138</td>
<td>Single 3 to 8 line decoder</td>
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<td>/37701BXX</td>
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</table>

Function: Gates, Buffers, Decoders

Grade 1: Note 3

Grade 2: Per QPL-38510

Notes:
1. Use the JANM38510 part number for ordering, not the commercial part number.
2. The "XX's" are for choice of case outline and lead finish respectively. Refer to QPL-38510 for specific choices available.
3. No Grade 1 version of this part is presently being supplied by any manufacturer. The Grade 2 part may be used for Grade 1 applications by upgrading in accordance with Appendix A. A non-standard part approval is required.
### MICROCIRCUITS
Digital, MIL-M-38510 CMOS

<table>
<thead>
<tr>
<th>Commercial Part Number</th>
<th>Function</th>
<th>Grade 1</th>
<th>Grade 2</th>
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<td>Part No.</td>
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<td>JANM38510</td>
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<td>Manufacturer</td>
<td>Manufacturer</td>
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<td>4001B</td>
<td>NOR, quad, 2-input</td>
<td>Note 3</td>
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<td>4012B R</td>
<td>NAND, dual, 4-input</td>
<td>Per QPL-38510</td>
<td>/05052BXX</td>
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<tr>
<td>4030B R, H</td>
<td>Exclusive-OR Gate Quad</td>
<td>Per QPL-38510</td>
<td>/05353BXX</td>
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<tr>
<td>4017B R</td>
<td>Decade Counter/Divider</td>
<td>/05651BXX</td>
<td>/05653BXX</td>
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<td>4020B R</td>
<td>14-stage ripple-carry binary</td>
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**NOTES:**
1. Use the JANM38510 part number for ordering, not the commercial part number.
2. The "XX's" are for choice of case outline and lead finish respectively. Refer to QPL-38510 for specific choices available.
3. No Grade 1 version of this part is presently being supplied by any manufacturer. The Grade 2 part may be used for Grade 1 applications by upgrading in accordance with Appendix A. A non-standard part approval is required.
4. The part types marked with superscripts R and H can be procured as radiation hard parts, hardened to $1 \times 10^5$ rads and $1 \times 10^6$ rads, respectively. See QPL for additional information.
## Index of Preferred Thermistors

<table>
<thead>
<tr>
<th>Style</th>
<th>Description</th>
<th>Specification</th>
<th>Refer To</th>
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<tbody>
<tr>
<td>311P18</td>
<td>Thermistor, Insulated, Negative Temp. Coeff.</td>
<td>GSFC S311-P-18</td>
<td>Page 14-2</td>
</tr>
</tbody>
</table>

September, 1984
# THERMISTORS

<table>
<thead>
<tr>
<th>Temp. Coeff.</th>
<th>Resistance (ohms)</th>
<th>Tolerance at 25°C (±%)</th>
<th>Operating Temperature Range (°C)</th>
<th>Resistance Ratio R(<em>{25^\circ \text{C}})/R(</em>{\text{MAX}})</th>
<th>Grade 1 and Grade 2</th>
<th>Part Number</th>
<th>Specification</th>
<th>Manufacturer</th>
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</thead>
<tbody>
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<td>Yellow Springs Instrument</td>
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**NOTES:**
1. WARNING: Use heat sinks when soldering or welding to thermistor leads.
2. The complete part number is 311P18- AA L XXX

**LEAD STYLE:**
- S = 32 AWG, Type C per MIL-STD-1276
- T = 28 AWG, Type ET per MIL-W-1687-16878
- N = 32 AWG, Type N-2 per MIL-STD-1276
- E = Insulated lead (TFE), 32 AWG per MIL-I-22129; Bare lead, Style S; Tubing (FEP), M23053/11-105c.

**LEAD LENGTH:**
Specify length in centimeters.
1R0 = 1.0, 10R = 10, 101 = 100.
Minimum length is 7.6cm.
# Index of Preferred Transformers

<table>
<thead>
<tr>
<th>Style 1</th>
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<th>Specification</th>
<th>Refer To</th>
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<td>M27/165</td>
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<td>MIL-STD-975</td>
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<td>Pulse, Low Power</td>
<td>MIL-T-21038</td>
<td>MIL-STD-975</td>
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**NOTES:**
1. The purchase order must specify that 100% screening is required. Otherwise, when unscreened parts are purchased, they shall be subjected to screening tests, as outlined in Table 15 of Appendix C prior to use.
### Index of Preferred Wire/Cable

<table>
<thead>
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<th>Style</th>
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<th>Refer To</th>
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<td>Wire, High temperature</td>
<td>MIL-W-22759</td>
<td>Page 16-2</td>
</tr>
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<td>M22759/18</td>
<td>Wire, Light weight, ETFE</td>
<td>MIL-W-22759</td>
<td>Page 16-3</td>
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<td>MIL-W-22759</td>
<td>Pages 16-3, 4, 5</td>
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<td>Wire, High voltage</td>
<td>GSFC S-311-P-13</td>
<td>Page 16-1</td>
</tr>
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<td>MIL-STD-975</td>
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<td>MIL-STD-975</td>
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<td>Cable, RF, Flexible, Coaxial</td>
<td>MIL-C-17</td>
<td>MIL-STD-975</td>
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<tr>
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<td>Cable, Electrical, Shielded and Unshielded</td>
<td>MIL-C-27500</td>
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**NOTES:**
1. GSFC WAIVES THE RESTRICTIONS AND REQUIREMENTS OF MIL-STD-975 ON THE USE OF SILVER COATED COPPER CONDUCTOR WIRE AND CABLE.
2. Flammability properties of these wires are controlled by the applicable specifications. However, applications in Space Transportation System (STS) payloads may require that the specific STS flammability hazards be addressed. Users are advised to consult the appropriate project systems safety officer.

16-1 PPL 17
September, 1984
# Wire

## Electrical, Insulated, High Temperature

<table>
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<tr>
<th>Style</th>
<th>Strands No. x AWG</th>
<th>Diameter over Insulation, mm</th>
<th>Voltage Rating, Maximum (volts/RMS)</th>
<th>Specification</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Remarks</th>
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<td>/9</td>
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**NOTES:**

1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (listed on page 16-7).
## WIRE

### Electrical, Insulated, Lightweight (Page 1 of 3)

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<th>Remarks</th>
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### NOTES:
1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (listed on Page 16-7).

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September, 1984
# WIRE

## Electrical, Insulated, Lightweight (Page 2 of 3)

<table>
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<th>Voltage Rating, Maximum (volts, RMS)</th>
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**NOTES:**

1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (Listed on Page 16-7).
### Wire Electrical, Insulated, Lightweight (Page 3 of 3)

<table>
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<th>Voltage Ratings Maximum (Volts/RMS)</th>
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<th>Remarks</th>
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**NOTES:**
1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (listed on page 16-7) except that for sizes 2 and larger the braid color shall be dark green and the designator shall be 5D.
# WIRE

## Electrical, Insulated

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<td>133 x 29</td>
<td>5.79</td>
<td>—</td>
</tr>
<tr>
<td>S311P13-XX-6-Z</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>133 x 27</td>
<td>7.06</td>
<td>—</td>
</tr>
<tr>
<td>S311P13-XX-4-Z</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>133 x 25</td>
<td>8.53</td>
<td>—</td>
</tr>
<tr>
<td>S311P13-XX-2-Z</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>665 x 30</td>
<td>10.1</td>
<td>—</td>
</tr>
<tr>
<td>S311P13-XX-0-Z</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1045 x 30</td>
<td>12.4</td>
<td>—</td>
</tr>
<tr>
<td>S311P13-XX-00-Z</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1330 x 30</td>
<td>14.2</td>
<td>—</td>
</tr>
</tbody>
</table>

**NOTES:**

1/ The complete part number is S311P13-XX-YY-Z

**VOLTAGE RATING**

- 01 = 600 volts
- 02 = 1000 volts
- 03 = 2500 volts

**WIRE SIZE**

- AWG #

**COLOR CODE**

See page 16-7

**Grade 1**

- Raychem Corp.

**Specification**

- GSFC S-311-P-13

**Grade 2**

- Max. Temp. 135°C

**Remarks**

- Tin-coated, copper conductor.
- Insulated with crosslinked polyalkene.
- Suitable for use in wire harnesses.

September, 1984
### Color Code Designators
for Wire According to MIL-STD-681

<table>
<thead>
<tr>
<th>Base Color</th>
<th>1st Stripe</th>
<th>2nd Stripe</th>
<th>Designator</th>
<th>Base Color</th>
<th>1st Stripe</th>
<th>2nd Stripe</th>
<th>Designator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>0</td>
<td>White</td>
<td>Black</td>
<td>Brown</td>
<td>901</td>
<td>White</td>
<td>Orange</td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
<td>White</td>
<td>Black</td>
<td>Red</td>
<td>902</td>
<td>White</td>
<td>Orange</td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>White</td>
<td>Black</td>
<td>Orange</td>
<td>903</td>
<td>White</td>
<td>Blue</td>
</tr>
<tr>
<td>Orange</td>
<td>3</td>
<td>White</td>
<td>Black</td>
<td>Yellow</td>
<td>904</td>
<td>White</td>
<td>Violet</td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
<td>White</td>
<td>Black</td>
<td>Green</td>
<td>905</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
<td>White</td>
<td>Black</td>
<td>Blue</td>
<td>906</td>
<td>White</td>
<td>Green</td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
<td>White</td>
<td>Black</td>
<td>Violet</td>
<td>907</td>
<td>White</td>
<td>Blue</td>
</tr>
<tr>
<td>Violet</td>
<td>7</td>
<td>White</td>
<td>Black</td>
<td>Gray</td>
<td>908</td>
<td>White</td>
<td>Violet</td>
</tr>
<tr>
<td>Gray</td>
<td>8</td>
<td>White</td>
<td>Brown</td>
<td>Red</td>
<td>912</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>White</td>
<td>9</td>
<td>White</td>
<td>Brown</td>
<td>Orange</td>
<td>913</td>
<td>White</td>
<td>Green</td>
</tr>
<tr>
<td>White</td>
<td>90</td>
<td>White</td>
<td>Brown</td>
<td>Yellow</td>
<td>914</td>
<td>White</td>
<td>Blue</td>
</tr>
<tr>
<td>White</td>
<td>91</td>
<td>White</td>
<td>Brown</td>
<td>Green</td>
<td>915</td>
<td>White</td>
<td>Violet</td>
</tr>
<tr>
<td>White</td>
<td>92</td>
<td>White</td>
<td>Brown</td>
<td>Blue</td>
<td>916</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>White</td>
<td>93</td>
<td>White</td>
<td>Brown</td>
<td>Violet</td>
<td>917</td>
<td>White</td>
<td>Green</td>
</tr>
<tr>
<td>White</td>
<td>94</td>
<td>White</td>
<td>Brown</td>
<td>Gray</td>
<td>918</td>
<td>White</td>
<td>Blue</td>
</tr>
<tr>
<td>White</td>
<td>95</td>
<td>White</td>
<td>Blue</td>
<td>Orange</td>
<td>923</td>
<td>White</td>
<td>Violet</td>
</tr>
<tr>
<td>White</td>
<td>96</td>
<td>White</td>
<td>Red</td>
<td>Yellow</td>
<td>924</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>White</td>
<td>97</td>
<td>White</td>
<td>Red</td>
<td>Green</td>
<td>925</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>White</td>
<td>98</td>
<td>White</td>
<td>Red</td>
<td>Blue</td>
<td>926</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>White</td>
<td>99</td>
<td>White</td>
<td>Red</td>
<td>Violet</td>
<td>927</td>
<td>White</td>
<td>Gray</td>
</tr>
</tbody>
</table>
APPENDIX A
Upgrading Grade 2 Devices
for Use in Grade 1 Applications

