GSFC PREFERRED PARTS LIST
PPL-16

(NASA-TM-85291) THE GODDARD SPACE FLIGHT CENTER PREFERRED PARTS LIST, PPL-16 (NASA) 96 p HC A05/MF A01 CSCL 13I
N83-23483
Unclas
G3/31 09917

JUNE 1982

GODDARD SPACE FLIGHT CENTER

This document was prepared by the Product Assurance Division of the Goddard Space Flight Center and the Preferred Parts Mission of the Sperry Systems Management Facility, Sperry Corp.

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PPL16 - Rev. 3/83

TO: Holders of GSFC Preferred Parts List

FROM: N. Tyson, Parts Branch, PAD

SUBJECT: Issuance of Revisions to GSFC Preferred Parts List 16

Revised pages 16-1 and 16-4 of March, 1983 and designated Rev. 3/83, supersede these same pages of PPL-16. The original pages should be discarded.

The revised pages contain wire usage restrictions and safety considerations relative to usage involving Space Transportation System payloads.

N Tyson

N. Tyson

PPL-16 – Rev. A
June 30, 1983

TO: Holders of the GSFC Preferred Parts List

FROM: The Parts Branch, PAD, GSFC

SUBJECT: Issuance of Revision A to GSFC Preferred Parts List No. 16

Revised pages vii, viii, 01-1, 01-4, 01-10, 01-11, 01-12, 08-1, 09-2, 10-1, 10-3, A-2, A-3, B-2, B-9, C-2, C-3, June 1982 and designated Rev. 6/83, supersede these same pages of PPL-16. The original pages should be discarded.

Page 10-3 is a new page added to PPL-16 and designated Rev. 6/83. Page 10-3 contains new technical information on a microprocessor. The remaining pages contain corrections.

This document was prepared by the Product Assurance Division of the Goddard Space Flight Center and the Sperry Corporation.

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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 (SPL), is the prime reference document for preferred electronic parts for NASA. The GSFC Preferred Parts List (PPL-16) 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-975D are identified in PPL-16 as a convenience to users. Several part types listed in MIL-STD-975D are not identified in PPL-16. They are not considered to be suitable for use in GSFC applications. The types are MIL-F-18327 band pass filters, JTX diodes, JTX transistors, military connectors and relays.

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-16 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 by GSFC, 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 Product Assurance 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. Requests for Military Specifications may be directed to:

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

REVISIONS

The PPL will be reissued during 1984. 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 Preferred Parts Staff 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) 344-7113 or (301) 344-6588 or (301) 344-7940.

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

GMI 5330.6, *Implementation of the Goddard Space Flight Center Parts Program,* should be reviewed by all those required to use the GSFC PPL. This requires that:
(a) In designing new systems, users shall use MIL-STD-975 or the PPL as the prime reference sources to select part types.
(b) The part should be purchased to the specifications referenced in MIL-STD-975 or PPL.
(c) Users should consult their project parts engineer for information concerning the detailed requirements on the information that must be included in or accompany a Non-Standard Parts Approval Request.

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.

RELIABILITY NOTES

RELIABILITY

Reliability is concerned with the degradation over time of the characteristics of materials and how this degradation affects the electrical and physical performance of a component. The reliability of a component is a function of its design, processing, and application. Parts listed in MIL-STD-975 and the PPL have been chosen because their designs, processing, and ratings provide the level of reliability needed for GSFC applications.

ESTABLISHED RELIABILITY

MIL-STD-975 and the PPL, whenever feasible, list capacitors, inductors, relays, and resistors procurable to military "Established Reliability" (ER) specifications. These specifications provide known levels of reliability (failure rates) which have been demonstrated under controlled test conditions, as specified in the military specifications, and expressed as percent failures per thousand hours (%/1000 hours). The failure rates are established at rated stress conditions and at 60 to 90% confidence levels, depending upon the particular part and military specifications. Use of non-standard parts because they are physically smaller is not an acceptable deviation from the use of standard parts. Because of additional controls imposed during manufacturing, an established reliability part with no additional derating is still superior to a derated commercial part.

PPL AND MIL-STD-975 SEMICONDUCTORS

JANTXV semiconductors and MIL-M-38510 Class B microcircuits are minimum quality levels listed in the PPL and MIL-STD-975. These levels were chosen because 100% internal visual examination of the parts is performed during manufacturing. This test cannot be duplicated after the completion of the part.

PART 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 (NSPAR). 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.

PART DERATING

Conservation 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.

PART 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.

PART RADIATION EFFECTS

Space radiation can present a hazard to electronic parts on every space mission. Appendix D gives more 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:

PART CATEGORY	SPECIALIST	TELEPHONE (301) 344-
Capacitors	P. Jones	5910
Connectors	J. Lawrence	5640
Crystals	N. Tyson	7113
Diodes	M. Robertson	5910
Filters	P. Jones	5910
Fuses	L. Buyer	5987
Inductors	L. Buyer	5987
Microcircuits	W. Denoon	7437
PC Boards	H. Chernikoff	5984
Relays	J. Lawrence	5640
Resistors	L. Buyer	5987
Solder	H. Chernikoff	5984
Thermistors	L. Buyer	5987
Transformers	L. Buyer	5987
Transistors	M. Robertson	5910
Wire and Cable	J. Lawrence	5640
All	Preferred Parts Staff, Sperry Systems Management	6485 6588

Additional services in support of the GSFC parts program are:

FUNCTION	CONTACT	TELEPHONE (301) 344-
Electronic Parts Qualification Testing, Maintenance of the PPL	N. Tyson	7113
Electronic Parts Incoming Test, Inspection, and Screening	W. Owens	6134
Data Systems	G. Ritter	7635
Failure Analysis Destructive Physical Analysis	B. Baldini	8923

FUNCTION	CONTACT	TELEPHONE (301) 344-
Quality Surveys / Procurement Request Review	Cognizant Office of Flight Assurance Representative	7669
Packaging Process Specialist	H. Chernikoff	5984
Radiation Effects	J. Adolphsen	8896
	D. Cleveland	6165

CONTENTS

CONTENTS (cont.)

Index of Preferred Capacitors[1]

Style	Description	Specification	Refer To
CCR	Ceramic, Temperature-compensating, Fixed	MIL-C-20	MIL-STD-975
CDR	Ceramic, Chip, Multiple-layered, Fixed	MIL-C-55681	
	Styles CDR01, 02, 03		Pages 01-2, 01-3
	Styles CDR04, 05, 06		MIL-STD-975
CKR	Ceramic, Fixed	MIL-C-39014	MIL-STD-975
CLR	Tantalum (non-solid) electrolytic, Fixed	MIL-C-39006	MIL-STD-975
CRH	Plastic (metalized), Fixed	MIL-C-83421	MIL-STD-975
CSR	Tantalum (solid) electrolytic, Fixed	MIL-C-39003	MIL-STD-975
CYR	Glass, Fixed	MIL-C-23269	
	Styles CYR10, 15, 20, 30		MIL-STD-975
	Styles CYR13, 41, 42, 43, 51, 52, 53		Pages 01-4 to 01-12

NOTES:

1. For part styles listed in MIL-STD-975, GSFC has the following requirements:
   - (a) CLR styles with ratings above 100 volts are not to be used for Grade 1 applications.
   - (b) CKR style sizes are to be limited to maximum capacitance values as follows:

     CKR05– 33,000 pf   CKR11– 4,700 pf   CKR14– 47,000 pf
     CKR06–330,000 pf   CKR12–10,000 pf   CKR15–180,000 pf
   - (c) CKR styles shall be purchased to revision C of MIL-C-39014.
   - (d) A Non Standard Parts Approval Request (NSPAR) is needed if the preceding requirements are to be waived. Parts not meeting requirements for Notes a, b, or c are nonstandard for GSFC applications.
   - (e) The requirement of MIL-STD-975 for destructive physical analysis of CCR, CDR, and CKR styles for use in Grade 1 applications is waived.
   - (f) Effective series resistance of CSR Style capacitors should be equal to or greater than one ohm/volt.
   - (g) Surge current testing shall be performed on CSR Style capacitors for all Grade 1 applications, and for Grade 2 applications where the effective series resistance is less than 1 ohm/volt.

MIL-C-55681, CAPACITORS

Fixed, Chip, Multiple Layer, Unencapsulated, Ceramic Dielectric, Established Reliability[1]

Part Number example: CDRXX BV XXX W T S Z

STYLE - "CDR" Multiple layers, fixed, ceramic dielectric, encapsulated, established reliability. XX = size code (see dimensions)

RATED TEMPERATURE AND VOLTAGE - TEMPERATURE LIMITS - "B" indicates the rated temperature range of -55°C to +125°C, "V" the voltage - temperature limits in accordance with the following table

V	Capacitance Change referenced to 25°C	
	0 Volts Applied	Rated Volts Applied
P	0 ± 30 ppm/°C	0 ± 30 ppm/°C
X	± 15%	+ 15% - 25%

CAPACITANCE - The nominal value, expressed in picofarads, the first two digits represent significant figures and the last digit specifies the number of zeros to follow.

RATED VOLTAGE - for continuous operation at 125°C, is specified in accordance with the following table:

W	Volts, DC
A	50
B	100

CAPACITANCE TOLERANCE - is specified in accordance with the following table:

T	(± %)
J	5
K	10
M	20

TERMINATION FINISH - "S"[2]

S	Finish
S	Solder
N	Gold

FAILURE RATE LEVEL (FRL) - is specified in accordance with the following table:

Z	(%/1000 hrs.)
P	0.1
R	0.01

Military Style	See Page 01-	Capacitance Range (pF)	Capacitance Tolerances T	DC Voltage Ratings W	Characteristics BV	Maximum D.F. (%) for BP	Maximum D.F. (%) for BX	Minimum Insulation Resistance	Dimensions (Millimeters, Max.) L	Dimensions W	Dimensions T	Grade 1 FRL	Grade 2 FRL	Manufacturer
CDR01	3	10-4700	J,K,M	A,B	BP,BX	0.15	2.5	[Note 3]	2.41	1.65	1.40	R	P	QPL-55681
CDR02		220-22000							4.95	1.65	1.40			
CDR03		330-68000							4.95	2.41	2.03			

NOTES.

1. For helpful information dealing with the handling, use, and protection of these chips, refer to AID No. 01-01 available from Parts Branch Library (301) 344-7240.
2. MIL-C-55681 specifies additional codes and finishes for these devices for soldering or thermocompression bonding. These parts are not intended for welding.
3. Insulation resistance = X/C, where X = 1000 megohm-microfarads and C is microfarads, at 25°C
   BX type shall be 10,000 megohms or 100 megohm-microfarads whichever is less
   BP type shall be 1,000 megohms or 10 megohm-microfarads whichever is less

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MIL-C-55681, STYLE CDR01
Fixed, Chip, Ceramic Dielectric, Established Reliability

Part Number[1,2]	Capacitance Nominal Value (pF)	Capacitance Tolerance T	Characteristic BV	Rated Voltage (volts, dc)
CDR01BP100BT SZ	10	J,K	BP	100
120BT SZ	12	J		
150BT SZ	15	J,K		
180BT SZ	18	J		
220BT SZ	22	J,K		
CDR01BP270BT SZ	27	J		
330BT SZ	33	J,K		
390BT SZ	39	J		
470BT SZ	47	J,K		
560BT SZ	56	J		
CDR01BP680BT SZ	68	J,K		
820BT SZ	82	J		
101BT SZ	100	J,K		
121BT SZ	120	J,K		
151BT SZ	150	J,K		
181BT SZ	180	J,K		
CDR01BX221BT SZ	220	K,M	BX	
271BT SZ	270	K		
331BT SZ	330	K,M		
391BT SZ	390	K		
471BT SZ	470	K,M		
CDR01BX561BT SZ	560	K		
681BT SZ	680	K,M		
821BT SZ	820	K		
102BT SZ	1,000	K,M		
122BT SZ	1,200	K		
CDR01BX152BT SZ	1,500	K,M		
182BT SZ	1,800	K		
222BT SZ	2,200	K,M		
272BT SZ	2,700	K		
332BT SZ	3,300	K,M		
CDR01BX392AT SZ	3,900	K		50
CDR01BX472AT SZ	4,700	K,M		

NOTES:
1. Refer to Page 01-2; Complete part number must include the following:
S - Termination finish symbol
T - Capacitance tolerance symbol
Z - Failure rate level symbol

2 See Note 1, page 01-2

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MIL-C-55681, STYLE CDR02
Fixed, Chip, Ceramic Dielectric, Established Reliability

Part Number[1,2]	Capacitance Nominal Value (pF)	Capacitance Tolerance K	Characteristic BV	Rated Voltage (volts, dc)
CDR02BP221BT SZ	220	J,K	BP	100
CDR02BP271BT SZ	270	J		
CDR02BX392BT SZ	3,900	K	BX	
472BT SZ	4,700	K,M		
562BT SZ	5,600	K		
682BT SZ	6,800	K,M		
822BT SZ	8,200	K		
103BT SZ	10,000	K,M		
CDR02BX123AT SZ	12,000	K		50
153AT SZ	15,000	K,M		
183AT SZ	18,000	K		
223AT SZ	22,000	K,M		

MIL-C-55681, STYLE CDR03
Fixed, Chip, Ceramic Dielectric, Established Reliability

Part Number[1,2]	Capacitance Nominal Value (pF)	Capacitance Tolerance T	Characteristic BV	Rated Voltage (volts, dc)
CDR03BP331BT SZ	330	J,K	BP	100
391BT SZ	390	J		
471BT SZ	470	J,K		
561BT SZ	560	J		
681BT SZ	680	J,K		
821BT SZ	820	J		
102BT SZ	1,000	J,K		
CDR03BX123BT SZ	12,000	K	BX	
153BT SZ	15,000	K,M		
183BT SZ	18,000	K		
223BT SZ	22,000	K,M		
273BT SZ	27,000	K		
333BT SZ	33,000	K,M		
CDR03BX393AT SZ	39,000	K		50
473AT SZ	47,000	K,M		
563AT SZ	56,000	K		
683AT SZ	68,000	K,M		

MIL-C-23269, CAPACITORS
Fixed, Glass Dielectric, Established Reliability

Part Number example. M23269 /XX XXXX

- M23269: M-Number – identifies "CYR" fixed, glass dielectric, established reliability capacitors conforming to MIL-C-23269.
- /XX: /XX – identifies the appropriate military specification sheet that uniquely specifies the capacitor family.
- XXXX: XXXX – uniquely specifies the nominal capacitance value, capacitance tolerance, rated dc voltage, and failure rate level (%/1000 hours).

Part Number	Style	See Page 01-	Capacitance Range (pF)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Temperature Range °C	Temperature Coefficient (ppm/°C)	Insulation Resistance (megohms)	Configuration Case Type	Configuration Lead Type	Grade 1 FRL	Grade 2 FRL	Manufacturer
M23269/05	CYR13	5, 6	0.5-300	0.7,0.3,0.1	300, 500	–55°C to +125°C	105±25	500 K @ 25°C	Rectangular glass, hermetic	Axial or Radial	R	P	QPL-23269
M23269/09	CYR41	7	0.5-1000		100		0±25			Radial	(Note 1)	(Note 1)	
	CYR42	8	0.5-300		50-500					Axial			
	CYR43	9	330-1200	0.1	50-300					Axial			
M23269/10 (Note 2)	CYR51	10, 11	1-560	0.2,0.1	300		140±25	100 K @ 125°C	Rectangular -epoxy	Radial	(Note 1)	M	
	CYR52	12	620-1000	0.1									
	CYR53	12	1100-2400	0.1									

NOTE:

1. No Grade 1 parts are listed on the QPL at the present time Until they become available, the Grade 2 part may be used for a Grade 1 application. A NSPAR is required.
2. M23269/10 capacitors must be subjected to thermal shock, per MIL-STD-202, Method 107, Condition B, while monitoring for discontinuity.

M23269/05, STYLE CYR13
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (±)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/05- Grade 1 FRL = R(0.01)	Part Number M23269/05- Grade 2 FRL = P(0.1)
0.5	0.25 pF	0.7	500	5001	4001
1.0	0.25 pF			5002	4002
1.5	0.25 pF			5003	4003
2.2	0.25 pF			5004	4004
	0.50 pF			5005	4005
2.7	0.25 pF			5006	4006
3.0	0.25 pF			5007	4007
	0.50 pF			5008	4008
3.3	0.25 pF			5009	4009
3.6	0.25 pF			5010	4010
	0.50 pF			5011	4011
3.9	0.25 pF			5012	4012
4.3	0.25 pF			5013	4013
	0.50 pF			5014	4014
4.7	0.25 pF			5015	4015
5.1	0.25 pF	0.3		5016	4016
5.6	0.25 pF			5017	4017
	5%			5018	4018
6.2	0.25 pF			5019	4019
	5%			5020	4020
6.8	0.25 pF			5021	4021
	5%			5022	4022
7.5	0.25 pF			5023	4023
	5%			5024	4024
8.2	0.25 pF			5025	4025
	5%			5026	4026
9.1	0.25 pF			5027	4027
	5%			5028	4028
10	0.25 pF			5029	4029
	5%			5030	4030
11	0.25 pF			5031	4031
	5%			5032	4032

Capacitance Value (pF)	Capacitance Tolerance (±)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/05- Grade 1 FRL = R(0.01)	Part Number M23269/05- Grade 2 FRL = P(0.1)
12	0.25 pF	0.3	500	5033	4033
	5%			5034	4034
13	2%			5035	4035
	5%			5036	4036
15	2%			5037	4037
	5%			5038	4038
16	2%			5039	4039
	5%			5040	4040
18	2%			5041	4041
	5%			5042	4042
20	2%			5043	4043
	5%			5044	4044
22	2%			5045	4045
	5%			5046	4046
24	2%			5047	4047
	5%			5048	4048
27	1%			5049	4049
	2%			5050	4050
	5%			5051	4051
30	1%	0.1		5052	4052
	2%			5053	4053
	5%			5054	4054
33	1%			5055	4055
	2%			5056	4056
	5%			5057	4057
36	1%			5058	4058
	2%			5059	4059
	5%			5060	4060
39	1%			5061	4061
	2%			5062	4062
	5%			5063	4063
43	1%			5064	4064

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M23269/05, STYLE CYR13 (continued)
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (± %)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/05- Grade 1 FRL = R(0.01)	Part Number M23269/05- Grade 2 FRL = P(0.1)
43	2	0.1	500	5065	4065
	5			5066	4066
47	1			5067	4067
	2			5068	4068
	5			5069	4069
51	1			5070	4070
	2			5071	4071
	5			5072	4072
56	1			5073	4073
	2			5074	4074
	5			5075	4075
62	1			5076	4076
	2			5077	4077
	5			5078	4078
68	1			5079	4079
	2			5080	4080
	5			5081	4081
75	1			5082	4082
	2			5083	4083
	5			5084	4084
82	1			5085	4085
	2			5086	4086
	5			5087	4087
91	1			5088	4088
	2			5089	4089
	5			5090	4090
100	1			5091	4091
	2			5092	4092
	5			5093	4093
110	1			5094	4094
	2			5095	4095

