INCH-POUND

MIL-P-29590
29 November 1991

MILITARY SPECIFICATION

POWER SUPPLIES, AIRBORNE, ELECTRONIC

GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers the general requirements for families of standard electronic power supplies for use in military aircraft systems including combat and other mission critical applications. These power supplies are coordinated under the Standard Hardware Acquisition and Reliability Program (SHARP).

1.2 Classification. Electronic power supplies whose initial application is for airborne use are classified as one of the following families.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, Systems Engineering and Standardization Department (SESD), Code 53, Lakehurst, NJ 08733-5100 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6130

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.2.1 Family A1. These units are forced air cooled Weapon Replaceable Assemblies (WRA) with an envelope in accordance with MIL-E-85726.

1.2.2 Family A2. These units are Shop Replaceable Assemblies (SRA) in the form of modules in format B, Span 2; format C; or format E.

Classes

Class II - For primary utilization in airborne applications and where stringent environmental requirements are imposed. Power supply interface temperature, rib surfaces, at minus 55 degrees Celsius (°C) low and 85°C high.

Class IV - For utilization where class II power supplies may be exposed to nuclear radiation. Power supply interface temperature, rib surfaces, at minus 55°C low and 85°C high.

Formats

Format B - Span 2 - The basic size (span 2) has a span of 5.74 inches (145.8 millimeters (mm)), a thickness of 0.290 inches (7.366 mm), and a total height of 1.95 inches (49.5 mm), including keying pins. The size may increase in thickness within the constraints of MIL-STD-1389. See appendix B of MIL-STD-1389.

Format C - The basic size has a span of 5.88 inches (149.4 mm), a thickness of 0.280 inches (7.112 mm), and a total height of 4.06 inches (103.1 mm), including keying pins. The size may increase in thickness within the constraints of MIL-STD-1389. See appendix C of MIL-STD-1389.

Format E - The basic size has a span of 5.88 inches (149.4 mm), a thickness of 0.380 inches (9.652 mm), and a total height of 6.68 inches (169.7 mm), including keying pins. The size may increase in thickness within the constraints of MIL-STD-1389. See appendix E of MIL-STD-1389.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

QQ-N-290	-	Nickel Plating (Electrodeposited).
PPP-B-00636	-	Boxes, Shipping, Fiberboard.
ZZ-R-765	-	Rubber, Silicone (General Specification).

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MIL-T-27	-	Transformers and Inductors (Audio, Power, and High-Power Pulse), General Specification for.
MIL-P-116	-	Preservation, Methods of.
MIL-B-117	-	Bags, Sleeves and Tubing.
MIL-E-5400	-	Electronic Equipment, Aerospace, General Specification for.
MIL-C-5541	-	Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-M-7793	-	Meter, Time Totalizing.
MIL-A-8625	-	Anodic Coatings, For Aluminum and Aluminum Alloys.

MIL-W-8939	-	Welding, Resistance, Electronic Circuit Modules.
MIL-Q-9858	-	Quality Program Requirements.
MIL-S-19500	-	Semiconductor Devices, General Specification for.
MIL-C-28754	-	Connectors, Electrical, Modular, and Component Parts, General Specification for.
MIL-M-28787	-	Modules, Standard Electronic, General Specification for.
MIL-C-28809	-	Circuit Card Assemblies, Rigid, Flexible, and Rigid-Flex.
MIL-A-28870	-	Assemblies, Electrical Backplane, Printed-Wiring, General Specification for.
MIL-M-38510	-	Microcircuits, General Specification for.
MIL-H-38534	-	Hybrid Microcircuits, General Specification for.
MIL-C-38999	-	Connector, Electrical Circular, Miniature, High Density Quick Disconnect (Bayonet, Threaded and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.
MIL-C-39003	-	Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification for.
MIL-C-39006/22	-	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum, (Polarized, Sintered Slug), 85°C (Voltage Derated to 125°C), Established Reliability, Style CLR79.
MIL-R-39008	-	Resistors, Fixed, Composition (Insulated), Established Reliability, General Specification for.
MIL-C-39018/9	-	Capacitors, Fixed, Electrolytic (Aluminum Oxide), (Polarized), Established Reliability, Style CUR02 (Insulated).