Both PPL-17 and MIL-STD-975 have sections in which no Grade 1 part is listed. This Appendix lists what is recommended by GSFC to upgrade a Grade 2 part for use in a Grade 1 application. In most cases, GSFC guidelines are the same as those in MIL-STD-975. Where differences exist, they are defined in the appropriate paragraphs. In addition, the PPL provides upgrading alternatives to those described in MIL-STD-975 for semiconductor devices. Upgraded parts should be identified by a special marking on each piece or on the package. Where package marking is used, parts control procedures must be instituted so that the identity of upgraded parts is not lost. In all cases, the upgrading of a Grade 2 part for use in a Grade 1 application requires a non-standard part approval request.

For the upgrading of diodes, transistors, microcircuits and filters, GSFC requires the sampling plan for destructive physical analysis (DPA) to be based on a “lot”. A lot is defined as all parts with identical part numbers and lot-date codes.

The sampling plan for DPA, used in this Appendix, is taken from GSFC S-311-70. The sample sizes shown below apply to all methods of upgrading of semiconductor devices given in this Appendix.

<table>
<thead>
<tr>
<th>Lot Size</th>
<th>No. Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>1</td>
</tr>
<tr>
<td>5-15</td>
<td>2</td>
</tr>
<tr>
<td>16-50</td>
<td>3</td>
</tr>
<tr>
<td>&gt;50</td>
<td>5</td>
</tr>
</tbody>
</table>

A-1 PPL 17
September, 1984
Section 1 — CAPACITORS

For styles listed in MIL-STD-975, see Appendix B of that document. For styles listed in PPL-17, where the appropriate Failure Rate is not available, a non-standard part approval is required to use a part with the next higher failure rate.

Section 3 — FILTERS

Grade 2 filters listed in PPL-17 and MIL-STD-975 may be upgraded for use in Grade 1 applications by performing the following additional sequence of tests and examinations:

(a) Visually examine the filters externally, for any damage or evidence of poor workmanship in accordance with 4.6.1.1 of MIL-F-28861.

(b) Radiographic examination in accordance with 4.6.8 of MIL-F-28861.

(c) Thermal shock test in accordance with 4.6.2.1 of MIL-F-28861. The filters shall be mounted in accordance with 4.6.2.1b, therein. Following the test and measurements, the filters shall be maintained in their torqued and mounted configuration for the subsequent voltage conditioning tests.

(d) Voltage condition the filters for 168 hours in accordance with 4.6.2.2.2 of MIL-F-28861. In addition to the electrical measurements required after the conditioning, visually examine the filters for any damage or evidence of physical degradation.

(e) Hermeticity tests on hermetically sealed filters in accordance with 4.6.9b of MIL-F-28861. The fine leak rate shall not exceed $1 \times 10^{-7}$ atm cc/sec, and there shall be no continuous stream of bubbles emanating from the filter during gross leak tests.

(f) Destructive physical analysis in accordance with Appendix D of MIL-F-28861, except that the sample size shall be as shown on page A-1 of this Appendix.

Section 4 — FUSES

GSFC considers the fuses in Section 4 of PPL-17 to be suitable for Grade 1 use when they are screened according to Table 04 in Appendix C.
Section 5 — INDUCTORS

For styles listed in MIL-STD-975, see Appendix B of that document.

Section 6 — RELAYS

If it is not possible to use one of the S-311-P-2(06) relays listed in PPL-17, then consult the parts specialist for advice in selection of a suitable relay.

Section 7 — RESISTORS

(a) When the appropriate Failure Rate is not available, a non-standard part approval is required to use the next higher available rate.

(b) For resistor networks listed in MIL-STD-975, see Appendix B of that document, except that a DPA shall be performed on a sample prior to the upgrading tests. See page A-1 of this Appendix for the DPA sample size.

Section 8 — DIODES

Grade 2 JANTXV diodes listed in PPL-17 and MIL-STD-975 may be upgraded for use in Grade 1 applications by two methods:

(a) In accordance with Appendix B of MIL-STD-975.

(b) When a procurement consists of not more than 200 parts, perform destructive physical analysis on samples in accordance with GSFC S-311-70. Rescreen the JTXV diodes to the JANS screening requirements (except for internal visual inspection and stability tests). Power burn-in test on all parts in the lot should be extended to 360 hours with a P.D.A. of 10 percent. Measurements of electrical parameters for which delta limits are prescribed shall be made before and after the burn-in. All other electrical measurements should be made only at the completion of the burn-in with limits as specified in the detail specification.

Referring to note 1, MIL-STD-975, Page B.4, diodes can be upgraded for Grade 1 use without first rescreening them to Grade 2 level. If they have been subjected to screening verification tests (Appendix E), then tests already completed do not have to be repeated in upgrading the parts to Grade 1.
Section 9 — TRANSISTORS

Grade 2 JANTXV transistors listed in PPL-17 and MIL-STD-975 may be upgraded for use in Grade 1 applications by two methods:

(a) In accordance with Appendix B of MIL-STD-975.

(b) When a procurement consists of not more than 200 parts, perform destructive physical analysis on samples in accordance with GSFC S-311-70. Rescreen the JTXV transistors to the JANS screening requirements (except for internal visual inspection and stability tests). Power burn-in test on all parts in the lot should be extended to 360 hours with a P.D.A. of 10 percent. Measurements of electrical parameters for which delta limits are prescribed shall be made before and after the burn-in. All other electrical measurements should be made only at the completion of the burn-in with limits as specified in the detail specification.

Referring to note 1, MIL-STD-975, Page B.4, transistors can be upgraded for Grade 1 use without first rescreening them to Grade 2 level. If they have been subjected to screening verification tests (Appendix E), then tests already completed do not have to be repeated in upgrading the parts to Grade 1.

Section 10 — MICROCIRCUITS

Grade 2 microcircuits may be upgraded for use in Grade 1 applications by two methods:

(a) In accordance with Appendix B of MIL-STD-975.

(b) When a procurement consists of not more than 200 parts, the upgrading requirements given in Table 3.2 of Appendix B of MIL-STD-975 shall be used except that the DPA, therein, shall be replaced with a DPA in accordance with GSFC S-311-70 and the Group B tests of Appendix B eliminated.

Section 14 — THERMISTORS

For styles listed in MIL-STD-975, consult the parts specialist.

Section 15 — TRANSFORMERS

For styles listed in MIL-STD-975, see Appendix B of that document.

Section 16 — WIRE and CABLE

For styles listed in MIL-STD-975, consult the parts specialist.

MISCELLANEOUS

For device types listed in MIL-STD-975 but not in PPL-17, consult the parts specialist.
APPENDIX B
Parts Derating Factors

This Appendix tabulates GSFC's guidelines for the derating of the parts and device types listed in MIL-STD-975 and PPL-17. Many of these derating guidelines are identical to those given in MIL-STD-975. However, where differences occur, the GSFC derating factors shall have precedence. If a derating factor is not provided here for a specific part type, consult the Parts Specialist.
<table>
<thead>
<tr>
<th>Dielectric Class</th>
<th>Maximum Ambient Operating Temperature °C</th>
<th>Derate to Following Percentage (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramic (CKR), (CDR), (CCR)</td>
<td>85</td>
<td>60</td>
<td>N/A</td>
</tr>
<tr>
<td>Plastic Film (CRH) (Note 1)</td>
<td>85</td>
<td>60</td>
<td>N/A</td>
</tr>
<tr>
<td>Glass or Porcelain (CYR)</td>
<td>70</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>Tantalum (Solid Electrolyte) (CSR)</td>
<td>70</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>Tantalum (Wet Electrolyte) (CLR)</td>
<td>70</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>Tantalum Foil (CLR)</td>
<td>70</td>
<td>50</td>
<td>75</td>
</tr>
</tbody>
</table>

NOTES:
1. CRH styles are not approved for use in circuits where the energy is less than 250 μjoules.
2. For applications where the effective circuit resistance is less than one ohm per volt, contact the Parts Specialist.
### Table 02. Derating Outline for Connectors

<table>
<thead>
<tr>
<th>Number of Contacts Used in Connector</th>
<th>Contact Size</th>
<th>Maximum Current Per Contact (^1) (Amperes)</th>
<th>Wire Size (AWG)</th>
<th>Maximum Operating Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>1 to 4</td>
<td>16</td>
<td>13.0</td>
<td>9.2</td>
<td>6.5</td>
</tr>
<tr>
<td>1 to 4</td>
<td>20</td>
<td>6.0</td>
<td>4.5</td>
<td>3.3</td>
</tr>
<tr>
<td>1 to 4</td>
<td>22</td>
<td>4.5</td>
<td>3.3</td>
<td>2.5</td>
</tr>
<tr>
<td>5 to 14</td>
<td>16</td>
<td>9.0</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>5 to 14</td>
<td>20</td>
<td>5.0</td>
<td>3.5</td>
<td>2.7</td>
</tr>
<tr>
<td>5 to 14</td>
<td>22</td>
<td>3.5</td>
<td>2.7</td>
<td>1.9</td>
</tr>
<tr>
<td>15 or more</td>
<td>16</td>
<td>6.5</td>
<td>5.0</td>
<td>3.7</td>
</tr>
<tr>
<td>15 or more</td>
<td>20</td>
<td>3.7</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>15 or more</td>
<td>22</td>
<td>2.5</td>
<td>2.0</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**NOTE:**

1. Maximum current may be carried by only 10% of the contacts at one time. At such time, other contacts should be limited to 100 mA.