Capacitance Value (pF)	Capacitance Tolerance (± %)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/05- Grade 1 FRL = R(0.01)	Part Number M23269/05- Grade 2 FRL = P(0.1)
110	5	0.1	500	5096	4096
120	1			5097	4097
	2			5098	4098
	5			5099	4099
130	1			5100	4100
	2			5101	4101
	5			5102	4102
150	1			5103	4103
	2			5104	4104
	5			5105	4105
160	1			5106	4106
	2			5107	4107
	5			5108	4108
180	1			5109	4109
	2			5110	4110
	5			5111	4111
200	1			5112	4112
	2			5113	4113
	5			5114	4114
220	1		300	5115	4115
	2			5116	4116
	5			5117	4117
240	1			5118	4118
	2			5119	4119
	5			5120	4120
270	1			5121	4121
	2			5122	4122
	5			5123	4123
300	1			5124	4124
	2			5125	4125
	5			5126	4126

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M23269/09, STYLE CYR41
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (±)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/09- Grade 1 & Grade 2 FRL = P(0.1)
0.5	0.25 pF	0.5	100	4001
1.5	0.25 pF			4002
2.7	0.25 pF			4003
3.3	0.25 Pf			4004
3.9	0.25 pF			4005
4.7	0.25 pF			4006
5.6	0.25 pF	0.3		4007
6.8	0.25 Pf			4008
	5%			4009
8.2	0.25 pF			4010
	5%			4011
10	0.25 pF			4012
	5%			4013
12	0.25 pF			4014
	5%			4015
15	0.25 pF			4016
	2%			4017
	5%			4018
18	0.25 pF			4019
	2%			4020
	5%			4021
22	0.25 pF			4022
	2%			4023
	5%			4024
27	1%			4025
	2%			4026
	5%			4027
33	1%	0.1		4028
	2%			4029
	5%			4030
39	1%			4031
	2%			4032
	5%			4033
47	1%			4034
	2%			4035
	5%			4036
56	1%			4037
	2%			4038
	5%			4039
68	1%			4040
	2%			4041
	5%			4042

Capacitance Value (pF)	Capacitance Tolerance (± %)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/09- Grade 1 & Grade 2 FRL = P(0.1)
82	1	0.1	100	4043
	2			4044
	5			4045
100	1			4046
	2			4047
	5			4048
120	1			4049
	2			4050
	5			4051
150	1			4052
	2			4053
	5			4054
180	1			4055
	2			4056
	5			4057
220	1			4058
	2			4059
	5			4060
270	1			4061
	2			4062
	5			4063
330	1			4064
	2			4065
	5			4066
390	1			4067
	2			4068
	5			4069
470	1			4070
	2			4071
	5			4072
560	1			4073
	2			4074
	5			4075
680	1			4076
	2			4077
	5			4078
820	1			4079
	2			4080
	5			4081
1000	1			4082
	2			4083
	5			4084

M23269/09, STYLE CYR42
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (±)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/09- Grade 1 & Grade 2 FRL = P(0.1)
0.5	0.25 pF	0.7	500	4101
1.5	0.25 pF			4102
2.7	0.25 pF			4103
3.3	0.25 pF			4104
3.9	0.25 pF			4105
4.7	0.25 pF			4106
5.6	0.25 pF	0.3		4107
6.8	0.25 pF			4108
	5%			4109
8.2	0.25 pF			4110
	5%			4111
10	0.25 pF			4112
	5%			4113
12	0.25 pF			4114
	5%			4115
15	0.25 pF			4116
	2%			4117
	5%			4118
18	0.25 pF			4119
	2%			4120
	5%			4121
22	0.25 pF			4122
	2%			4123
	5%			4124
27	1%			4125
	2%			4126
	5%			4127
33	1%	0.1		4128
	2%			4129
	5%			4130
39	1%			4131
	2%			4132
	5%			4133

Capacitance Value (pF)	Capacitance Tolerance (± %)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/09- Grade 1 & Grade 2 FRL = P(0.1)
47	1	0.1	500	4134
	2			4135
	5			4136
56	1			4137
	2			4138
	5			4139
68	1		300	4140
	2			4141
	5			4142
82	1			4143
	2			4144
	5			4145
100	1		100	4146
	2			4147
	5			4148
120	1			4149
	2			4150
	5			4151
150	1			4152
	2			4153
	5			4154
180	1			4155
	2			4156
	5			4157
220	1			4158
	2			4159
	5			4160
270	1		50	4161
	2			4162
	5			4163
300	1			4164
	2			4165
	5			4166

M23269/09, STYLE CYR43
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (± %)	Rated Voltage (volts, dc)	Part Number M23269/09- Grade 1 & Grade 2 FRL = P(0.1)
330	1	300	4301
	2		4302
	5		4303
390	1		4304
	2		4305
	5		4306
470	1	100	4307
	2		4308
	5		4309
560	1		4310
	2		4311
	5		4312
680	1		4313
	2		4314
	5		4315

Capacitance Value (pF)	Capacitance Tolerance (± %)	Rated Voltage (volts, dc)	Part Number M23269/09- Grade 1 & Grade 2 FRL = P(0.1)
820	1	50	4316
	2		4317
	5		4318
1000	1		4319
	2		4320
	5		4321
1200	1		4322
	2		4323
	5		4324

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M23269/10, STYLE CYR51[1]
Fixed, Glass Dielectric, Established Reliability

Capacitance		Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/10-
Value (pF)	Tolerance (±)			Grade 1 & Grade 2 FRL = M(1.0)
1	0.25pF	0.2	300	3001
1.5	0.25pF			3002
2.2	0.25pF			3003
2.7	0.25pF			3004
3.0	0.25pF			3005
3.3	0.25pF			3006
3.6	0.25pF			3007
3.9	0.25pF			3008
4.3	0.25pF			3009
4.7	0.25pF			3010
5.1	0.25pF			3011
	5%			3012
5.6	0.25pF			3013
	5%			3014
6.2	0.25pF			3015
	5%			3016
6.8	0.25pF			3017
	5%			3018
7.5	0.25pF			3019
	5%			3020
8.2	0.25pF			3021
	5%			3022
9.1	0.25pF			3023
	5%			3024
10	0.25pF			3025
	5%			3026
11	0.25pF			3027
	5%			3028
12	0.25pF			3029
	5%			3030
13	0.25pF			3031
	2%			3032
	5%			3033
15	0.25pF			3034
	2%			3035
	5%			3036
16	0.25pF			3037
	2%			3038

Capacitance		Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/10-
Value (pF)	Tolerance (±)			Grade 1 & Grade 2 FRL = M(1.0)
16	5%	0.2	300	3039
18	0.25pF			3040
	2%			3041
	5%			3042
20	0.25pF			3043
	2%			3044
	5%			3045
22	0.25pF			3046
	2%			3047
	5%			3048
24	0.25pF			3049
	2%			3050
	5%			3051
27	1%			3052
	2%			3053
	5%			3054
30	1%			3055
	2%			3056
	5%			3057
33	1%			3058
	2%			3059
	5%			3060
36	1%			3061
	2%			3062
	5%			3063
39	1%			3064
	2%			3065
	5%			3066
43	1%			3067
	2%			3068
	5%			3069
47	1%			3070
	2%			3071
	5%			3072
51	1%			3073
	2%			3074
	5%			3075
56	1%			3076

NOTE.
1. M23269/10 capacitors must be subjected to thermal shock, per MIL-STD-202, Method 107, Condition B, while monitoring for discontinuity

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M23269/10, STYLE CYR51 (continued)[1]
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (± %)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/10- Grade 1 & Grade 2 FRL = M(1.0)
56	2	0.2	300	3077
	5			3078
62	1			3079
	2			3080
	5			3081
68	1			3082
	2			3083
	5			3084
75	1			3085
	2			3086
	5			3087
82	1			3088
	2			3089
	5			3090
91	1			3091
	2			3092
	5			3093
100	1			3094
	2			3095
	5			3096
110	1	0.1		3097
	2			3098
	5			3099
120	1			3100
	2			3101
	5			3102
130	1			3103
	2			3104
	5			3105
150	1			3106
	2			3107
	5			3108
160	1			3109
	2			3110
	5			3111
180	1			3112
	2			3113

Capacitance Value (pF)	Capacitance Tolerance (± %)	Dissipation Factor (%)	Rated Voltage (volts, dc)	Part Number M23269/10- Grade 1 & Grade 2 FRL = M(1.0)
180	5	0.1	300	3114
200	1			3115
	2			3116
	5			3117
220	1			3118
	2			3119
	5			3120
240	1			3121
	2			3122
	5			3123
270	1			3124
	2			3125
	5			3126
300	1			3127
	2			3128
	5			3129
330	1			3130
	2			3131
	5			3132
360	1			3133
	2			3134
	5			3135
390	1			3136
	2			3137
	5			3138
430	1			3139
	2			3140
	5			3141
470	1			3142
	2			3143
	5			3144
510	1			3145
	2			3146
	5			3147
560	1			3148
	2			3149
	5			3150

NOTE:
1. M23269/10 capacitors must be subjected to thermal shock, per MIL-STD-202, Method 107, Condition B, while monitoring for discontinuity.

M23269/10, STYLE CYR52[1]
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (± %)	Rated Voltage (volts, dc)	Part Number M23269/10- Grade 1 & Grade 2 FRL = M(1.0)
620	1	300	3201
	2		3202
	5		3203
680	1		3204
	2		3205
	5		3206
750	1		3207
	2		3208
	5		3209
820	1		3210
	2		3211
	5		3212
910	1		3213
	2		3214
	5		3215
1000	1		3216
	2		3217
	5		3218

M23269/10, STYLE CYR53[1]
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (± %)	Rated Voltage (volts, dc)	Part Number M23269/10- Grade 1 & Grade 2 FRL = M(1.0)
1100	1	300	3301
	2		3302
	5		3303
1200	1		3304
	2		3305
	5		3306
1300	1		3307
	2		3308
	5		3309
1500	1		3310
	2		3311
	5		3312
1600	1		3313
	2		3314
	5		3315
1800	1		3316
	2		3317
	5		3318
2000	1		3319
	2		3320
	5		3321
2200	1		3322
	2		3323
	5		3324
2400	1		3325
	2		3326
	5		3327

NOTE:

1. M23269/10 capacitors must be subjected to thermal shock, per MIL-STD-202, Method 107, Condition B, while monitoring for discontinuity.

Index of Preferred Connectors[1]

Style	Description	Specification	Refer To
G311P10	Power Connectors, Solder Contacts (sub-miniature)	GSFC S-311-P-10	Page 02-2
311P409 and 311P405	Power Connectors, Removable Contacts (sub-miniature)	GSFC S-311-P-4/9 and 4/5	Page 02-3
311P407	Power connectors, Crimp Removable Contacts (sub-miniature High Density)	GSFC S311P-4/7	Page 02-4
NLS	High Density, Miniature	MSFC 40 M38277	MIL-STD-975
NB	Miniature (200°C)	MSFC 40 M39569	MIL-STD-975

NOTE
1 MIL-STD-975 lists several military specification connectors GSFC considers these to be non-standard parts

POWER CONNECTORS
Rack and Panel, Sub-Miniature, Solder Contacts

Construction	Contacts		For Use With Wire Size	Grade 1 & Grade 2			Remarks
	Qty.	Type		GSFC Type[1]	Specification GSFC	Manufacturer	
Receptacle, Rectangular	9	Socket	AWG #20 max.	G311P10B-1S-C-15	S-311-P-10	ITT Cannon Electric TRW Cinch Connectors	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, indicate by "-12."
	15	Socket		G311P10B-2S-C-15			
	25	Socket		G311P10B-3S-C-15			
	37	Socket		G311P10B-4S-C-15			
	50	Socket		G311P10B-5S-C-15			
Plug, Rectangular	9	Pin		G311P10-1P-C-15			
	15	Pin		G311P10-2P-C-15			
	25	Pin		G311P10-3P-C-15			
	37	Pin		G311P10-4P-C-15			
	50	Pin		G311P10-5P-C-15			

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

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POWER CONNECTORS
Rack and Panel, Sub-Miniature, Crimp Removable Contacts

Construction	Contacts		For Use With Wire Size	Grade 1 & Grade 2					Remarks
				Shell		Contact		Manufacturer	
	Qty.	Type		GSFC Type[1] 311P409	GSFC Specification	GSFC Type	GSFC Specification		
Receptacle, Rectangular	9 15 25 37 50	Socket	AWG # 20-22-24	-1S-B-15 -2S-B-15 -3S-B-15 -4S-B-15 -5S-B-15	S-311-P-4/9	G10S1	S-311-P-4/10	AMP, Inc. ITT Cannon Electric TRW Cinch Connectors	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, indicate by "-12."
Plug, Rectangular	9 15 25 37 50	Pin		-1P-B-15 -2P-B-15 -3P-B-15 -4P-B-15 -5P-B-15		G10P1			

NOTES
1. B = 200 gamma residual magnetism level. Other levels are available when required by the application and may be selected as shown below.

Residual Magnetism (gamma)	Shell		Contacts		
	GSFC Type	Specification GSFC	Pin	Socket	Specification GSFC
20	311P405XX-C-XX	S-311-P-4/5	GPP1	GPS1	S-311-P-4/6
2	311P405XX-D-XX				

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

Construction	Contacts		For Use With Wire Size	Grade 1 & Grade 2					Remarks
				Shell		Contact		Manufacturer	
	Qty.	Type		GSFC Type[1] 311P407	Specification GSFC	GSFC Type	Specification GSFC		
Receptacle, Rectangular	15 26 44 62 78 104	Socket	AWG # 22-24-26-28	-1S-B-15 -2S-B-15 -3S-B-15 -4S-B-15 -5S-B-15 -6S-B-15	S-311-P-4/7	G08S1	S-311-P-4/8	Amp, Inc.	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, indicate by "-12."
Plug, Rectangular	15 26 44 62 78 104	Pin		-1P-B-15 -2P-B-15 -3P-B-15 -4P-B-15 -5P-B-15 -6P-B-15		G08P1			

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

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Index of Preferred Filters[1]

Style	Description	Specification	Refer To
S-311-P-5/3	Electromagnetic Interference Suppression	GSFC S-311-P-5(03)/3	Page 03-2
S-311-P-5/4	Electromagnetic Interference Suppression	GSFC S-311-P-5(03)/4	Page 03-2

NOTE
1 MIL-STD-975 lists the MIL-F-18327 Band Pass Filter This filter is not acceptable for GSFC applications It is considered to be a non-standard part

FILTERS[1]
Electromagnetic Interference (EMI) Suppression

Description	Voltage Rating (VDC) (@ 85°C)	Insertion Loss (25°C, No-Load)		GSFC Specification	Grade 1	Grade 2	Remarks
		Freq. Range	DB Range		Manufacturer & Part Type		
L Section, Hermetically Sealed, Stud-Mounted	35	10 MHz thru 1 GHz 150 kHz	>64 db >25 db	S-311-P-5(03)/3	Erie S-311-P-5(03)/3		Inductor at threaded end. Similar to Erie 9200-530-0025
L Section, Hermetically Sealed, Stud-Mounted	35	10 MHz thru 1 GHz 150 kHz	>64 db >25 db	S-311-P-5(03)/4	Erie S-311-P-5(03)/4		Capacitor at threaded end. Similar to Erie 9215-530-0025

NOTE:
1 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.

Index Of Preferred Fuses

Style	Description	Specification	Refer To
FM04A	Fuse, Subminiature	MIL-F-23419	Page 04-2
FM08A	Fuse, Subminiature	MIL-F-23419	Page 04-2

FUSE
Subminiature[7]
(Axial Leads)

Current Rating[3,6] (Amperes)	Maximum Rated Voltage (Volts)	Maximum Short Circuit Interrupt Current @ Rated VDC (Amperes)	Grade 1[1,4] Voltage Drop @ Rated Current (Min-Max) (Volts)	Grade 1[1,4] Maximum Cold Resistance (ohms)	Grade 1[1,4] Mil Part Number	Grade 1[1,4] Specification	Grade 1[1,4] Manufacturer	Grade 2[2] Voltage Drop @ Rated Current (Min-Max) (Volts)	Grade 2[2] Maximum Cold Resistance (ohms)	Grade 2[2] Mil Part Number	Grade 2[2] Specification	Grade 2[2] Manufacturer
1/8			*.85-1.15*	*2.31*	*FM08A 125V 1/8A*			*.85-1.15*	*2.70*	*FM04A 125V 1/8A*		
1/4			*.590-.800*	*.781*	*FM08A 125V 1/4A*	Note 6		*.544-.736*	*.960*	*FM04A 125V 1/4A*	Note 6	
3/8			*.527-.713*	*.462*	*FM08A 125V 3/8A*			*.527-.713*	*.560*	*FM04A 125V 3/8A*		
1/2			*.488-.660*	*.308*	*FM08A 125V 1/2A*			*.510-.690*	*.365*	*FM04A 125V 1/2A*		
3/4			.145-.197	.187	**FM08A125V 3/4A**			.134-.182	.215	**FM04A125V 3/4A**		
1			.157-.213	.138	**FM08A125V 1A**	MIL-F-23419/8	QPL-23419	.157-.213	.165	**FM04A125V 1A**	MIL-F-23419/4	QPL-23419
1-1/2			.153-.207	.088	**FM08A125V 1-1/2A**			.153-.207	.105	**FM04A125V 1-1/2A**		
2	125		.144-.196	.0605	**FM08A125V 2A**			.144-.196	.072	**FM04A125V 2A**		
2-1/2		300	.125-.169	.0462	**FM08A125V 2-1/2A**			-	-	Note 5		
3			.139-.187	.0388	**FM08A125V 3A**			.128-.173	.047	**FM04A125V 3A**		
4			.110-.150	.0253	**FM08A125V 4A**			.110-.150	.029	**FM04A125V 4A**		
5			.087-.118	.0154	**FM08A125V 5A**			.087-.118	.019	**FM04A125V 5A**		
7			.087-.118	.0110	**FM08A125V 7A**					Note 5		
10			.073-.099	.0066	**FM08A125V 10A**							
15	32		.065-.087	.0044	**FM08A32V 15A**							