MIL-G-45204	-	Gold Plating, Electrodeposited.
MIL-I-46058	-	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies).
MIL-P-50884	-	Printed Wiring, Flexible and Rigid-Flex.
MIL-P-55110	-	Printed Wiring Board, General Specification for.
MIL-C-83527	-	Connectors, Plug and Receptacle, Electrical, Rectangular Multiple Insert Type, Rack to Panel, Environment Resisting, 150°C Total Continuous Operating Temperature.
MIL-E-85726	-	Enclosure, Standard Avionics, Forced Air Cooled, General Specification for.

STANDARDS

FEDERAL

FED-STD-595	-	Colors Used in Government Procurement.

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MIL-STD-12	-	Abbreviations for Use on Drawings, and in Specifications, Standards and Technical Documents.
MIL-STD-129	-	Marking for Shipment and Storage.
MIL-STD-130	-	Identification Marking of U.S. Military Property.
MIL-STD-202	-	Test Methods for Electronic and Electrical Component Parts.
MIL-STD-275	-	Printed Wiring for Electronic Equipment.
MIL-STD-454	-	Standard General Requirements for Electronic Equipment.

MIL-STD-461	-	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462	-	Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-481	-	Configuration Control-Engineering Changes (Short Form), Deviations and Waivers.
MIL-STD-701	-	Lists of Standard Semiconductor Devices.
MIL-STD-704	-	Aircraft Electric Power Characteristics.
MIL-STD-756	-	Reliability Modeling and Prediction.
MIL-STD-810	-	Environmental Test Methods and Engineering Guidelines.
MIL-STD-883	-	Test Methods and Procedures for Microelectronics.
MIL-STD-889	-	Dissimilar Metals.
MIL-STD-961	-	Military Specifications and Associated Documents, Preparation of.
MIL-STD-1285	-	Marking of Electrical and Electronic Parts.
MIL-STD-1389	-	Design Requirements for Standard Electronic Modules.
MIL-STD-1472	-	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities.
MIL-STD-1562	-	Lists of Standard Microcircuits.
MIL-STD-1665	-	Test Equipment for the Standard Electronic Modules Program.
MIL-STD-1686	-	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric).

MIL-STD-1772 - Certification Requirements for Hybrid Microcircuit Facilities and Lines.

DOD-STD-1788 - Avionics Interface Design Standard.

MIL-STD-2000 - Standard Requirements for Soldered Electrical and Electronic Assemblies.

MIL-STD-2038 - Requirements for Employing Standard Power Supplies.

MIL-STD-2073-1 - DOD Materiel Procedures for Development and Application of Packaging Requirements.

MIL-STD-2164 - Environmental Stress Screening Process for Electronic Equipment.

MIL-STD-45662 - Calibration Systems Requirements.

HANDBOOKS

FEDERAL

HANDBOOK H4-2 - Federal Supply Code for Manufacturers (United States and Canada) Code to name.

HANDBOOK H6 - Federal Item Name Directory for Supply Cataloging.

MILITARY

MIL-HDBK-217 - Reliability Prediction of Electronic Equipment.

DOD-HDBK-263 - Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric).

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

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

S1.4	Sound Level Meters, Specification for.
S1.11	Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, New York 10018-3308.)

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

3. REQUIREMENTS

3.1 General.

3.1.1 Associated detail specifications. The individual power supply requirements shall be as specified herein and in accordance with the associated detail specification. In the event of any conflict between the requirements of this specification and the associated detail specification, the latter shall govern.

3.1.1.1 Specification format. Associated detail specifications for both family A1 and family A2 shall be slash sheets to this specification and shall be written in accordance with MIL-STD-2038.

3.1.2 Definitions. The definition of terms used in this specification shall be in accordance with 6.5 of this document and definitions in MIL-STD-2038.

3.2 Qualification. Power supplies furnished under this specification shall be products which are authorized by the airborne power supply products quality assurance activity (APSP-QAA) for listing on the applicable qualified products list at the time of delivery (see 4.4 and 6.4).