### Table 03. Derating Outline for EMI Filters

<table>
<thead>
<tr>
<th>Class</th>
<th>Derate To</th>
<th>Maximum Ambient Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Filters</td>
<td>50% rated feed through current and 50% rated DC working voltage</td>
<td>85°C</td>
</tr>
</tbody>
</table>
Table 04. Derating Outline for Fuses

Subminiature

<table>
<thead>
<tr>
<th>Fuse Current Rating (Amperes)</th>
<th>Derate to the Following (% of Rated Current)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15, 10, 7, 5, 4, 3, 2 1/4, 2</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>1 1/2, 1</td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>3/8</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>1/4</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>1/8</td>
<td>25%</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. Derating factors are based on data from fuses mounted on printed circuit boards and conformally coated. For other type mountings, consult the parts specialist for recommendations.
2. Derating of fuses also allows for possible loss of internal gases in a space environment, which lowers the blow current rating and allows for a decrease of current capability with time.
3. Fuse current ratings are based on a measured blow current of 200% rated current for a maximum of 5 seconds to blow the fuse and a minimum ratio of 4/1 of blow to operating current. The minimum of 4/1 of blow to operating currents corresponds to the 50% derating factor. An 8/1 ratio of blow to operating currents corresponds to the 25% derating factor for the 1/8 ampere fuse. For maximum life in critical space applications, GSFC recommends an 8/1 ratio.

THE FLIGHT USE OF FUSES RATED 1/4 AMPERE AND LESS REQUIRES APPLICATION APPROVAL BY THE APPLICABLE GSFC PROJECT OFFICE.
Table 05. Derating Outline for Inductors/Coils

<table>
<thead>
<tr>
<th>Class Per MIL-C-39010</th>
<th>Class Per MIL-C-15305</th>
<th>Maximum Operating Temperature</th>
<th>Derate To</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>O</td>
<td>65°C</td>
<td>50% of Maximum rated voltage.</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td>85°C</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>105°C</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. a) Maximum operating temperature equals ambient temperature + temperature rise + 10°C (allowance for hot spot).

Temperature rise (°C) = \( \frac{R - r}{T} \) (T + 2345) - (T-t)

Where R = Winding resistance under load
r = No load winding resistance at ambient temperature T(°C).

b) The insulation classes of MIL style inductive parts have maximum operating temperature ratings which are generally based upon a life expectancy of at least 10,000 hrs. The maximum operating temperatures in this table are selected to extend the life expectancy to 50,000 hrs.

c) Custom made inductive devices shall be evaluated on a materials basis and stressed at levels below the maximum rated operating temperature for the materials used. Devices having a maximum rated operating temperature in the range of 85°C to 130°C, shall be derated to: Maximum Operating Temperature (°C) = .75 x Maximum Rated Operating Temperature (°C). For devices with maximum rated temperatures outside this temperature interval consult the parts specialist for temperature derating recommendations.
### Table 06.
**Derating Outline for Relays**

<table>
<thead>
<tr>
<th>Class</th>
<th>Derate To</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Relays</td>
<td>50% of rated contact current</td>
<td>Users are cautioned not to derate coil current or voltage, as this can result in non-operation of the device.</td>
</tr>
</tbody>
</table>

**NOTES:**
1. For additional derating guidelines, see MIL-STD-975, Appendix A.

### Table 07.
**Derating Outline for Resistors**

<table>
<thead>
<tr>
<th>Type</th>
<th>Derate To</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon composition, Style RCR</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
<tr>
<td>Film, General Purpose, Style RLR</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
<tr>
<td>Wirewound, Accurate, Style RBR</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
<tr>
<td>1% Tolerance</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
<tr>
<td>0.5% Tolerance</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
<tr>
<td>0.1% Tolerance, or less</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
<tr>
<td>Wirewound, Power, Chassis Mount, Style RER</td>
<td>60% of Rated Power</td>
<td>(a) Maximum voltage shall not exceed 80% of the maximum rated voltage on any resistor.</td>
</tr>
<tr>
<td>Wirewound, Power, Style RWR</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
<tr>
<td>Variable Trimmers, Styles RTR &amp; RJR</td>
<td>70% of Rated Current</td>
<td></td>
</tr>
<tr>
<td>Film, High Stability, Style RNC</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
<tr>
<td>Film, Fixed, Networks, Style R20</td>
<td>60% of Rated Power</td>
<td></td>
</tr>
</tbody>
</table>
## Table 08.
Derating Outline for Diodes

<table>
<thead>
<tr>
<th>Class</th>
<th>Derate to the Following Percentage</th>
<th>Junction Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diodes, Silicon Rectifiers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diodes, Silicon Small Signal Switching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diodes, Silicon Voltage Reference, Voltage Regulator, Current Regulator, Variable Capacitor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diodes, Other</td>
<td>Consult project parts engineer for identification of parameters to be derated and recommended derating factors. Derating will be determined on an individual part type basis.</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE 1:** All Devices

Derate junction temperature as follows:

\[ T_{J(\text{derated})} = \text{Derating Factor} \times (T_{J(\text{max})} - 25^\circ C) + 25^\circ C \]

- \( T_{J(\text{max})} \) = Manufacturer's specified maximum junction temperature.

**NOTE 2:** Derate average forward current (\( I_{O(\text{allowed})} \)) to satisfy junction temperature derating calculated in note 1, as follows:

- Devices Operated Without Heat Sink (Figure 1)
  \[ I_{O(\text{allowed})} = \text{Derating Factor} \times I_{O(\text{max})} \]  
  \[ I_{O(\text{allowed})} = \text{Derating Factor} \times I_{O(\text{max})} \times \left(1 - \frac{T_{A} - 25^\circ C}{T_{J(\text{derated})} - 25^\circ C}\right), T_{A} > 25^\circ C \]

- \( I_{O(\text{max})} \) = Manufacturer's absolute maximum current rating.
- \( T_{A} \) = Ambient temperature.

- Devices Operated With Heat Sink (Figure 2)
  \[ I_{O(\text{allowed})} = \text{Derating Factor} \times I_{O(\text{max})} \times \left(1 - \frac{T_{C} - T_{D}}{T_{J(\text{derated})} - T_{D}}\right), T_{C} > T_{D} \]

- \( T_{D} = T_{J(\text{derated})} - \text{Derating Factor} \times (T_{J(\text{max})} - T_{D}) \).
- \( T_{D} \) = Case temperature above which \( I_{O(\text{allowed})} \) must be further derated to satisfy derated junction temperature.
- \( T_{M} \) = Maximum case temperature at which manufacturer permits full rated current, \( I_{O(\text{max})} \).
- \( I_{O(\text{max})} \) = Manufacturer's absolute maximum average forward current.

---

**Figure 1.** Derating curve from MIL-HDBK-217 modified to show operating region for devices operated without heat sinks and a Derating Factor of 0.8.

**Figure 2.** Derating curve from MIL-HDBK-217 modified to show operating region for devices operated with heat sinks and a Derating Factor of 0.8.

**NOTES:**

3. In no event shall the junction temperature exceed 125°C.
### Table 09
Derating Outline for Transistors

<table>
<thead>
<tr>
<th>Class</th>
<th>Silicon NPN, PNP</th>
<th>J-FET, MOSFET, N-Channel, P-Channel, Silicon General Purpose, Med. Power, High Power, High Speed Switching</th>
<th>RF NPN, Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Derate to the Following Percentage</td>
<td>Voltage</td>
<td>Current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>

NOTE 1: All devices:
Derate junction temperature as follows:
\[ T_{j}(\text{derated}) = \text{Derating Factor} \times (T_{j}(\text{max}) - 25°C) + 25°C = \text{Maximum recommended operating junction temperature.} \]
\[ T_{j}^{\text{max}} = \text{Manufacturer's specified maximum junction temperature.} \]

NOTE 2: Derate power dissipation to satisfy the junction temperature derating calculated in Note 1, as follows:

**Devices operated without heat sink (Figure 1)**
- \( P_D(\text{allowed}) = \text{Derating Factor} \times P_D^{\text{(max)}}, T_A \leq 25°C \)
- \( P_D(\text{allowed}) = \frac{T_J(\text{derated}) - T_A}{R_{J-A}}, T_A > 25°C \)

- \( P_D^{\text{(max)}} = \text{Mfr's absolute maximum power rating.} \)
- \( R_{J-A} = \text{Junction to ambient thermal resistance from mfr's data sheet (°C/watt).} \)
- \( T_A = \text{Ambient temperature.} \)

**Devices operated with heat sink (Figure 2)**
- \( P_D(\text{allowed}) = \text{Derating Factor} \times P_D^{\text{(max)}}, T_{\text{case}} \leq T_D \)
- \( P_D(\text{allowed}) = \frac{T_J(\text{derated}) - T_{\text{case}}}{R_{J-C}}, T_{\text{case}} > T_D \)

- \( R_{J-C} = \text{Junction to case thermal resistance specified in mfr's data sheet (°C/watt).} \)
- \( T_D = T_J(\text{derated}) - R_{J-C}(\text{Derating Factor} \times P_D^{\text{(max)}}, \text{Junction temperature above which power must be further reduced to satisfy junction temperature requirements.}) \)
- \( P_D^{\text{(max)}} = \text{Mfr's specified absolute maximum power rating.} \)

NOTE 3: In no event shall the junction temperature exceed 125°C.

Figure 1. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated without heat sinks and a Derating Factor of 0.6.

Figure 2. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated with heat sinks and a Derating Factor of 0.6.