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

Index of Preferred Inductors

Style	Description	Specification	Refer To
MIL-T-27/146	Audio Frequency, High Q	MIL-T-27	MIL-STD-975
MIL-T-27/164	Audio Frequency, High Q	MIL-T-27	MIL-STD-975
MS21367	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Iron Core	MIL-C-15305	MIL-STD-975
MS21368	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Iron Core	MIL-C-15305	MIL-STD-975
MS21369	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Iron Core	MIL-C-15305	MIL-STD-975
MS90538	Coil, Fixed, Radio Frequency, Subminiature, Iron Core	MIL-C-15305	MIL-STD-975
MS90539	Coil, Fixed, Radio Frequency, Subminiature, Iron Core	MIL-C-15305	MIL-STD-975
MIL-C-39010/01	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Phenolic Core	MIL-C-39010	MIL-STD-975
MIL-C-39010/02	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Iron Core	MIL-C-39010	MIL-STD-975
MIL-C-39010/03	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Ferrite Core	MIL-C-39010	MIL-STD-975
MIL-C-39010/06	Coil, Fixed, Radio Frequency, Micro Miniature, Phenolic Core	MIL-C-39010	MIL-STD-975
MIL-C-39010/07	Coil, Fixed, Radio Frequency, Micro Miniature, Powdered Iron Core	MIL-C-39010	MIL-STD-975

Index of Preferred Relays[1]

Style	Description	Specification	Refer To
P2/33	Latching	GSFC S311 P2(06)/33	Page 06-3
P2/37	Latching	GSFC S311 P2(06)/37	Page 06-3
P2/39	Nonlatching	GSFC S311 P2(06)/39	Page 06-2
P2/42	Nonlatching	GSFC S311 P2(06)/42	Page 06-2
P2/47	Nonlatching	GSFC S311 P2(06)/47	Page 06-2
P2/48	Nonlatching	GSFC S311 P2(06)/48	Page 06-2
P2/50	Latching	GSFC S311 P2(06)/50	Page 06-3
P2(06)/19	Nonlatching	GSFC S311 P2(06)/19	Page 06-2
P2(06)/23	Nonlatching	GSFC S311 P2(06)/23	Page 06-2
P2(06)/27	Latching	GSFC S311 P2(06)/27	Page 06-3
P2(06)/35	Latching	GSFC S311 P2(06)/35	Page 06-3

NOTE

1 There are military relays listed in MIL-STD-975 that are not acceptable for GSFC applications These parts are considered to be non-standard parts

Relays, Nonlatching

Electrical Data				Mechanical Data			Grade 1 & Grade 2			Remarks
Contact Rating at 28 vdc Resistive[1] (amps)	Coil Voltage Nominal (vdc)	Coil Voltage Pull-in (max) (vdc)	Nominal dc Coil Resistance (ohms)	*Contact Form*[2]	*Package Type*	*Terminal Type*	GSFC Part Number	*Specification* GSFC-S-311-P-2(06)	Mfr.	
1 0[3]	26.5 18.0 12.0 9.0 6.0	18.0 13.5 9.0 6.8 4.5	1560 880 390 220 98	2 Form C (2PDT)	TO-5 Can	Wire Leads	P2/39-01 P2/39-02 P2/39-03 P2/39-04 P2/39-05	/39	Teledyne	
1.0[3]	26.5 18.0 12.0 9.0 6.0	18.0 13.5 9.0 6.8 4.5	1560 880 390 220 98	2 Form C (2PDT)	TO-5 Can	Wire Leads	P-2/48-01 P-2/48-02 P-2/48-03 P-2/48-04 P-2/48-05	/48	Teledyne	Coil Transient Suppression
1 0[3]	26.5 12.0 6.0	13.5 5.4 2.7	720 115 28	4 Form C (4PDT)	Low[4] Profile	Pins	P-2/42-03 P-2/42-02 P-2/42-01	/42	GE	
2 0[3]	26.5 12.0 6.0	13.5 5.4 2.7	1350 210 56	2 Form C (2PDT)	1/2 Crystal Can	Solder Lugs	P-2/47-01 P-2/47-02 P-2/47-03	/47	GE	
10.0	28.0	18.0	320	2 Form C (2PDT)	Crystal Can	Solder Lugs	P-2(06)/23-01	/23	QPL-6106 (MS27401)	
						Pins	P-2(06)/23-02			
10.0	28.0	18.0	290	4 Form C (4PDT)	One Inch Cube	Solder Lugs	P-2(06)/19-01	/19	QPL-6106 (MS27400)	
						Pins	P-2(06)/19-02			

NOTES
1 For contact ratings for other types of loads (inductive, capacitive, lamp, motor), contact the EEE Parts Section.
2. Refer to MIL-R-39016 or the NARM Engineers Relay Handbook for definitions of forms (example. form C = single break, double throw, transfer, break before make)
3 Contacts also rated for low level applications
4. 15.5 mm x 15 5 mm x 8.1 mm high (.610" x .610" x .320").

Relays, Latching

Electrical Data				Mechanical Data			Grade 1 & Grade 2			Remarks
Contact Rating at 28 vdc Resistive[1] (amps)	Coil Voltage Nominal (vdc)	Coil Voltage Pull-in (max) (vdc)	Nominal dc Coil Resistance (ohms)	Contact Form[2]	Package Type	Terminal Type	GSFC Part Number	Specification GSFC-S-311-P-2(06)	Mfr.	
1.0[3]	26.5 18.0 12.0 9.0 6.0	18.0 13.5 9.0 6.8 4.5	2000 1130 500 280 120	2 Form C (2PDT)	TO-5 Can	Wire Leads	P2/33-01 P2/33-02 P2/33-03 P2/33-04 P2/33-05	/33	Teledyne	-
1.0[3]	26.5 18.0 12.0 9.0 6.0	18.0 13.5 9.0 6.8 4.5	2000 1130 500 280 120	2 Form C (2PDT)	TO-5 Can	Wire Leads	P-2/37-01 P-2/37-02 P-2/37-03 P-2/37-04 P-2/37-05	/37	Teledyne	Coil Transient Suppression
2.0[3]	24.0 12.0	18.0 6.8	1000 250	2 Form C (2 PDT)	1/2 Crystal Can	Solder Hook	P2/50-01 P2/50-02	/50	Potter and Brumfield (AMF)	
	24.0 12.0 24.0 12.0	18.0 6.8 18.0 6.8	1000 250 1000 250			Pins	P2/50-03 P2/50-04 P2/50-05 P2/50-06			
2 0[3]	26.5	13.5	975	4 Form C (4PDT)	Low[4] Profile	Pins	P-2(06)/27-01	/27	GE	
25.0	28.0	18.0	450	3 Form C (3PDT)	One Inch Cube	Solder Lugs	P-2(06)/35-01	/35	QPL-6106 (MS27742)	
						Pins	P-2(06)/35-02			

NOTES
1. For contact ratings for other types of loads (inductive, capacitive, lamp, motor), contact the EEE Parts Section
2. Refer to MIL-R-39016 or the NARM Engineers Relay Handbook for definitions of forms (example form C = single break, double throw, transfer, break before make).
3. Contacts also rated for low level applications.
4. 15.5 mm x 15.5 mm x 8 1 mm high (.610" x .610" x .320").

Index of Preferred Resistors

Style	Description	Specification	Refer To
RBR	Wire wound, Precision, Accurate	MIL-R-39005	MIL-STD-975
RWR	Wire wound, Power	MIL-R-39007	MIL-STD-975
RCR	Composition	MIL-R-39008	MIL-STD-975
RER	Wire wound, Power, Chassis Mounted Non-Inductive and Inductive winding	MIL-R-39009	MIL-STD-975
RLR	Film, General Purpose	MIL-R-39017	MIL-STD-975
RTR	Wire wound, Variable	MIL-R-39015	MIL-STD-975
RJR	Non-wire wound, variable	MIL-R-39035	MIL-STD-975
RN(X)[1]	Film, High Stability	MIL-R-55182	MIL-STD-975
RZO	Fixed Film Networks	MIL-R-83401	MIL-STD-975

NOTE
1. 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

Index of Preferred Diodes[1,4]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Description	Refer To
	1N645-1 1N647-1 1N649-1	Small Signal	MIL-STD-975
	1N746A-1 thru 1N759A,-1	Zener Voltage Regulator	
	1N821-1	Voltage Reference	Page 08-3
	1N823,-1		MIL-STD-975
	1N825-1		Page 08-3
	1N827,-1 1N829,-1		MIL-STD-975
	1N935B		Page 08-3
	1N937B thru 1N940B	Zener Voltage Reference	MIL-STD-975
	1N941B 1N943B 1N944B 1N945B	Voltage Reference	Page 08-3
	1N962B thru 1N992B 1N962B-1 thru 1N978B-1 1N2970B thru 1N3051B	Zener Voltage Regulator	MIL-STD-975
	1N3595 1N3600	Switching	Page 08-2
	1N3821A thru 1N3828A	Voltage Regulator	MIL-STD-975
	1N3891 1N3893	Fast Switching Power Rectifier	
	1N4099 thru 1N4135	Voltage Regulator	Page 08-4
	1N4148-1	Small Signal	MIL-STD-975
	1N4150-1 1N4153-1	Switching	Page 08-2

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Description	Refer To
	1N4245 1N4247 1N4249	Power Power	Page 08-7
	1N4306 1N4307	Switching	Page 08-2
	1N4370A-1 thru 1N4372A-1	Voltage Regulator	MIL-STD-975
	1N4454-1	Switching	Page 08-2
	1N4460 thru 1N4496	Zener Voltage Regulator	MIL-STD-975
	1N4531	Switching	Page 08-2
	1N4565A thru 1N4569A	Voltage Reference	Page 08-3
	1N4570A thru 1N4574A	Zener Voltage Reference	MIL-STD-975
	1N4614 thru 1N4627	Voltage Regulator	Page 08-5
	1N4942 1N4944 1N4946 1N4947 1N4948	Fast Switching Power Rectifier	Page 08-6
	1N4954 thru 1N4995	Voltage Regulator	MIL-STD-975
	1N5139A thru 1N5148A	Voltage Variable Capacitor	Page 08-7
	1N5285 thru 1N5314	Current Regulator	MIL-STD-975
	1N5415 thru 1N5420	Fast Switching Power Rectifier	
	1N5550 thru 1N5554 1N5614	Power Rectifier	

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Description	Refer To
	1N5615 1N5616 1N5617 1N5618 1N5619 1N5620 1N5621 1N5622 1N5623	Fast Switching Power Rectifier Power Rectifier Fast Switching Power Rectifier Power Rectifier Fast Switching Power Rectifier Power Rectifier Fast Switching Power Rectifier Power Rectifier Fast Switching Power Rectifier	MIL-STD-975
	1N5629A thru 1N5665A	Zener Voltage Suppressor	
	1N5711 1N5712	Schottky Barrier Switching	
	1N5768 1N5770 1N5772 1N5774	Array	
	1N5806 1N5811	Fast Recovery	
	1N5814 1N5816	Power Rectifier	
	1N5907	Zener Voltage Suppressor	
	1N6073 thru 1N6081	Fast Switching Power Rectifier	Page 08-6
	1N6100	Array	MIL-STD-975
	1N6102,A thru 1N6173,A	Transient Voltage Suppressor	
	2N2322A 2N2324A 2N2326A 2N2328A	SCR	

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NOTES.
1. JTX diodes listed in MIL-STD-975 are not shown in this index GSFC considers them to be non-standard parts.
2. 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 NSPAR is required.
3. JANTXV diodes must be rescreened in accordance with the applicable TX detail specification of MIL-S-19500 for use in Grade 2 applications.
4. Refer to Appendix D for information on radiation effects.

DIODES
Switching, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	Maximum Forward Voltage (Vdc)	@ Forward Current (mAdc)	Maximum Reverse Current (μAdc)	@ Reverse Voltage (Vdc)	Reverse Recovery Time (t_{rr}) (nsec)	Capacitance (pF)	Case Dwg.	Remarks
	1N3595	/241	QPL-19500	0.88	50	0.001	125	3000	8.0	Note 4	
	1N3600	/231		0.86	50	0.10	50	4	2.5		
	1N4150-1			0.86	50	0.10	50		2.5		
	1N4153-1	/337		0.81	10	0.05	50		2.0	DO35	
	1N4306	/278		0.81	10	5.0	75		2.0	4 lead flat pack 5	Two matched discrete hermetically sealed diodes are encapsulated in a plastic module.
	1N4307	/284		0.81	10	5.0	75		2.0	8 lead flat pack Note 6	Four matched discrete hermetically sealed diodes are encapsulated in a plastic module.
	1N4454-1	/144		1.0	10	0.1	50	4	2.0	DO35	
	1N4531	/116		1.0	10	5.0	75	5	4.0	Note 4	

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

DIODES
Voltage Reference, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	Reference Voltage (min/max) (Vdc)	@ Zener Current (mAdc)	Voltage Change (Vdc)	over Temperature Range	Impedance (ohms)	@ Zener Current (mAdc)	Case Dwg.
	1N821-1	/159	QPL-19500	5.90/6.50	7.5	0.096	-55°C - 100°C	15	7.5	DO7
	1N825-1					0.019				
	1N935B	/156		8.55/9.45		0.184	-55°C - 150°C	20		
	1N941B	/157		11.12/12.28		0.239		30		
	1N943B					0.047				
	1N944B					0.024				
	1N945B					0.012				
	1N4565A	/452		6.08/6.72	0.5	0.100	-55°C - 100°C	200	0.5	
	1N4566A					0.050				
	1N4567A					0.020				
	1N4568A					0.010				
	1N4569A					0.005				

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

DIODES (Page 1 of 2)
Voltage Regulator, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	Nominal Reference Voltage V_Z (V)	@ I_Z (mA)	Max. Impedance Z_Z (Ohms)	Max. Diss. T_A = 25°C (W)	Voltage Temp. Coefficient (%/°C)	Max. Temp.	Case Dwg.	Remarks
	1N4099	/435	QPL-19500	6.8	56	200	0.40	+0.060	175°C	D014	Low Noise Devices
	1N4100			7.5	51			+0.065			
	1N4101			8.2	46			+0.070			
	1N4102			8.7	44			+0.075			
	1N4103			9.1	42			+0.080			
	1N4104			10.0	38						
	1N4105			11.0	35						
	1N4106			12.0	32						
	1N4107			13.0	29						
	1N4108			14.0	27			+0.085			
	1N4109			15.0	25	100					
	1N4110			16.0	24						
	1N4111			17.0	22			+0.090			
	1N4112			18.0	21						
	1N4113			19.0	20	150					
	1N4114			20.0	19						
	1N4115			22.0	17						
	1N4116			24.0	16						
	1N4117			25.0	15						
	1N4118			27.0	14						
	1N4119			28.0	14	200		+0.095			
	1N4120			30.0	13						
	1N4121			33.0	12						
	1N4122			36.0	11						
	1N4123			39.0	9.8						
	1N4124			43.0	8.9	250					
	1N4125			47.0	8.1						
	1N4126			51.0	7.5	300		+0.100			
	1N4127			56.0	6.7						
	1N4128			60.0	6.4	400					
	1N4129			62.0	6.1	500					
	1N4130			68.0	5.6	700					
	1N4131			75.0	5.1						
	1N4132			82.0	4.6	800					
	1N4133			87.0	4.4	1000					
	1N4134			91.0	4.2	1200					
	1N4135			100.0	3.8	1500					

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

DIODES (Page 2 of 2)
Voltage Regulator, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	Nominal Reference Voltage V_Z (V)	@ I_Z (mA)	Max. Impedance Z_Z (Ohms)	Max. Diss. T_A = 25°C (W)	Voltage Temp. Coefficient (%/°C)	Max. Temp.	Case Dwg.	Remarks
	1N4614	/435	QPL-19500	1.8	212	1200	0.040	-0.075	175°C	D014	Low Noise Devices
	1N4615			2.0	190	1250					
	1N4616			2.2	173	1300					
	1N4617			2.4	159	1400					
	1N4618			2.7	141	1500					
	1N4619			3.0	127	1600					
	1N4620			3.3	116	1650					
	1N4621			3.6	106	1700		-0.065			
	1N4622			3.9	98	1650		-0.060			
	1N4623			4.3	87	1600		-0.050			
	1N4624			4.7	81	1550		-0.040/+0.020			
	1N4625			5.1	75	1500		-0.045/+0.030			
	1N4626			5.6	68	1400		-0 020/+0.040			
	1N4627			6.2	61	1200		-0.010/+0.050			

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

DIODES

Power Rectifiers, Fast Switching, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	*Manufacturer*	I_O (Adc)		V_{RM} (wkg) [V (pk)]	Reverse Recovery *Time* (t_{rr}) (nsec)	Maximum Reverse Current (μAdc) @	Reverse *Voltage* (Vdc)	I_{FSM} *(1/120 sec)* (A pk)	Case Dwg.
	1N3891	/304	QPL-19500	12	@T_C = 100°C	200	200	25	200	150	DO4
	1N4942	/359		1.0	@T_A = 55°C	200	150	1.0	200	10	DO15
	1N4944					400	150		400		
	1N4946					600	150		600		
	1N4947					800	250		800	15	
	1N4948					1000	500		1000	10	
	1N5816	/478		20	@T_C = 100°C	150	35	10.0	150	400	DO4
	1N6073	/503		0.85	@T_A = 55°C	50	30	1.0	50	35	Note 4
	1N6074					100			100		
	1N6075					150			150		
	1N6076			1.3		50		5.0	50	75	
	1N6077					100			100		
	1N6078					150			150		
	1N6079			2.0		50		10.0	50	175	
	1N6080					100			100		
	1N6081					150			150		

NOTES

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

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	Maximum Forward Voltage [V (pk)]	Forward Current [A (pk)]	Maximum Reverse Current 25°C (μAdc) @	150°C (mAdc) @	Reverse Voltage (Vdc)	Reverse Recovery Time t_{rr} (μsec)	Case Dwg.
	1N4245	/286	QPL-19500	1.3	3.0	1.0	.15	200	5	DO15
	1N4247							600		
	1N4249							1000		

DIODES
Voltage Variable Capacitor, Silicon

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	Nominal Cap. @V_R = 4Vdc (pF)	Cap. Ratio V_R = 4v to 60v (times)	Max. Cont. Work. Volts V_R (volts)	Min. Q @f = 50MHz V_R = 4vdc	Max. Diss. (W)	Max. Temp. (°C)	Case Dwg.
	1N5139A	/383	QPL-19500	6.8	2.7	60	350	0.4	175°C	DO7
	1N5140A			10	2.8		300			
	1N5141A			12						
	1N5142A			15			250			
	1N5143A			18						
	1N5144A			22	3.2		200			
	1N5145A			27						
	1N5146A			33						
	1N5147A			39						
	1N5148A			47						

