GSFC PREFERRED PARTS LIST
PPL-17

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GODDARD SPACE FLIGHT CENTER

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

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PREFACE

PURPOSE

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

AUTHORITY

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

STANDARDIZATION

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

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

QUALITY LEVELS

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

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

All specifications listed in the PPL are maintained on file in the Parts Branch for reference purposes. GSFC personnel can obtain copies of specifications through their division offices from the Parts Branch Library, code 310.1, telephone (301) 344-7240. Contractors, approved domestic and foreign experimenters, and international cooperative project working groups can obtain copies

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of the PPL and copies of referenced documents, except MIL specifications, by a written request via the cognizant project office. All others may obtain copies of the PPL through the National Technical Information Service (NTIS), Springfield, VA 22161 or the GIDEP data bank. Requests for Military Specifications should be directed to:

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

REVISIONS

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

PART CHARACTERISTICS

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

CRITERIA FOR LISTING PARTS

Parts are listed in the PPL based on the following criteria:

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

USER RESPONSIBILITY

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

PARTS APPLICATIONS

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

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

PARTS UPGRADING

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

PARTS DERATING

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

PARTS SCREENING

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

PARTS RADIATION EFFECTS

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

REFERENCED SPECIFICATIONS

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

PARTS INFORMATION DIRECTORY

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

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

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

PART CATEGORY	SPECIALIST	TELEPHONE (301) 344-
Capacitors	P. Jones	5910
Connectors	J. Lawrence	5640
Crystals	V. Patel	6382
Diodes	M. Robertson	5910
Electro Optics	L. Hilliard	5987
Filters	V. Patel	6382
Fuses	J. Henegar	5345
Inductors	F. Kreis	7339
Microcircuits	S. Bryant	7437
PC Boards	H. Chernikoff	5984
	F. Kreis	7339
Relays	J. Lawrence	5640
Resistors	F. Kreis	7339
Thermistors	J. Henegar	5345
Transformers	F. Kreis	7339
Transistors	M. Robertson	5910
Wire and Cable	J. Lawrence	5640
All	Preferred Parts	6588 6220

Additional services in support of the GSFC parts program are:

FUNCTION	CONTACT	TELEPHONE (301) 344-
Electronic Parts Qualification Testing, Maintenance of the PPL	B. Baldini	8923
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-
Packaging Process Specialist	H. Chernikoff	5984
	F. Kreis	7339
Radiation Effects	J. Adolphsen	8896
	D. Cleveland	7437

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 Styles CDR01, 03, 04, 05, 06	MIL-C-55681	MIL-STD-975
CKR[2]	Ceramic, Fixed	MIL-C-39014	MIL-STD-975
CLR[3, 4]	Tantalum (non-solid) electrolytic, Fixed	MIL-C-39006	MIL-STD-975
CRH	Plastic (metalized), Fixed	MIL-C-83421	MIL-STD-975
CSR[5, 6]	Tantalum (solid) electrolytic, Fixed	MIL-C-39003	MIL-STD-975
CWR	Tantalum Chip, Fixed	MIL-C-55365	MIL-STD-975
CYR	Glass, Fixed Styles CYR10, 15, 20, 30 Styles CYR13, 41, 42, 43, 51, 52, 53	MIL-C-23269	MIL-STD-975 Pages 01-2 to 01-7

NOTES:
1. CKR styles are to be limited to maximum capacitance values as follows:
   CKR05— 33,000 pf   CKR11— 4,700 pf   CKR14— 47,000 pf
   CKR06—333,000 pf   CKR12— 10,000 pf   CKR15— 180,000 pf
   CKR styles shall be purchased to revision C of MIL-C-39014.
2. CLR styles with ratings above 100 volts are not to be used for Grade I applications.
3. A non-standard parts approval is needed if the requirements of notes 1 and 2 are to be waived.
4. The CLR79 style wet slug tantalum capacitors shall be subjected to an acid indicator leak test in accordance with paragraphs III and IV of GSFC screening procedure SP01.23.
5. EFFECTIVE SERIES RESISTANCE SEEN BY CSR STYLE CAPACITORS SHOULD BE EQUAL TO OR GREATER THAN ONE OHM/VOLT. AS NOTED IN MIL-STD-975, THE CSR STYLE OF CAPACITOR IS NOT RECOMMENDED FOR USE IN APPLICATIONS OF LESS THAN ONE OHM/VOLT, AS IN POWER SUPPLY FILTERS.
6. Surge current testing shall be performed on CSR style capacitors for all Grade 1 applications per MIL-STD-975.

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

Part Number example: M23269 /XX XXXX

- 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)	Maximum Dissipation Factor (%)	Rated Voltage (volts, dc)	Temperature Range °C	Temperature Coefficient (ppm/°C)	Minimum Insulation Resistance (megohms)	Configuration Case Type	Configuration Lead Type	**Grade 1** FRL	**Grade 2** FRL	Manufacturer
M23269/05	CYR13	3,4	0.5-300	0.7,0.3,0.1	300, 500	−55°C to +125°C	105±25	500 K @ 25°C	Rectangular, hermetic	Axial or Radial	R	P	QPL-23269
M23269/09	CYR41	5	0.5-1000		100		0±25			Radial	(Note 1)	P	
	CYR42	6	0.5-300		50-500					Axial			
	CYR43	7	330-1200	0.1	50-300					Axial			

NOTES:
1. No Grade 1 parts are available at the present time.

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

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

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 2 FRL = P(0.1)
0.5	0.25pF	0.5	100	4001
1.5	0.25pF			4002
2.7	0.25pF			4003
3.3	0.25Pf			4004
3.9	0.25pF			4005
4.7	0.25pF			4006
5.6	0.25pF	0.3		4007
6.8	0.25Pf			4008
	5%			4009
8.2	0.25pF			4010
	5%			4011
10	0.25pF			4012
	5%			4013
12	0.25pF			4014
	5%			4015
15	0.25pF			4016
	2%			4017
	5%			4018
18	0.25pF			4019
	2%			4020
	5%			4021
22	0.25pF			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 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 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 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[1]
Fixed, Glass Dielectric, Established Reliability

Capacitance Value (pF)	Capacitance Tolerance (± %)	Rated Voltage (volts, dc)	Part Number M23269/09- 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 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

NOTE:
1. Dissipation factor = 0.1%

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	Power Connectors, Crimp Removable Contacts (sub-miniature)	GSFC S-311-P-4/9	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
NBS	Electrical, Miniature, Circular (200°C)	MSFC 40 M38298	MIL-STD-975

NOTES:
1. OTHER PARTS ARE LISTED IN MIL-STD-975, BUT GSFC CONSIDERS ONLY THE ONES LISTED ABOVE AS STANDARD PARTS.

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

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; indicated 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.

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; indicated 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; if required, consult the parts specialist.

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; indicated 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.

Index of Preferred Filters[1, 2, 3]

Style	Description	Specification	Refer To
FS11	Electromagnetic Interference Suppression	MIL-F-28861/1	MIL-STD-975
FS50	Electromagnetic Interference Suppression	MIL-F-28861/5	MIL-STD-975

NOTES:

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

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

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

   b. THE FILTERS MUST BE TREATED AS BEING HEAT SENSITIVE. HEAT SINK THE DEVICE WHEN SOLDERING TO THE FILTER.

Index Of Preferred Fuses

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]					Grade 2[2]				
			Voltage Drop @ Rated Current (Min-Max) (Volts)	Maximum Cold Resistance (ohms)	Mil Part Number	Specification	Manufacturer	Voltage Drop @ Rated Current (Min-Max) (Volts)	Maximum Cold Resistance (ohms)	Mil Part Number	Specification	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*			*.544-.736*	*.960*	*FM04A 125V 1/4A*		
3/8			*.527-.713*	*.462*	*FM08A 125V 3/8A*	Note 6		*.527-.713*	*.560*	*FM04A 125V 3/8A*	Note 6	
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**			.157-.213	.165	**FM04A125V 1A**		
1-1/2			.153-.207	.088	**FM08A125V 1-1/2A**	MIL-F-23419/8	QPL-23419	.153-.207	.105	**FM04A125V 1-1/2A**	MIL-F-23419/4	QPL-23419
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
MS21367[1]	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Iron Core	MIL-C-15305	MIL-STD-975
MS21368[1]	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Iron Core	MIL-C-15305	MIL-STD-975
MS21369[1]	Coil, Fixed, Radio Frequency, Micro Miniature, Shielded, Iron Core	MIL-C-15305	MIL-STD-975
MS90538[1]	Coil, Fixed, Radio Frequency, Subminiature, Iron Core	MIL-C-15305	MIL-STD-975
MS90539[1]	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

NOTES:
1. MIL-C-15305 PARTS ARE NOT SCREENED AND ARE CONSIDERED TO BE NON-STANDARD PARTS. FOR SPACE FLIGHT USE THEY MUST BE SCREENED AS OUTLINED IN APPENDIX C, TABLE 05.