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Table 10
Derating, Outline for Microcircuits

<table>
<thead>
<tr>
<th>Microcircuits Parameters</th>
<th>Digital</th>
<th>Interface</th>
<th>Linear</th>
<th>Processors, Peripherals and Memories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Supply Voltages</td>
<td>±5% of nominal</td>
<td>90% of rated</td>
<td>±5% of nominal</td>
<td>±5% of nominal</td>
</tr>
<tr>
<td>2. Supply Current</td>
<td>80%</td>
<td>90%</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>3. Power Dissipation¹</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>(percent of rated power at case temperature)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Frequency</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>(percent of maximum rating)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Output Current</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>(percent of rated current)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Input Voltage</td>
<td>70%</td>
<td>70%</td>
<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

NOTES:
¹ The maximum case temperature is 85°C for all microcircuits.
### Table 14.
**Derating Outline for Thermistors**
*(Temperature Sensitive Resistor)*

<table>
<thead>
<tr>
<th>Class</th>
<th>Derate To</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Thermistors</td>
<td>50% of rated power</td>
</tr>
</tbody>
</table>

### Table 15.
**Derating Outline for Transformers**

<table>
<thead>
<tr>
<th>Class Per MIL-T-27</th>
<th>Class Per MIL-T-21038</th>
<th>Maximum Operating Temperature</th>
<th>Derate To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>Q</td>
<td>65°C</td>
<td>50% of Maximum rated voltage</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
<td>85°C</td>
<td>50% of Maximum rated voltage</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
<td>105°C</td>
<td>50% of Maximum rated voltage</td>
</tr>
</tbody>
</table>

**NOTES:**

1. a) Maximum operating temperature equals ambient temperature + temperature rise + 10°C (allowance for hot spot).
   Compute temperature rise as follows:
   
   \[ \text{Temperature rise (°C)} = \frac{R - r}{r} (T + 234.5) \cdot (T - t) \]
   
   Where:
   
   - \( R \) = Winding resistance under load.
   - \( r \) = No load winding resistance at ambient temperature \( T(°C) \).
   - \( t \) = Initial ambient temperature (°C).
   - \( T \) = Ambient temperature at power shutoff. \( T \) shall not differ from \( t \) by more than 5°C.

b) The insulation classes of MIL style inductive parts have maximum operating temperature ratings which are generally based upon a life expectancy of at least 10,000 hrs. The maximum operating temperatures in this table are selected to extend the life expectancy to 50,000 hrs.

c) Custom made inductive devices shall be evaluated on a materials basis and stressed at levels below the maximum rated operating temperature for the materials used. Devices having a maximum rated operating temperature in the range of 85°C to 130°C, shall be derated to: Maximum Operating Temperature (°C) = 0.75 * Maximum Rated Operating Temperature (°C).
   For devices with maximum rated temperatures outside this temperature interval consult the parts specialist for temperature derating recommendations.
### Table 16. Derating Outline for Wire and Cable

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Derate To - Amperes Maximum</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Bundle or Cable</strong></td>
<td><strong>Single</strong></td>
</tr>
<tr>
<td>30</td>
<td>0.7</td>
<td>1.3</td>
</tr>
<tr>
<td>28</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>26</td>
<td>1.4</td>
<td>2.5</td>
</tr>
<tr>
<td>24</td>
<td>2.0</td>
<td>3.3</td>
</tr>
<tr>
<td>22</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td>20</td>
<td>3.7</td>
<td>6.5</td>
</tr>
<tr>
<td>18</td>
<td>5.0</td>
<td>9.2</td>
</tr>
<tr>
<td>16</td>
<td>6.5</td>
<td>13.0</td>
</tr>
<tr>
<td>14</td>
<td>8.5</td>
<td>19.0</td>
</tr>
<tr>
<td>12</td>
<td>11.5</td>
<td>25.0</td>
</tr>
<tr>
<td>10</td>
<td>16.5</td>
<td>33.0</td>
</tr>
<tr>
<td>8</td>
<td>23.0</td>
<td>44.0</td>
</tr>
<tr>
<td>6</td>
<td>30.0</td>
<td>60.0</td>
</tr>
<tr>
<td>4</td>
<td>40.0</td>
<td>81.0</td>
</tr>
<tr>
<td>2</td>
<td>50.0</td>
<td>108.0</td>
</tr>
<tr>
<td>0</td>
<td>75.0</td>
<td>147.0</td>
</tr>
<tr>
<td>00</td>
<td>87.5</td>
<td>169.0</td>
</tr>
</tbody>
</table>
APPENDIX C
Screening of Non-standard Parts

This PPL is intended to serve as a selection source for standard parts that are properly processed and screened for use in high-reliability space flight applications. Where non-standard parts are selected for use, proper processing and screening of those parts must be determined and applied. Such determinations are the responsibility of the user, with parts engineering assistance, and must consider the type of part, its function, its design, construction, and manufacturing, as well as its significant failure modes and sensitivities. Such a screening program must be developed with the knowledge of the part’s response to use, and to qualification and evaluation testing exercises.

This appendix tabulates a series of recommended screening tests for various types of parts. It is not the intent to delineate an exacting or all-inclusive set of detailed test procedures and requirements for each of a myriad of possible non-standard part selections. Rather, it is intended to stimulate the design of a detailed screening regimen to be incorporated in the part procurement document or screening specification. It brings to bear the combined experiences and knowledge of GSFC and GSFC contractor parts engineers to act as a guide in developing screening for specific parts. It is not intended to be a “cookbook” to be applied without careful consideration of the part to be screened. Furthermore, since there is generally a smaller data base for non-standard parts than preferred parts, the user must assure himself that the specified screens are non-destructive, appropriate parameters and limits are prescribed, and a lot “Percent Defective Allowable” (PDA) is included.

Other techniques, such as Destructive Physical Analysis (DPA), Residual Gas Analysis (RGA), Lot Acceptance Inspections, etc. should be applied where appropriate.
### Table 01. Screening Outline for Capacitors

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>1-3</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Reference Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Examinations and Electrical Tests</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-STD-202</td>
</tr>
<tr>
<td><strong>Visual &amp; C, Q, DWV IR, Driving Torque</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-20</td>
</tr>
<tr>
<td><strong>Test Condition A, except step 3 shall be @ max. rated temperature</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-39014, MIL-C-55681</td>
</tr>
<tr>
<td><strong>Test Condition B, except step 1 shall be @ -55°C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-23269</td>
</tr>
<tr>
<td><strong>Visual &amp; C, DF, DWV, IR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-39001</td>
</tr>
<tr>
<td><strong>Test Condition D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-19978</td>
</tr>
<tr>
<td><strong>Test Condition A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-83421</td>
</tr>
<tr>
<td><strong>Acid Indicator test per GSFC SP 01.23</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-39006, GSFC SP 01.23</td>
</tr>
<tr>
<td><strong>Test Conditions C, D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-39003, GSFC S-311-P-17(01)</td>
</tr>
<tr>
<td><strong>Acid Indicator test per GSFC S-311-P-15(01)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-C-39003</td>
</tr>
<tr>
<td><strong>Visual &amp; C, DF, IR, DWV, Corona</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GSFC S-311-P-15(01)</td>
</tr>
<tr>
<td><strong>Test Condition A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GSFC S-311-P-15(01)</td>
</tr>
<tr>
<td><strong>Rated Voltage @ 85°C and Surge Current Test Per MIL-C-39003/6 (Note 6)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GSFC S-311-P-15(01)</td>
</tr>
</tbody>
</table>

### NOTES:
1. Test procedures and requirements in accordance with those in the applicable Military or NASA referenced document. For additional information see the referenced document.
2. Legend: C = Capacitance, DF = Dissipation Factor, DWV = Dielectric Withstanding Voltage, IR = Insulation Resistance, Q = Quality Factor (Initial electrical tests are optional).
3. Insulation resistance measurements are normally performed at +25°C, but the option is made to perform this measurement at maximum rated temperature as well.
4. Voltage conditioning shall be performed using procedures and requirements of MIL-C-39014 Rev. C or later.
5. Voltage conditioning shall be conducted for 192 hours for polarized styles. For non-polarized styles, voltage conditioning shall be conducted for 192 hours with the voltage polarity reversed after 96 hours.
6. Surge current testing shall be performed on CSR style capacitors for all Grade 1 applications. Where the effective series resistance is < one ohm/volt, consult Part Specialist.
7. Testing at high voltage (DWV, corona) shall be limited to the rated voltage.
8. Seal leak tests apply only to hermetically sealed, unsleeved styles; however, the acid indicator test is required on all tantalum wet slug styles.
9. Final IR measurements to be made at both +25°C and at max. rated temperature.
### Table 03.
Screening Outline for EMI Suppression Filters

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Reference Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Initial Measurements and examination</td>
<td>Thermal Shock</td>
<td>Seal Leak Test</td>
<td>Voltage Conditioning</td>
<td>Final Measurements and examination</td>
<td>MIL-F-28861</td>
</tr>
<tr>
<td></td>
<td>As per MIL-STD-202, Method 107 Test Condition Condition A; except that in step 3, sample units shall be tested at 125°C, or max. rated temperature.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fine and Gross Leak tests (applicable to hermetically sealed devices only).</td>
<td>As per MIL-STD-202, Method 108 at test temperature +125°C, or max. rated temperature, ±3°C. DC rated filter is 2X rated voltage for 164 ± 4 hours. AC rated filter is 1.2X rated voltage for 164 ± 4 hours.</td>
<td>Repeat initial examinations and measurements, except radiographic examinations. Final measurements to be made at both +25°C and at max. rated temperature.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
1. Performance of initial electrical tests is optional.
2. Consult the parts specialist for assistance in screening other types of filters.
3. Filters shall be mounted in a thru-hole and torqued in place on a rigid metal plate to the specified value. Not applicable to solder-in types.
4. At completion of or during the final cycle and before the filter is removed from the plate, measure and record insulation resistance at +125°C, or maximum rated temperature.
5. For voltage conditioning, use the test circuit described in MIL-F-28861, par. 4.6.2.2.2d.
6. After completion of voltage conditioning and while still at +125°C, or maximum rated temperature, the insulation resistance shall be measured per MIL-F-28861, par. 4.6.13.
<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>Category</th>
<th>1 Initial Measurements</th>
<th>2 Thermal Shock</th>
<th>3 Final Measurements</th>
<th>4 Acceptance Criteria</th>
<th>Reference Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fuses, Subminiature</td>
<td>Perform visual and mechanical inspections per paragraph 3.5 of MIL-F-23419.</td>
<td>MIL-STD-202 method 107, condition B</td>
<td>Repeat Initial inspection and measurements Calculate $R_{HOT1}$ (voltage drop/rated current).</td>
<td>GSFC recommends using fuses in lower half of the voltage drop range and those where $R_{HOT1}$ and $R_{HOT2}$ differ by less than 3%</td>
<td>MIL-F-23419</td>
</tr>
<tr>
<td>FM04</td>
<td></td>
<td>Measure cold resistance at 10% or less of rated current.</td>
<td></td>
<td></td>
<td></td>
<td>MIL-F-23419/4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subject fuses to 100% rated current for not less than 5 minutes. Maintain current at this level and measure the voltage drop within the next 5 minutes. Calculate $R_{HOT1}$, (voltage drop/rated current).</td>
<td></td>
<td></td>
<td></td>
<td>MIL-F-23419/8</td>
</tr>
</tbody>
</table>