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

Index of Preferred Transistors[1,4]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Description	Refer To
G3000			
G3001		Microwave, Power	Page 09-6
G3005			
	2N718A	Low Power – NPN	Page 09-2
	2N918	RF – NPN	MIL-STD-975
	2N1613	Medium Power – NPN	Page 09-3
	2N2060	Dual – NPN	
	2N2219A	Medium Power – NPN	
2N2222A	2N2222A	Lower Power – NPN	MIL-STD-975
	2N2369A		
	2N2432A	Chopper – NPN	
	2N2484	Low Power – NPN	
	2N2605	Low Power – PNP	
	2N2857	RF – NPN	Page 09-6
	2N2880	High Power – NPN	Page 09-4
	2N2905A	Medium Power – PNP	
	2N2907A	Low Power – PNP	MIL-STD-975
	2N2920	Dual – NPN	
	2N2944A		Page 09-3
	2N2945A	Chopper – PNP	MIL-STD-975
	2N2946A		Page 09-3
	2N3019	Medium Power – NPN	

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Description	Refer To
	2N3251A	Low Power – PNP	Page 09-2
	2N3375	RF – NPN	Page 09-6
	2N3553	RF – NPN	
	2N3637	Medium Power – PNP	MIL-STD-975
	2N3700	Low Power – NPN	
	2N3741	High Power – PNP	Page 09-4
	2N3749	High Power – NPN	MIL-STD-975
	2N3763	Medium Power – PNP	Page 09-2
	2N3765	Low Power – PNP	
	2N3792	High Power – PNP	Page 09-4
	2N3810	Dual – PNP	MIL-STD-975
	2N3811	Dual – PNP	
	2N3821		Page 09-5
	2N3822	J-FET (N-CH)	
	2N3823		MIL-STD-975
	2N3866	RF – NPN	Page 09-6
	2N3868	Medium Power – PNP	Page 09-2
	2N3996	High Power – NPN	
	2N4150	Medium Power – NPN	MIL-STD-975
	2N4399	High Power – PNP	
	2N4440	RF – NPN	Page 09-6

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Description	Refer To
	2N4856		MIL-STD-975
	2N4857	J-FET (N-CH)	Page 09-5
	2N4858		
	2N4931	Medium Power – PNP	Page 09-2
	2N4948	Unijunction	
	2N4957	RF – PNP	
	2N5038	High Power – NPN	MIL-STD-975
	2N5114	J-FET (P-CH)	
	2N5250	High Power – NPN	Page 09-4
	2N5416	Low Power – PNP	MIL-STD-975
	2N5660	High Power – NPN	Page 09-4
	2N5662	Medium Power – NPN	Page 09-3
	2N5666	High Power – NPN	
	2N5667	High Power – NPN	MIL-STD-975
	2N5672	High Power – NPN	
	2N5745	High Power – PNP	Page 09-4
	2N6308	High Power – NPN	
	4N23		
	4N23A		MIL-STD-975
	4N24	Photocoupler	
	4N24A		
	4N47		
	4N48		
	4N49		

NOTES.
1. JTX transistors listed in MIL-STD-975 are not shown in this index. GSFC considers them to be non-standard parts
2. 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 NSPAR is required
3. JANTXV transistors must be rescreened in accordance with the applicable TX detail specification of MIL-S-19500 for use in Grade 2 applications
4. Refer to Appendix D for information on radiation effects.

TRANSISTORS
NPN, Silicon, Low Power[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	h_{FE} (min/max)	@ I_C (mAdc)	@ V_{CE} (Vdc)	I_{CBO} (nAdc)	@ V_{CB} (Vdc)	V_{CE}(SAT) (Vdc)	@ I_C (mAdc)	@ I_B (mAdc)	BV_{CBO} (Vdc)	P_T @T_A = 25°C (mW)	Case Dwg.
	2N718A	/181	QPL-19500	40/120	150	10	10	60	1.5	150	15	75	500	TO18

TRANSISTORS
PNP, Silicon, Low Power[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	h_{FE} (min/max)	@ I_C (mAdc)	@ V_{CE} (Vdc)	I_{CBO} (nAdc)	@ V_{CB} (Vdc)	V_{CE}(SAT) (Vdc)	@ I_C (mAdc)	@ I_B (mAdc)	BV_{CBO} (Vdc)	P_T @T_A = 25°C (mW)	Switching Time t_{on} (nsec)	Switching Time t_{off} (nsec)	Case Dwg.
	2N3251A	/323	QPL-19500	100/300	-10	-1	-20	-40	-0.25	-10	-1	-60	360	70	250	TO18
	2N3765	/396		40/140	-500	-1	-100	-30	-0.5	-500	-50		500	43	115	TO46

TRANSISTORS
PNP, Silicon, Medium Power[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	h_{FE} (min/max)	@ I_C (mAdc)	@ V_{CE} (Vdc)	I_{CBO} (nAdc)	@ V_{CE} (Vdc)	V_{CE}(SAT) (Vdc)	@ I_C (mAdc)	@ I_B (mAdc)	BV_{CBO} (Vdc)	P_T @T_A = 25°C (mW)	Switching Time t_{on} (nsec)	Switching Time t_{off} (nsec)	Case Dwg.
	2N3763	/396	QPL-19500	40/140	-500	-1	-100	-30	-0.5	-500	-50	-60	1000	43	115	TO5
	2N3868	/350		30/150	-1500	-2	I_{CEX} = -1000	V_{CE} = -60Vdc						100	600	
	2N4931	/397		50/200	-30	-10	-500	-200	-1.2	-30	-3	-250		not specified		TO39

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, Medium Power[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	h_{FE} (min/max)	@ I_C (mAdc)	@ V_{CE} (Vdc)	I_{CBO} (nAdc)	@ V_{CB} (Vdc)	V_{CE}(SAT) (Vdc)	@ I_C (mAdc)	@ I_B (mAdc)	BV_{CBO} (Vdc)	P_T @T_A = 25°C (mW)	Switching Time t_{on} (nsec)	Switching Time t_{off} (nsec)	Case Dwg.
	2N1613	/181	QPL-19500	40/120	150	10	10	60	1.5	150	15	75	800	not specified		TO5
	2N3019	/391	QPL-19500	100/300	150	10	I_{CES} = 10nAdc	V_{CE} = 90Vdc	0.2	150	15	140	800	not specified		TO5
	2N5662	/454	QPL-19500	40/120	500	5	100	200	0.4	1000	100	250	1200	250	850	TO5

TRANSISTORS
PNP, Chopper, Low Power, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacture	h_{FE} (min)	@ I_C (mAdc)	@ V_{CE} (Vdc)	r_{ec} (on) (max) (Ohms)	@ f = 1kHz I_E = 0 and I_B (mAdc)	I_e (μ A)	V_{EC}(ofs) (max) (Vdc)	@ I_E (mAdc)	@ I_B (mAdc)	BV_{CBO} (Vdc)	P_T @T_A = 25°C (mW)	Case Dwg.
	2N2944A	/382	QPL-19500	100	-1	-0.5	4	-1	100	-0.6	0	-1	-15	400	TO46
	2N2946A	/382	QPL-19500	50	-1	-0.5	8	-1	100	-2.0	0	-1	-40	400	TO46

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[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	h_{FE} (min/max)	@ I_C (Adc)	@ V_{CE} (Vdc)	I_{CBO} (mAdc)	@ V_{CB} (Vdc)	$V_{CE}(SAT)$ (Vdc)	@ I_C (Adc)	@ I_B (Adc)	BV_{CBO} (Vdc)	P_T @ $T_C = 25°C$ (Watts)	Case Dwg
	2N2880	/315	QPL-19500	40/120	1	5	0.0004	80	0.25	1	0.1	110	30@ T_C = 373K	Note 4
	2N5250	/380		30/90	20	5	I_{CES} = 0.1mAdc	V_{CE} = 125Vdc	1.0	40	4	125	350	Note 4
	2N5660	/454		40/120	0.5	5	0.0001	200	0.4	1	0.1	250	20@ T_C = 373K	TO66

TRANSISTORS
PNP, Silicon, High Power[1]

Grade 1[2] Type Designation JANS	Grade 2 Type Designation JANTXV[3]	Specification MIL-S-19500	Manufacturer	h_{FE} (min/max)	@ I_C (Adc)	@ V_{CE} (Vdc)	I_{CBO} (mAdc)	@ V_{CB} (Vdc)	$V_{CE}(SAT)$ (Vdc)	@ I_C (Adc)	@ I_B (Adc)	BV_{CBO} (Vdc)	P_T @ $T_C = 25°C$ (Watts)	Switching Time t_{on} (μ sec)	Switching Time t_{off} (μ sec)	Case Dwg.
	2N3741	/441		30/100	-0.250	-1	-0.0001	-80	-0.6	-1	-0.125		25	0.4	1.0	TO66
	2N3792	/379	QPL-19500	50/150	-1	-2	I_{CES} = -1mAdc	V_{CE} = -70Vdc	-1	-5	-0.5	-80	150	1.5	2.0	TO3
	2N5745	/433		15/60	-10	-2	-1	-80	-1	-10	-1		200	1.0	3.0	

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
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[1]

<table>
<tr><th>Grade 1[2]</th><th>Grade 2</th><th rowspan="3">Specification MIL-S-19500</th><th rowspan="3">Manufacturer</th><th rowspan="3">V_{DG} and V_{DS} (max) (Vdc)</th><th rowspan="3">V_{GS} (max) (Vdc)</th><th rowspan="3">I_G (mA)</th><th rowspan="3">V_{GS}(off) max. (Vdc)</th><th colspan="2">@</th><th rowspan="3">I_{DSS} (min/max) (mA)</th><th colspan="2">@</th><th rowspan="3">P_T (mW)</th><th rowspan="3">Case Dwg.</th></tr>
<tr><th rowspan="2">Type Designation JANS</th><th rowspan="2">Type Designation JANTXV[3]</th><th rowspan="2">V_{DS} (Vdc)</th><th rowspan="2">I_D (nA)</th><th rowspan="2">V_{DS} (Vdc)</th><th rowspan="2">V_{GS} (Vdc)</th></tr>
<tr></tr>
<tr><td rowspan="4"></td><td>2N3821</td><td rowspan="2">/375</td><td rowspan="4">QPL-19500</td><td rowspan="2">50</td><td rowspan="2">-50</td><td rowspan="2">10</td><td>-4</td><td rowspan="4">15</td><td rowspan="4">0.5</td><td>0.5/2.5</td><td rowspan="4">15</td><td rowspan="4">0</td><td rowspan="2">300</td><td rowspan="2">TO72</td></tr>
<tr><td>2N3822</td><td rowspan="2">-6</td><td>2/10</td></tr>
<tr><td>2N4857</td><td rowspan="2">/385</td><td rowspan="2">40</td><td rowspan="2">-40</td><td rowspan="2">50</td><td>20/100</td><td rowspan="2">360</td><td rowspan="2">TO18</td></tr>
<tr><td>2N4858</td><td>-4</td><td>8/80</td></tr>
</table>

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
RF, NPN, Silicon[1]

Grade 1[2] Type Designation	Grade 2 Type Designation JANTXV[3]	Specification	Manufacturer	h_{FE} (min/max)	@ I_C (mAdc)	@ V_{CE} (Vdc)	BV_{CBO} (Volts)	P_{OUT} (min/max) (Watts)	@ P_{IN} (Watts)	@ f (MHz)	@ η (%)	P_T T_C = 298K (Watts)	Case Dwg.
G3000		GSFC S-311-35	Microwave Semiconductor Corp.	15/120	100	5	50	G_{PB} = 11.0db min.		2250		Not Specified[4]	Microwave Pkg.
G3001		GSFC S-311-36						G_{PB} = 10.8db min.					
G3005		GSFC S-311-37						G_{PB} = 8.0db min.					
	2N2857	MIL-S-19500 /343	QPL-19500	30/150	3	1	30	G_{PB} = 12.5/21db		450		0.3	TO72
	2N3375	MIL-S-19500 /341		15/150	150	5	65	7.5/14 3/6	1 1	100 400	65 40	11.6	TO60
	2N3553							2.5/5	0.25	175	50	7.0	TO39
	2N3866	MIL-S-19500 /398		15/200	50		60	1/2 0.5 min.	0.15 0.075	400 400	45 40	1.0 @ T_A = 25°C	
	2N4440	MIL-S-19500 /341						10/16 4/8	1 1	100 400	65 40	11.6	TO60

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
4. Power dissipation is determined by the type of heat sink used with the device

INDEX TO PREFERRED MICROCIRCUITS [1,2,3]

LINEAR

Operational Amplifier

- HA2500
- HA2520
- HA2600
- LF155
- LM101A
- LM108A
- LM118
- LM741
- LM747

Voltage Regulator

- LM109
- LM120
- LM140
- LM140K12
- LM723

Voltage Comparators

- LM111
- LM139
- LM710

Line Driver

- 9614
- 55113

Line Receiver

- 9615
- 55107
- 55108

Precision Timer

- 555
- 556

DIGITAL

Low Power Schottky, TTL

54LS00	54LS37	54LS112	54LS174
54LS02	54LS38	54LS113	54LS175
54LS03	54LS40	54LS114	54LS190
54LS04	54LS42	54LS123	54LS191
54LS05	54LS47	54LS125	54LS193
54LS08	54LS51	54LS126	54LS194
54LS10	54LS54	54LS132	54LS195
54LS11	54LS73	54LS138	54LS240
54LS12	54LS74	54LS139	54LS241
54LS13	54LS76	54LS148	54LS251
54LS14	54LS83A	54LS151	54LS253
54LS15	54LS85	54LS153	54LS257
54LS20	54LS86	54LS156	54LS258
54LS21	54LS90	54LS157	54LS266
54LS22	54LS92	54LS158	54LS283
54LS26	54LS93	54LS160	54LS295
54LS27	54LS95	54LS161	54LS365
54LS28	54LS96	54LS162	54LS367
54LS30	54LS107	54LS163	54LS368
54LS32	54LS109	54LS164	54LS375
			54LS395

TTL

5401	5425	5453	54145
5406	5443	5470	54150
5407	5444	5472	54154
5409	5448	5477	54163
5416	5449	5482	54165
5423	5450	54121	

Low Power TTL

- 54L71
- 54L72
- 54L78

DIGITAL

CMOS

4000A	4014A	4025A	4075B
4001A	4015A	4027A	4077B
4002A	4017A	4031A	4081B
4006A	4018A	4049A	4082B
4007A	4019A	4050A	4085B
4009A	4020A	4069UB	4086B
4010A	4021A	4070B	4098B
4011A	4022A	4071B	4099B
4012A	4023A	4072B	4502B
4013A	4024A	4073B	

MEMORY

PROM

82S126	82S130	82S137	82S185
82S129	82S131	82S181	82S191

RAM

93L425

MICROPROCESSOR

2901B 8080A

SBP 9989

Refer to Page 10-3

HYBRID

Refer to Page 10-2

NOTES

1 MIL-STD-975D lists all of the preferred microcircuits except Microprocessor SBP 9989 which is listed in this PPL
2. When no JANS microcircuit is listed on the QPL, a Grade 2 microcircuit may be upgraded for use in Grade 1 applications in accordance with Appendix A. A NSPAR is required
3. Refer to Appendix D for information on radiation effects.

MICROCIRCUIT INFORMATION

HYBRID MICROCIRCUITS NOT LISTED IN PPL OR MIL-STD-975

Hybrid microcircuits are defined as parts which are comprised of any one of a combination of the following: multiple semiconductor chips (integrated circuits and/or discrete diodes or transistors), thin or thick films, and discrete passive elements. Since many processing techniques for hybrids are similar to those for monolithic microcircuitry, similar precautions and procedures for their procurement should be observed. Hybrid microcircuits by their nature tend to be low volume non-standard parts. Procedural guidelines for the procurement of nonstandard hybrid microcircuits are given in the following paragraphs.

1. A survey of the manufacturer's hybrid facility should be performed.

2. Since hybrid microcircuits may contain critical circuit assemblies approaching subsystems in complexity and function, it is advised that a design review, including parts stress analysis, be performed.

3. A sample quantity from each hybrid microcircuit order should be subjected to destructive physical analysis in accordance with Method 5009 of MIL-STD-883.

4. Procurement specifications for hybrid microcircuits shall require qualification, lot acceptance, and screening to assure that the discrete parts used within hybrids are selected and screened with the same care as for monolithic microcircuits. For product assurance requirements for hybrid microcircuits, consult the GSFC Specification for Hybrid Microcircuit Requirements, S-311-74, Rev. A.

5. Environmental test levels for hybrid microcircuits shall be tailored to the processing techniques so as not to produce overstress.

MICROCIRCUITS
MIL-M-38510 /MICROPROCESSOR

Commercial Part Number[1]	Case Style	Description	Grade 1	Grade 2[2]		
			Part Number	Part Number[3] JANM38510/	Specification MIL-M-38510	Manufacturer
SBP 9989	64-Pin Dip	16-Bit Bipolar Integrated Injection Logic (I^2L)		46501BYC	/465	TI Inc.

Microcircuits

Microprocessor Peripheral Devices

At the present time, there are no suitable microprocessor peripheral devices available to any Military or NASA Specification. Consult your project parts engineer on the procurement and use of these devices.

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NOTES:

1. Use the JANM38510/ Part Number, not the Commercial Part Number.
2. Non-critical flight and non-mission-essential ground support applications. There are no Grade 1 microprocessor parts available.
3. The "Y" is the choice of case outline. Lead finish may be either Kovar or Alloy 42 with Gold Plate as designated by letter "C".

INDEX TO PREFERRED SOLDER

Style	Description	Specification	Refer To
SN60	Solder, Rosin Core	QQ-S-571	Page 11-2
SN63	Solder, Rosin Core	QQ-S-571	Page 11-2

Solder, Rosin Core

Type No.[1,2]	Approx. Gauge (AWG)	Tin Content (%)	Lead Content (%)	Antimony Content (%)	Max. Total Other Constituents Content (%)	Approx. Melting Range °C		Specification	Manufacturer
						Solidus	Liquidus		
SN60WRMAP SN60WRP SN60WRAP	16, 18, 20	59.5-61.5	39.8 - 37.5	0.20-0.50	0.47	182	190	QQ-S-571	Per QPL-QQ-S-571
SN63WRMAP SN63WRP SN63WRAP	16, 18, 20	62.5-63.5	36.8 - 35.5	0.20-0.50	0.47	182	182	QQ-S-571	Per QPL-QQ-S-571

NOTES.