Index of Preferred Relays (Grade 1 and Grade 2)

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
M39016/6	Nonlatching	MIL-R-39016/6	MIL-STD-975[2, 3]
M39016/9	Nonlatching	MIL-R-39016/9	Page 06-2[1, 3]
M39016/11	Nonlatching	MIL-R-39016/11	MIL-STD-975[2, 3]
M39016/12	Latching	MIL-R-39016/12	Page 06-3[1, 3]
M39016/13	Nonlatching	MIL-R-39016/13	Page 06-2[1, 3]
M39016/14	Nonlatching	MIL-R-39016/14	Page 06-2[1, 3]
M39016/15	Nonlatching	MIL-R-39016/15	Page 06-2[1, 3]
M39016/20	Nonlatching	MIL-R-39016/20	MIL-STD-975[2, 3]
M39016/21	Nonlatching	MIL-R-39016/21	MIL-STD-975[2, 3]
M39016/29	Latching	MIL-R-39016/29	Page 06-3[1, 3]
M39016/30	Latching	MIL-R-39016/30	MIL-STD-975[2, 3]
M39016/31	Latching	MIL-R-39016/31	Page 06-3[1, 3]
M39016/38	Nonlatching	MIL-R-39016/38	MIL-STD-975[2, 3]
MS27400	Nonlatching	MIL-R-6106	Page 06-2[1, 3]
MS27401	Nonlatching	MIL-R-6106	Page 06-2[1, 3]
MS27742	Latching	MIL-R-6106	Page 06-3[1, 3]

NOTES:

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

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

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

Relays, Nonlatching

Electrical Data				Mechanical Data			Grade 1			Grade 2[6]			Remarks
Contact Rating at 28 vdc Resistive[2] (amps)	Coil Voltage Nominal (vdc)	Coil Voltage Pick-up (max) (vdc)	Nominal dc Coil Resistance (ohms)	Contact Form[3]	Package Type	Terminal Type	GSFC Part Number[1]	GSFC Specification S-311-P-2(06)	Mfr.	MIL Part Number[1]	Specification	Mfr.	
1.0[4]	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	M39016/9-062P M39016/9-061P M39016/9-080P M39016/9-059P M39016/9-058P	MIL-R-39016/9		
1.0[4]	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	M39016/15-081P M39016/15-080P M39016/15-079P M39016/15-078P M39016/15-077P	MIL-R-39016/15	QPL-39016	Coil Transient Suppression
1.0[4]	26.5 12.0 6.0	13.5 5.4 2.7	720 115 28	4 Form C (4PDT)	Low[5] Profile	Pins	P-2/42-03 P-2/42-02 P-2/42-01	/42	Genicom	M39016/14-002M M39016/14-007M M39016/14-005M	MIL-R-39016/14		
2.0[4]	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	Genicom	M39016/13-060P M39016/13-065P M39016/13-064P	MIL-R-39016/13		
10.0	28.0	18.0	320	2 Form C (2PDT)	Crystal Can	Solder Lugs	P-2(06)/23-01	/23	Leach	MS27401-13	MIL-R-6106	QPL-6106	
						Pins	P-2(06)/23-02			MS27401-14			
10.0	28.0	18.0	290	4 Form C (4PDT)	One Inch Cube	Solder Lugs	P-2(06)/19-01	/19	Leach	MS27400-9			
						Pins	P-2(06)/19-02			MS27400-10			

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

Relays, Latching

Electrical Data				Mechanical Data			Grade 1			Grade 2[7]			Remarks
Contact Rating at 28 vdc Resistive[2] (amps)	Coil Voltage Nominal (vdc)	Coil Voltage Pick-up (max) (vdc)	Nominal dc Coil Resistance (ohms)	Contact Form[3]	Package Type	Terminal Type	GSFC Part Number[1]	GSFC Specification S-311-P-2(06)	Mfr.	MIL Part Number[1]	Specification	Mfr.	
1.0[4]	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	M39016/12-060P M39016/12-050P M39016/12-058P M39016/12-057P M39016/12-056P	MIL-R-39016/12	QPL-39016	
1.0[4]	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	M39016/29-060P M39016/29-059P M39016/29-058P M39016/29-057P M39016/29-056P	MIL-R-39016/29		Coil Transient Suppression
2.0[4]	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)	Note 6			
	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[4]	26.5	13.5	975	4 Form C (4PDT)	Low[5] Profile	Pins	P-2(06)/27-01	/27	Genicom	P-2(06)/27-01	MIL-R-39016/31		
25.0	28.0	18.0	450	3 Form C (3PDT)	One Inch Cube	Solder Lugs	P-2(06)/35-01	/35	Leach	MS27742-1	MIL-R-6106	QPL-6106	
						Pins	P-2(06)/35-02			MS27742-2			

NOTES:

1. See Note 1 on Page 06-2.
2. See Note 2 on Page 06-2.
3. See Note 3 on Page 06-2.
4. See Note 4 on Page 06-2.
5. See Note 5 on Page 06-2.
6. Use Grade 1 parts.
7. FOR GRADE 2 PARTS, SEE REQUIREMENTS ON PAGE 06-1.

Index of Preferred Resistors

Style	Description	Specification	Refer To
RBR	Wire wound, Accurate	MIL-R-39005	MIL-STD-975
RWR	Wire wound, Power	MIL-R-39007	MIL-STD-975
RCR[1]	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)[2]	Film, High Stability	MIL-R-55182	MIL-STD-975
RZO[3]	Fixed Film Networks	MIL-R-83401	MIL-STD-975

NOTES:

1. GSFC considers RCR styles at the "S" failure rate suitable for both Grade 1 and Grade 2 applications.
2. GSFC does not consider type "C" terminal material to be readily weldable, and recommends using type "N" in welding applications. Type "C" and "R" may be used in soldering applications. Styles 75 and 90 are available only with type "C" terminal material.
3. GSFC considers RZO styles listed in MIL-STD-975 acceptable for use in Grade 2 applications. For Grade 1 applications, consult the Parts Specialist.

Index of Preferred Diodes[1, 3]

Grade 1[1] Type Designation JANS Type No.	Grade 2[2] Type Designation JANTXV Type No.	Description	Refer To
	IN645-1 IN647-1 IN649-1	Small Signal	MIL-STD-975
IN754A-1 thru IN759A-1	IN746A-1 thru IN759A-1	Zener Voltage Regulator	
	IN821-1 IN823-1 IN825-1 IN827-1 IN829-1 IN935B	Voltage Reference	MIL-STD-975
	IN937B thru IN940B	Zener Voltage Reference	
	IN941B IN943B IN944B IN945B	Voltage Reference	Page 08-3
IN962B-1 thru IN973B-1	IN962B thru IN992B IN962B-1 thru IN973B-1	Zener Voltage Regulator	MIL-STD-975
	IN1202A	High Power	
	IN2970B thru IN3051B	Zener Voltage Regulator	
	IN3595 IN3600	Switching	Page 08-2
	IN3821A thru IN3828A	Voltage Regulator	MIL-STD-975
	IN3891 IN3893	Fast Switching Power Rectifier	
	IN4099 thru IN4135	Voltage Regulator	Page 08-4

Grade 1[1] Type Designation JANS Type No.	Grade 2[2] Type Designation JANTXV Type No.	Description	Refer To
IN4148-1	IN4148-1	Small Signal	MIL-STD-975
	IN4150-1 IN4153-1	Switching	
	IN4245 IN4247 IN4249	Power	Page 08-7
	IN4306 IN4307	Switching	Page 08-2
	IN4370A-1 thru IN4372A-1	Voltage Regulator	MIL-STD-975
	IN4454-1	Switching	Page 08-2
	IN4460 thru IN4496	Zener Voltage Regulator	MIL-STD-975
	IN4531	Switching	Page 08-2
	IN4565A thru IN4569A	Voltage Reference	MIL-STD-975
	IN4570A thru IN4574A	Zener Voltage Reference	
	IN4614 thru IN4627	Voltage Regulator	
	IN4942 IN4944 IN4946 IN4947 IN4948	Fast Switching Power Rectifier	Page 08-6
	IN4954 thru IN4995	Voltage Regulator	MIL-STD-975

NOTES:
1. When no JANS diode is listed on the QPL, a Grade 2 diode may be upgraded for use in Grade 1 applications in accordance with Appendix A. A non-standard part approval is required.
2. JANTXV diodes must be subjected to the screening verification tests of Appendix E.
3. Refer to Appendix D for information on radiation effects.

Index of Preferred Diodes[1, 3] (continued)

Grade 1[1] Type Designation JANS	Grade 2[2] Type Designation JANTXV	Description	Refer To
	IN5139A thru IN5148A	Voltage Variable Capacitor	Page 08-7
	IN5285 thru IN5314	Current Regulator	MIL-STD-975
	IN5415 thru IN5420	Fast Switching Power Rectifier	MIL-STD-975
	IN5550 thru IN5554	Power Rectifier	MIL-STD-975
	IN5611	Voltage Suppressor	MIL-STD-975
	IN5614	Power Rectifier	MIL-STD-975
	IN5615	Fast Switching Power Rectifier	MIL-STD-975
	IN5616	Power Rectifier	MIL-STD-975
	IN5617	Fast Switching Power Rectifier	MIL-STD-975
	IN5618	Power Rectifier	MIL-STD-975
	IN5619	Fast Switching Power Rectifier	MIL-STD-975
	IN5620	Power Rectifier	MIL-STD-975
	IN5621	Fast Switching Power Rectifier	MIL-STD-975
	IN5622	Power Rectifier	MIL-STD-975
	IN5623	Fast Switching Power Rectifier	MIL-STD-975
	IN5629A thru IN5665A	Zener Voltage Suppressor	MIL-STD-975

Grade 1[1] Type Designation JANS	Grade 2[2] Type Designation JANTXV	Description	Refer To
	IN5711 IN5712	Schottky Barrier Switching	MIL-STD-975
	IN5768 IN5770 IN5772 IN5774	Array	MIL-STD-975
	IN5804 IN5806 IN5809 IN5811	High Power	MIL-STD-975
	IN5814 IN5816	Power Rectifier	MIL-STD-975
	IN5907	Zener Voltage Suppressor	MIL-STD-975
	IN6073 thru IN6081	Fast Switching Power Rectifier	Page 08-6
	IN6100	Array	MIL-STD-975
	IN6108	Array	Page 08-8
	IN6102A thru IN6173A	Transient Voltage Suppressor	MIL-STD-975
	IN6320 thru IN6336	Voltage Regulator	Page 08-5
	2N2323A 2N2324A 2N2326A 2N2328A	SCR	MIL-STD-975

DIODES
Switching, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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		
	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 1 on Page 08-1.
3. See Note 2 on Page 08-1.
4. This case does not meet the dimensional criteria for any JEDEC outline. See MIL-S-19500 detail specification for case outline dimensions.
5. 11.30 mm x 4.37 mm x 7.62 mm.
6. 11.30 mm x 4.37 mm x 12.45 mm.

DIODES
Voltage Reference, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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.
	1N944B 1N945B	/157	QPL-19500	11.12/12.28	7.5	0.024 0.012	-55°C - 150°C	30	7.5	DO7

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

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

Grade 1[2] Type Designation JANS	Grade 2[3] 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. Storage Temp. (°C)	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 1 on Page 08-1.
3. See Note 2 on Page 08-1.