3.3 Electrical performance requirements. Power supplies shall be in accordance with the electrical requirements herein and in the associated detail specifications.

3.3.1 Input power.

3.3.1.1 Normal operation. Power supplies shall operate and maintain specified performance when the input power has the characteristics for normal operation as specified in MIL-STD-704.

3.3.1.2 Emergency operation. Power supplies shall operate and maintain specified performance during emergency operation when the input power has the characteristics specified in MIL-STD-704.

3.3.1.3 Transient operation. Power supplies shall operate and maintain specified performance when the input power has the characteristics specified in MIL-STD-704 (see 3.3.2.21, 4.7.2.9.1, 4.7.2.9.2, 4.7.2.9.3 and 4.7.2.9.4).

3.3.1.4 Abnormal operation. Power supplies shall be permitted degraded performance or loss of function when the input power characteristics are outside the normal operation limits but within the abnormal operation limits of MIL-STD-704. Power supplies shall not produce a damaging or unsafe condition during abnormal operation. Power supplies shall automatically recover full specified performance within 250 msec after the input power characteristics are restored to the normal operation limits.

3.3.1.5 Auxiliary DC input. Power supplies shall operate and maintain specified performance when operating from DC power applied to the auxiliary input terminals which are separate from the AC input terminals. The nominal DC input voltage amplitude and characteristics are specified in the associated detail specification. Intended uses of the auxiliary DC input include back-up power, uninterrupted power and extension of the power supply hold-up capability.

3.3.1.6 Alternate input sources. When specified in the associated detail specification, power supplies shall operate from alternate input sources to allow for multiple platform or subsystem applications. Requirements for alternate input sources shall be in accordance with the associated detail specification.

3.3.1.7 Input protection. Power supplies shall not be damaged by polarity reversal, momentary interruptions (up to 30 seconds), loss of a single phase (with 3-phase input), low input line voltage, or a short circuit on the input power lines. The maximum input current drawn under any steady state input voltage conditions less than the maximum specified input voltage shall be no greater than 1.8 times the steady state Root Mean Square (RMS) or DC current at maximum rated load and nominal input voltage. The applicable turn-on current paragraph (see 3.3.1.11.1 or 3.3.1.11.2) shall apply for the maximum input current drawn during any transient input condition. The power supply output shall not exceed the overvoltage requirements specified in 3.3.2.15 during the transient or overvoltage input power conditions. Upon restoration of normal input power, the power supplies shall recover automatically and perform as specified herein. A power supply failure shall not cause damage to the input power lines.

3.3.1.8 Turn-on threshold. Power supply turn-on threshold is defined as the input voltage where the output voltage rises to a level greater than or equal to 95 percent of the nominal level, at maximum load. The AC input voltage threshold for power supply turn-on shall be between 90 and 104 VAC RMS line-to-neutral. The threshold for an alternate DC input (see 3.3.1.6) shall be specified in the associated detail specification.

3.3.1.8.1 Turn-on threshold for a DC or alternate input voltage. The threshold for a DC or alternate input voltage shall be as specified in the associated detail specification.

3.3.1.9 Turn-on to turn-off hysteresis. Power supply turn-off is defined as the input voltage where the output voltage drops to a level less than 95 percent of the nominal level, at maximum load. The power supply turn-off line-to-neutral voltage shall be a minimum of 15 VAC RMS below the input voltage threshold at which the power supply turned on (see 3.3.1.8). However, to allow for the coincidence of transient low line, maximum line distortion and maximum phase unbalance conditions, the turn-off voltage shall be less than 75 VAC RMS line-to-neutral. The power supply outputs are not required to meet the static output regulation requirements (see 3.3.2.5) for input voltages less than 80 VAC RMS line-to-neutral regardless of the turn-off threshold.

3.3.1.9.1 Turn-on to turn-off hysteresis for a DC or alternate input voltage. Turn-on to turn-off hysteresis for a DC or alternate input voltage shall be as specified in the associated detail specification.

3.3.1.10 Input current balance. The RMS value of the input currents on the 3-phase input lines shall be within 5 percent of each other when the source voltage is balanced within 1 percent between input lines.