1. As a guide the recommended order of use for these solders and fluxes and the procedure for cleaning after soldering is as follows:
   (a) Type RMA flux is suitable for all electronic applications. (RMA is rosin core/mildly activated)
   (b) Type R may be used in critical applications such as in extremely low leakage circuits. A good joint may be more difficult to obtain with R than with type RMA. (R is rosin core/non-activated)
   (c) Type RA may be used when a joint cannot be made with RMA or R. (RA is rosin core/activated)
   (d) Cleaning requirements· All three fluxes, R, RMA, and RA must be cleaned with one of the solvents listed below after soldering:
      (1) Ethyl alcohol, ACS grade.
      (2) Isopropyl alcohol, ACS grade.
      (3) Trichlorotrifluoroethane, ACS grade.
      (4) Any mixture of these.
   (e) The degree of corrosiveness of the fluxes are as follows
      R - least corrosive
      RMA - moderately corrosive
      RA - most corrosive
2. Refer to NASA publication NHB5300.4(3A-1), Requirements for Soldered Electrical Connections

Index of Preferred Thermistors

Style	Description	Specification	Refer To
311P18	Thermistor, Insulated, Negative Temp Coeff	GSFC S311-P-18	Page 14-2
RTH	Thermistor, Insulated, Positive Temp Coeff	MIL-T-23648	MIL-STD-975

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THERMISTORS[1]

Temp. Coeff.	Resistance (ohms)	Tolerance at 25°C (±%)	Operating Temperature Range (°C)	Resistance Ratio $R_{25°C}/R_{MAX}$	Grade 1 and Grade 2		
					Part Number[2]	Specification	Manufacturer
Neg.	2252	1	-55 to 90	10.93	311P18-01LXXX	GSFC S-311-P-18	Yellow Springs Instrument
	2252	0.5	-55 to 70	5.71	311P18-02LXXX		
	3000	1	-55 to 90	10.91	311P18-03LXXX		
	3000	0.5	-55 to 70	5.71	311P18-04LXXX		
	5000	1	-55 to 90	10.91	311P18-05LXXX		
	5000	0.5	-55 to 70	5.71	311P18-06LXXX		
	10000	1	-55 to 90	9.23	311P18-07LXXX		
	10000	0.5	-55 to 70	5.03	311P18-08LXXX		
	30000	1	-55 to 90	10.72	311P18-09LXXX		
	30000	0.5	-55 to 70	5.60	311P18-10LXXX		

NOTES:

1. WARNING. Use heat sinks when soldering or welding to thermistor leads.
2. The complete part number is 311P18– AA L XXX

DASH NUMBER (AA)
(01, 02, etc.)

LEAD STYLE (L):
S = 32 AWG, Type C per MIL-STD-1276
T = 28 AWG, Type ET per MIL-W-16876
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 (XXX):
Specify length in centimeters.
1R0 = 1.0, 10R = 10, 101 = 100
Minimum length is 7.6cm.

Index of Preferred Transformers

Style	Description	Specification	Refer To
M27/103	Audio Frequency	MIL-T-27	MIL-STD-975
M27/165	Audio Frequency	MIL-T-27	MIL-STD-975
M27/166	Audio Frequency	MIL-T-27	MIL-STD-975
M27/197	Audio Frequency	MIL-T-27	MIL-STD-975
M21038/9-005	Pulse, Low Power	MIL-T-21038	MIL-STD-975

Index of Preferred Wire/Cable [1]

Style	Description	Specification	Refer To
M22759/11 and /9	Wire, High temperature	MIL-W-22759	Page 16-2
M22759/18	Wire, Light weight	MIL-W-22759	Page 16-3
S311P13	Wire, High voltage	GSFC S-311-P-13	Page 16-4
M22759/3/11/ 12/16/22/23	Wire, Extruded TFE	MIL-W-22759	MIL-STD-975
M81381	Wire, Fluorocarbon-Polymide	MIL-W-81381	MIL-STD-975
M16878	Wire, High Temperature	MIL-W-16878	MIL-STD-975
M5086	Wire, PVC insulated	MIL-W-5086	MIL-STD-975
M17	Cable, RF, Flexible, Coaxial	MIL-C-17	MIL-STD-975
M27500	Cable, Electrical, Shielded and Unshielded	MIL-C-27500	MIL-STD-975

NOTE

1. GSFC waives the restrictions and requirements of MIL-STD-975 on the use of silver coated copper conductor wire and cable

WIRE
Electrical, Insulated, High Temperature

Style[1]	Strands No. x AWG #	Diameter over Insulation, mm		Voltage Rating, Maximum (volts/RMS)	Specification MIL-W-22759	Grade 1	Grade 2	Remarks
		Minimum	Maximum			Manufacturer		
M22759/11-28-X	7 x 36	.79	.90	600	/11	QPL-22759/11		Silver-coated, copper conductor; Insulated with extruded TFE; Suitable for UHF; Maximum Temperature 200°C
M22759/11-26-X	19 x 38	.91	1.02					
M22759/11-24-X	19 x 36	1.04	1.14					
M22759/11-22-X	19 x 34	1.19	1.30					
M22759/11-20-X	19 x 32	1.42	1.52					
M22759/11-18-X	19 x 30	1.68	1.78					
M22759/11-16-X	19 x 29	1.85	1.96					
M22759/11-14-X	19 x 27	2.24	2.34					
M22759/11-12-X	19 x 25	2.74	2.90					
M22759/11-10-X	37 x 26	3.43	3.63					
M22759/11- 8-X	33 x 29	5.03	5.23					
M22759/9-22-X	19 x 34	1.47	1.57	1000	/9	QPL-22759/9		
M22759/9-20-X	19 x 32	1.68	1.78					
M22759/9-18-X	19 x 30	1.93	2.03					
M22759/9-16-X	19 x 29	2.11	2.21					

NOTES:
1 For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (listed on page 16-5).

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WIRE
Electrical, Insulated, Lightweight

Style[1]	Strands No. x AWG #	Diameter over Insulation, mm		Voltage Rating, Maximum (volts/RMS)	Specification MIL-W-22759	Grade 1	Grade 2	Remarks
		Minimum	Maximum			Manufacturer		
M22759/18-26-X	19 x 38	.762	.864	600	/18	QPL-22759/18		Tin-coated copper conductor Insulated with extruded ETFE Maximum temperature 150°C; suitable for use as hookup wire.
M22759/18-24-X	19 x 36	.864	.965					
M22759/18-22-X	19 x 34	1.04	1.14					
M22759/18-20-X	19 x 32	1.24	1.35					
M22759/18-18-X	19 x 30	1.50	1.60					
M22759/18-16-X	19 x 29	1.65	1.75					
M22759/18-14-X	19 x 27	2.01	2.11					
M22759/18-12-X	37 x 28	2.57	2.67					
M22759/18-10-X	37 x 26	3.15	3.25					

NOTES
1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (listed on Page 16-5)

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WIRE
Electrical, Insulated

Style[1]	600 Volt		1000 Volt		2500 Volt		Specification	Grade 1	Grade 2	Remarks
	Strands No. x AWG #	Diameter over Insulation, mm. Max.	Strands No. x AWG #	Diameter over Insulation, mm. Max.	Strands No. x AWG #	Diameter over Insulation, mm. Max.		Manufacturer		
S311P13-XX-30-Z	7 x 38	.71	–	–	–	–	GSFC S-311-P-13	Raychem Corp.		Tin-coated, copper conductor. Insulated with crosslinked polyalkene. Max. Temp. 135°C. Suitable for use in wire harnesses.
S311P13-XX-28-Z	7 x 36	.79	7 x 36	.86	–	–				
S311P13-XX-26-Z	7 x 34	.89	7 x 34	1.04	–	–				
S311P13-XX-24-Z	19 x 36	1.04	19 x 36	1.17	19 x 36	1.50				
S311P13-XX-22-Z	19 x 34	1.22	19 x 34	1.35	19 x 34	1.80				
S311P13-XX-20-Z	19 x 32	1.42	19 x 32	1.55	19 x 32	2.03				
S311P13-XX-18-Z	19 x 30	1.68	19 x 30	1.88	19 x 30	2.29				
S311P13-XX-16-Z	19 x 29	1.88	19 x 29	2.08	19 x 29	2.54				
S311P13-XX-14-Z	19 x 27	2.29	19 x 27	2.49	19 x 27	3.00				
S311P13-XX-12-Z	37 x 28	2.84	19 x 25	3.23	19 x 25	3.71				
S311P13-XX-10-Z	–	–	37 x 26	3.61	37 x 26	4.19				
S311P13-XX-8-Z	–	–	133 x 29	5.28	133 x 29	5.79				
S311P13-XX-6-Z	–	–	–	–	133 x 27	7.06				
S311P13-XX-4-Z	–	–	–	–	133 x 25	8.53				
S311P13-XX-2-Z	–	–	–	–	665 x 30	10.1				
S311P13-XX-0-Z	–	–	–	–	1045 x 30	12.4				
S311P13-XX-00-Z	–	–	–	–	1330 x 30	14.2				

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 16-5

Color Code Designators for Wire According to MIL-STD-681

Base Color	1st Stripe	2nd Stripe	Designator
Black			0
Brown			1
Red			2
Orange			3
Yellow			4
Green			5
Blue			6
Violet			7
Gray			8
White			9
White	Black		90
White	Brown		91
White	Red		92
White	Orange		93
White	Yellow		94
White	Green		95
White	Blue		96
White	Violet		97
White	Gray		98

Base Color	1st Stripe	2nd Stripe	Designator
White	Black	Brown	901
White	Black	Red	902
White	Black	Orange	903
White	Black	Yellow	904
White	Black	Green	905
White	Black	Blue	906
White	Black	Violet	907
White	Black	Gray	908
White	Brown	Red	912
White	Brown	Orange	913
White	Brown	Yellow	914
White	Brown	Green	915
White	Brown	Blue	916
White	Brown	Violet	917
White	Brown	Gray	918
White	Red	Orange	923
White	Red	Yellow	924
White	Red	Green	925
White	Red	Blue	926
White	Red	Violet	927
White	Red	Gray	928

Base Color	1st Stripe	2nd Stripe	Designator
White	Orange	Yellow	934
White	Orange	Green	935
White	Orange	Blue	936
White	Orange	Violet	937
White	Orange	Gray	938
White	Yellow	Green	945
White	Yellow	Blue	946
White	Yellow	Violet	947
White	Yellow	Gray	948
White	Green	Blue	956
White	Green	Violet	957
White	Green	Gray	958
White	Blue	Violet	967
White	Blue	Gray	968
White	Violet	Gray	978

APPENDIX A
Upgrading Grade 2 Devices for Use in Grade 1 Applications

Both PPL-16 and MIL-STD-975D 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. The PPL has differences from MIL-STD-975 in the procedures to upgrade semiconductor devices. In all cases, the upgrading of a Grade 2 part for use in a Grade 1 application requires a Non-Standard Part Approval Request (NSPAR). 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.

For the upgrading of diodes, transistors, and microcircuits; 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. This requirement applies to both methods of upgrading given in this Appendix.

The sampling plan for DPA, used in this Appendix, is taken from GSFC S-311-70. The sample sizes are as follows:

Lot Size	No. Samples
<5	1
5–15	2
16–50	3
>50	5

UPGRADING GUIDELINES

Section 1 – CAPACITORS

For styles listed in MIL-STD-975D, see Appendix B of that document. For styles listed in PPL-16, where the appropriate Failure Rate Level is not available, a NSPAR is required to use the next lowest available level.

Section 3 – FILTERS

Consult the parts specialist.

Section 4 – FUSES

GSFC considers the fuses in Section 4 of PPL-16 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-16 then consult the parts specialist for advice in selection of a suitable relay.

Section 7 – RESISTORS

When the appropriate Failure Rate Level is not available, a NSPAR is required to use the next lowest available level.

Section 8 – DIODES

Grade 2 JANTXV diodes listed in PPL-16 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. Electrical measurements should be made only at the completion of the burn-in with parameter and delta limits as specified in the detail specification.

Referring to note 1, MIL-STD-975D, Page B.4, diodes can be upgraded for Grade 1 use without first rescreening them to Grade 2 level. If they have been rescreened to the Grade 2 level, then tests already completed in the rescreening do not have to be repeated in upgrading the parts to Grade 1.

Section 9 – TRANSISTORS

Grade 2 JANTXV transistors listed in PPL-16 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. Electrical measurements should be made only at the completion of the burn-in with parameter and delta limits as specified in the detail specification.

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

Section 10 – MICROCIRCUITS

Grade 2 microcircuits listed in 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, the screening given in Table 3.2 of Appendix B of MIL-STD-975 will be used and the following procedure will be substituted for the DPA and Group B tests. Perform destructive physical analysis on samples in accordance with GSFC S-311-70A.

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-16, consult the parts specialist.

APPENDIX B
Parts Derating Factors

This appendix tabulates GSFC's guidelines for the derating of the component types listed in MIL-STD-975 and PPL-16. Many of these derating guidelines are identical to those given in MIL-STD-975. Where differences occur, they are based on GSFC experiences.

Table 01.
Derating Outline for Capacitors

Dielectric Class	Maximum Ambient Operating Temperature °C	Derate to Following Percentage (%)	
		Rated Voltage	Ripple Voltage
Ceramic (CKR), (CDR)	85	60	N/A
Plastic Film (CRH)[1]		60	
Glass or Porcelain (CYR)		50	
Tantalum (Solid Electrolyte) (CSR)			75
> 1 ohm/volt effective circuit impedance	70	60	
< 1 ohm/volt effective circuit impedance	50	40	
Tantalum (Wet Electrolyte) (CLR)	70	60	
Tantalum Foil (CLR)		50	

NOTES.

1. CRH styles are not approved for use in circuits where the energy is less than 250 μ joules.

Table 02. Derating Outline for Connectors

Number of Contacts Used in Connector	Contact Size	Maximum Current Per Contact[1] (Amperes)							Maximum Operating Voltage
		Wire Size (AWG)							
		16	18	20	22	24	26	28	
1 to 4	16	13.0	9.2	6.5					25% of rated Dielectric Withstanding Voltage
1 to 4	20			6.0	4.5	3.3			
1 to 4	22				4.5	3.3	2.5	1.8	
5 to 14	16	9.0	7.0	5.0					
5 to 14	20			5.0	3.5	2.7			
5 to 14	22				3.5	2.7	1.9	1.4	
15 or more	16	6.5	5.0	3.7					
15 or more	20			3.7	2.5	2.0			
15 or more	22				2.5	2.0	1.4	1.0	

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

Class	Derate To	Maximum Ambient Temperature
All Filters	50% rated feed through current and 50% rated DC working voltage	85°C

NOTE Consult the Parts Specialist for assistance in derating other filter types

Table 04. Derating Outline for Fuses

Subminiature[1, 2, 3, 4]

Fuse Current Rating (Amperes)	Derate to the Following (%) of Rated Current	Remarks
15	50%	
10	50%	
5	50%	
2	50%	
1	45%	
1/2	40% Note 4	
3/8	35% Note 4	
1/4	30% Note 4	
1/8	25% Note 4	

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 pressure, 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

4. The flight use of fuses rated ½ ampere and less requires application approval by the applicable GSFC project office.

Table 05.
Derating Outline for Inductors/Coils

Class Per MIL-C-39010	Class Per MIL-C-15305	Maximum Operating Temperature	Derate To
-	O	65°C	50% of Maximum rated voltage.
A	A	85°C	
B	B	105°C	

NOTES:

1. a) Maximum operating temperature equals ambient temperature + temperature rise + 10°C (allowance for hot spot) Compute temperature rise as follows.

$$\text{Temperature rise } (^\circ C) = \frac{R - r}{r} (T + 234.5)$$

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

Class	Derate To	Remarks
All Relays	50% of rated contact current	Users are cautioned not to derate coil current or voltage, as this can result in non-operation of the device.

Table 07.
Derating Outline for Resistors

Type	Derate To	Remarks
Carbon composition, Style RCR	60% of Rated Power	All resistors: (a) Maximum voltage shall not exceed 80% of the maximum rated voltage on any resistor. (b) Resistors with weldable nickel leads shall be derated by an additional factor of 0.5
Film, General Purpose, Style RLR	60% of Rated Power	
Wirewound, Accurate, Style RBR		
1% Tolerance	60% of Rated Power	
0.5% Tolerance	35% of Rated Power	
0.1% Tolerance	25% of Rated Power	
Wirewound, Power, Chassis Mount, Style RER	60% of Rated Power	
Wirewound, Power, Style RWR	60% of Rated Power	
Variable Trimmers, Styles RTR & RJR	70% of Rated Current	
Thick Film, Style SHV	60% of Rated Power	
Film, High Stability, Style RNC	60% of Rated Power	

Table 08.
Derating Outline for Diodes

<table>
<tr><th rowspan="2">Class</th><th colspan="2">Derate to the Following Percentage</th></tr>
<tr><th>Peak Inverse Voltage</th><th>Junction Temperature</th></tr>
<tr><td>Diodes,
Rectifiers</td><td rowspan="3">75</td><td rowspan="3">60[1,2]</td></tr>
<tr><td>Diodes,
Small Signal Switching</td></tr>
<tr><td>Diodes,
Voltage Reference, Voltage Regulator, Current Regulator, Variable Capacitor</td></tr>
<tr><td>Diodes,
Silicon Controlled Rectifier, Voltage Suppressor, PIN, Schottky Barrier Switching, Light Emitting</td><td colspan="2">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></tr>
</table>

NOTE 1 All Devices

Derate junction temperature as follows.

T_J(derated) = Derating Factor X [T_J(max)-25°C] +25°C. = Maximum allowable operating junction temperature.

T_J(max) = Manufacturer's specified maximum junction temperature

NOTE 2 Derate average forward current (I_O) to satisfy junction temperature derating calculated in note 1, as follows.

Devices Operated Without Heat Sink (Figure 1)

$I_{O(allowed)}$ = Derating Factor X $I_{O(max)}$, $T_A \leq 25°C$

$I_{O(allowed)}$ = Derating Factor X $I_{O(max)} \left[1 - \dfrac{T_A - 25°C}{T_{J(derated)} - 25°C}\right]$, $T_A > 25°C$

$I_{O(max)}$ = Manufacturer's absolute maximum current rating.

T_A = Ambient temperature.

Devices Operated With Heat Sink (Figure 2)

$I_{O(allowed)}$ = Derating Factor X $I_{O(max)}$, $T_{Case} \leq T_D$

$I_{O(allowed)}$ = Derating Factor X $I_{O(max)} \left[1 - \dfrac{T_{case} - T_D}{T_{J(derated)} - T_D}\right]$, $T_{Case} > T_D$

$T_D = T_{J(derated)}$ - Derating Factor ($T_{J(max)} - T_M$)

T_D = Case temperature above which I_O must be further derated to satisfy derated junction temperature.

T_M = Maximum case temperature at which manufacturer permits full rated current. (I_{Omax}).

$I_{O(max)}$ = Manufacturer's absolute maximum average forward current.