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

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	Specification MIL-S-19500	Manufacturer	Nominal Reference Voltage V_Z (V)	@ I_Z (mA)	Max. Impedance Z_Z (Ohms)	Max Diss. TL = 75°C (W) Note 5	Voltage Temp. Coefficient (%/°C)	Max. Storage Temp. (°C)	Case Dwg.	Remarks
	IN6320			6.8	20	3.0		.062			
	IN6321			7.5	20	4.0		.068			
	IN6322			8.2	20	5.0		.075			
	IN6323			9.1	20	6.0		.076			
	IN6324			10	20	6.0		.079			
	IN6325			11	20	7.0		.082			
	IN6326			12	20	7.0		.083			
	IN6327			13	9.5	8.0		.079			
	IN6328	/533	QPL-19500	15	8.5	10	0.500	.082	200	Note 4	Low Power
	IN6329			16	7.8	12		.083			
	IN6330			18	7.0	14		.085			
	IN6331			20	6.2	18		.086			
	IN6332			22	5.6	20		.087			
	IN6333			24	5.2	24		.088			
	IN6334			27	4.6	27		.090			
	IN6335			30	4.2	32		.091			
	IN6336			33	3.8	40		.092			

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

DIODES
Power Rectifiers, Fast Switching, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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.
	1N4942	/359	QPL-19500	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	
	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 1 on Page 08-1.
3. See Note 2 on Page 08-1.
4. This case does not meet the dimensional criteria for any JEDEC outline. See MIL-S-19500 detail specification for case outline dimensions.

DIODES
Power, Silicon[1]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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[3] Type Designation JANTXV	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) TA = 25°C	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 1 on Page 08-1.
3. See Note 2 on Page 08-1.

DIODES
Switching, Silicon[1], Arrays

Garde 1[2]	Grade 2[3]										
Type Designation JANS	Type Designation JANTXV	Specification MIL-S-19500	Manufacturer	Maximum Forward Voltage (Vdc)	@ Forward Current (mAdc)	Maximum Reverse Current (ηAdc)	@ Reverse Voltage (Vdc)	Reverse Recovery Time (t_{rr}) (nsec)	Capacitance (pF)	Case Dwg.	Remarks
	1N6101	/517	QPL-19500	1.0	100	25	20	5	3	Note 4	Monolithic

NOTES:
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 08-1.
3. See Note 2 on Page 08-1.
4. PLackage is 16-pin ceramic dual in-line package (DIP).

Index of Preferred Transistors[1, 3]

Grade 1[1] Type Designation JANS	Grade 2[2] Type Designation JANTXV	Description	Refer To
	2N718A	Low Power—NPN	Page 09-2
2N918	2N918	RF—NPN	MIL-STD-975
	2N1613	Medium Power—NPN	Page 09-3
	2N2060	Dual—NPN	
2N2219AL	2N2219A	Medium Power—NPN	
2N2222A	2N2222A		
2N2369A	2N2369A	Lower Power—NPN	MIL-STD-975
	2N2432A	Chopper—NPN	
	2N2484	Low Power—NPN	
	2N2605	Low Power—PNP	
	2N2857	RF—NPN	
	2N2880	High Power—NPN	Page 09-4
2N2905AL	2N2905A	Medium Power—PNP	
2N2907A	2N2907A	Low Power—PNP	MIL-STD-975
	2N2920	Dual—NPN	
	2N2944A	Chopper—PNP	Page 09-3
	2N2945A	Chopper—PNP	MIL-STD-975
	2N2946A	Chopper—PNP	Page 09-3
	2N3019	Medium Power—NPN	
	2N3251A	Low Power—PNP	
	2N3375	RF—NPN	
	2N3468	Low Power—PNP	
	2N3501	Low Power—NPN	MIL-STD-975
	2N3553	RF—NPN	
	2N3637	Medium Power—PNP	
	2N3700	Low Power—NPN	
	2N3716	Low Power—NPN	
	2N3741	High Power—PNP	

Grade 1[1] Type Designation JANS	Grade 2[2] Type Designation JANTXV	Description	Refer To
	2N3743	Low Power—PNP	Page 09-3
	2N3749	High Power—NPN	
	2N3763	Medium Power—PNP	
	2N3765	Low Power—PNP	
	2N3792	High Power—PNP	
	2N3810	Dual—PNP	MIL-STD-995
	2N3811	Dual—PNP	
	2N3821	J-FET(N-CH)	
	2N3822	J-FET (N-CH)	
	2N3823	J-FET (N-CH)	
	2N3866	RF—NPN	
	2N3868	Medium Power—PNP	Page 09-2
	2N3996	High Power—NPN	
	2N4150	Medium Power—NPN	
	2N4399	High Power—PNP	
	2N4416A	J-FET (N-CH)	
	2N4856	J-FET (N-CH)	MIL-STD-975
	2N4857	J-FET (N-CH)	
	2N4858	J-FET (N-CH)	
	2N4931	Medium Power—PNP	Page 09-2
	2N4957	RF—PNP	
	2N5038	High Power—NPN	MIL-STD-975
	2N5114	J-FET (P-CH)	
	2N5115	J-FET (P-CH)	
	2N5116	J-FET (P-CH)	

Grade 1[1] Type Designation JANS	Grade 2[2] Type Designation JANTXV	Description	Refer To
	2N5250	High Power—NPN	Page 09-4
	2N5415S	Low Power—PNP	Page 09-2
	2N5416	Low Power—PNP	MIL-STD-975
	2N5660	High Power—NPN	Page 09-4
	2N5662	Medium Power—NPN	Page 09-3
	2N5664	High Power—NPN	
	2N5665	High Power—NPN	
	2N5666	High Power—NPN	
	2N5667	High Power—NPN	MIL-STD-975
	2N5672	High Power—NPN	
	2N5745	High Power—PNP	
	2N6308	High Power—NPN	
	2N6546	High Power—NPN	Page 09-4
	4N23		MIL-STD-975
	4N23A		
	4N24		
	4N24A	Photocoupler	
	4N47		
	4N48		
	4N49		

NOTES:

1. When no JANS transistor is listed on the QPL, a Grade 2 transistor may be upgraded for use in Grade 1 applications in accordance with Appendix A. A non-standard part approval is required.
2. JANTXV transistors must be subjected to the screening verification of Appendix E.
3. Refer to Appendix D for information on radiation effects.

TRANSISTORS
NPN, Silicon, Low Power[1]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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[3] Type Designation JANTXV	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)	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
	2N5415S	/485		30/120	-50	-10	500μA	200	-2.0	-50	-5	350	750	1000	140	TO5

TRANSISTORS
PNP, Silicon, Medium Power[1]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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)	t_{off} (nsec)	Case Dwg.
	2N3763	/396	QPL-19500	40/140	-500	-1	-100	-30	-0.5	-500	-50	-60	1.0	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
	2N3743			50/200	-30	-10	-500	-300	-1.2	-30	-3	-300		Not specified		T039

NOTES:
1. See MIL-STD-975 for additional types.
2. See Note 1 on Page 09-1.
3. See Note 2 on Page 09-1.

TRANSISTORS
NPN, Silicon, Medium Power[1]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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		100/300	150	10	I_{CES} = 10nAdc	V_{CE} = 90Vdc	0.2	150	15	140				
	2N5662	/454		40/120	500	5	100	200	0.4	1000	100	250	1200	250	850	

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

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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			50			8			-2.0			-40		

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, 3]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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 = 125°C	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 = 125°C	TO66
	2N6546	/525		16/30	10	2	1	600	1.5	10	2	300	175	TO3

TRANSISTORS
PNP, Silicon, High Power[1]

Grade 1[2] Type Designation JANS	Grade 2[3] Type Designation JANTXV	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	QPL-19500	30/100	-0.250	-1	-0.0001	-80	-0.6	-1	-0.125	-80	25	0.4	1.0	TO66
	2N3792	/379		50/150	-1	-2	I_{CES} = -1mAdc	V_{CE} = -70Vdc	-1	-5	-0.5		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 1 on Page 09-1.
3. See Note 2 on Page 09-1.
4. This case does not meet the dimensional criteria for any JEDEC outline. See MIL-S-19500 detail specification for case outline dimensions.

TRANSISTORS
Field-Effect, N-Channel, Junction, Silicon[1]

<table>
<tr><th>Grade 1[2]</th><th>Grade 2[3]</th><th rowspan="2">Specification MIL-S-19500</th><th rowspan="2">Manufacturer</th><th rowspan="2">V_{DG} and V_{DS} (max) (Vdc)</th><th rowspan="2">V_{GS} (max) (Vdc)</th><th rowspan="2">I_G (mA)</th><th rowspan="2">V_{GS}(off) max. (Vdc)</th><th colspan="2">@</th><th rowspan="2">I_{DSS} (min/max) (mA)</th><th colspan="2">@</th><th rowspan="2">P_T (mW)</th><th rowspan="2">Case Dwg.</th></tr>
<tr><th>Type Designation JANS</th><th>Type Designation JANTXV</th><th>V_{DS} (Vdc)</th><th>I_D (nA)</th><th>V_{DS} (Vdc)</th><th>V_{GS} (Vdc)</th></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 1 on Page 09-1.
3. See Note 2 on Page 09-1.