3.3.1.11 Turn-on current. The following requirements apply to all AC, DC, and alternate inputs to the power supply.

3.3.1.11.1 Step input. The peak inrush current during the entire turn-on cycle resulting from a step input voltage shall be limited to 10 times the input steady state true RMS or DC current at maximum rated load and nominal input voltage. The rate of change of the step input voltage shall be greater than or equal to one volt per microsecond (see 4.7.2.1).

3.3.1.11.2 Slowly rising input. For slowly rising input voltage with a rate of change less than 1 volt per millisecond or for remote turn-on (see 3.3.3.1), the rate of rise of input current shall be not greater than 10 amperes (A) per millisecond per kilowatt of nominal input power. This specified rate of rise of input current is related to the maximum value of external input inductance specified in the associated detail specification. The peak input current during the entire turn-on cycle shall be limited to 2.5 times the input steady state true RMS or DC current at maximum rated load and nominal input voltage.

3.3.1.12 Harmonic current limitation. Each power supply shall minimize harmonic distortion effects on the electrical system. Power supplies shall limit the harmonic content of the input current so that no individual harmonic line current from the second harmonic through 20 kilohertz (kHz) exceeds a magnitude of 100/n percent of the unit's full load fundamental current, where n is the harmonic multiple number. Harmonic line current requirements apply when power supplies are operating in the mode that generates the highest input current harmonics (see 4.7.2.2).

3.3.1.13 Power factor. The power factor shall be between 0.8 and unity (see 4.7.2.3).

3.3.1.14 Electrical bonding. Power supplies shall have a minimum of one zero-volt reference connector pin connected directly to external parts of the power supply (except other connector pins or parts requiring electrical isolation). DC resistance between the connector pin and any part of the chassis shall be 0.1 ohm maximum. The connector pin shall have a current rating equal to or greater than the input power pins. Non-conductive protective finishes shall be omitted (or removed) from bonding surfaces. The design shall assure permanence of low impedance bonds in the presence of humid and saline atmospheres over the power supply life.

3.3.1.15 External input filter. When specified in the associated detail specification, an external input filter is required to enable the power supplies to meet conducted emissions in accordance with MIL-STD-461, requirement CE03. The input impedance limit (see 3.10.9) of the power supply shall be as specified in the associated detail specification so the input filter can be designed by the user to operate together with the power supply.

3.3.1.16 Isolation resistance. Input power connections and chassis ground shall be isolated by not less than 10 megohms resistance at 600 VDC. Input power connections and DC output voltage and return shall be isolated by not less than 10 megohms resistance at 600 VDC.

3.3.1.17 Input capacitive loading. The capacitive loading on each input power line to chassis ground shall be not greater than 0.02 microfarad (uf).

3.3.2 Output power.

3.3.2.1 Output voltage and current. Power supplies shall deliver the DC voltages and rated currents in accordance with the associated detail specifications. Where more than one output voltage may be selected, the output voltage shall be determined by the wiring interconnection of the system. Unless otherwise specified in the associated detail specification, any output adjustment devices (other than pin programming) shall be internal to the power supply (see 3.10.6) and shall be designated as factory, depot or shop adjust only. If the adjustment entails a moving part (for example, potentiometer), the part shall be secured after adjustment to prevent movement during vibration and shock.

3.3.2.2 Output load characteristics. Power supplies shall provide the output voltage and currents specified in the associated detail specification for load conditions which include resistive, capacitive (up to 30 uf per rated output ampere), and constant current loads. The requirements shall be met for input line variations within the specified limits, through all environmental extremes specified, and for any combination of these conditions. The threshold voltage at which a constant current load shall be assumed to operate at full rated load shall be less than or equal to 2.0 VDC. Additional capacitive loading for parallel output shall be in accordance with 3.3.2.20.