**NOTES:**
1. Tests shall be designed to minimize the time in excess of 5 minutes that the fuses are subjected to full rated currents. These fuses should not be operated at rated currents for more than 30 minutes or parts may be degraded so that fuse life is reduced. MIL-F-23419 specifies minimum life at 110% of Rated Current to be 1.5 hours according to lot sampling tests. Rated current according to MIL-F-23419 is "the amount of current the fuse will carry indefinitely without interruption."
2. Initial electrical tests are optional.
3. For fuses rated 1/2 ampere and less, time at rated current should be further minimized by measuring parameters at earliest stable reading.
Table 05.
Screening Outline for Inductors/Coils

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>Category</th>
<th>1 Initial Measurements</th>
<th>2 Thermal Shock</th>
<th>3 Burn-In</th>
<th>4 Final Measurements and Delta Reject Criteria</th>
<th>Reference Document</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2. D.C. Resistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Insulation Resistance (IR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Dielectric Withstanding Voltage (DWV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Inductance (L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Q</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Self Resonant Frequency (SRF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. D.C. Resistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Insulation Resistance (IR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Dielectric Withstanding Voltage (DWV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Inductance (L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Q</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Self Resonant Frequency (SRF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Table 06
### General Screening Outline for Relays

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Initial Visual Examination</td>
<td>Initial Seal Leak Tests</td>
<td>Initial Electrical Measurements</td>
<td>Sinusoidal Vibration</td>
<td>High Temp Soak Test</td>
<td>Low Temp Miss Test</td>
<td>Room Temp Miss Test</td>
<td>Final Seal Leak Test</td>
<td>Final Electrical Measurements</td>
<td>Final Visual Examination</td>
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<td><strong>Relays - Latching and Non-Latching</strong></td>
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<td>a. External Visual</td>
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<td>b. Pre-Cap Visual</td>
<td>Fine leaks Test Cond. C</td>
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</table>

### NOTES:
1. These screening tests are to be performed per GSFC S-311-P2(06) in the sequence shown. When the screening is performed by the relay manufacturer, the initial external visual (1), seal leak (2) and electrical measurements (3) are optional. For additional information, consult the Parts Specialist.
2. Pre-cap visuals are applicable only to parts procured to specification, e.g. a source control drawing (SCD), which includes pre-cap visual accept/reject criteria.
3. The test sequence of electrical measurements is optional; also, the performance of initial electrical measurements is optional.
4. For relays rated at higher than 30g, consult the Parts Specialist for screening g-level.
5. Drop out voltage is not applicable to latching relays.
6. A DESTRUCTIVE PHYSICAL ANALYSIS (DPA) SHALL BE PERFORMED PER GSFC S-311-70 IF PRE CAP VISUAL IS NOT PERFORMED.

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### Table 07. (Page 1 of 2)
Screening Outline for Resistors

<table>
<thead>
<tr>
<th>Category</th>
<th>Test Sequence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Reference Document</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Initial</td>
<td>Thermal Shock</td>
<td>Conditioning</td>
<td>Seal Leak Test</td>
<td>Final Measurements and Delta Reject Criteria</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measurements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-R-39008</td>
</tr>
<tr>
<td>Resistors, Fixed, Carbon Comp.</td>
<td>Visual Inspection Resistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistors, Fixed, Film, General Purpose</td>
<td>Visual Inspection Resistance</td>
<td></td>
<td></td>
<td>1.5 x rated power at room temperature for 24 hours</td>
<td></td>
<td></td>
<td>MIL-R-39017</td>
</tr>
<tr>
<td>Resistors, Fixed, Film, High Stability</td>
<td>Visual Inspection Resistance</td>
<td>MIL-STD-202 Method 107 Cond. F</td>
<td>Mil. equivalent styles: Style 50, 55, 60: 5 x rated power at room temperature for 1 hour. Style 65: 4 x rated power at room temperature for 1 hour. Style 70 and 75: 2.25 x rated power at room temperature for 1 hour. Style 90: 6.25 x rated power for 5 seconds at room temperature.</td>
<td>MIL-STD-883 Method 1014 Cond. D (For hermetically sealed units)</td>
<td>Visual Inspection Resistance Reject: ΔR &gt; ±0.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistors, Fixed, Wirewound, Power</td>
<td>Visual Inspection Resistance</td>
<td></td>
<td></td>
<td>1.0 x rated power for 1.5 hours on, 0.5 hour off for 100 hours at 25°C.</td>
<td></td>
<td></td>
<td>MIL-R-39005</td>
</tr>
<tr>
<td>Resistors, Fixed, Wirewound, Power, Chassis Mount</td>
<td>Visual Inspection Resistance</td>
<td></td>
<td></td>
<td>1.0 x rated &quot;free air&quot; power for 1.5 hours on, 0.5 hour off for 96 hours at 25°C.</td>
<td></td>
<td></td>
<td>MIL-R-39009</td>
</tr>
</tbody>
</table>

**NOTES:**
1. For resistors with nontransparent envelopes, perform the dye penetrant leak test of MIL-STD-883, Method 1014, Cond. D, except substitute the following post exposure inspection procedure:
   (a) thoroughly cleanse the resistors to remove external dye;
   (b) at a minimum temperature of 80°C rotate the resistors about their longitudinal axes (maintain the longitudinal axes horizontal) for a minimum of 2 minutes;
   (c) inspect for evidence of dye leakage.

Reference Document:
- MIL-R-39008
- MIL-R-39017
- MIL-R-55182
- MIL-R-39005
- MIL-R-39007
- MIL-R-39009

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<table>
<thead>
<tr>
<th>Category</th>
<th>Test Sequence</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>Reference Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistors, Variable, Wirewound, Low Power</td>
<td>Initial</td>
<td>Visual Inspection</td>
<td>Thermal Shock</td>
<td>Conditioning</td>
<td>Seal Leak Test 2</td>
<td>Final Measurements</td>
<td>MIL-R-39015</td>
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<td>Measurements</td>
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<td>—</td>
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<td>and Delta Reject Criteria</td>
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<tr>
<td>Resistors, Variable, Non-Wirebound, Low Power</td>
<td>Visual</td>
<td>Visual Inspection</td>
<td>Visual Inspection</td>
<td>1 watt power for 1.5 hours on, 0.5</td>
<td>—</td>
<td>Visual Inspection, Resistance, Peak</td>
<td>MIL-R-39035</td>
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<tr>
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<td>Inspection</td>
<td>Resistance</td>
<td>Resistance</td>
<td>hour off for 50 hours at 25°C.</td>
<td>—</td>
<td>Noise, Continuity, End Resistance,</td>
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<tr>
<td></td>
<td>Resistance</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Torque Reject: ΔR &gt; ±0.5%</td>
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<tr>
<td>Resistors, Fixed Networks</td>
<td>Visual Inspection</td>
<td>MIL-STD-202 Method 107 Cond. B</td>
<td>1.0 x rated power for 1.5 hours on, 0.5</td>
<td>MIL-STD-202 Method 112 Cond. C</td>
<td>Visual Inspection, Resistance, Contact</td>
<td>ΔR &gt; ±2% (char. C)</td>
<td>MIL-R-83401</td>
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<tr>
<td></td>
<td>Resistance</td>
<td>Method 107</td>
<td>hour off for 100 hours at 25°C.</td>
<td>Cond. C</td>
<td>Resistance, End Resistance Torque</td>
<td>ΔR &gt; ±1.5% (char. F)</td>
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<tr>
<td></td>
<td></td>
<td>(For hermetically sealed units)</td>
<td></td>
<td></td>
<td>Reject: ΔR &gt; ±1% (char. H)</td>
<td>ΔR &gt; ±1% (char. H)</td>
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<table>
<thead>
<tr>
<th>Test Sequence</th>
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<tr>
<td></td>
<td>Internal Visual Inspection</td>
<td>Initial Insp. &amp; Electrical Parameter Measurements</td>
<td>High Temperature Storage</td>
<td>Thermal Shock (Temperature Cycling)</td>
<td>Acceleration</td>
<td>PIND-2</td>
<td>Seal Leak Tests</td>
<td>Pre-Power and Reverse Bias Burn-In Electrical Measurements</td>
<td>Reverse Bias Burn-In (Notes 2, 6)</td>
<td></td>
</tr>
<tr>
<td>b. Diodes, Switching, Silicon</td>
<td>MIL-STD-750 Method 2071</td>
<td>Test Condition C, except 10 cycles; except the maximum temperature shall be 125°C (Note 3.)</td>
<td>MIL-STD-750 Method 2006, except test shall be 20,000 G in Y orientation only, one time only. (Note 1.)</td>
<td>MIL-STD-750 Method 2006</td>
<td>Read and record BV and Z.</td>
<td>Same as above except 96 hrs Ia* rated value.</td>
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<tr>
<td>c. Diodes, Voltage Reference, Silicon</td>
<td>(Note 2.)</td>
<td>(Note 1.)</td>
<td>Same as above except 9000 G</td>
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<tr>
<td>d. Diodes, Voltage Regulator, Silicon</td>
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<td>e. Diodes, Power Rectifier, Silicon, (Fast Recovery or Gen. Purposes)</td>
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NOTES:
1. Performance of electrical measurements at sequence 2 is optional. Measurements at high and low temperatures are also optional at this point, however, if performed here they need not be performed in sequence 13. For Grade 1 applications, high and low temperature measurements shall be made on all parts; whereas LTPD sampling is permissible for Grade 2 applications.
2. Tests shall be conducted at the maximum operating temperature. If parts have leads that are not gold-plated, they may be subject to tarnishing at temperatures greater than 125°C. Therefore, such parts must be tested in an inert atmosphere. After test, leads should be inspected for tarnishing, and refinished if necessary.
3. For axial lead glass body diodes, 10 cycles of thermal shock (glass strain) in accordance with MIL-STD-750, method 1056, test condition A, over the temperature range 0° to +100°C shall be substituted for this test.
4. Particle Impact Noise Detection (PIND) shall be performed only on parts with internal package cavities.
5. For Grade 2 applications, the seal leak tests may be performed at either test sequence 7 or 14. For Grade 1 applications, the tests must be performed in test sequence 14; in addition the test may be performed in test sequence 7, as well.
6. Reverse bias remains applied at the end of burn-in until Tq reaches 30°C.
<table>
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<tr>
<th>Test Sequence</th>
<th>Part Category</th>
<th>Category</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>11</td>
<td>b. Diodes, Switching Silicon</td>
<td>b. Diodes, Switching Silicon</td>
<td>Read and record $V_T$ and $I_B$, and calculate deltas.</td>
</tr>
<tr>
<td>14</td>
<td>e. Diodes, Power Rectifiers, Silicon (Fast Recovery or General Purpose)</td>
<td>e. Diodes, Power Rectifiers, Silicon (Fast Recovery or General Purpose)</td>
<td>Read and record $V_T$ and $I_B$, and calculate deltas.</td>
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</table>