INDEX TO PREFERRED MICROCIRCUITS[1,2,3,4]
DIGITAL
(Generic Part Numbers Shown)

Low Power Schottky, TTL

54LS00	54LS51	54LS139	54LS241	54LS395
54LS02	54LS54	54LS148	54LS244	54LS490
54LS03	54LS73	54LS151	54LS245	54LS670
54LS04	54LS74	54LS153	54LS251	
54LS05	54LS75	54LS156	54LS253	
54LS08	54LS76	54LS157	54LS257	
54LS10	54LS83A	54LS158	54LS258	
54LS11	54LS85	54LS160	54LS259	
54LS12	54LS86	54LS161	54LS266	
54LS13	54LS90	54LS162	54LS273	
54LS14	54LS92	54LS163	54LS279	
54LS15	54LS93	54LS164	54LS283	
54LS20	54LS95	54LS165	54LS290	
54LS21	54LS96	54LS166	54LS293	
54LS22	54LS107	54LS174	54LS295	
54LS26	54LS109	54LS175	54LS298	
54LS27	54LS112	54LS190	54LS348	
54LS28	54LS113	54LS191	54LS365	
54LS30	54LS114	54LS192	54LS366	
54LS32	54LS122	54LS193	54LS367	
54LS37	54LS123	54LS194	54LS368	
54LS38	54LS126	54LS195	54LS375	
54LS42	54LS132	54LS197	54LS390	
54LS47	54LS138	54LS240	54LS393	

Advanced Low Power Schottky, TTL (Refer to page 10-4)

54ALS00	54ALS08	54ALS20	54ALS133
54ALS02	54ALS10	54ALS27	54ALS138
54ALS04	54ALS11	54ALS30	54ALS200A
			54ALS244A

TTL

5401	5423	5470	54121	54163
5406	5425	5472	54145	54180A
5407	5450	5477	54150	
5416	5453	5482	54154	

CMOS/Bulk

4000A	4019A	4069UB^{R}
4002A	4020A	4070B
4006A	4021A	4071B
4007A	4022A	4072B
4008A	4023A	4073B
4009A	4024A	4075B^{R}
4010A	4025A	4077B^{R}
4011A	4027A	4081B^{R}
4013A	4031A	4082B^{R}
4014A	4043A	4085B^{R}
4015A	4049A	4086B^{R}
4016A	4050A	4098B^{R}
4018A	4066A	4099B^{R}
		4502B^{R}

(Refer to page 10-5)

4001B	4012B^{R}	4030B$^{R, H}$
4017B^{R}	4020B^{R}	

Memory

- Prom, Schottky TTL

82S126	82S131	82S181
82S129	82S136	82S185
82S130	82S137	82S191
		82S2708

- Ram, Schottky TTL

93L422 93L422A 93L425 93L415

- Ram, NMOS

MK2164

Microprocessor, NMOS

8080A 8086 Z80A Z8002

Microprocessor, I^2L

9989

Hybrid

(Refer to page 10-3)

NOTES:

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

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

LINEAR
BIPOLAR AND BI-FeT

Operational Amplifiers		Voltage Regulators		Voltage Comparators
HA2600	LM101A	LM109	LM120K-15	LM111
HA2101A	LM108A	LM723	LM140H-12	LM139
HA2500	LM118	LM120H-05	LM140H-15	LM710
HA2510	LM124	LM120H-12	LM140K-05	
HA2520	LM148	LM120H-15	LM140K-12	
LF155	LM741	LM120K-05	LM140K-15	
LF156	LM747A	LM120K-12		
LF156A	LM1558			
LF157A	LH2101A			

Line Drivers	Line Receivers	Precision Timers	DAC	Switches
9614	9615	555	08	155A
55113	55107	556	08A	200
	55108			201

HYBRID MICROCIRCUITS

Hybrid microcircuits are defined as microcircuits in which the circuits elements are contained on more than one die or chip, as compared to a monolithic microcircuit where all the circuit elements are contained on a single die. A hybrid microcircuit generally contains an insulating substrate or substrates on which are deposited a conductor network and sometimes thick film resistors. Semiconductor dice and sometimes passive elements are attached to the substrate. Additional connections are made between the active and passive elements, the substrate, and the package leads using interconnection wires. Hybrid microcircuits are normally low volume non-standard parts. A non-standard part approval is required for all non-standard types. General requirements for hybrid microcircuits are presented in GSFC specification S-311-200.

MICROCIRCUITS
Digital, MIL-M-38510 Advanced Low Power Schottky TTL

Commercial Part Number[1]	Function		Grade 1 Part No. JANM38510	Grade 1 Manufacturer	Grade 2 Part No.[2] JANM38510	Grade 2 Manufacturer
54ALS00	Gates	NAND, quad 2-input	Note 3		/37001BXX	Per QPL-38510
54ALS02		NOR, quad 2-input			/37301BXX	
54ALS04		Hex Inverter			/37006BXX	
54ALS08		And, quad 2-input			/37401BXX	
54ALS10		NAND, Triple 3-input			/37002BXX	
54ALS11		AND, Triple 3-input			/37402BXX	
54ALS20		NAND, dual 4-input			/37003BXX	
54ALS27		NOR, Triple 3-input			/373002BXX	
54ALS30		NAND, 8-input			/37004BXX	
54ALS133		NAND, 13-input			/37005BXX	
54ALS240A	Buffers	Octal, inverting buffer			/38301BXX	
54ALS244A		Octal, noninverting buffer			/38303BXX	
54ALS138	Decoders	Single 3 to 8 line decoder			/37701BXX	

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

MICROCIRCUITS
Digital, MIL-M-38510 CMOS[4]

Commercial Part Number[1]	Function		Grade 1 Part No. JANM38510	Grade 1 Manufacturer	Grade 2 Part No.[2] JANM38510	Grade 2 Manufacturer
4001B	Gates	NOR, quad, 2-input	Note 3	Per QPL-38510	/05252BXX	Per QPL-38510
4012B[R]		NAND, dual, 4-input			/05052BXX	
4030B[R, H]		Exclusive-OR Gate Quad			/05353BXX	
4017B[R]	Counter/ Dividers	Decade Counter/Divider			/05651BXX	
4020B[R]		14-stage ripple-carry binary			/05653BXX	

NOTES:
1. Use the JANM38510 part number for ordering, not the commercial part number.
2. The "XX's" are for choice of case outline and lead finish respectively. Refer to QPL-38510 for specific choices available.
3. No Grade 1 version of this part is presently being supplied by any manufacturer. The Grade 2 part may be used for Grade 1 applications by upgrading in accordance with Appendix A. A non-standard part approval is required.
4. The part types marked with superscripts R and H can be procured as radiation hard parts, hardened to 1×10^5 rads and 1×10^6 rads, respectively. See QPL for additional information.

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

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-1687-16878
N = 32 AWG, Type N-2 per MIL-STD-1276
E = Insulated lead (TFE), 32 AWG per MIL-I-22129; Bare lead, Style S; Tubing (FEP), M23053/11-105c.

LEAD LENGTH (XXX):
Specify length in centimeters.
1R0 = 1.0, 10R = 10, 101 = 100.
Minimum length is 7.6cm.

Index of Preferred Transformers

Style[1]	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

NOTES:

1. *The purchase order must specify that 100% screening is required. Otherwise, when unscreened parts are purchased,* they shall be subjected to screening tests, as outlined in Table 15 of Appendix C prior to use.

Index of Preferred Wire/Cable[1, 2]

Style	Description	Specification	Refer To
M22759/9	Wire, High temperature	MIL-W-22759	Page 16-2
M22759/18	Wire, Light weight, ETFE	MIL-W-22759	Page 16-3
M22759/32/33/34/35	Wire, Lightweight, crosslinked ETFE	MIL-W-22759	Pages 16-3, 4, 5
S311P13	Wire, High voltage	GSFC S-311-P-13	Page 16-
M22759/3/11/ 12/22/23	Wire, Extruded TFE	MIL-W-22759	MIL-STD-975
M22759/16	Wire, ETFE	MIL-W-22759	MIL-STD-975
M81381	Wire, Fluorocarbon-Polyimide	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

NOTES:
1. GSFC WAIVES THE RESTRICTIONS AND REQUIREMENTS OF MIL-STD-975 ON THE USE OF SILVER COATED COPPER CONDUCTOR WIRE AND CABLE.
2. Flammability properties of these wires are controlled by the applicable specifications. However, applications in Space Transportation System (STS) payloads may require that the specific STS flammability hazards be addressed. Users are advised to consult the appropriate project systems safety officer.

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		
M22759/9-22-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 16-7).

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

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 16-7).

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

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		
M22759/32-30-X M22759/32-28-X M22759/32-26-X M22759/32-24-X M22759/32-22-X M22759/32-20-X M22759/32-18-X M22759/32-16-X M22759/32-14-X M22759/32-12-X	7 x 38 7 x 36 19 x 38 19 x 36 19 x 34 19 x 32 19 x 30 19 x 29 19 x 27 37 x 28	.559 .635 .762 .889 1.04 1.22 1.47 1.68 2.08 2.54	.660 .737 .864 .991 1.14 1.37 1.63 1.83 2.29 2.74	600	/32	QPL-22759		Tin-coated copper conductor, insulated with crosslined ETFE Maximum temperature 150°C
M22759/33-30-X M22759/33-28-X M22759/33-26-X M22759/33-24-X M22759/33-22-X M22759/33-20-X	7 x 38 7 x 36 19 x 38 19 x 36 19 x 34 19 x 32	.559 .635 .762 .889 1.04 1.22	.660 .737 .864 .991 1.14 1.37	600	/33	QPL-22759		Silver coated high strength copper alloy, Insulated with crosslinked ETFE Maximum temperature 150°C

NOTES:
1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (Listed on Page 16-7).

WIRE
Electrical, Insulated, Lightweight (Page 3 of 3)

Style[1]	Strands No. x AWG#	Diameter over Insulation, mm		Voltage Ratings Maximum (Volts/RMS)	Specification MIL-W-22759	Grade 1	Grade 2	Remarks
		Minimum	Maximum			Manufacturer		
M22759/34-24-X	19 x 36	1.09	1.19	600	/34	QPL-22759		Tin-coated copper conductor Insulated with crosslinked ETFE. Maximum temperature 150°C
M22759/34-22-X	19 x 34	1.12	1.37					
M22759/34-20-X	19 x 32	1.42	1.57					
M22759/34-18-X	19 x 30	1.70	1.85					
M22759/34-16-X	19 x 29	1.88	2.08					
M22759/34-14-X	19 x 27	2.31	2.51					
M22759/34-12-X	37 x 28	2.74	2.95					
M22759/34-10-X	37 x 26	3.30	3.61					
M22759/34-8-X	133 x 29	4.75	5.16					
M22759/34-6-X	133 x 27	5.87	6.38					
M22759/34-4-X	133 x 25	7.62	8.13					
M22759/34-2-X	665 x 30	9.88	10.70					
M22759/34-1-X	817 x 30	10.90	11.71					
M22759/34-0-X	1045 x 30	11.91	12.73					
M22759/34-00-X	1330 x 36	13.39	14.30					
M22759/35-26-X	19 x 38	.965	1.07	600	/35	QPL-22759		Silver-coated High Strength Copper Alloy Insulated with crosslinked ETFE. Maximum temperature, 200°C.
M22759/35-24-X	19 x 36	1.09	1.19					
M22759/35-22-X	19 x 34	1.22	1.37					
M22759/35-20-X	19 x 32	1.42	1.52					

NOTES:
1. For the "X" suffix, substitute the appropriate color code designator from MIL-STD-681 (listed on page 16-7) except that for sizes 2 and larger the braid color shall be dark green and the designator shall be 5D.