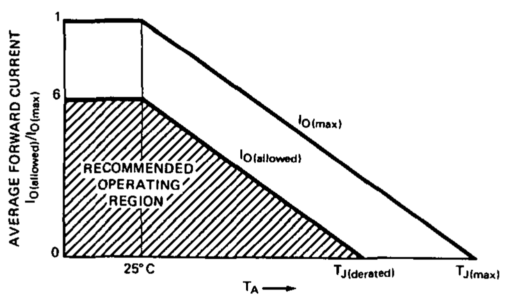

Figure 1. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated without heat sinks and a Derating Factor of 0 6

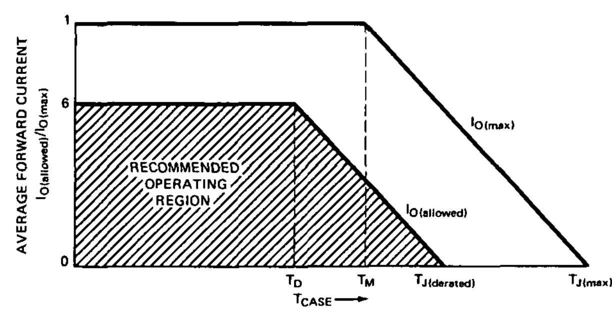

Figure 2 Derating curve from MIL-HDBK-217 modified to show operating region for devices operated with heat sinks and a Derating Factor of 0.6

Table 09.
Derating Outline for Transistors

Class	Derate to the Following Percentage			
	Voltage	Current	Power	Junction Temperature
Silicon NPN, PNP Low power, Med. power, High power, Switching, Dual, Complimentary, Chopper, Unijunction. J-FET, N-Channel, P-Channel General Purpose, Med. Power, High Power, High Speed Switching	75	75	60	60
RF NPN, Microwave Power, Phototransistor, Opto-coupler.	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.			

NOTE 1: All devices:
Derate junction temperature as follows:
T_J(derated) = Derating Factor X [T_J(max)-25°C]+25°C = Maximum recommended operating junction temperature.
$T_J$max = 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 (allowed) = Derating Factor X P_D (max), $T_A \leq 25°C$

P_D (allowed) = $\frac{T_J(\text{derated}) - T_A}{R\theta_{J-A}}$, $T_A > 25°C$

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

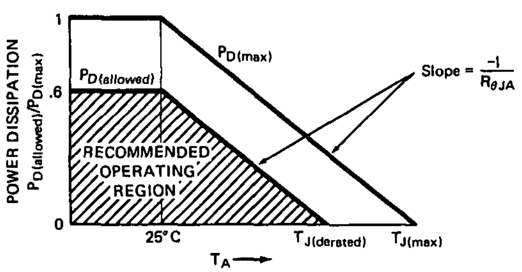

Figure 1. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated without heat sinks and a Derating Factor of 0 6.

Devices operated with heat sink (Figure 2)

P_D (allowed) = Derating Factor X P_D (max), $T_{case} \leq T_D$

P_D (allowed) = $\frac{T_J(\text{derated}) - T_{case}}{R\theta_{JC}}$, $T_{case} > T_D$

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

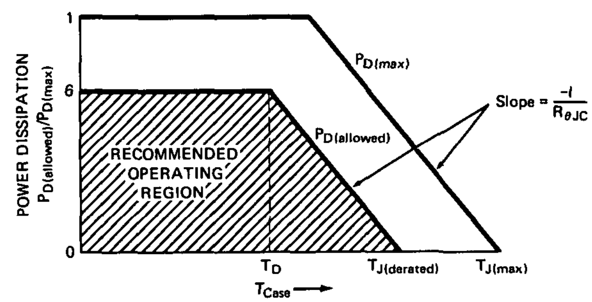

Figure 2. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated with heat sinks and a Derating Factor of 0 6.

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Table 10
Derating Outline for Microcircuits[1]

<table>
<tr><th colspan="2" rowspan="2">Type</th><th colspan="4">Derate to the Following Percentage</th></tr>
<tr><th>Supply Voltage</th><th>Power</th><th>Input Voltage</th><th>Output Current</th></tr>
<tr><td rowspan="3">Digital</td><td>TTL</td><td>100</td><td rowspan="3">80</td><td>100</td><td rowspan="3">80</td></tr>
<tr><td>CMOS</td><td>70</td><td>70</td></tr>
<tr><td>NMOS</td><td>100</td><td>100</td></tr>
<tr><td colspan="2">Operational Amplifier</td><td>80</td><td>75</td><td>70</td><td>80</td></tr>
<tr><td colspan="2">Voltage Regulator</td><td>N.A.</td><td>80</td><td>80</td><td>80</td></tr>
<tr><td colspan="2">Voltage Comparator</td><td>90</td><td rowspan="3">75</td><td>80</td><td rowspan="5">80</td></tr>
<tr><td colspan="2">Sense Amplifier</td><td>80</td><td>70</td></tr>
<tr><td colspan="2">Current Amplifier</td><td>80</td><td>80</td></tr>
<tr><td colspan="2">Analog Switch</td><td>90</td><td rowspan="2">80</td><td>90</td></tr>
<tr><td colspan="2">Line Drivers and Receivers</td><td>100</td><td>100</td></tr>
</table>

NOTES:
1. Maximum case temperature is 85°C

Table 14.
Derating Outline for Thermistors
(Temperature Sensitive Resistor)

Class	Derate To
All Thermistors	50% of rated power

Table 15.
Derating Outline for Transformers

Class Per MIL-T-27	Class Per MIL-T-21038	Maximum Operating Temperature[1]	Derate To
Q	Q	65°C	50% of Maximum rated voltage.
R	R	85°C	
S	S	105°C	

NOTE:

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

$$\text{Temperature rise } (^\circ C) = \frac{R - r}{r}(T + 234.5) - (T - t)$$

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) = .75 × Maximum Rated Operating Temperature (°C). For devices with maximum rated temperatures outside this temperature interval consult the parts specialist for temperature derating recommedations

Table 16.
Derating Outline for Wire and Cable

Wire Size	Derate To - Amperes Maximum		Remarks
	Bundle or Cable	Single	
30	0.7	1.3	1. Current ratings for bundles or cables are based on bundles of 15 or more wires at 70°C in a hard vacuum. For smaller bundles the allowable current may be proportionally increased as the bundle approaches a single wire. 2 Ratings are based on Teflon insulated wire (Type TFE).
28	1.0	1.8	
26	1.4	2.5	
24	2.0	3.3	
22	2.5	4.5	
20	3.7	6.5	
18	5.0	9.2	
16	6.5	13.0	
14	8.5	19.0	
12	11.5	25.0	
10	16.5	33.0	
8	23.0	44.0	
6	30.0	60.0	
4	40.0	81.0	
2	50.0	108.0	
0	75.0	147.0	
00	87.5	169.0	

APPENDIX C
Screening of Electronic Parts
for Flight Equipment

This appendix to the PPL lists the minimum screening requirements which must be incorporated into procurement documents when nonstandard parts are to be procured. It specifies nominal levels of screening to be imposed on conventional MIL and commercial parts for flight applications when Established Reliability (ER), TXV, or parts to other high reliability MIL or NASA specifications are not available. (Refer to the Preface for a brief explanation of ER and TXV parts.) These screens are the minimum requirements to reduce the risk of fabricating into a system parts which do not meet advertised characteristics or which may fail latently in the system.

Because of the inherently higher risk with nonstandard parts, additional parts over the quantity needed for fabrication should be procured for test and analysis. Destructive physical analysis is recommended to ascertain the quality of construction and the workmanship applied in fabricating the parts. Step-stress testing, similar to that specified in MIL-STD-883, Method 5006, "Limit Testing", is recommended. It can yield information on failure modes to which the parts may be susceptible. These tests and analyses can determine if serious reliability hazards exist with parts for a particular application, and permit a better assessment of the risk incurred with their use.

A procurement document which is made up only of the parameters from the manufacturer's data sheet and the screens listed in the appropriate table of this appendix, is not comparable with military specifications or source controlled drawings which control other aspects of parts manufacture. The latter documents contain requirements for process controls, device construction, lot acceptance, and qualification in addition to screening. Ideally such documents should be developed for each nonstandard part, but the quantity of devices involved in a procurement, schedules, or economic constraints often preclude the development and use of such complete specifications.

For help in developing complete procurement requirements when a nonstandard part must be used, users are urged to consult their project parts engineers or the cognizant parts specialist.

Table 01.
Screening Outline for Capacitors[1]

Test Sequence / Category	1	2	3	4	5	6	Reference Documents MIL-STD-202
	Initial Examinations and Electrical Tests Reference Documents[2]	Thermal Shock MIL-STD-202, Method 107	Seal Leak Tests MIL-STD-202, Method 112	Radiographic MIL-STD-202, Method 209	Conditioning per Referenced Documents	Final Examination per Reference Documents	
(a) Air or Glass, Variable	Visual & Mechanical, C, Q, DWV IR, Driving Torque	Test Condition A	N/A	N/A	N/A	Repeat Initial Examination	MIL-C-14409
(b) Ceramic	Visual & Mechanical, C, DF, DWV, IR	Test Condition A, except step 3 shall be at max. rated temperature		In accordance with MIL-C-39014. N/A to style CD	2 x rated voltage @ max. rated temperature for 96 hours (Note 3)		MIL-C-20 MIL-C-39014 MIL-C-55681
(c) Glass & Porcelain		Test Condition B		N/A	2 × rated voltage @ 125°C for 96 hours		MIL-C-23269
(d) Mica		Test Condition A, except step 3 shall be at max. rated temperature			2 x rated voltage @ max. rated temperature for 96 hours		MIL-C-39001
(e) Paper & Polyethylene terephalate		Test Condition B	Test Condition E	In accordance with MIL-C-19978	1 4 × rated voltage@ rated temperature for 96 hours		MIL-C-19978
(f) Polycarbonate, metallized film		Test Condition A, except step 3 shall be at 100°C.	Test Conditions C, E	N/A	1.4 x rated voltage @ 100°C for 96 hours		MIL-C-83421
(g) Tantalum Electrolytic, Wet Slug	Visual & Mechanical, C, DF, DC Leakage	Test Condition A	Acid Indicator test per GSFC SP 01.23		Rated voltage @ 85°C for 168 hours		MIL-C-39006 GSFC SP 01.23
Foil			Test Conditions A and C Hermetic seal styles only		Rated voltage at 85°C (Note 4)		
(h) Tantalum Electrolytic, Solid (1) Hermetically sealed			Test Condition C	In accordance with MIL-C-39003	Rated Voltage at 85°C and Surge Current Test Per MIL-C-39003/6 (Note 5)		MIL-C-39003
(2) Non-hermetically sealed			N/A	N/A			GSFC S-311-P-17(01)
(i) High Voltage Ceramic (Note 6)	Visual & Mechanical C, DF, IR, DWV, Corona	Test Condition A (Note 7)	N/A		Rated Voltage rated Temperature 100 hours		GSFC S-311-P-15(01)

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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
3. Voltage conditioning shall be performed using procedures and requirements of MIL-C-39014 Rev C or later.
4. Voltage conditioning shall be conducted for 168 hours for polarized styles. For non-polarized styles, voltage conditioning shall be conducted for 192 hours with the voltage polarity reversed after 98 hours.
5. Effective series resistance of CSR style capacitors should be equal to or greater than one ohm/volt Surge current testing shall be performed on CSR style capacitors for all Grade 1 applications, and for Grade 2 applications where the effective series resistance is less than one ohm/volt.
6. Testing at high voltage (DWV, corona) shall be limited to the rated voltage.
7. Lot acceptance shall include 50 cycles of thermal shock on sample parts to determine susceptibility to thermal shock.

Rev 6/83
C-2 PPL 16
June 1982

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TABLE 2

Table 03.
Screening Outline for EMI Suppression Filters[1]

Test Sequence / Category	1	2	3	4	5	Reference Documents
	Initial Measurements and examination	Thermal Shock[2,3]	Seal Leak Test	Voltage Conditioning[4]	Final Measurements and examination	MIL-F-28861
Filters, EMI Suppression (with Ceramic Capacitor Elements) For Both Grade 1/ Grade 2 parts	1. Visual 2. Dielectric Withstanding Voltage (DWV) 3. Capacitance (when applicable) 4. Dissipation Factor (DF) (when applicable) 5. Insulation Resistance (IR) at 25°C and rated elevated temperature 6. D.C. Resistance 7. Radiographic examination, Grade 1 only.	As per MIL-STD-202, Method 107 Test Condition Condition A; except that in step 3, sample units shall be tested at 125°C.	Fine and Gross Leak tests (applicable to hermetically sealed devices only).	As per MIL-STD-202, Method 108 at test temperature +125°C ± 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.	Repeat initial examinations and measurements, except radiographic examinations. Add insertion loss tests. Final filter selection shall be made on basis of absolute IR Values and stability.	MIL-STD-202

NOTES:

1. Consult the GSFC Parts Branch (Code 311) for assistance in screening other types of filters.
2. Mounting (for Grade 1 only)—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.
3. Measurements (for Grade 1 only)—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.
4. After completion of voltage conditioning and while still at +125°C, the insulation resistance shall be measured as MIL-F-28861, par. 4.6.13.

Table 04.
Screening Outline for Subminiature Fuses[1]

Category \ Test Sequence	1 Initial Measurements	2 Thermal Shock	3 Final Measurements	4 Acceptance Criteria	Reference Documents
Fuses, Subminiature FM08, FM04	Perform visual and mechanical inspections per paragraph 3.5 of MIL-F-23419. Measure cold resistance at 10% or less of rated current. 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 $^{R}HOT_1$ (voltage drop/rated current).[2,3]	MIL-STD-202 method 107, condition B	Repeat Initial inspection and measurements Calculate = $^{R}HOT_2$	GSFC recommends using fuses in lower half of the FM08 voltage drop range and those where $^{R}HOT_1$ and $^{R}HOT_2$ differ by less than 3%	MIL-F-23419 MIL-F-23419/4 MIL-F-23419/8

NOTES:
1. For complete procurement requirements, consult the Parts Specialist
2. 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."
3. For fuses rated ½ 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[1]

Category \ Test Sequence	1	2	3	4	Reference Document
	Initial Measurements	Thermal Shock	Burn-In	Final Measurements and Tests	
Coils, Fixed, Molded, RF	1. Visual Inspection 2. D.C. Resistance 3. Insulation Resistance (IR) 4. Dielectric Withstanding Voltage (DWV) 5. Inductance (L) 6. Q 7. Self Resonant Frequency (SRF)	MIL-STD-202 Method 107, Condition A-1, use maximum operating temperature of coil.	48 hrs. at rated current at rated maximum operating temperature.	Visual Inspection Repeat initial measurements. Reject criteria: $\Delta R > \pm 3\%$, $\Delta L > \pm 3\%$, Q<min. specified, SRF<min. specified, DWV<min. specified, IR<min. specified.	MIL-C-39010

NOTE:
1 For complete procurement requirements, consult the Parts Specialist

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Table 06.
General Screening Outline for Relays[1]

Test Sequence	1	2	3	4	5	6	7	8	9	10	
Category	External Visual Examination	Seal Leak Test	Initial Measurements	Vibration	High Temp Soak	Low Temp Miss Test	Room Temp Miss Test	Seal Leak Test	Final Measurements	External Visual Examination	Reference Document[2]
Relays - Latching and Non-Latching	Para. 3.5	Para. 3.6 Fine leak: Para. 3.6.1 Gross leak: Para. 3.6.2	Para. 3.7 Coil Resistance Pull In and Drop Out Voltage Contact Resistance Contact Transfer Characteristics Insulation Resistance Dielectric Strength	Para. 3.8 100-2000 Hz 30 g peak	Para. 3.10 16 hrs at 125°C	Para. 3.12 1000 operation miss test at -65°C	Para. 3.13 5000 operation miss test at 25°C	Para. 3.6.1 and 3.6.2 Repeat test sequence no. 2	Para. 3.7 Repeat test sequence no. 3	Para. 3.5	GSFC-S-311-P2(06) Contains procedures for these screening subtests.

NOTES.
1. For additional information, and to establish rejection criteria, see the reference documents or consult the EEE Parts Section, Parts Branch. For complete procurement requirements, consult the Parts Specialist
2. Other screening tests in this specification are provided for special applications.

Table 07.
Screening Outline for Resistors[1]

Category \ Test Sequence	1 Initial Measurements	2 Thermal Shock	3 Conditioning	4 Seal Leak Test[2]	5 Final Measurements	Reference Document
Resistors, Fixed, Carbon Comp., RCR Style	Visual Inspection Resistance	—	—	—	—	MIL-R-39008 Group A Inspection
Resistors, Fixed, Film, General Purpose, RLR Style	Visual Inspection Resistance	—	1.5 x rated power at room temperature for 24 hours.	—	Visual Inspection Resistance Reject: $\Delta R > \pm 0.5\%$	MIL-R-39017 Group A Inspection
Resistors, Fixed, Film, High Stability, RNC Style	Visual Inspection Resistance	MIL-STD-202 Method 107 Cond. F	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.	MIL-STD-883 Method 1014 Cond. D (For hermetically sealed units)	Visual Inspection Resistance Reject: $\Delta R > \pm 0.2\%$ Style 90: $\Delta R > \pm 0.05\%$	MIL-R-55182 Group A Inspection
Resistors, Fixed, Wirewound, Accurate, RBR Style	Visual Inspection Resistance	—	1.0 x rated power for 1.5 hours on, 0.5 hour off for 100 hours at 25°C.	—	Visual Inspection Resistance Reject: $\Delta R > \pm 0.01\%$	MIL-R-39005 Group A Inspection Subgroup 1
Resistors, Fixed, Wirewound, Power, RWR Style	Visual Inspection Resistance	—	1.0 x rated power for 1.5 hours on, 0.5 hour off for 100 hours at 25°C.	—	Visual Inspection Resistance Reject: $\Delta R > \pm 0.2\%$	MIL-R-39007 Group A Inspection
Resistors, Fixed, Wirewound, Power, Chassis Mount, RER Style	Visual Inspection Resistance	—	1.0 x rated "free air" power for 1.5 hours on, 0.5 hour off for 96 hours at 25°C.	—	Visual Inspection Resistance Reject: $\Delta R > \pm 0.2\%$	MIL-R-39009 Group A Inspection
Resistors, Variable, Wirewound, Low Power, RTR Style	Visual Inspection Resistance	—	1 watt power for 1.5 hours on, 0.5 hour off for 50 hours at 25°C.	—	Visual Inspection, Resistance, Peak Noise, Continuity, End Resistance, Torque Reject: $\Delta R > \pm 0.5\%$	MIL-R-39015 Group A Inspection
Resistors, Variable, Non-Wirewound, Low Power, RJR Style	Visual Inspection Resistance	—	1.5 x rated power for 1.5 hours on, 0.5 hour off for 50 hours at 25°C.	—	Visual Inspection, Resistance, Contact Resistance, End Resistance, Torque Reject: $\Delta R > \pm 2\%$ (char. C) $\Delta R > \pm 1.5\%$ (char. F) $\Delta R > \pm 1\%$ (char. H)	MIL-R-39035 Group A Inspection

NOTES.
1 For complete procurement requirements, consult the Parts Specialist
2 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.