3.3.2.3 Total ripple and noise. Unless otherwise specified in the associated detail specification, total peak-to-peak ripple and noise in the 10 Hz to 5 megahertz (MHz) bandwidth (see 4.7.2.4) including spikes, hash, periodic and aperiodic components, shall not exceed 1.3 percent of the nominal output voltages of each power supply or 130 millivolts (mV), whichever is greater, while operating over the range of 10 to 100 percent of full rated load current and over the specified input voltage range. In addition, the ripple and noise in a 10 Hz to 5 MHz bandwidth shall not exceed 2 percent of the nominal output voltages of each power supply or 200 mV, whichever is greater, when operated at loads in excess of 100 percent which do not result in more than a 5 percent decrease in output voltage or at loads below the specified minimum (see 4.7.2.4). The peak-to-peak ripple and noise in a 10 Hz to 20 MHz bandwidth shall not exceed 6 percent of the nominal output voltages of each power supply.

3.3.2.3.1 Low frequency ripple and noise. The peak-to-peak ripple and noise in a 10 Hz to 10 kHz bandwidth impressed upon the output voltage shall not exceed 0.5 percent of the nominal output voltage or 50 mV, whichever is greater. This requirement shall be met at full rated load current and over the specified input voltage range (see 4.7.2.4.1).

3.3.2.3.2 High frequency ripple and noise. The peak-to-peak ripple and noise in a bandwidth from 10 kHz to 20 megahertz (MHz) impressed upon the output voltage shall not exceed 0.5 percent of the nominal output voltage or 50 mV, whichever is greater. This requirement shall be met at full rated load current and over the specified input voltage range (see 4.7.2.4.2).

3.3.2.3.3 Single spectral line amplitude. When specified in the associated detail specification, the amplitude of any single spectral line on the outputs of the power supply shall meet the requirements as specified therein under any allowable combination of input voltage and output load current.

3.3.2.4 Common mode output current. Common mode output current from any power output terminal and return terminal pair to the chassis shall not exceed 200 milliamperes peak-to-peak (mAp-p) in the 10 Hz to 20 MHz band for any load current from 10 percent to full rated load (see 4.7.2.5).

3.3.2.5 Static line and load regulation. Unless otherwise specified in the associated detail specification, the steady state output voltage shall remain within plus or minus one percent of the specified nominal output voltage at 25°C for all allowable combinations of input voltage and output current. Static line and load regulation shall be measured in accordance with 4.7.2.6.

3.3.2.6 Static regulation temperature effects. Line and load regulation shall not exceed plus or minus 2 percent of the nominal output voltages of the power supply when operated over the temperature and altitude range specified in 3.5.2.1.1 for family A1 or 3.5.2.1.2(a), 3.5.2.1.2(b), and 3.5.2.1.2(d) for family A2 and for all allowed simultaneous variations of line voltage and load current.

3.3.2.7 Dynamic load regulation. The transient response of the output voltage to a step change in load current shall be non-oscillatory or highly damped. The response shall be limited to an initial single half cycle overshoot (undershoot) with an amplitude less than 3 percent of the nominal output voltage. If present, the second half cycle undershoot (overshoot) shall have an amplitude less than 1.5 percent of the nominal output voltage. Any additional overshoot or undershoot excursions shall be within the ripple and noise envelope specified in 3.3.2.3 (see 4.7.2.7).

3.3.2.8 Dynamic line regulation. The transient response of the output voltage to a step change in input voltage shall be non-oscillatory or highly damped. The response shall be limited to an initial single half cycle overshoot (undershoot) with an amplitude less than 3 percent of the nominal output voltage. If present, the second half cycle undershoot (overshoot) shall have an amplitude less than 1.5 percent of the nominal output voltage. Any additional overshoot or undershoot excursions shall be within the ripple and noise envelope specified in 3.3.2.3 (see 4.7.2.8).

3.3.2.9 Interaction of multiple output supplies. The requirements of this specification apply to each output with all possible combinations of output loading.

3.3.2.10 Hold-up time. Each power supply output voltage shall remain within 3 percent regulation limits for a minimum of 50 microseconds (us) at full rated load current following the loss of input power. This hold-up time requirement shall be following the loss of input power when operating at any allowable input voltage down to and including the minimum transient AC or DC voltage of MIL-STD-704. When a power interrupt signal is available from the power supply, the hold-up time requirement shall be met following the loss of input power as indicated by the power interrupt signal (see 3.3.4.3).