WIRE
Electrical, Insulated

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	—	—	—	—				
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, copper conductor.
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				Insulated with crosslinked polyalkene.
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	GSFC S-311-P-13	Raychem Corp.		
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				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 wire harnesses.
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 16-7

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

Base Color	1st Stripe	2nd Stripe	Designator	Base Color	1st Stripe	2nd Stripe	Designator	Base Color	1st Stripe	2nd Stripe	Designator
Black			0	White	Black	Brown	901	White	Orange	Yellow	934
Brown			1	White	Black	Red	902	White	Orange	Green	935
Red			2	White	Black	Orange	903	White	Orange	Blue	936
Orange			3	White	Black	Yellow	904	White	Orange	Violet	937
Yellow			4	White	Black	Green	905	White	Orange	Gray	938
Green			5	White	Black	Blue	906				
Blue			6	White	Black	Violet	907	White	Yellow	Green	945
Violet			7	White	Black	Gray	908	White	Yellow	Blue	946
Gray			8					White	Yellow	Violet	947
White			9	White	Brown	Red	912	White	Yellow	Gray	948
				White	Brown	Orange	913				
White	Black		90	White	Brown	Yellow	914	White	Green	Blue	956
White	Brown		91	White	Brown	Green	915	White	Green	Violet	957
White	Red		92	White	Brown	Blue	916	White	Green	Gray	958
White	Orange		93	White	Brown	Violet	917				
White	Yellow		94	White	Brown	Gray	918	White	Blue	Violet	967
White	Green		95					White	Blue	Gray	968
White	Blue		96	White	Red	Orange	923				
White	Violet		97	White	Red	Yellow	924				
White	Gray		98	White	Red	Green	925				
				White	Red	Blue	926				
				White	Red	Violet	927				
				White	Red	Gray	928				

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

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

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

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

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

Section 3 — FILTERS

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

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

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

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

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

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

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

Section 4 — FUSES

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

Section 5 — INDUCTORS

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

Section 6 — RELAYS

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

Section 7 — RESISTORS

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

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

Section 8 — DIODES

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

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

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

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

Section 9 — TRANSISTORS

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

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

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

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

Section 10 — MICROCIRCUITS

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

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

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

Section 14 — THERMISTORS

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

Section 15 — TRANSFORMERS

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

Section 16 — WIRE and CABLE

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

MISCELLANEOUS

For device types listed in MIL-STD-975 but not in PPL-17, consult the parts specialist.

APPENDIX B
Parts Derating Factors

This Appendix tabulates GSFC's guidelines for the derating of the parts and device types listed in MIL-STD-975 and PPL-17. Many of these derating guidelines are identical to those given in MIL-STD-975. However, where differences occur, the GSFC derating factors shall have precedence. If a derating factor is not provided here for a specific part type, consult the Parts Specialist.

Table 01.
Derating Outline for Capacitors

Dielectric Class	Maximum Ambient Operating Temperature °C	Derate to Following Percentage (%)	
		Rated Voltage	Ripple Voltage
Ceramic (CKR), (CDR), (CCR)		60	
Plastic Film (CRH) (Note 1)	85	60	N/A
Glass or Porcelain (CYR)		50	
Tantalum (Solid Electrolyte) (CSR) > 1 ohm/volt effective circuit impedance (Note 2)	70	60	75
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 joultes.
2. For applications where the effective circuit resistance is less than one ohm per volt, contact the Parts Specialist.

Table 02. Derating Outline for Connectors

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

Table 04. Derating Outline for Fuses

Subminiature [1, 2, 3, 4]

Fuse Current Rating (Amperes)	Derate to the Following (%) of Rated Current	Remarks
15, 10, 7, 5 4, 3, 2½, 2	50%	
1½, 1	45%	
¾	40%	
1/2 *3/8* *1/4* *1/8*	*40%* *35%* *30%* *25%*	THE FLIGHT USE OF FUSES RATED ½ AMPERE AND LESS REQUIRES APPLICATION APPROVAL BY THE APPLICABLE GSFC PROJECT OFFICE.

NOTES:

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

Table 05.
Derating Outline for Inductors/Coils[1]

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:

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

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

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

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

Table 06.
Derating Outline for Relays[1]

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.

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

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, or less	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	
Film, High Stability, Style RNC	60% of Rated Power	
Film, Fixed, Networks, Style R20	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, Silicon
Rectifiers</td><td rowspan="2">75</td><td rowspan="3">60[1, 2, 3]</td></tr>
<tr><td>Diodes, Silicon
Small Signal Switching</td></tr>
<tr><td>Diodes, Silicon
Voltage Reference, Voltage Regulator, Current Regulator, Variable Capacitor</td><td></td></tr>
<tr><td>Diodes, Other</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:

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

$T_J(\text{max})$ = 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)

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

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

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

T_A = Ambient temperature.

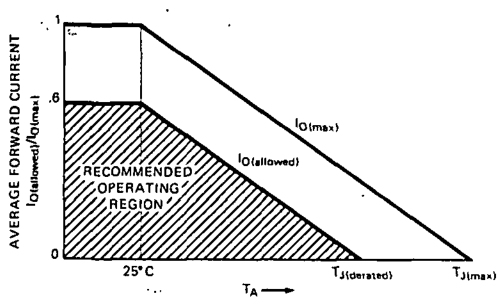

Figure 1. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated without heat sinks and a Derating Factor of 0.6.

Devices Operated With Heat Sink (Figure 2)

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

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

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

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});

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

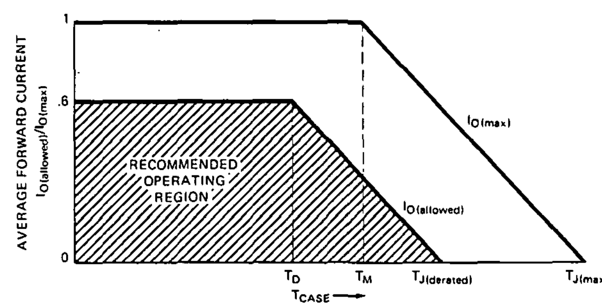

Figure 2. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated with heat sinks and a Derating Factor of 0.6.

NOTES:

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

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, MOSFET, N-Channel, P-Channel, Silicon General Purpose, Med. Power, High Power, High Speed Switching	75	75	60	60[1, 2, 3]
RF NPN, Other	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), $T_A \leq 25°C$

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

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

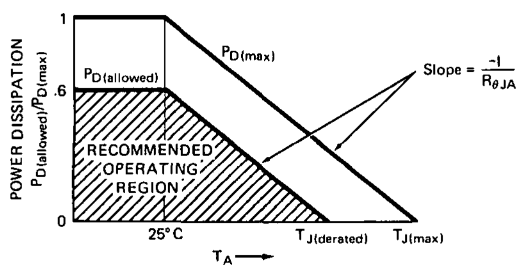

Figure 1. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated without heat sinks and a Derating Factor of 0.6.

Devices operated with heat sink (Figure 2)

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

$P_D(allowed) = \frac{T_J(derated) - T_{case}}{R_{\theta JC}}$, $T_{case} > T_D$

$T_D = T_J(derated) - R_{\theta J\text{-}C}$(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).

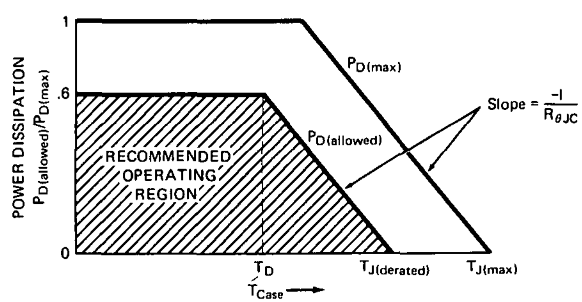

Figure 2. Derating curve from MIL-HDBK-217 modified to show operating region for devices operated with heat sinks and a Derating Factor of 0.6.

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

Table 10
Derating, Outline for Microcircuits[1]

Microcircuits Parameters	Digital		Interface					Linear				Processors, Peripherals and Memories			
	BIPOLAR	CMOS 4000 Series	A/D Converters	D/A Converters	Line Receivers	Line Drivers	Analog Switches	Opera'l. Anpl.	Voltage Compara tors	Voltage Req.	Analog Switches	CMOS	TTL	NMOS	I^2L
1. Supply Voltages	±5% of nominal	90% of rated	±5% of nominal	±5% of nominal	±5% of nominal	±5% of nominal	90% of rated	80% of rated	90% of rated		90% of rated	±5% of nominal	±5% of nominal	±5% of nominal	
2. Supply Current															±3% of nominal
3. Power Dissipation[1] (percent of rated power at case temperature)	80%	80%	80%	80%	80%	80%	80%	75%	75%	75%	75%	75%	75%	75%	75%
4. Frequency (percent of maximum rating)	90%	90%	90%	90%	90%	90%		90%			90%	90%	90%	90%	90%
5. Output Current (percent of rated current)	80%	80%			80%	80%	90%	80%	80%	80%	80%				
6. Input Voltage								70%		90%					

NOTES:
1. The maximum case temperature is 85°C for all microcircuits.

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	
R	R	85°C	50% of Maximum rated voltage.
S	S	105°C	

NOTES:

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

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

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. Deratings listed are for Teflon insulated wire (TYPE TFE) rated for 200°C. a.) For 150°C wire, use 80% of value shown in table. b.) For 135°C wire, use 70% of value shown in table. c.) For 105°C wire, use 50% of value shown in table.
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 Non-standard Parts

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

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

Other techniques, such as Destructive Physical Analysis (DPA), Residual Gas Analysis (RGA), Lot Acceptance Inspections, etc. should be applied where appropriate.