**Notes:**
- MIL-STD-750 Method 1038 Test: Condition B, 168 hours at specified $V_T$ and $I_B$ with $f = 60$ Hz. $T_A = 25^\circ C$.
- MIL-STD-750 Method 1071.1, Fine Leak: Test Condition G or H, Gross Leak: Test Condition C. (Note 5)
- MIL-STD-750 Method 2076 required for Grade 1, Optional for Grade 2.
- MIL-STD-750 Method 2071; 3X min.

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<th>Test Sequence</th>
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<td>Internal Visual (Precap) Inspection</td>
<td>Initial Insp. &amp; Electrical Parameter Measurements</td>
<td>High Temperature Storage</td>
<td>Thermal Shock (Temperature Cycling)</td>
<td>Acceleration</td>
<td>PNQ²</td>
<td>Seal Leak Tests</td>
<td>Pre-Power and Reverse Bias Burn-In Electrical Measurements</td>
<td>Reverse Bias Burn-In (Notes 2, 6)</td>
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<td><strong>f. Diodes, Voltage-Variable Capacitor, Silicon</strong></td>
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<td>g. Thyristors, (Silicon Controlled Rectifiers)</td>
<td>MIL-STD-750 Method 2074. This test can only be performed by manufacturer when specified in procurement document.</td>
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<td>i. Diodes, Switching, PIN</td>
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<td>j. Diodes, Light Emitting</td>
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<tr>
<td>M. MIL-STD-750 Method 2052 Only for Grade 1 screening (Note 4)</td>
<td>MIL-STD-750 Method 2052, Method 1071, Fine Leak: Test Condition C or H. Gross Leak: Test Condition C. (Note 5)</td>
<td>MIL-STD-750 Method 2006 except test shall be 20,000g in Y₅ orientation only, one time only.</td>
<td></td>
<td></td>
<td>Read and record I₉</td>
<td>Same as above except 96 hrs at Tₕ = 125°C with Rₕ and V₉FBXM at rated values. Note: Thyristors which turn on during this burn-in shall be rejected.</td>
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</tr>
<tr>
<td>L. Read and record V₉, VB, and Iₕ</td>
<td>Read and record Iₕ and I₉</td>
<td>Read and record Iₕ and V₉</td>
<td>Read and record Iₕ and VB</td>
<td>Read and record Iₕ and VB.</td>
<td>Read and record Iₕ and VB.</td>
<td>Read and record Iₕ and VB.</td>
<td>Read and record Iₕ and VB.</td>
<td>Read and record Iₕ and VB.</td>
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1. Table 08. (page 3 of 4) Screening Outline for Diodes

2. Table 08. (page 3 of 4) Screening Outline for Diodes

3. Table 08. (page 3 of 4) Screening Outline for Diodes

4. Table 08. (page 3 of 4) Screening Outline for Diodes

5. Table 08. (page 3 of 4) Screening Outline for Diodes

6. Table 08. (page 3 of 4) Screening Outline for Diodes

7. Table 08. (page 3 of 4) Screening Outline for Diodes

8. Table 08. (page 3 of 4) Screening Outline for Diodes

9. Table 08. (page 3 of 4) Screening Outline for Diodes
Table 08. (page 4 of 4 )
Screening Outline for Diodes

<table>
<thead>
<tr>
<th>Part Category</th>
<th>Test Sequence</th>
<th>Post Reverse Bias Burn-In Electrical Measurements</th>
<th>Power Burn-In</th>
<th>Post Power Burn-In Electrical Measurements</th>
<th>Final Electrical Parameter Measurements</th>
<th>Seal Leak Tests</th>
<th>Radiograph</th>
<th>External Visual Examination</th>
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</thead>
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<tr>
<td>f. Diodes, Voltage-Variable Capacitor, Silicon</td>
<td>10</td>
<td>Read and record Iq and calculate delta.</td>
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<tr>
<td>g. Thyristors, Silicon Controlled Rectifiers</td>
<td></td>
<td>Read and record Iraxm, Iraxm, VOr and IGT and calculate delta.</td>
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<td></td>
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</tr>
<tr>
<td>h. Diodes, Current Regulator, Silicon</td>
<td></td>
<td>MIL-STD-750 Method 1038 168 hours at $T_R = 25°C$ and $P_{OV}$ (Peak Operating Voltage) = maximum rated value.</td>
<td>Read and record Iq and calculate delta.</td>
<td></td>
<td>1.1 Measure $25°C$ electrical parameters except those measured in sequence 12.</td>
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</tr>
<tr>
<td>i. Diodes, Switching, Schottky Barrier, Silicon</td>
<td></td>
<td>Same as above except Test Condition B. 168 hours at $T_R = 25°C$ at specified $V_D$ and $I_D$ with $f = 60$ Hz.</td>
<td>Read and record VB and Iq and calculate delta.</td>
<td></td>
<td>2. Electrical parameters at maximum operating temperature extremes. (Note 1)</td>
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</tr>
<tr>
<td>j. Diodes Switching, PIN</td>
<td></td>
<td>Same as above except 168 hours at $T_R (or T_C) = 25°C$. $I_D$ = 80% of maximum rated continuous forward current.</td>
<td>Read and record VD and Iq and calculate delta.</td>
<td></td>
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</tr>
<tr>
<td>k. Diode, Light Emitting</td>
<td></td>
<td></td>
<td></td>
<td>Read and record VD and $P_D$ and calculate delta.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. MIL-STD-750, Method 1071.3 Fine Leak: Test Condition G or H, Gross Leak: Test Condition E. (Note 5)
2. MIL-STD-750, Method 2075, Fine Leak: Test Condition H. (Note 5)
3. MIL-STD-750, Method 2071, Optional for Grade 1 screening.
4. MIL-STD-750, Method 2071, 3X min.
5. MIL-STD-750, Method 2071.

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# Table 09. (page 1 of 4)
## Screening Outline for Transistors

<table>
<thead>
<tr>
<th>Part Category</th>
<th>Test Sequence</th>
<th>Internal Visual (Precaution Inspection)</th>
<th>Initial Inspection &amp; Electrical Parameter Measurements</th>
<th>High Temperature Storage</th>
<th>Thermal Shock (Temperature Cycling)</th>
<th>Acceleration</th>
<th>PIND</th>
<th>Seal Leak Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Transistors, Silicon, NPN, Low, Medium Power, Switching or General Purpose</td>
<td>1</td>
<td>MIL-STD-750 Method 2072. (This test can only be performed by the manufacturer, when specified in procurement document.)</td>
<td>1. Visual Inspection per MIL-STD-750, Method 2071, 3X min.</td>
<td>MIL-STD-202 Method 107F Test Condition C, except 10 cycles, except the maximum temperature shall be 125°C</td>
<td>MIL-STD-750 Method 2006 except that test shall be 20,000 g in Y₁ orientation, one time only. The 1 min hold-time requirement shall not apply.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Transistors, Silicon, PNP, Low, Medium Power, Switching or General Purpose</td>
<td>1</td>
<td>MIL-STD-750 Method 2072. (This test can only be performed by the manufacturer, when specified in procurement document.)</td>
<td>1. Visual Inspection per MIL-STD-750, Method 2071, 3X min.</td>
<td>MIL-STD-202 Method 107F Test Condition C, except 10 cycles, except the maximum temperature shall be 125°C</td>
<td>MIL-STD-750 Method 2006 except that test shall be 20,000 g in Y₁ orientation, one time only. The 1 min hold-time requirement shall not apply.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Transistors, Silicon, PNP, High Power</td>
<td>1</td>
<td>MIL-STD-750 Method 2072. (This test can only be performed by the manufacturer, when specified in procurement document.)</td>
<td>1. Visual Inspection per MIL-STD-750, Method 2071, 3X min.</td>
<td>MIL-STD-202 Method 107F Test Condition C, except 10 cycles, except the maximum temperature shall be 125°C</td>
<td>MIL-STD-750 Method 2006 except that test shall be 20,000 g in Y₁ orientation, one time only. The 1 min hold-time requirement shall not apply.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Transistors, Silicon, PNP, High Power</td>
<td>1</td>
<td>MIL-STD-750 Method 2072. (This test can only be performed by the manufacturer, when specified in procurement document.)</td>
<td>1. Visual Inspection per MIL-STD-750, Method 2071, 3X min.</td>
<td>MIL-STD-202 Method 107F Test Condition C, except 10 cycles, except the maximum temperature shall be 125°C</td>
<td>MIL-STD-750 Method 2006 except that test shall be 20,000 g in Y₁ orientation, one time only. The 1 min hold-time requirement shall not apply.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Transistors, Field-Effect, Junction, N-Channel, Silicon</td>
<td>1</td>
<td>MIL-STD-750 Method 2072. (This test can only be performed by the manufacturer, when specified in procurement document.)</td>
<td>1. Visual Inspection per MIL-STD-750, Method 2071, 3X min.</td>
<td>MIL-STD-202 Method 107F Test Condition C, except 10 cycles, except the maximum temperature shall be 125°C</td>
<td>MIL-STD-750 Method 2006 except that test shall be 20,000 g in Y₁ orientation, one time only. The 1 min hold-time requirement shall not apply.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Transistors, Field-Effect, Junction, P-Channel, Silicon</td>
<td>1</td>
<td>MIL-STD-750 Method 2072. (This test can only be performed by the manufacturer, when specified in procurement document.)</td>
<td>1. Visual Inspection per MIL-STD-750, Method 2071, 3X min.</td>
<td>MIL-STD-202 Method 107F Test Condition C, except 10 cycles, except the maximum temperature shall be 125°C</td>
<td>MIL-STD-750 Method 2006 except that test shall be 20,000 g in Y₁ orientation, one time only. The 1 min hold-time requirement shall not apply.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. Performance of electrical measurements at sequence 2 is optional. Measurements at high and low temperatures are also optional at this point; however, if performed here they need not be performed at sequence 12. For Grade 1 applications, high and low temperature measurements shall be made on all parts; whereas, LPTD sampling is permissible for Grade 2 applications.