3.3.2.11 Power turn-on/turn-off response. Each power supply output voltage shall rise to and remain within the regulation limits within 250 milliseconds (ms) after application of the input power (with remote on/off control turned on (see 3.3.3.1)) and under any allowable load. The maximum transient component of excursion of output voltage (overshoot or undershoot) resulting from turn-on or turn-off shall not exceed plus or minus 5 percent of the nominal output voltage. The output voltage shall rise as specified even with an externally applied positive or negative bias on the output pins. The positive bias shall be any voltage up to and including the upper regulation limit of the output voltage. The negative bias shall be a current source of 1 ampere or 10 percent of full load (whichever is less) applied into the negative output pins with the current return path through the positive output pins.

3.3.2.12 Control turn-on/turn-off response. Each power supply output voltage shall rise to and remain within the regulation limits within 250 ms after turn-on of the remote on/off control and under any allowable load (see 3.3.3.1). The maximum transient component of excursion of output voltage (overshoot or undershoot) resulting from turn-on or turn-off shall not exceed plus or minus 5 percent of the nominal output voltage. The output voltage shall rise as specified even with an externally applied positive or negative bias on the output pins as specified in 3.3.2.11.

3.3.2.13 Overcurrent protection. Each output of a power supply shall be provided with overcurrent (and short-circuit) protection with automatic recovery. Overcurrent shall not exceed 125 percent full rated load current. Recovery from overcurrent shall occur within 250 ms (recovery time after removal of the overcurrent). The maximum transient component of excursion of output voltage (overshoot or undershoot) resulting from overcurrent recovery shall not exceed plus or minus 5 percent of the nominal output voltage. The power supply shall operate under any overcurrent indefinitely.

3.3.2.14 Overvoltage protection. The voltage of each output of a power supply shall not exceed 15 percent above its highest nominal output voltage. The power supplies shall not activate the output overvoltage circuitry in the event of power supply turn-on, short circuit recovery, load or line transients or noise spikes. Activations of these types shall be regarded as a failure of the power supply. Unless otherwise specified in the associated detail specification, overvoltage crowbar protection shall not be used.

3.3.2.14.1 Overvoltage latch. Unless otherwise specified in the associated detail specification, the overvoltage protection circuit shall latch all outputs off when an overvoltage condition occurs on any one output. The power supply output voltage shall reset when the input voltage is taken to zero and then reapplied. If the overvoltage condition has not been cleared, the protector circuit shall trip again.

3.3.2.15 Remote voltage sensing. Unless otherwise specified in the associated detail specification, power supplies shall be capable of remote voltage sensing up to 10 inches (length of load and sense leads) from the power supply output terminals and compensating for at least a 3 percent voltage drop of the highest nominal output voltage in the load leads between the power supply output voltage terminals and the corresponding load terminals. When the associated detail specification requires remote voltage sensing, there shall be an application warning in the associated detail specification that the allowed load lead inductance to the sense point together with the load capacitance can affect stability. (See associated detail specification.)

3.3.2.15.1 Open sensing lead protection. Each power supply type requiring remote sensing shall provide protection against excessive output voltage overshoot in the event of opening one or both remote sensing leads. The output voltages (at the power supply terminals) shall completely recover to and remain within plus or minus 5 percent of the nominal supply output voltage within 100 ms after the occurrence of an open sensing lead. The maximum excursion of output voltage measured across the power supply output voltage terminals during this 100 ms interval shall not exceed 0.5 VDC or plus 10 or minus 5 percent of the nominal output voltages, whichever is greater. Reversal of the sensing leads shall not cause damage to the power supply nor cause the power supply output to exceed the overvoltage limits. Opening of a load lead (with sense leads connected) shall not cause damage to the power supply.

3.3.2.16 Output impedance. The value of output impedance will be specified in the associated detail specification.

3.3.2.17 Isolation resistance. The chassis ground shall be isolated from the output voltage and return connections by greater than 10 megohms resistance at 50 VDC. The outputs of multiple output power supplies shall be isolated in accordance with the associated detail specification.

3.3.2.18 Nonpolarized operation. Unless otherwise specified in the associated detail specification, all power supplies shall meet all requirements when operated as either positive or negative power supplies.