Table 01.
Screening Outline for Capacitors

Test Sequence / Category	1[2,3] Initial Examinations and Electrical Tests	2 Thermal Shock MIL-STD-202, Method 107	3[8] Seal Leak Tests MIL-STD-202, Method 112	4 Radiographic MIL-STD-202, Method 209	5 Conditioning	6[9] Final Examination	Reference Documents MIL-STD-202
(a) Air or Glass, Variable	Visual & C, Q, DWV IR, Driving Torque	Test Condition A, except step 3 shall be @ max. rated temperature	N/A	N/A	N/A	Repeat Initial Examination and Electrical Measurements	MIL-C-14409
(b) Ceramic	Visual & C, DF, DWV, IR			In accordance with MIL-C-39014. N/A to chip styles	2 x rated voltage @ max. rated temperature for 96 hours (Note 4)		MIL-C-20 MIL-C-39014 MIL-C-55681
(c) Glass & Porcelain		Test Condition B, except step 1 shall be @ - 55°C		N/A	2 × rated voltage @ 125°C for 96 hours		MIL-C-23269
(d) Mica		Test Condition A, except step 3 shall be @ max. rated temperature			2 x rated voltage @ max. rated temperature for 96 hours		MIL-C-39001
(e) Paper and/or plastic film			Test Condition D	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 @ 100°C.	Test Conditions C, D		1.4 x rated voltage @ 100°C for 96 hours		MIL-C-83421
(g) Tantalum Electrolytic, Wet Slug	Visual & C, DF DC Leakage	Test Condition A	Acid Indicator test per GSFC SP 01.23	N/A	Rated voltage @ 85°C for 168 hours		MIL-C-39006 GSFC SP 01.23
Foil			Test Conditions D		Rated voltage @ 85°C (Note 5)		
(h) Tantalum Electrolytic, Solid (1) Hermetically sealed			Test Condition D	In accordance with MIL-C-39003	Rated Voltage @ 85°C and Surge Current Test Per MIL-C-39003/6 (Note 6)		MIL-C-39003
(2) Non-hermetically sealed			N/A	N/A			GSFC S-311-P-17(01)
(i) High Voltage Ceramic (Note 7)	Visual & C, DF, IR, DWV, Corona	Test Condition A	N/A		Rated Voltage rated Temperature 100 hours		GSFC S-311-P-15(01)

NOTES:
1. Test procedures and requirements in accordance with those in the applicable Military or NASA referenced document. For additional information see the referenced document.
2. Legend: C = Capacitance, DF = Dissipation Factor, DWV = Dielectric Withstanding Voltage, IR = Insulation Resistance, Q = Quality Factor (initial electrical tests are optional).
3. Insulation resistance measurements are normally performed at +25°C, but the option is made to perform this measurement at maximum rated temperature as well.
4. Voltage conditioning shall be performed using procedures and requirements of MIL-C-39014 Rev. C or later.
5. Voltage conditioning shall be conducted for 168 hours for polarized styles. For non-polarized styles, voltage conditioning shall be conducted for 192 hours with the voltage polarity reversed after 96 hours.
6. Surge current testing shall be performed on CSR style capacitors for all Grade 1 applications. Where the effective series resistance is < one ohm/volt, consult Part Specialist.
7. Testing at high voltage (DWV, corona) shall be limited to the rated voltage.
8. Seal leak tests apply only to hermetically sealed, unsleeved styles; however, the acid indicator test is required on all tantalum wet slug styles.
9. Final IR measurements to be made at both +25°C and at max. rated temperature.

Table 03.
Screening Outline for EMI Suppression Filters[2]

Category \ Test Sequence	1	2	3	4	5	Reference Documents
	Initial Measurements and examination	Thermal Shock[3,4]	Seal Leak Test	Voltage Conditioning[5,6]	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 optional at max. rated 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, or max. rated temperature.	Fine and Gross Leak tests (applicable to hermetically sealed devices only).	As per MIL-STD-202, Method 108 at test temperature +125°C, or max. rated temperature, ±3°C. DC rated filter is 2X rated voltage for 164± 4 hours. AC rated filter is 1.2X rated voltage for 164± 4 hours.	Repeat initial examinations and measurements, except radiographic examinations. Final measurements to be made at both +25°C and at max. rated temperature.	MIL-STD-202

NOTES:
1. Performance of initial electrical tests is optional.
2. Consult the parts specialist for assistance in screening other types of filters.
3. Filters shall be mounted in a thru-hole and torqued in place on a rigid metal plate to the specified value. Not applicable to solder-in types.
4. At completion of or during the final cycle and before the filter is removed from the plate, measure and record insulation resistance at +125°C, or maximum rated temperature.
5. For voltage conditioning, use the test circuit described in MIL-F-28861, par. 4.6.2.2.2d.
6. After completion of voltage conditioning and while still at +125°C, or maximum rated temperature, the insulation resistance shall be measured per MIL-F-28861, par. 4.6.13.

Table 04.
Screening Outline for Subminiature Fuses[1, 3]

Test Sequence / Category	1	2	3	4	Reference Documents
	Initial Measurements[2]	Thermal Shock	Final Measurements	Acceptance Criteria	
Fuses, Subminiature 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).	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 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. Tests shall be designed to minimize the time in excess of 5 minutes that the fuses are subjected to full rated currents. These fuses should not be operated at rated currents for more than 30 minutes or parts may be degraded so that fuse life is reduced. MIL-F-23419 specifies minimum life at 110% of Rated Current to be 1.5 hours according to lot sampling tests. Rated current according to MIL-F-23419 is "the amount of current the fuse will carry indefinitely without interruption."
2. Initial electrical tests are optional.
3. For fuses rated 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

Category \ Test Sequence	1 Initial Measurements	2 Thermal Shock	3 Burn-In	4 Final Measurements and Delta Reject Criteria	Reference Document
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.	MIL-STD-981 Par. 30.1.2.2	Visual Inspection Repeat initial measurements. Reject $\Delta R > \pm 5\%$ $\Delta L > \pm 5\%$	MIL-C-39010 MIL-STD-981
Coils, Audio and Power	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.	MIL-STD-981 Par. 30.1.2.1.2	Visual Inspection. Repeat initial measurements. Reject: $\Delta R > \pm 5\%$ $\Delta L > \pm 5\%$	MIL-T-27 MIL-STD-981

Table 06.
General Screening Outline for Relays[1, 6]

Test Sequence	1	2	3	4	5	6	7	8	9	10
Category	Initial Visual Examination	Initial Seal Leak Tests	Initial Electrical Measurements[3]	Sinusodial Vibration[4]	High Temp Soak Test	Low Temp Miss Test	Room Temp Miss Test	Final Seal Leak Test	Final Electrical Measurements	Final Visual Examination
Relays - Latching and Non-Latching	a. External Visual b. Pre-Cap[2] Visual	MIL-STD-202 Method 112 Fine leaks Test Cond. C Gross leak Test Cond. D	Coil Resistance Pull In and Drop Out Voltage[5] Contact Resistance Contact Transfer Characteristics Insulation Resistance Dielectric Strength	10-2000 Hz 30 g peak	8 hrs. soak at 125°C	1000 operation miss test at -65°C	5000 operation miss test at 25°C	Repeat test sequence no. 2	Repeat test sequence no. 3	External Visual

NOTES:

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

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

Category \ Test Sequence	1	2	3	4	5	Reference Document
	Initial Measurements	Thermal Shock	Conditioning	Seal Leak Test[1]	Final Measurements and Delta Reject Criteria	
Resistors, Fixed, Carbon Comp.	Visual Inspection Resistance	—	—	—	—	MIL-R-39008
Resistors, Fixed, Film, General Purpose	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
Resistors, Fixed, Film, High Stability	Visual Inspection Resistance	MIL-STD-202 Method 107 Cond. F	Mil. equivalent styles: Style 50, 55, 60: 5 x rated power at room temperature for 1 hour. Style 65: 4 x rated power at room temperature for 1 hour. Style 70 and 75: 2.25 x rated power at room temperature for 1 hour. Style 90: 6.25 x rated power for 5 seconds at room temperature.	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
Resistors, Fixed, Wirewound, Power	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
Resistors, Fixed, Wirewound, Power,	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
Resistors, Fixed, Wirewound, Power, Chassis Mount	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

NOTES:

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

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

Category \ Test Sequence	1 Initial Measurements	2 Thermal Shock	3 Conditioning	4 Seal Leak Test[2]	5 Final Measurements and Delta Reject Criteria	Reference Document
Resistors, Variable, Wirewound, Low Power	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
Resistors, Variable, Non-Wirebound, Low Power	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'
Resistors, Fixed Networks	Visual Inspection Resistance	MIL-STD-202 Method 107 Cond. B	1.0 x rated power for 1.5 hours on, 0.5 hour off for 100 hours at 25°C.	MIL-STD-202 Method 112 Cond. C (For hermetically sealed units)	Visual Inspection, Resistance, Reject: $\Delta R > \pm 0.25\%$ (char. C) $\Delta R > \pm 0.50\%$ (char. H) $\Delta R > \pm 2.0\%$ (char. M)	MIL-R-83401

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 (Notes 2, 6)
a. Diodes, Small Signal, Silicon	MIL-STD-750 Method 2074. This test can only be performed by the manufacturer, when specified in procurement document.)	1. Visual Insp. per MIL-STD-750 Method 2071. 3X min 2. Electrical parameter measurements (Note 1.)	MIL-STD-750 Method 1032 Store for 48 hrs. (Note 2.)	MIL-STD-202 Method 107 Test Condition C, except 10 cycles; except the maximum temperature shall be 125°C (Note 3.)	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. (Note 4.)	MIL–STD–750 Method 1071.1. Fine Leak: Test Condition G or H. Gross Leak: Test Condition C. (Note 5.)	Read and record V_F and I_R.	
b. Diodes, Switching, Silicon									MIL–STD–750 Method 1038 Test Cond. A. 72 hrs
c. Diodes, Voltage Reference, Silicon								Read and record BV and Z.	Same as above except 96 hrs I_Z = rated value.
d. Diodes, Voltage Regulator, Silicon								Read and record BV, I_R and Z.	Same as above except 96 hrs I_Z = maximum rated value.
e. Diodes, Power Rectifier, Silicon, (Fast Recovery or Gen. Purpose)					Same as above except 5000G			Read and record V_f and I_R.	