Table 08. (page 1 of 4)
Screening Outline for Diodes[1]

Part Category \ Test Sequence	1 Internal Visual (Precap) Inspection	2 Initial Insp. & Electrical Parameter Measurements	3 High Temperature Storage	4 Thermal Shock (Temperature Cycling)	5 Acceleration	6 PIND[2]	7 Seal Leak Tests	8 Pre-Power and Reverse Bias Burn-In Electrical Measurements	9 Reverse Bias Burn-In
a Diodes, Small Signal, Silicon	MIL–STD–750 Method 2074 (Since this test can only be performed by the manufacturer, *specify* internal visual inspection in procurement document)	Visual Insp per MIL–STD–750 Method 2071; Measure all electrical parameters	All devices shall be stored for 48 hrs at T_A = 200°C If leads are tinned or *made of silver, the* heating must be in an inert atmosphere or reduce temperature to T_A = 125°C	MIL–STD–750 Method 1051 (Refers to MIL–STD–202 Method 107 for procedural details) Test Condition C, except 20 cycles total with >10 minutes rest at each temperature extreme	MIL–STD–750 Method 2006, except test shall be 20,000 G in Y_1 orientation *only, one time* only	MIL–STD–750 Method 2052 Only for Grade 1 screening.	MIL–STD–750 Method 1071 1 Fine Leak Test Condition G or H. Gross Leak; Test Condition C. Only for Grade 2 screening.	Serialize devices. Measure V_F and I_R Record values and reject all devices that exceed their specified limits	None
b. Diodes, Switching, Silicon			Same as above except T_A = 175°C	Same as above except maximum temperature is 175°C					MIL–STD–750 Method 1038 Test Cond. A 72 hrs at T_A = 150°C Note at end of test V_R remains applied until T_A = 30°C
c Diodes, Voltage Reference, Silicon								Same as above except measure BV and Z	Same as above except 96 hrs at T_A = 150°C with I_Z = rated value
d Diodes, Voltage Regulator, Silicon								Same as above except measure BV, I_R and Z	Same as above except 96 hrs at T_A = 25°C with I_Z = maximum rated value
e Diodes, Power Rectifier, Silicon, (Fast Recovery or Gen Purpose)								Same as Part Category a except measure v_f and I_R	None

Notes

1 For complete procurement requirements, consult the Parts Specialist
2. *PIND = Particle Impact Noise Detection*
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

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

Test Sequence / Part Category	10	11	12	13	14	15	16
	Post Reverse Bias Burn-In Electrical Measurements	Power Burn-In	Post Power Burn-In Electrical Measurements	Final Electrical Parameter Measurements	Seal Leak Tests	Radiography	External Visual Examination
a Diodes, Small Signal, Silicon	None	MIL–STD–750 Method 1038 Test Condition B 168 hours at specified v_r and I_o with f = 60 Hz	Remeasure V_F and I_R Record Values and reject devices that exceed their specified limits In addition reject diodes exceeding the following delta (Δ) change $\Delta V_F = \pm 2.5\%$, ΔI_R = 100% or a number value determined for each diode part type, whichever is greater	All electrical parameters of each device shall be measured	MIL–STD–750 Method 1071 1 Fine Leak Test Condition G or H Gross Leak Test Condition C Only for Grade 1 screening	MIL–STD–750 Method 2076 Only for Grade 1 screening	MIL–STD–750 Method 2071 Only for Grade 1 screening
b Diodes, Switching Silicon	Remeasure V_F and I_R Delta (Δ) reject criteria for V_F and I_R are to be determined individual diode type						
c Diodes, Voltage Reference, Silicon	Remeasure BV and Z Reject devices that exceed specified limits or exceed the following delta limits $\Delta Z = \pm 10\%$ ΔBV = appropriate value determined for each part type	None	None				
d Diodes, Voltage Regulator, Silicon	Remeasure BV, I_R and Z Reject devices that exceed specified limits or exceed the following delta limits $\Delta BV = \pm 2\%$ $\Delta Z = 10\%$ ΔI_R = 100% or a number value determined for each part type, whichever is greater						
e Diodes, Power Rectifiers, Silicon (Fast Recovery or General Purpose)	None	168 hours at $T_A = 25^\circ C$ for diodes with leads) or $T_C = 100^\circ C$ (For stud mfg) with 60 Hz waveform applied to diode During the half cycle when the diode is fwd biased, I_o = max rated value During reversed bias half cycle, v_r = max rated value	Remeasure v_f and I_R Follow above procedure a and b and use following delta changes $\Delta v_f = \pm 0.1v$ (pk) and ΔI_R = 100% or a number value determined for each part type, whichever is greater				

Table 08. (page 3 of 4)
Screening Outline for Diodes[1]

Part Category \ Test Sequence	1 Internal Visual (Precap) Inspection	2 Initial Insp & Electrical Parameter Measurements	3 High Temperature Storage	4 Thermal Shock (Temperature Cycling)	5 Acceleration	6 PIND[2]	7 Seal Leak Tests	8 Pre-Power and Reverse Bias Burn-In Electrical Measurements	9 Reverse Bias Burn-In
g Diodes, Voltage-Variable Capacitor, Silicon			All devices shall be stored for 48 hrs at $T_A = 200°C$ (If leads are tinned or made of silver, the heating must be in an inert atmosphere or reduce temperature to $T_A = 125°C$	MIL–STD–750 Method 105 1 (Refers to MIL–STD–202 Method 107 for procedural details) Test Condition C, except 10 cycles total with 15 minutes rest at each temperature extreme	MIL–STD–750 Method 2006 except test shall be 20,000g in Y_1 orientation only, one time only			Serialize devices Measure I_R Record values and reject all devices that exceed their specified limits	MIL–STD–750 Method 1038 Test Cond A 72 hrs at $T_A = 175°C$ Note at end of test V_R remains applied until $T_A = 30°C$
h Thyristors, (Silicon Controlled Rectifiers)	MIL–STD–750 Method 2074 (Since this test can only be performed by the manufacturer, specify internal visual inspection in procurement document)	Visual Insp per MIL–STD-750 Method 2071 Measure all electrical parameters	Same as above except $T_A = 150°C$	Same as above except Test Condition F	Same as above except stress level to be determined by part size	MIL–STD–750 Method 2052 Only for Grade 1 screening	MIL–STD–750, Method 1071 1 Fine Leak Test Condition G or H Gross Leak Test Condition C Only for Grade 2 screening	Same as above except measure I_{RBXM}, I_{FBXM}, V_F, V_{GT}, and I_{GT}	Same as above except 96 hrs at $T_A = 125°C$ with R_{OR} and V_{FBXM} at rated values Note Thyristors which turn on during this burn-in shall be rejected
i Diodes, Current Regulator, Silicon			Same as above except $T_A = 175°C$	Same as above except high temperature = 125°C	Same as Part Category g above			Same as above except measure I_P only	
j. Diodes, Switching, Schottky Barrier, Silicon			Same as above except $T_A = 200°C$	Same as Part Category g above				Same as above except measure I_R and VB only	
k Diodes, Switching, PIN			Same as above except $T_A = 150°C$	Same as Part Category g above except Test Condition F				Same as above except measure I_R and VB only	None
l Diodes, Light Emitting			Same as above except T_A limited to manufacturer's specified maximum storage temperature	Same as above except temperature extremes limited to manufacturer's specified minimum and maximum storage temperature	Same as above except acceleration in Z_1 direction		MIL–STD–750 Method 1071 Fine Leak Test Condition H Gross Leak Test Condition E Only for Grade 2 screening	Measure and record values for V_F and P_O (Radiant Power Output) Reject devices not meeting specifications	

Notes
1 For complete procurement requirements, consult the Parts Specialist
2. PIND = Particle Impact Noise Detection

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

Part Category \ Test Sequence	10 Post Reverse Bias Burn-In Electrical Measurements	11 Power Burn-In	12 Post Power Burn-In Electrical Measurements	13 Final Electrical Parameter Measurements	14 Seal Leak Tests	15 Radiograph	16 External Visual Examination
g Diodes, Voltage-Variable Capacitor, Silicon	Remeasure I_R Reject devices that exceed specified limits or exceed the following delta limits ΔI_R = 100% or a number value determined for each part type, whichever is greater	None	None				
h Thyristors, (Silicon Controlled Rectifiers)	Remeasure I_{RBXM}, I_{FBXM}, V_{GT} and I_{GT} Follow procedure above and use the following delta changes ΔI_{RBXM} = appropriate value ΔI_{FBXM} = appropriate value						
i Diodes, Current Regulator, Silicon	None	168 hours at T_A = 25°C and P_{OV} (Peak Operating Voltage) = maximum rated value	Remeasure I_P Reject devices that exceed specified limits or exceed the following delta limits ΔI_P = +5%	Visual Inspection per MIL-STD-750 Method 2071 All electrical parameters of each device shall be measured as listed on the manufacturer's data sheet	MIL–STD–750, Method 1071 1 Fine Leak Test Condition G or H Gross Leak Test Condition C Only for Grade 1 screening	MIL–STD–750 Method 2076 Only for Grade 1 screening	MIL–STD–750 Method 2071 Only for Grade 1 screening
j Diodes, Switching, Schottky Barrier, Silicon		MIL–STD–750 Method 1038 Test Condition B 168 hours at T_A = 25°C at specified V_r and I_o with f = 60 Hz	Remeasure VB and I_R Reject devices that exceed limits or exceed the following delta limits YVB = 10% ΔI_R = 100% or a number value determined for each part type, whichever is greater				
k Diodes Switching, PIN			Remeasure V_F and I_R Reject devices that exceed specified limits or exceed the following delta limits ΔV_F = ±10% ΔI_R = same as ΔI_R above				
l Diode, Light Emitting		168 hours at T_A (or T_C) = 25°C I_F = 80% of maximum rated continuous forward current	Remeasure V_F and P_O Reject devices not meeting specifications or exceeding the following delta limits ΔV_F = ±2 5% ΔP_O = -2 5%		MIL–STD–750 Method 1071 Fine Leak Test Condition H Gross Leak Test Condition E only for Grade 1 screening		

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

<table>
<tr><th rowspan="2">Test Sequence / Part Category</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th></tr>
<tr><th>Internal Visual (Precap) Inspection</th><th>Initial Inspection & Electrical Parameter Measurements</th><th>High Temperature Storage</th><th>Thermal Shock (Temperature Cycling)</th><th>Acceleration</th><th>PIND[2]</th><th>Seal Leak Tests</th></tr>
<tr><td>a. Transistors, Silicon, NPN, Low, Medium Power, Switching or General Purpose</td><td rowspan="6">MIL–STD–750 Method 2072. (Since this test can only be performed by the manufacturer, specify internal visual inspection in procure – ment document.)</td><td rowspan="6">Visual Inspection per MIL–STD–750, Method 2071.

Measure all electrical parameters.</td><td rowspan="6">Store for 48 hours at $T_A = 200°C$. (If leads are silver or tinned the heating must be in an inert atmos- phere or reduce temperature to $T_A = 125°C$).</td><td rowspan="6">MIL–STD–750 Method 1051. (Refer user to MIL–STD–202 Method 107 for procedural details). Test Condition C, except 20 cycles total with > 10 minutes rest at each temper- ature extreme.</td><td rowspan="2">MIL–STD–750 Method 2006 except that test shall be 20,000 g in Y_1 orientation, one time only. The 1 min hold-time requirement shall not apply.</td><td rowspan="6">MIL–STD–750 Method 2052

Only for Grade 1 screening</td><td rowspan="2">MIL–STD–750 Method 1071, Fine Leak Test Condition G or H. Gross Leak: Test Condition C. Only for Grade 2 screening</td></tr>
<tr><td>b. Transistors, Silicon, PNP, Low, Medium Power, Switching or General Purpose</td></tr>
<tr><td>c. Transistors, Silicon, PNP, High Power</td><td rowspan="2">Same as above except 5,000 g.</td><td rowspan="2">Same as above except fine leak rejection value of 5×10^{-7} atm cc/sec. Only for Grade 2 screening</td></tr>
<tr><td>d. Transistors, Silicon, NPN, High Power</td></tr>
<tr><td>e. Transistors, Field-Effect, Junction, N-Channel, Silicon</td><td rowspan="2">Same as above except 20,000 g.</td><td rowspan="2">MIL–STD–750 Method 1071.1 Fine Leak: Test Condition G or H Gross Leak. Test Condition C.

Only for Grade 2 screening</td></tr>
<tr><td>f. Transistors, Field-Effect, Junction, P-Channel, Silicon</td></tr>
</table>

Notes:

1. For complete procurement requirements, consult the Parts Specialist.
2. PIND = Particle Impact Noise Detection

Table 09. (page 2 of 4)
Screening Outline for Transistors

<table>
<tr><th rowspan="2">Test Sequence / Part Category</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>
<tr><th>Reverse Bias Burn-In</th><th>Pre-Burn-In Electrical Measurements</th><th>Burn-In</th><th>Post Burn-In Tests</th><th>Final Electrical Parameter Measurements</th><th>Seal Leak Tests</th><th>Radiography</th><th>External Visual Examination</th></tr>
<tr><td>a Transistors, Silicon, NPN, Low, Medium Power, Switching or General Purpose</td><td rowspan="4">48 Hours at V_{CB} = 80% of V_{CBO} $I_E = 0$ $T_A = 150^{\circ}C$ Reduce temperature to $T_A = 30^{\circ}C$ before reverse voltage is removed at end of test Measure I_{CBO} and reject devices that exceed their specified limits</td><td rowspan="4">Measure I_{CBO} (or I_{CES}) and h_{FE} Record values and reject all devices that exceed limits (I_{CES} is measured when value for I_{CBO} is not specified)</td><td rowspan="2">168 hrs at $T_A = 25^{\circ}C$ at specified V_{CB} (or V_{CE}) and P_T (max rated power dissipation at T_A)</td><td rowspan="4">Remeasure values of I_{CBO} and h_{FE} Record values and reject devices that exceed their specified limits In addition reject devices exceeding the following delta (Δ) change during the burn-in Low Power — $\Delta h_{FE} = \pm 15\%$, ΔI_{CBO} = 100% or 5nAdc, whichever is greater, Medium Power — Δh_{FE} = ±20%, ΔI_{CBO} = 100% or 100nAdc, High Power — Δh_{FE} = ±25%, ΔI_{CBO} = 100% or 100uAdc (It should be noted that the 5nA value varies from part to part in the ΔI_{CBO} rejection criteria This number value is for the purpose of not rejecting devices which have very low initial leakage current (I_{CBO}) which can vary more than 100% during burn-in)</td><td rowspan="6">All electrical parameters of each device shall be measured as listed on the manufacturer's data sheets</td><td rowspan="2">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 rowspan="6">MIL—STD—750 Method 2026

Only for Grade 1 screening</td><td rowspan="6">MIL—STD—750 Method 2072

Only for Grade 1 screening</td></tr>
<tr><td>b Transistors, Silicon, PNP, Low, Medium Power, Switching or General Purpose Purpose</td></tr>
<tr><td>c Transistors, Silicon, PNP, High Power</td><td rowspan="2">Same as above except P_T at case temperature specified</td><td rowspan="2">Same as above except fine leak rejection value 5 x 10^{-7} atm cc/sec Only for Grade 1 screening</td></tr>
<tr><td>d Transistors, Silicon, NPN, High Power</td></tr>
<tr><td>e Transistors, Field-Effect, Junction, N-Channel, Silicon</td><td rowspan="2">N A</td><td rowspan="2">Measure I_{GSS}, I_{DSS} and $|Y_{fs}|$ Reject all devices that exceed limits</td><td rowspan="2">168 hrs at $T_A = 175^{\circ}C$ at specified V_{GS} and V_{DS} Reduce T_A below 30°C, hold for 10 min before removing voltage (This is a high temperature reverse bias burn-in)</td><td rowspan="2">Remeasure values of I_{GSS}, I_{DSS} and $|Y_{fs}|$ Record values and reject devices that exceed their specified limits In addition reject devices exceeding the following delta (Δ) change during the burn-in $\Delta I_{DSS} = \pm 10\%$, $\Delta |Y_{fs}| = \pm 20\%$ and ΔI_{GSS} = 100% or a number value determined for each part type, whichever is greater Note If the max rated I_{GSS} is less than 100pA, omit ΔI_{GSS} criteria</td><td rowspan="2">MIL–STD–750 Method 107 1 Fine Leak Test Condition G or H Gross Leak Test Condition C Only for Grade 1 screening</td></tr>
<tr><td>f Transistors, Field-Effect, Junction, P-Channel, Silicon</td></tr>
</table>

Table 09. (page 3 of 4)
Screening Outline for Transistors[1]

Part Category \ Test Sequence	1 Internal Visual (Precap) Inspection	2 Initial Inspection & Electrical Parameter Measurements	3 High Temperature Storage	4 Thermal Shock (Temperature Cycling)	5 Acceleration	6 PIND[2]	7 Seal Leak Tests
g. Transistors, Silicon, Unijunction	MIL–STD–750 Method 2072. (Since this test can only be performed by the manufacturer, specify internal visual inspection in procurement document.)	Visual Inspection per MIL–STD–750 Method 2071. Radiographic Inspection per MIL–STD–750, Method 2076. Measure all electrical parameters at this time.	Store for 48 hours at $T_A = 200°C$ (If leads are silver or tinned the heating must be in an inert atmosphere or reduce temperature to $T_A = 125°C$	MIL–STD–750 Method 1051. (Refers user to MIL–STD–202 Method 107 for procedural details.) Test Conditions C, except 20 cycles total with > 10 minutes rest at each temperature extreme		MIL–STD–750 Method 2052 Only for Grade 1 screening	MIL–STD–750 Method 1071.1. Fine Leak: Test Condition G or H Gross Leak: Test Condition C. Only for Grade 2 screening.
h. Transistors, Silicon, Chopper							
i. Phototransistor			Same as above except T_A shall be limited to manufacturer's specified maximum storage temperature.	Same as above except temperature extremes shall be limited to manufacturer's specified minimum and maximum storage temperature.	MIL–STD–750 Method 2006 except that test shall be 20,000 g in Y_1 orientation, one time only. The 1 min. hold-time requirement shall not apply.		MIL–STD–750 Method 1071 Fine Leak: Test Condition H. Gross Leak: Test Condition C. Only for Grade 2 Screening
j. Optically Coupled Isolator							MIL–STD–750 Method 1071.1. Fine Leak: Test Condition G or H Gross Leak: Test Condition C. Only for Grade 2 Screening