3.3.2.19 Reverse voltage protection. Unless otherwise specified in the associated detail specification, the power supply shall be protected against reverse voltage on its output terminals by clamping the reversed voltage to 1.0 VDC or less while sinking up to 1 ampere or 10 percent of its full load current (whichever is less) continuously. This requirement is designed to provide protection when an unenergized power supply has a low level leakage current applied to its output, through load circuitry, from another energized, opposite polarity power supply.

3.3.2.20 Parallel operation. When applicable, the requirement for parallel operation shall be specified in the associated detail specification. The following minimum requirements shall be specified:

(a) The number of power supplies of equal power rating to be paralleled.

(b) The method of current sharing.

(c) The current sharing differential.

(d) The maximum output capacitance of each power supply.

(e) Allowed impedance imbalance between each parallel output and the load.

Failure modes that may cause a system of parallel power supplies to fail shall have a failure rate not greater than 5 percent of the failure rate determined by the mean time between failures (MTBF) of a single power supply (see 3.7.1). Failure of any power supply (other than a short in the power supply output circuitry) shall not cause failure of the output power bus. Power supplies operating in parallel shall drive the output capacitance of the paralleled supplies in addition to the loading required in 3.3.2.2.

3.3.2.21 Line transient response. The transient response of the output voltage to the transient voltages specified in the associated detail specification shall be non-oscillatory or highly damped. The response shall be limited to an initial single half cycle overshoot (undershoot) with an amplitude less than 5 percent of the nominal output voltage. If present, the second half cycle undershoot (overshoot) shall have an amplitude less than

2.5 percent of the nominal output voltage. Any additional overshoot or undershoot excursions shall be within the ripple and noise envelope specified in 3.3.2.3 (see 4.7.2.9).

3.3.3 Control signals.

3.3.3.1 Output voltage remote on/off. The power supply output voltage shall be capable of being turned on and off using the remote switch interface. This interface shall accept transistor-transistor logic (TTL) level (zero VDC minimum, 5.5 VDC maximum) signals. A logic high (2.0 VDC minimum, 100 microampere (uA) maximum) or open circuit shall turn the power supply off. A logic low (0.8 VDC maximum, 3.2 milliamperes (mA) maximum) or connecting the remote switch pin to the remote switch return shall turn the power supply on. When specified in the associated detail specification, input terminals shall have 100K ohms minimum electrical isolation at 100 VDC from the power supply circuitry and chassis.

3.3.3.2 Voltage programming. When specified in the associated detail specification, each power supply output voltage shall be selectable to either value specified using contacts on the input/output connector. An open circuit shall select the lower value output voltage and a closed circuit to the voltage programming return shall select the higher output voltage. Spurious noise signals on the voltage programming contact shall not be directly transmitted to the output being controlled. Unless otherwise specified in the associated detail specification, there shall be a minimum of 15 decibels (dB) rejection of signals (in the frequency range of 100 Hz to 50 kHz) appearing on the voltage programming contact.

3.3.3.3 Susceptibility to common mode noise. The control signals shall not be susceptible to input common mode noise up to plus or minus 15 volts between the chassis ground and any signal lead and its return (see 4.7.2.10).

3.3.3.4 Synchronization. When specified in the associated detail specification, the power supply shall be designed such that the switching frequency can be synchronized with an external source. The synchronization signal will be as defined in the associated detail specification.

3.3.4 Status signals.

3.3.4.1 Isolation. Unless otherwise specified in the associated detail specification, status signal outputs shall be isolated from the other power supply circuitry and chassis by a minimum of 100K ohms resistance at 30 VDC.