NOTES:
1. Performance of electrical measurements at sequence 2 is optional. Measurements at high and low temperatures are also optional at this point, however, if performed here they need not be performed in sequence 13. For Grade 1 applications, high and low temperature measurements shall be made on all parts; whereas LTPD sampling is permissible for Grade 2 applications.
2. Tests shall be conducted at the maximum operating temperature. If parts have leads that are not gold-plated, they may be subject to tarnishing at temperatures greater than 125°C. Therefore, such parts must be tested in an inert atmosphere. After test, leads should be inspected for tarnishing, and refinished if necessary.
3. For axial lead glass body diodes, 10 cycles of thermal shock (glass strain) in accordance with MIL-STD-750, method 1056, test condition A, over the temperature range 0° to +100°C shall be substituted for this test.
4. Particle Impact Noise Detection (PIND) shall be performed only on parts with internal package cavities.
5. For Grade 2 applications, the seal leak tests may be performed at either test sequence 7 or 14. For Grade 1 applications, the tests must be performed in test sequence 14; in addition the test may be performed in test sequence 7, as well.
6. Reverse bias remains applied at the end of burn-in until T_A reaches 30°C.

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		MIL–STD–750 Method 1038 Test Condition B. 168 hours at specified v_r and I_o with f = 60 Hz. $T_A = 25°C$	Read and record V_F and I_R and calculate deltas.	1.) Measure 25°C electrical parameters except those measured in sequence 12. 2.) Electrical parameters at maximum operating temperature extremes. (Note 1)			
b. Diodes, Switching Silicon	Read and record V_F and I_R.						
c. Diodes, Voltage Reference, Silicon	Read and record BV and Z and calculate deltas.				MIL–STD–750 Method 1071.1. Fine Leak: Test Condition G or H. Gross Leak: Test Condition C. (Note 5)	MIL-STD-750 Method 2076 required for Grade 1, Optional for Grade 2.	MIL-STD-750 Method 2071; 3X min.
d. Diodes, Voltage Regulator, Silicon	Read and record BV, F_R and Z and calculate deltas.						
e. Diodes, Power Rectifiers, Silicon (Fast Recovery or General Purpose)		Same as (a.) above except (t_c = 100°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.	Read and record V_F and I_R and calculate deltas.				

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 (Notes 2, 6)
f. Diodes, Voltage-Variable Capacitor, Silicon					MIL–STD–750 Method 2006 except test shall be 20,000g in Y_1 orientation only, one time only.			Read and record I_R	MIL–STD–750 Method 1038 Test Cond. A. 72 hrs
g. Thyristors, (Silicon Controlled Rectifiers)	MIL-STD-750 Method 2074. This test can only be performed by manufacturer when specified in procurement document.	1.) Visual Insp. per MIL-STD-750 Method 2071. 3X min. 2.) Electrical parameter measurements (Note 1)	MIL-STD-750 Method 1032 Store for 48 hrs. (Note 2)	MIL-STD-202 Method 107 Test Condition C, except 10 cycles, except the maximum temperature shall be 125°C. (Note 3)		MIL–STD–750 Method 2052 Only for Grade 1 screening (Note 4)	MIL–STD–750, Method 1071.1. Fine Leak: Test Condition G or H. Gross Leak: Test Condition C. (Note 5)	Read and record 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.
h. Diodes, Current Regulator, Silicon								Read and record I_P	
i. Diodes, Switching, Schottky Barrier, Silicon								Read and record I_R and VB	
j. Diodes, Switching, PIN								Read and record I_R and VB.	
k. Diodes, Light Emitting					Same as above except acceleration in Z_1 direction.		MIL–STD–750 Method 1071 Fine Leak: Test Condition H. Gross Leak: Test Condition E. (Note 5)	Read and record V_F and P_O.	

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

Test Sequence / Part Category	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
f. Diodes, Voltage-Variable Capacitor, Silicon	Read and record I_R and calculate delta.						
g. Thyristors, (Silicon Controlled Rectifiers)	Read and record I_{RBXM}, I_{FBXM}, V_{GT} and IGT and calculate deltas.						
h. Diodes, Current Regulator, Silicon		MIL–STD–750 Method 1038 168 hours at T_A = 25°C and P_{OV} (Peak Operating Voltage) = maximum rated value.	Read and record I_p and calculate delta.	1.) Measure 25°C electrical parameters except those measured in sequence 12. 2.) Electrical parameters at maximum operating temperature extremes. (Note 1)	MIL-STD-750, Method 1071.1 Fine Leak: Test Condition G or H. Gross Leak: Test Condition C. (Note 5)	MIL-STD-750 Method 2076 required for Grade 1 screening Optional for Grade 2	MIL-STD-750 Method 2071 3X min.
i. Diodes, Switching, Schottky Barrier, Silicon		Same as above except Test Condition B. 168 hours at T_A = 25°C at specified V_r and I_o with f = 60 Hz.	Read and record VB and I_R and calculate deltas.				
j. Diodes Switching, PIN			Read and record V_F and I_R and calculate deltas.				
k. Diode, Light Emitting		Same as above except 168 hours at: T_A (or T_C) = 25°C I_F = 80% of maximum rated continuous forward current.	Read and record V_F and P_o and calculate deltas.		MIL–STD–750 Method 1071 Fine Leak: Test Condition H. Gross Leak: Test Condition E (Note 5)		

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

Test Sequence / Part Category	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
a. Transistors, Silicon, NPN, Low, Medium Power, Switching or General Purpose	MIL-STD-750 Method 2072. (This test can only be performed by the manufacturer, when specified in procurement document.)	1. Visual Inspection per MIL-STD-750, Method 2071. 3X min. 2. Electrical parameter measurements (Note 1)	MIL-STD-750 Method 1032 Store for 48 hours (Note 2)	MIL-STD-202 Method 107 Test Condition C, except 10 cycles, except the maximum temperature shall be 125°C	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 2052 Only for Grade 1 screening (Note 3)	MIL–STD–750 Method 1071, Fine Leak. Test Condition G or H. Gross Leak: Test Condition C. Only for Grade 2 screening (Note 4)
b. Transistors, Silicon, PNP, Low, Medium Power, Switching or General Purpose							
c. Transistors, Silicon, PNP, High Power					Same as above except 5,000 g.		Same as above except fine leak rejection value of 5 x 10^{-7} atm cc/sec. Only for Grade 2 screening
d. Transistors, Silicon, NPN, High Power							
e. Transistors, Field-Effect, Junction, N-Channel, Silicon					Same as above except 20,000 g.		MIL–STD–750 Method 1071.1 Fine Leak: Test Condition G or H Gross Leak: Test Condition C. Only for Grade 2 screening
f. Transistors, Field-Effect, Junction, P-Channel, Silicon							

NOTES:
1. Performance of electrical measurements at sequence 2 is optional. Measurements at high and low temperatures are also optional at this point; however, if performed here they need not be performed at sequence 12. For Grade 1 applications, high and low temperature measurements shall be made on all parts; whereas, LPTD sampling is permissible for Grade 2 applications.
2. Tests shall be conducted at the maximum operating temperature. If parts have leads that are not gold-plated they may be subject to tarnishing at temperature greater than 125°C. Therefore, such parts must be tested in an inert atmosphere. After test, leads should be inspected for tarnishing, and refinished if necessary.
3. Particle Impact Noise Detection (PIND) shall be performed only on parts with internal package cavities.
4. For Grade 2 applications, the seal leak tests may be performed at either test sequence 7 or 14. For Grade 1 applications, the tests must be performed in test sequence 14; in addition, the test may be performed in test sequence 7.
5. Reverse bias remains applied at the end of burn-in until T_A reaches 30°C in test sequence 8.

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

Test Sequence / Part Category	8 Reverse Bias Burn-in (Notes 2, 5)	9 Pre-Burn-In Electrical Measurements	10 Burn-in (Notes 2, 5)	11 Post Burn-In Tests Measurements	12 Final Electrical Parameter Measurements	13 Seal Leak Tests (Note 4)	14 Radiography	15 External Visual Examination
a. Transistors, Silicon, NPN, Low, Medium Power, Switching or General Purpose	MIL-STD-750 Method 1039 48 Hours at: V_{CB} = 80% of V_{CBO} $I_E = 0$	Read and record I_{CBO} (or I_{CES} and h_{FE}.	MIL-STD-750 Method 1039 168 hrs at specified V_{CB} (or V_{CE}) and P_T (max rated power dissipation at T_A).	Read and record I_{CBO} and h_{FE} and calculate deltas.	1.) Measure 25°C electrical parameters except those measured in sequence 11. 2.) Electrical parameters at maximum operating temperature extremes. (Note 1)	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 Optional for Grade 2, Required for Grade 1	MIL—STD—750 Method 2072 3X min.
b. Transistors, Silicon, PNP, Low, Medium Power, Switching or General Purpose Purpose								
c. Transistors, Silicon, PNP, High Power			Same as above except P_T at case temperature specified.			Same as above except fine leak rejection value 5 x 10^{-7} atm cc/sec. Only for Grade 1 screening		
d. Transistors, Silicon, NPN, High Power								
e. Transistors, Field-Effect, Junction, N-Channel, Silicon		Read and record I_{GSS}, I_{DSS} and $\|Y_{fs}\|$.	Same as above except at specified V_{GS} and V_{DS}.	Read and record I_{GSS}, I_{DSS} and $\|Y_{fs}\|$ and calculate deltas.		Same as above except Fine Leak: Test Condition G or H Gross Leak: Test Condition C.		
f. Transistors, Field-Effect, Junction, P-Channel, Silicon								

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

Test Sequence / Part Category	1 Internal Visual (Precap) Inspection	2 Initial Inspection & Electrical Parameter Measurements	3 High Temperature Storage (Note 2)	4 Thermal Shock (Temperature Cycling)	5 Acceleration	6 PIND[2]	7 Seal Leak Tests (Note 4)
g. Transistors, Silicon, Unijunction							
h. Transistors, Silicon, Chopper	MIL-STD-750 Method 2072. This test can only be performed by the manufacturer, when specified in procurement document.)	1. Visual Inspection per MIL-STD-750 Method 2071. 3X min. 2. Electrical parameter measurements (Note 1)	MIL-STD-750 Method 1032 Store for 48 hours. (Note 2)	MIL-STD-202 Method 107 details.) Test Conditions C, except 10 cycles, except the maximum temperature shall be 125°C.	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 2052 Only for Grade 1 screening (Note 3)	MIL–STD–750 Method 1071.1. Fine Leak: Test Condition G or H Gross Leak: Test Condition C. Only for Grade 2 screening.
i. Phototransistor							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