Notes:

1 For complete procurement requirements, consult the Parts Specialist
2. PIND = Particle Impact Noise Detection

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

Test Sequence / Part Category	8 Reverse Bias Burn-In	9 Pre Burn-In Electrical Measurements	10 Burn-In	11 Post-Burn-In Electrical Measurements	12 Final Electrical Parameter Measurements	13 Seal Leak Tests	14 Radiography	15 External Visual Examination
g. Transistors, Silicon, Unijunction	N A	Measure I_{EB20}, R_{BBO} and η Record values and reject all devices that exceed limits	168 hrs at $T_A = 25^\circ C$ at specified V_{B2B1} and I_{E1} (Maximum rated power)	Remeasure values of I_{EB20}, R_{BBO} and η Record values and reject devices that exceed their specified limits In addition reject devices exceeding the following delta (Δ) change during the burn-in $\Delta\eta = \pm 10\%$, $\Delta R_{BBO} = \pm 20\%$ and $\Delta I_{EB20} = 100\%$ or 5 nA, whichever is greater				
h Transistors, Silicon, Chopper	48 hrs at $V_{CB} = 80\%$ of V_{CBO} $I_E = 0$, $T_A = 150^\circ C$ Reduce temperature to $T_A = 30^\circ C$ before reverse voltage is removed at end of test Measure I_{CBO} and reject devices that exceed their specified limits	Measure I_{CBO} and h_{FE} (inverted). Record values and reject all devices that exceed limits	168 hrs at $T_A = 25^\circ C$ at specified V_{CB} (or V_{CE}) and P_T. (Max rated power dissipation at T_A).	Remeasure values of I_{CBO} and h_{FE} (inverted) Record values and reject devices that exceed their specified limits In addition reject devices exceeding the following delta (Δ) change during the burn-in Δh_{FE} (inverted) = $\pm 15\%$, ΔI_{CBO} = 100% or 5 nAdc, whichever is greater (It should be noted that the 5 nA value varies from part to part in the ΔI_{CBO} rejection criteria This number value is for the purpose of not rejecting devices which have very low initial leakage current (I_{CBO}) which can vary more than 100% during burn-in)		MIL–STD–750 Method 1071 1 Fine Leak Test Condition G or H Gross Leak Test Condition C Only for Grade 1 screening	MIL–STD–750 Method 2026 Only for Grade 1 screening	MIL–STD–750 Method 2072 Only for Grade 1 screening
i Phototransistor	48 hrs at $V_{CE} = 80\%$ of V_{CEO} E_e (Incident Radiant Energy = 0) T_A (or T_C) = manufacturer's specified maximum operating temperature Measure I_D (Dark Current) and reject devices exceeding specified limits	Measure I_D and I_L Record values and reject all devices that exceed specified limits.	168 hrs at T_A (or T_C) = $25^\circ C$ at specified V_{CE}. Adjust E_e (incident radiant energy) for $P_T = 80\%$ of maximum continuous device dissipation at T_A (or T_C) = $25^\circ C$	Remeasure values of I_D and I_L Reject devices that exceed specified limits or exceed the following delta limits $\Delta I_L = \pm 25\%$ ΔI_D = 100% or an absolute value determined for each part type, whichever is greater	All electrical parameters of each device shall be measured as listed on the manufacturer's data sheets.	MIL–STD–750 Method 1071 Fine Leak Test Condition H Gross Leak Test Condition C Only for Grade 1 screening		
j Optically Coupled Isolator	MIL–STD–750 Method 1019 Test Condition A $V_{CE} = 80\%$ of V_{CEO} T_A (or T_C) = $125^\circ C$ or maximum specified operating temperature, whichever is lower (Do not bias LED during this test) Measure I_C (OFF) within 4 hours of test completion Reject devices that exceed specified limits	Measure the following parameters Phototransistor I_C (OFF) I_C (ON) h_{FE} LED I_R Record values and reject devices that exceed specified limits	168 hrs at T_A (or T_C) = $25^\circ C$ at specified V_{CE} Select an LED forward current (I_F) for a phototransistor power dissipation of $P_T = 80\%$ of maximum continous device dissipation at T_A (or T_C) = $25^\circ C$	Remeasure I_C (OFF), I_C (ON), h_{FE}, and I_R Reject devices that exceed specified limits or exceed the following delta limits Phototransistor ΔI_C (ON) = $\pm 25\%$ Δh_{FE} = $\pm 25\%$ ΔI_C(OFF)= 100% or a number value determined for each part type, whichever is greater Ligh Emitting Diode ΔI_R = 100% or an absolute value determined for each part type, whichever is greater		MIL–STD–750 Method 1071 1 Fine Leak Test Condition G or H. Gross Leak Test Condition C. Only for Grade 1 screening		

Table 10.
Screening Outline for Microcircuits[1]

Two levels of screening are outlined for microcircuits. Level 1 screening is required for all non-standard parts intended for use in a grade 1 application. Level 2 screening is required for non-standard parts intended for other than grade 1 applications.

Screening Sequence / Screening Level	1	2[2]	3	4[3]	5	6[4]	7[5]	8[6,7]
	Internal Visual (Precap) Can only be performed by mfr. Specify requirement	Stabilization Bake	Temperature Cycling	Constant Acceleration	Particle Impact Noise Detection (PIND)	Seal	Interim Electrical Parameter Measurements	Burn-In
1	MIL-STD-883 Method 2010 Condition A	MIL-STD-883 Method 1008 Condition C	MIL-STD-883 Method 1010 Condition C	MIL-STD-883 Method 2001 Condition E. Y Orientation only.	MIL-STD-883 Method 2020 Condition A or B. Specify test condition	MIL-STD-883 Method 1014 Fine Leak: Cond. A or B. Gross Leak Cond. C. Specify test conditions	Specify DC & AC parameters and parameters requiring delta calculations	MIL-STD-883 Method 1015 240 hrs at 125°C (Dynamic) Specify test cond. and burn-in circuitry
2	Same as above except Condition B	Same as above	Same as above	Same as above	Not Required	Same as above	Measure parameters requiring delta calculations	Same as above except 160 hrs. at 125°C See note 6

Screening Sequence / Screening Level	9	10[6]	11[5]	12[4]	13
	Interim Electrical Parameter Measurements	Reverse Bias Burn-In	Final Electrical Measurements	Radiographic	External Visual
1	Remeasure parameters specified in step 7. Specify delta limits and percent defective allowable. (PDA)	MIL-STD-883 Method 1015 Condition A or C. 72 hrs at 150°C Specify test cond. & burn-in circuitry.	Specify DC, AC and delta measurements at 25°C, min. and max. operating temperatures.	MIL-STD-883 Method 2012	MIL-STD-883 Method 2009
2	Not Required	Not Required	Same as above	Not Required	Same as above

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NOTES
1. For complete procurement requirements, consult the Parts Specialist
2. User should be aware of tarnish problems of some lead finishes at temperatures above 150°C.
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. Seal and radiographic tests may be performed in any sequence after PIND test.
5. The parameter measurements and delta calculations required for both level 1 and level 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. For level 1 screening, the order of the burn-in in step 8 and step 10 is optional.
7. For level 2 screening, SSI and MSI MOS devices shall be exposed to both dynamic (160 hrs at 125°C) and static (160 hrs at 125°C, or optionally 24 hrs at 150°C) burn-ins in screening step 8. The order of the burn-ins is optional. For other technologies, use the burn-in method specified for Class B screening in the MIL-M-38510 slash sheet for the selected or similar part types. If no slash sheets are available for the selected or similar part types, consult the Parts Specialist for recommendations

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TABLES 11 - 13

Table 14.
Screening Outline for Thermistors[1]

Test Sequence / Category	1	2	3	4	5	6	7
	External Visual Examination	Initial Measurements	Bake	Temperature Cycle	Burn-In	Final Measurements and Tests	External Visual Examination
(a) Thermistors, (Thermally Sensitive Registor) (Negative Temp. Coef.)	MIL-T-23648 Paragraph 4.6.1	Zero-Power Resistance at 25°C and IR	100 hrs at Maximum Specified Operating Temperature	MIL-STD-202 Method 107 Cond. B	Not Required	Zero-Power Resistance at 25°C	MIL-T-23648 Paragraph 4.6.1
(b) Thermistors, Fixed Silicon (Positive Temp. Coef.)		Zero-Power Resistance at 25°C	Not Required		1.5 x rated pwr. for 96 hrs at 25°C		

NOTE:
1 For complete procurement requirements, consult the Parts Specialist

Table 15. Screening Outline for Transformers[1]

Test Sequence / Category	1	2	3	4	5	Reference Documents
	Initial Measurements	Thermal Shock	Burn-In	Seal Leak Test	Final Measurements and Tests	
Transformers, Audio and Power	1. Visual Examination 2. Dielectric Withstanding Voltage (DWV) 3. Induced Voltage 4. Insulation Resistance (IR) 5. D.C. Resistance (DCR) of each winding 6. Primary Inductance (L) 7. Turns Ratio	MIL-STD-202, Method 107, Test Condition A-1. Use maximum temperature specified for transformer as maximum temperature.	Not Required	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.	Repeat initial examinations and measurements Reject criteria: $\Delta L > \pm 3\%$. (Powder toroid cores, gapped E, H, U/I and pot cores); $\Delta L > \pm 10\%$ (ungapped E, H, U/I and pot cores). $\Delta DCR > \pm 3\%$. DWV < min specified. IR < min specified Turns ratio must equal specified value.	MIL-T-27 MIL-STD-202
Transformers, Pulse, Low Power	1. Visual Examination 2. Dielectric Withstanding Voltage (DWV) 3. Induced Voltage 4. Insulation Resistance (IR) 5. DC Resistance (DCR) 6. Open Circuit Inductance (OCL) 7. Leakage Inductance 8. Turns Ratio	Not Required	MIL-T-21038 Para. 4.7.4	MIL-T-21038 Para. 4.7 7 (Gross Leak Test)	Repeat initial measurements and examinations. Measure turns ratio and waveform (rise time, overshoot, droop, backswing, decay time). Reject criteria: $\Delta DCR < \pm 3\%$, DWV < min. specified, IR < min. specified. Turns ratio must equal specified value. Waveform parameters must not exceed the specified maximums.	MIL-T-21038

NOTE:
1. For complete procurement requirements, consult the Parts Specialist

WIRE
Electrical, Insulated

Style 1/ 2/	600 Volt		1000 Volt		2500 Volt		Specification	Grade 1 / Grade 2	Remarks
	Strands No. x AWG #	Diameter over Insulation, mm. Max.	Strands No. x AWG #	Diameter over Insulation, mm. Max.	Strands No. x AWG #	Diameter over Insulation, mm. Max.		Manufacturer	
S311P13-XX-30-Z	7 x 38	.71	—	—	—	—			
S311P13-XX-28-Z	7 x 36	.79	7 x 36	.86	—	—			
S311P13-XX-26-Z	7 x 34	.89	7 x 34	1.04	—	—			
S311P13-XX-24-Z	19 x 36	1.04	19 x 36	1.17	19 x 36	1.50			Tin-coated,
S311P13-XX-22-Z	19 x 34	1.22	19 x 34	1.35	19 x 34	1.80			copper conductor.
S311P13-XX-20-Z	19 x 32	1.42	19 x 32	1.55	19 x 32	2.03			
S311P13-XX-18-Z	19 x 30	1.68	19 x 30	1.88	19 x 30	2.29			Insulated with
S311P13-XX-16-Z	19 x 29	1.88	19 x 29	2.08	19 x 29	2.54			crosslinked
S311P13-XX-14-Z	19 x 27	2.29	19 x 27	2.49	19 x 27	3.00	GSFC	Raychem Corp.	polyalkene.
S311P13-XX-12-Z	37 x 28	2.84	19 x 25	3.23	19 x 25	3.71	S-311-P-13		
S311P13-XX-10-Z	—	—	37 x 26	3.61	37 x 26	4.19			Max. Temp. 135°C
S311P13-XX-8-Z	—	—	133 x 29	5.28	133 x 29	5.79			
S311P13-XX-6-Z	—	—	—	—	133 x 27	7.06			Suitable for use in
S311P13-XX-4-Z	—	—	—	—	133 x 25	8.53			wire harnesses.
S311P13-XX-2-Z	—	—	—	—	665 x 30	10.1			
S311P13-XX-0-Z	—	—	—	—	1045 x 30	12.4			
S311P13-XX-00-Z	—	—	—	—	1330 x 30	14.2			

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 16-5

2/ It has been determined that this wire does not meet the flammability requirements of NHB 8060 1B and it must be evaluated for compliance with project safety requirements For new designs involving Space Transportation System (STS) payloads, the preferred wire insulations are: a) wire, extruded TFE (MIL-W-22759), or b) wire, flurocarbon polyimide (MIL-W-81381).

WIRE
Electrical, Insulated, Lightweight

Style[1]	Strands No. x AWG #	Diameter over Insulation, mm		Voltage Rating, Maximum (volts/RMS)	Specification MIL-W-22759	Grade 1	Grade 2	Remarks
		Minimum	Maximum			Manufacturer		
M22759/18-26-X	19 x 38	.762	.864	600	/18	QPL-22759/18		Tin-coated copper conductor Insulated with extruded ETFE Maximum temperature 150°C; suitable for use as hookup wire.
M22759/18-24-X	19 x 36	.864	.965					
M22759/18-22-X	19 x 34	1.04	1.14					
M22759/18-20-X	19 x 32	1.24	1.35					
M22759/18-18-X	19 x 30	1.50	1.60					
M22759/18-16-X	19 x 29	1.65	1.75					
M22759/18-14-X	19 x 27	2.01	2.11					
M22759/18-12-X	37 x 28	2.57	2.67					
M22759/18-10-X	37 x 26	3.15	3.25					

NOTES:
1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (listed on Page 16-5).

WIRE
Electrical, Insulated, High Temperature

Style	Strands No. x AWG #	Diameter over Insulation, mm		Voltage Rating, Maximum (volts/RMS)	Specification MIL-W-22759	Grade 1	Grade 2	Remarks
		Minimum	Maximum			Manufacturer		
M22759/11-28-X	7 x 36	.79	.90	600	/11	QPL-22759/11		Silver-coated, copper conductor Insulated with extruded TFE Suitable for UHF Maximum Temperature 200°C
M22759/11-26-X	19 x 38	.91	1.02					
M22759/11-24-X	19 x 36	1.04	1.14					
M22759/11-22-X	19 x 34	1.19	1.30					
M22759/11-20-X	19 x 32	1.42	1.52					
M22759/11-18-X	19 x 30	1.68	1.78					
M22759/11-16-X	19 x 29	1.85	1.96					
M22759/11-14-X	19 x 27	2.24	2.34					
M22759/11-12-X	19 x 25	2.74	2.90					
M22759/11-10-X	37 x 26	3.43	3.63					
M22759/11- 8-X	33 x 29	5.03	5.23					
M22759/9-22-X	19 x 34	1.47	1.57	1000	/9	QPL-22759/9		
M22759/9-20-X	19 x 32	1.68	1.78					
M22759/9-18-X	19 x 30	1.93	2.03					
M22759/9-16-X	19 x 29	2.11	2.21					

NOTES
1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (listed on page 16-5)

Index of Preferred Wire/Cable 1/

Style	Description	Specification	Refer To
M22759/11 and /9	Wire, High temperature	MIL-W-22759	Page 16-2
M22759/18	Wire, Light weight	MIL-W-22759	Page 16-3
S311P13 2/	Wire, High voltage	GSFC S-311-P-13	Page 16-4
M22759/3/11/ 12/16/22/23	Wire, Extruded TFE	MIL-W-22759	MIL-STD-975
M81381	Wire, Fluorocarbon-Polymide	MIL-W-81381	MIL-STD-975
M16878	Wire, High Temperature	MIL-W-16878	MIL-STD-975
M5086	Wire, PVC insulated	MIL-W-5086	MIL-STD-975
M17	Cable, RF, Flexible, Coaxial	MIL-C-17	MIL-STD-975
M27500	Cable, Electrical, Shielded and Unshielded	MIL-C-27500	MIL-STD-975

NOTE

1/ GSFC waives the restrictions and requirements of MIL-STD-975 on the use of silver coated copper conductor wire and cable

2/ It has been determined that this wire does not meet the flammability requirements of NHB 8060 1B and it must be evaluated for compliance with project safety requirements For new designs involving Space Transportation System (STS) payloads, the preferred wire insulations are a) wire, extruded TFE (MIL-W-22759), or b) wire, flurocarbon polyimide (MIL-W-81381)

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APPENDIX D
Part Radiation Effects

The natural radiation environment of space presents a hazard of varying degrees to different types of electronic parts. The inherent level of sensitivity of a specific part to radiation will dictate if it can or cannot be used in a particular mission. Factors which affect the response of a part to radiation include the inherent device hardness, its use in circuit and system applications, and operational aspects. Similarly, the radiation environment of a spacecraft can vary widely, depending on orbit parameters of altitude, angle of inclination, and eccentricity. Thus, it is essential, in addressing a mission's radiation problem, that an initial step must be the prediction of the radiation environment throughout the mission lifetime. No mission should be assumed to have an environment so benign that no radiation requirements exist.

In dealing with the natural radiation environment, spacecraft systems' designers must be concerned about two types of radiation damage, total ionizing radiation and single event phenomena.

Total ionizing dose damage is sustained due to energetic electrons and protons in the earth's trapped radiation (Van Allen) belts, in similar fields about other planets, and in interplanetary space. Total dose damage is cumulative with time, and dependent on the particle fluence integrated over the mission lifetime. The total dose absorbed by parts can usually be reduced by the deliberate placement of shielding material(s) between the part and the environment, and the effects of total dose damage often can be reduced by circuit design considerations. For example, transistors should be operated near the peak of their gain-current curves, not near the low current end.

Single event phenomena are due to passage of a single, very high energy particle (cosmic ray), either a proton or ion, passing through a sensitive volume in a microcircuit. Collection of charges generated as a result of the passage can result in either a "soft" error or a "hard" error. In the case of a soft error, a memory cell in the device changes logic state. In a hard error, SCR latchup occurs; resulting in loss of function of that device or system at best, or in destructive burnout of the device and system loss at worst. Unlike total dose damage, shielding is ineffective against very high energy particles and single event phenomena, and may even increase the probability of an error in some cases.

The PPL will be providing more guidance on part radiation effects and radiation tolerant parts in the future. In the meantime, the Parts Branch solicits questions and discussions on part radiation effects, specific mission problems, and requests for assistance in selecting appropriate parts. Please contact your parts engineer or the designated specialists listed in the Parts Information Directory.