2. Tests shall be conducted at the maximum operating temperature. If parts have leads that are not gold-plated they may be subject to tarnishing at temperature greater than 125°C. Therefore, such parts must be tested in an inert atmosphere. After test, leads should be inspected for tarnishing, and refinished if necessary.

3. Particle Impact Noise Detection (PIND) shall be performed only on parts with internal package cavities.

4. For Grade 2 applications, the seal leak tests may be performed at either test sequence 7 or 14. For Grade 1 applications, the tests must be performed in test sequence 14. In addition, the test may be performed in test sequence 7.

5. Reverse bias remains applied at the end of burn-in until Tₘ reaches 30°C in test sequence 8.

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Screening Outline for Transistors

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>Part Category</th>
<th>Reverse Bias Burn-in (Notes 2, 5)</th>
<th>Pre-Burn-In Electrical Measurements</th>
<th>Burn-in (Notes 2, 5)</th>
<th>Post-Burn-In Tests Measurements</th>
<th>Final Electrical Parameter Measurements</th>
<th>Seal Leak Tests (Note 4)</th>
<th>Radiography</th>
<th>External Visual Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Transistors, Silicon, NPN, Low, Medium Power, Switching or General Purpose</td>
<td>MIL-STD-750 Method 1039 48 Hours at $V_{CB} = 80%$ of $V_{CEO}$ $T_a = 0$</td>
<td>Read and record $I_{cb}$ and $h_{fe}$</td>
<td>MIL-STD-750 Method 1039 168 hrs at specified $V_{ce}$ and $P_{d}$ (max. power dissipation at $T_a$)</td>
<td>Read and record $I_{cb}$ and $h_{fe}$ and calculate deltas.</td>
<td>1.) Measure $25^\circ$C electrical parameters except those measured in sequence 11. 2.) Electrical parameters at maximum operating temperature extremes. (Note 1)</td>
<td>1.) Measure $25^\circ$C electrical parameters except those measured in sequence 11. 2.) Electrical parameters at maximum operating temperature extremes. (Note 1)</td>
<td>MIL-STD-750 Method 1071.1 Fine Leak: Test Condition G or H Gross Leak: Test Condition C. Only for Grade 1 screening</td>
<td>MIL-STD-750 Method 2026 Optional for Grade 2, Required for Grade 1</td>
<td>MIL-STD-750 Method 2072 3X min.</td>
</tr>
<tr>
<td>b. Transistors, Silicon, PNP, Low, Medium Power, Switching or General Purpose Purpose</td>
<td>Same as above except $P_d$ at case temperature specified</td>
<td>Same as above except specified $V_{ce}$ and $V_{DS}$</td>
<td>Read and record $I_{oss}$, $V_{oss}$ and $I_{igs}$ and calculate deltas.</td>
<td>Same as above except fine leak rejection value $9 \times 10^{-7}$ atm cc/sec. Only for Grade 1 screening</td>
<td>Same as above except fine leak rejection value $9 \times 10^{-7}$ atm cc/sec. Only for Grade 1 screening</td>
<td>Same as above except fine leak rejection value $9 \times 10^{-7}$ atm cc/sec. Only for Grade 1 screening</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Transistors, Silicon, PNP, High Power</td>
<td>Read and record $I_{oss}$, $V_{oss}$ and $I_{igs}$ and calculate deltas.</td>
<td>Read and record $I_{cb}$ and $h_{fe}$ and calculate deltas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Transistors, Silicon, NPN, High Power</td>
<td></td>
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<td></td>
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<tr>
<td>e. Transistors, Field-Effect, Junction, N-Channel, Silicon</td>
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<tr>
<td>f. Transistors, Field-Effect, Junction, P-Channel, Silicon</td>
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<tr>
<td>Part Category</td>
<td>Test Sequence</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
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<td>---------------</td>
<td></td>
</tr>
<tr>
<td>g. Transistors, Silicon, Unijunction</td>
<td>Internal Visual (Precap) Inspection</td>
<td>Initial Inspection &amp; Electrical Parameter Measurements</td>
<td>High Temperature Storage (Note 2)</td>
<td>Thermal Shock (Temperature Cycling)</td>
<td>Acceleration</td>
<td>PIN0^2</td>
<td>Seal Leak Tests (Note 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Transistors, Silicon, Chopper</td>
<td>MIL-STD-750 Method 2072. This test can only be performed by the manufacturer, when specified in procurement document.</td>
<td>1. Visual Inspection per MIL-STD-750 Method 2071. 3X min.</td>
<td>MIL-STD-750 Method 1022. Store for 48 hours. (Note 2)</td>
<td>MIL-STD-150 Method 2006 except that test shall be 30,000 g in Y orientation, and 1 cycle only. The 1 min. hold-time requirement shall not apply.</td>
<td>MIL-STD-750 Method 2052</td>
<td>Only for Grade 2 screening (Note 3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Phototransistor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Optically Coupled Isolator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note 1:**
- Acceleration: MIL-STD-750 Method 2006 except that test shall be 30,000 g in Y orientation, and 1 cycle only. The 1 min. hold-time requirement shall not apply.
- Seal Leak Tests: MIL-STD-750 Method 2052 Only for Grade 2 screening (Note 3).

**Note 2:**

**Note 3:**
- Phototransistor: Only for Grade 2 screening.
- Optically Coupled Isolator: Only for Grade 2 screening.

**Note 4:**
- Seal Leak Tests: MIL-STD-750 Method 2052 Only for Grade 2 screening (Note 3).
# Table 09. (page 4 of 4)
## Screening Outline for Transistors

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Category</td>
<td></td>
<td>Pre Burn-in Electrical Measurements</td>
<td>Burn-in (Note 2)</td>
<td>Post-Burn-in Electrical Measurements</td>
<td>Final Electrical Parameter Measurements</td>
<td>Seal Leak Tests (Note 4)</td>
<td>Radiography</td>
<td>External Visual Examination</td>
</tr>
<tr>
<td>g. Transistors, Silicon, Unijunction</td>
<td></td>
<td>Read and record $I_{CEO}$, $R_{BS}$, and $n$.</td>
<td>MIL-STD-750 Method 1039 168 hrs at specified $V_{G(BI)}$ and $I_{E(BI)}$. (Maximum rated power.)</td>
<td>Read and record $I_{E(BI)}$, $R_{E(BI)}$, and $n$ and calculate deltas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Transistors, Silicon, Chopper</td>
<td>MIL-STD-750 Method 1039 48 Hours at: $V_{CE} = 80%$ of $V_{CEO}$ $E_e = 0$</td>
<td>Read and record $I_{CEO}$ and $h_{FE}$ (inverted).</td>
<td>Same as above except at specified $V_{CE}$ and $P_T$. (Max rated power dissipation at $T_A$.)</td>
<td>Read and record $I_{CEO}$ and $h_{FE}$ (inverted) and calculate deltas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Phototransistor</td>
<td>Same as above except 48 hrs at: $V_{CE} = 80%$ of $V_{CEO}$ $E_e$ (incident radiant energy) = 0</td>
<td>Read and record $I_{D}$ and $I_{L}$.</td>
<td>Same as above except at specified $V_{CE}$-Adjust $E_e$ (incident radiant energy) for $P_T = 80%$ of maximum continuous device dissipation</td>
<td>Read and record $I_{D}$ and $I_{L}$ and calculate deltas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Optically Coupled Isolator</td>
<td>Same as above except Test Condition A, $V_{CE} = 80%$ of $V_{CEO}$</td>
<td>Read and record Phototransistor: $I_{C(D/O)}$, $I_{C(ON)}$, $h_{FE}$, LED, $I_R$</td>
<td>Same as above except at max. rated $V_{CEO}$ $P_T = 80%$ of maximum continuous device dissipation</td>
<td>Read $V_{CE}$ (OFF), $I_{C(ON)}$, $h_{FE}$, and $I_R$ and record and calculate deltas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### Table 10. Screening Outline For Microcircuits

<table>
<thead>
<tr>
<th>Screening Sequence</th>
<th>Grade</th>
<th>Internal Visual (Precap)</th>
<th>Initial Electrical Measurements</th>
<th>Stabilization Bake</th>
<th>Temperature Cycling</th>
<th>Constant Acceleration</th>
<th>Particle Impact Noise Detection (PIND)</th>
<th>Seal</th>
<th>Interim Electrical Parameter Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>Same as Grade 1 except condition B</td>
<td>Same as Grade 1</td>
<td>Same as Grade 1</td>
<td>Same as Grade 1</td>
<td>Same as Grade 1</td>
<td>Same as Grade 1</td>
<td>Same as Grade 1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Screening Sequence</th>
<th>Grade</th>
<th>Burn-In</th>
<th>Interim Electrical Parameter Measurements</th>
<th>Reverse Bias Burn-In</th>
<th>Final Electrical Measurements</th>
<th>Radiographic</th>
<th>External Visual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>Same as Grade 1 except 160 hrs.</td>
<td>CMOS only</td>
<td>Same as Grade 1</td>
<td>Same as Grade 1</td>
<td>Not required</td>
<td>Same as Grade 1</td>
</tr>
</tbody>
</table>

**NOTES:**

1. Performance of electrical measurements at this point is optional. However, if high and low measurements are performed here, they need not be repeated in sequence 12. High and low temperature DC parameter measurements shall be made on all parts. AC parameter measurements are only required at +25°C. Therefore, such parts must be tested in an inert atmosphere. After test, leads should be inspected for tarnishing, and refinished if necessary.