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

Test Sequence / Part Category	8	9	10	11	12	13	14	15
	Reverse Bias Burn-in (Notes 2, 5)	Pre Burn-In Electrical Measurements	Burn-in (Note 2)	Post-Burn-In Electrical Measurements	Final Electrical Parameter Measurements	Seal Leak Tests (Note 4)	Radiography	External Visual Examination
g. Transistors, Silicon, Unijunction		Read and record I_{EB20}, R_{BBO} and η.	MIL-STD-750 Method 1039 168 hrs at specified V_{B2B1} and I_{E1}. (Maximum rated power.)	Read and record IEB20 R_{BBO} and n and calculate deltas.	1.) Measure 25°C electrical parameters except those measured in sequence 11. 2.) Electrical parameters of maximum operating temperature extremes. (Note 1)			
h. Transistors, Silicon, Chopper	MIL-STD-750 Method 1039 48 Hours at: V_{CB} = 80% of V_{CBO} I_F = 0	Read and record I_{CBO} and h_{FE} (inverted).	Same as above except at specified V_{CB} (or V_{CE}) and P_T. (Max rated power dissipation at T_A).	Read and record I_{CBO} and h_{FE} (inverted) and calculate deltas.		MIL–STD–750 Method 1071.1. Fine Leak: Test Condition G or H. Gross Leak: Test Condition C.	MIL-STD-750 Method 2026 Required for Grade 1 Optional for Grade2	MIL-STD-750 Method 2072 3X min.
i. Phototransistor	Same as above except 48 hrs at: V_{CE} = 80% of V_{CEO} E_e (Incident Radiant Energy = 0)	Rad and record I_D and I_L.	Same as above except at specified V_{CE}. Adjust E_e (incident radiant energy) for P_T = 80% of maximum continuous device dissipation	Read and record I_D and I_L and calculate deltas.		MIL–STD–750 Method 1071 Fine Leak: Test Condition H. Gross Leak: Test Condition C.		
j. Optically Coupled Isolator	Same as above except Test Condition A. V_{CE} = 80% of V_{CEO}	Read and record Phototransistor I_C (OFF) I_C (ON) h_{FE} LED I_R	Same as above except at max. rated V_{CE}. P_T = 80% of maximum continous device dissipation	Read VI_C (OFF), I_C(ON), h_{FE}, and I_R and record and calculate deltas.		MIL–STD–750 Method 1071.1 Fine Leak: Test Condition G or H. Gross Leak: Test Condition C.		

Table 10.
Screening Outline For Microcircuits

Screening Sequence / Grade	1	2	3[2]	4	5[3]	6	7[4]	8[5]
	Internal Visual (Precap) Can only be performed by mfr. Specify requirement	Initial Electrical Measurements	Stabilization Bake	Temperature Cycling	Constant Acceleration	Particle Impact Noise Detection (PIND)	Seal	Interim Electrical Parameter Measurements
1	MIL-STD-883 Method 2010 Condition A	(Note 1)	MIL-STD-883 Method 1008 condition C	MIL-STD-883 Method 1010 condition C, except the maximum temperature shall be 125°C.	MIL-STD-883 Method 2001 condition E. *Y Orientation only.*	MIL-STD-883 Method 2020 Condition A. Lot acceptance per method 2020	MIL-STD-883 Method 1014 Fine Leak: cond. A or B. *Gross Leak:* Cond. C.	Measure +25°C DC & AC parameters and record parameters *requiring delta* calculations
2	Same as Grade 1 except condition B	Same as Grade 1	Same as Grade 1	Same as Grade 1	Same as Grade 1	Same as Grade 1	Same as Grade 1	Same as Grade 1

Screening Sequence / Grade	9[7]	10	11[6, 7]	12[5, 8]	13[4]	14
	Burn-In	Interim Electrical Parameter Measurements	Reverse Bias Burn-In	Final Electrical Measurements	Radiographic	External Visual
1	MIL-STD-883 *Method 1015* 240hrs @ 125°C (Dynamic) Specify test cond. and burn-in circuitry	*Remeasure parameters* specified in step 8. Calculate delta and percent defective.	MIL-STD 883 Method 1015 Condition A	Measure DC, AC and *delta parameters @* 25°C. Measure DC parameters @ min. and max. operating temperatures.	MIL-STD-883 Method 2012	MIL-STD-883 Method 2009
2	Same as Grade 1 except 160 hrs.	CMOS only	Same as Grade 1	Same as Grade 1	Not required	Same as Grade 1

NOTES:
1. Performance of electrical measurements at this point is optional. However, if high and low measurements are performed here, they need not be repeated in sequence 12. High and low temperature DC parameter measurements shall be made on all parts. AC parameter measurements are only required at +25°C.
2. If parts have leads that are not gold-plated, they may be subject to tarnishing at temperatures greater than 125°C. Therefore, such parts must be tested in an inert atmosphere. After test, leads should be inspected for tarnishing, and refinished if necessary.
3. For 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 grade 1 & grade 2 screening shall include those parameters and deltas (including measurements for each test condition for each parameter) specified in the MIL-M-38510 slash sheet for the selected part. If no slash sheet is available for the selected part, model the parameter and delta requirements from a slash sheet for a similar part type. If no slash sheet is available for selected or similar part types, consult the Parts Specialist for recommendations.
6. Screening sequence 11 not required except for CMOS parts. Also, for CMOS parts, a Static I and Static II burn-in is required per MIL-M-38510 for class S devices.
7. The order of the burn-ins for steps 9 and 11 is optional.
8. Min. and Max. operating temperature parameter measurements are optional here if performed in sequence 2.

Table 14.
Screening Outline for Thermistors

Category \ Test Sequence	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		

Table 15.
Screening Outline for Transformers[1]

Category \ Test Sequence	1 Initial Measurements	2 Thermal Shock	3 Burn-In	4 Seal Leak Test	5 Final Measurements and Delta Reject Criteria	Reference Documents
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.	MIL-STD-981 Par. 30.1.2.1.	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; $\Delta L > \pm 5\%$ $\Delta DCR > \pm 5\%$	MIL-T-27 MIL-STD-202 MIL-STD-981
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. Reject; $\Delta DCR > \pm 5\%$	MIL-T-21038

APPENDIX D
Radiation Effects

The charged particles in the natural space environment pose a radiation risk to some electronic parts, because when these particles pass through them, they can significantly degrade their performance. Ground radiation tests on different electronic part types have indicated that while parts like resistors and capacitors show no noticeable degradation, many microcircuits are very sensitive to ionizing radiation. In comparison with microcircuits, most discrete semiconductor devices — with some exceptions such as microwave and MOS transistors — show much less degradation. However, some transistors, particularly small signal types, are very susceptible to radiation induced failures when operated at low collector currents. Further, the radiation environment seen by a device differs from one application to another depending upon the orbit parameters and upon location within the spacecraft, i.e., the equivalent shielding between it and the outside environment. Therefore, while selecting electronic parts, it is necessary not only to consider the device hardness, but also the application and the projected radiation environment for the application.

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

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

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

Table 1. Comparison of Radiation Susceptibility for Microcircuits of Different Technologies.[1]

Technology	Total Dose[2] Hardness Level Rads (Si)	Relative Susceptibility[3] To: Soft Error	Latch-Up
DIGITAL			
NMOS	$5x10^2 - 10^4$	High	Immune
CMOS/Bulk (unhardened)	$10^3 - 10^5$	Moderate to high	Moderate
CMOS/Bulk (hardened)	$2x10^3 - 10^6$	Low	Low
CMOS/SOS	$10^3 - 10^5$	Very low	Immune
TTL, Low Power TTL	$10^5 - 10^7$	Low to High	Low
Schottky TTL, Low Power Schottky TTL	$10^5 - 10^7$	Low to High	None to Low
Advanced Low Power Schottky TTL	$2x10^4 - 10^6$	— No Data Available —	
I^2L	$2x10^4 - 10^6$	Moderate	None too Low
ECL	$\geq 5x10^6$	Low	None to Low
LINEAR			
CMOS	$10^3 - 2x10^7$	— No Data Available —	
Bipolar, BI-FeT	$6x10^3 - 10^7$	— No Data Available —	

NOTES:

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

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

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

Table 1 provides only a qualitative guideline of radiation sensitivity of microcircuits and is derived from published radiation test data.[1, 2] This often may not be sufficient as the rapid changes which have been occuring in microcircuit technology have been accompanied by changes in the radiation hardness of the parts. In general, lot sample testing may be necessary to determine the hardness levels of a procured lot of devices prior to their usage in a particular application. However, it may be noted that a number of vendors are making efforts to qualify their parts to four standard radiation levels: namely 2.5 K, 10 K, 100 K and 1 M rads. The parts qualified to these levels are identified in MIL-specifications by the symbols, M, D, R and H respectively, inserted in place of the slash mark in part markings. For more information and guidelines, consult the radiation effects specialists listed in this PPL.

BIBLIOGRAPHY

1. "Microcircuit Radiation Data Bank", NTIS, Access # N83-27903.

2. Proceedings of IEEE Annual Conference on Nuclear and Space Radiation Effects, from 1977 through 1983, published in the December issue of IEEE Transaction on Nuclear Science, vol. 24 through Vol. 30.

APPENDIX E

SCREENING VERIFICATION

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

	MIL-S-19500 Requirement Paragraph	MIL-STD-750 Test Method
1. External Visual		2071
2. PIND	4.6.4.2	2052 (Condition A or B)
3. Fine Leak	---	1071 Test Condition G, H
4. Gross Leak	---	1071 Test Condition, A, C, E, F
5. Initial Electrical	---	as specified (25 °C only)
6. Power Burn-In or Burn-In per slash sheet	---	1039 (Transistors) 1038 (Diodes)
7. Post Burn-In Electrical	---	as specified (25 °C only)
8. Delta Calculation	---	as specified
9. PDA	4.6.1	------