2. If parts have leads that are not gold-plated, they may be subject to tarnishing at temperatures greater than 125°C. Therefore, parts must be tested in an inert atmosphere. After test, leads should be inspected for tarnishing, and refinished if necessary.

3. For microcircuit packages having an inner seal or cavity perimeter greater than 2 inches, or a mass greater than 5 grams, refer to MIL-STD-883B, Method 5004, paragraph 3.2 for acceleration instructions.

4. Radiographic tests may be performed in any sequence after PIND test.

5. The parameter measurements and delta calculations required for both grade 1 & grade 2 screening shall include those parameters and deltas (including measurements for each test condition for each parameter) specified in the MIL-M-38510 slash sheet for the selected part. If no slash sheet is available for the selected part, model the parameter and delta requirements from a slash sheet for a similar part type. If no slash sheet is available for selected or similar part types, consult the Parts Specialist for recommendations.

6. Screening sequence 11 not required except for CMOS parts. Also, for CMOS parts, a Static I and Static II burn-in is required per MIL-M-38510 for class S devices.

7. The order of the burn-ins for steps 9 and 11 is optional.

8. Min. and Max. operating temperature parameter measurements are optional here if performed in sequence 2.
## Table 14.
### Screening Outline for Thermistors

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Thermistors, Fixed Silicon (Positive Temp. Coef.)</td>
<td>Zero-Power Resistance at 25°C</td>
<td>Not Required</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

MIL-T-23648 Paragraph 4.6.1

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<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>Category</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transformers, Audio and Power</td>
<td>Initial Measurements</td>
<td>Thermal Shock</td>
<td>Burn-In</td>
<td>Seal Leak Test</td>
<td>Final Measurements and Delta Reject Criteria</td>
</tr>
<tr>
<td></td>
<td>1. Visual Examination</td>
<td>MIL-STD-202, Method 107, Test Condition A-1. Use maximum temperature specified for transformer as maximum temperature.</td>
<td>MIL-STD-981 Par. 30.1.2.1.</td>
<td>Do not perform these tests on encapsulated units. MIL-STD-202, Method 112, Test Condition C for Fine Leak, Test Condition D for Gross Leak. Use maximum temperature specified for transformer as bath temperature.</td>
<td>Repeat initial examinations and measurements. Reject; ( \Delta L &gt; \pm 5% ), ( \Delta DCR &gt; \pm 5% )</td>
<td>Reference Documents</td>
</tr>
<tr>
<td></td>
<td>3. Induced Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Insulation Resistance (IR)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. D.C. Resistance (DCR) of each winding</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>6. Primary Inductance (L)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>7. Turns Ratio</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Transformers, Pulse, Low Power</td>
<td>Initial Measurements</td>
<td>Thermal Shock</td>
<td>Burn-In</td>
<td>Seal Leak Test</td>
<td>Final Measurements and Delta Reject Criteria</td>
</tr>
<tr>
<td></td>
<td>1. Visual Examination</td>
<td>MIL-T-21038 Para. 4.7.4 (Gross Leak Test)</td>
<td></td>
<td></td>
<td></td>
<td>Repeat initial measurements and examinations. Reject; ( \Delta DCR &gt; \pm 5% )</td>
</tr>
<tr>
<td></td>
<td>2. Dielectric Withstanding Voltage (DWV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MIL-T-21038</td>
</tr>
<tr>
<td></td>
<td>3. Induced Voltage</td>
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<tr>
<td></td>
<td>4. Insulation Resistance (IR)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>5. DC Resistance (DCR)</td>
<td></td>
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<td>6. Open Circuit Inductance (OCL)</td>
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<tr>
<td></td>
<td>7. Leakage Inductance</td>
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<tr>
<td></td>
<td>8. Turns Ratio</td>
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</tbody>
</table>
The charged particles in the natural space environment pose a radiation risk to some electronic parts, because when these particles pass through them, they can significantly degrade their performance. Ground radiation tests on different electronic part types have indicated that while parts like resistors and capacitors show no noticeable degradation, many microcircuits are very sensitive to ionizing radiation. In comparison with microcircuits, most discrete semiconductor devices — with some exceptions such as microwave and MOS transistors — show much less degradation. However, some transistors, particularly small signal types, are very susceptible to radiation induced failures when operated at low collector currents. Further, the radiation environment seen by a device differs from one application to another depending upon the orbit parameters and upon location within the spacecraft, i.e., the equivalent shielding between it and the outside environment. Therefore, while selecting electronic parts, it is necessary not only to consider the device hardness, but also the application and the projected radiation environment for the application.

In dealing with the natural space environment, designers have to be concerned with two types of radiation damage, namely total dose effect and single event phenomena. The total dose effect is due to the cumulative ionization caused by the passage of all the ionizing particles through the device and is uniform over the device. This effect causes shifts in the threshold voltages of MOS transistors and can also decrease the carrier mobility in channels resulting in increased propagation delay times. In bipolar devices, current gain and junction leakage currents are adversely affected. The extent of total dose damage depends not only on the total absorbed dose but also on the dose rate and annealing characteristic of the device.

In contrast to the total dose effect, the single event upset is a localized effect which occurs when a single heavy ion or proton of high energy causes logic upset in semiconductor devices containing memory cells. This type of error is called a “soft error” as it causes no permanent damage and the device can be reprogrammed for correct functioning. However, single heavy ions can also cause latch-up, or hard errors, in devices with technologies where four layer SCR action is possible. Once latch-up is initiated in a device, control and functionality are lost. Device destruction may also result unless current is limited or power is turned off and on again.

The available radiation test data indicates that the radiation hardness of microcircuits can be expected to vary not only with the device type and technology, but also with subtle process variations continually being made by the manufacturers, i.e., with different manufacturing lots. Also, the radiation test results are strongly dependent upon the bias conditions and other details of radiation testing, such as the dose rate and the nature of irradiating source. Furthermore, the same device type can be hard with respect to single event upsets while being soft to total dose effects or vice versa. All these factors make it very difficult to specify the hardness levels for a particular part type and/or technology. However, in recent years a data base on the relative hardness of different technologies to total dose and single event upsets has emerged from the radiation tests performed by different experimenters. Table 1 gives a comparison of the susceptibilities of different technologies to the two types of natural radiation effects discussed above.
### Table 1. Comparison of Radiation Susceptibility for Microcircuits of Different Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Total Dose(^2)</th>
<th>Relative Susceptibility(^3) To:</th>
<th>Soft Error</th>
<th>Latch-Up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hardness Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rads (Si)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIGITAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMOS</td>
<td>(5 \times 10^2 - 10^4)</td>
<td>High</td>
<td>Immune</td>
<td></td>
</tr>
<tr>
<td>CMOS/Bulk (unhardened)</td>
<td>(10^3 - 10^5)</td>
<td>Moderate to high</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>CMOS/Bulk (hardened)</td>
<td>(2 \times 10^3 - 10^6)</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>CMOS/SOS</td>
<td>(10^3 - 10^5)</td>
<td>Very low</td>
<td>Immune</td>
<td></td>
</tr>
<tr>
<td>TTL, Low Power TTL</td>
<td>(10^5 - 10^7)</td>
<td>Low to High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Schottky TTL, Low Power</td>
<td>(10^5 - 10^7)</td>
<td>Low to High</td>
<td>None to Low</td>
<td></td>
</tr>
<tr>
<td>Schottky TTL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced Low Power Schottky</td>
<td>(2 \times 10^4 - 10^6)</td>
<td>— No Data Available —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I(_2)L</td>
<td>(2 \times 10^4 - 10^6)</td>
<td>Moderate</td>
<td>None too Low</td>
<td></td>
</tr>
<tr>
<td>ECL</td>
<td>(\geq 5 \times 10^6)</td>
<td>Low</td>
<td>None to Low</td>
<td></td>
</tr>
<tr>
<td>LINEAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMOS</td>
<td>(10^3 - 2 \times 10^7)</td>
<td>— No Data Available —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bipolar, BI-FeT</td>
<td>(6 \times 10^3 - 10^7)</td>
<td>— No Data Available —</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. Refer to pages 10-1 and 10-2 for the technologies of different microcircuits listed in this PPL.

2. These figures define process averages. However, some devices may not meet these levels while others may exceed them, e.g. some Schottky TTL RAM's fall much below the lower limit listed in the Table while most other devices with this technology fall within the range shown.

3. The single event susceptibility "ratings" listed here are relative to each other. However, a "moderate" error rate in a specific application may be unacceptably high if the application is critical.

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Table 1 provides only a qualitative guideline of radiation sensitivity of microcircuits and is derived from published radiation test data. This often may not be sufficient as the rapid changes which have been occurring in microcircuit technology have been accompanied by changes in the radiation hardness of the parts. In general, lot sample testing may be necessary to determine the hardness levels of a procured lot of devices prior to their usage in a particular application. However, it may be noted that a number of vendors are making efforts to qualify their parts to four standard radiation levels: namely 2.5 K, 10 K, 100 K and 1 M rads. The parts qualified to these levels are identified in MIL-specifications by the symbols, M, D, R and H respectively, inserted in place of the slash mark in part markings. For more information and guidelines, consult the radiation effects specialists listed in this PPL.

BIBLIOGRAPHY


APPENDIX E

SCREENING VERIFICATION

All JANTXV semiconductors purchased to the requirements of MIL-S-19500 shall be subjected to the following 100% screening verification tests before use as Grade 2 parts. This requirement shall not apply to JANS semiconductors. These tests may be used in lieu of the JANTXV rescreening requirements specified in MIL-STD-975. Screening verification shall also be performed on nonstandard JANTX and JANTXV parts.

<table>
<thead>
<tr>
<th>MIL-S-19500 Requirement Paragraph</th>
<th>MIL-STD-750 Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. External Visual</td>
<td>2071</td>
</tr>
<tr>
<td>2. PIND</td>
<td>4.6.4.2</td>
</tr>
<tr>
<td>3. Fine Leak</td>
<td>---</td>
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<tr>
<td>4. Gross Leak</td>
<td>---</td>
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<tr>
<td>5. Initial Electrical</td>
<td>---</td>
</tr>
<tr>
<td>6. Power Burn-In or Burn-In per slash sheet</td>
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<td></td>
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<tr>
<td>7. Post Burn-In Electrical</td>
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<tr>
<td>8. Delta Calculation</td>
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</tr>
<tr>
<td>9. PDA</td>
<td>4.6.1</td>
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