3.3.4.2 Over-temperature indication. Power supplies shall contain two internal thermally activated normally open switching devices to indicate excessive temperature and unsafe temperature. A nominal unsafe temperature is 10°C above the worst case transient critical component temperature (TCCT) (see 3.12.1.2). An excessive temperature shall be nominally 11°C to 15°C below the nominal unsafe temperature set point. The tolerance of the temperature sensing devices shall be plus or minus 5°C maximum. The unsafe indicator activation shall occur before any component damage. Both indicators shall reset to normally open prior to the resumption of power supply operation at or below an average thermal interface (see 6.5.7) of 85°C. The current rating of the contacts shall be at least 0.5 A resistive at 28 VDC. The voltage drop of the closed contacts shall not exceed 0.4 VDC for any current less than 0.5 A. When specified in the associated detail specification, the normally open contact switching device may be replaced by a normally high level signal or a high impedance "off" state device. In this situation, an excessive temperature or unsafe temperature shall be indicated by a low level (0.4 VDC maximum, 5.0 mA minimum) signal. The maximum applicable external voltage shall be 30 VDC and the "off" state leakage current at 30 VDC shall not exceed 200 microamperes.

3.3.4.3 Power interrupt signal. When specified in the associated detail specification, the power supplies shall monitor internal circuitry and shall provide a low level signal (0.4 VDC maximum, 5.0 mA minimum) to indicate normal prime power input in accordance with 3.3.1 and a high level signal, or a high impedance "off" state, to indicate that prime power is low or has been interrupted. The power interrupt signal shall be a positive output with respect to the power interrupt signal return. The maximum applicable external voltage shall be 30 VDC and the "off" state leakage current at 30 VDC shall not exceed 200 uA. As the input voltage is applied to the power supply, the power interrupt signal shall go to a low level when the input voltage is greater than or equal to 80 VAC RMS line-to-neutral input voltage but less than or equal to the turn-on threshold voltage specified in 3.3.1.8. The power interrupt signal shall remain low until the input voltage drops to 75 VAC RMS line-to-neutral input voltage. The power interrupt signal shall settle to within 10 percent of its steady state value within 5 usec of an initial high or low transition. The power interrupt signal shall delay 50 usec before indicating a loss of power. The power interrupt input voltage for DC and alternate input power shall be specified in the associated detail specification.

3.3.4.4 Output status signal. The power supply BIT shall monitor each output voltage and shall provide a single low level signal (0.4 VDC maximum, 5.0 mA minimum) to indicate that each power supply output voltage is equal to or greater than 91 percent plus or minus 4 percent of its lowest nominal output but less than 106 percent of its highest nominal output voltage. When the output voltage drops below 91 percent plus or minus 4 percent, the output status signal shall go to a high level or a high impedance "off" state. The output status signal shall go to a high level or high impedance "off" state when the output voltage is greater than or equal to 106 percent of the highest nominal, but less than or equal to the overvoltage limit specified in 3.3.2.14. The output status signal shall be a positive output with respect to the output status signal return. The maximum applicable external voltage shall be 30 VDC and the "off" state leakage current at 30 VDC shall not exceed 200 uA. The output status signal shall go to a high level or high impedance "off" state when the output voltage remote on/off control is OFF (see 3.3.3.1). The output status signal shall settle to within 10 percent of its steady state value within 2 ms of an initial high or low transition. When two or more power supplies are operated in parallel, the output status signal is not required to indicate the correct status of its own output, since it could have voltage applied to its output from a paralleled power supply.

3.3.4.5 Malfunction signal. When specified in the associated detail specification, the power supplies shall provide a signal to indicate when an internal fault condition exists. The malfunction signal shall be a positive output with respect to the malfunction signal return. A low level signal (0.4 VDC maximum, 5.0 mA minimum) shall indicate normal power supply operation and a high level signal or high impedance "off" state, shall indicate that an internal fault exists. The maximum applicable external voltage shall be 30 VDC and the "off" state leakage current at 30 VDC shall not exceed 200 uA. The combinations of conditions which result in a malfunction indication are shown in table I. The malfunction signal will indicate a malfunction when conditions A AND C AND D are "yes" AND B is "no" or when C AND E are "yes" or when F is "yes". No other combination of conditions shall cause a malfunction indication. The malfunction low level signal shall settle to within 10 percent of its steady state value within 2 ms of an initial high or low transition. When power supplies are paralleled, it may be necessary to add a malfunction signal to be capable of detecting a faulty power supply (see 3.3.4.4).

3.3.4.6 Status signal noise. Noise on the power interrupt signal, output status signal and malfunction signal outputs shall be between the limits of -500 mV peak to +500 mV peak (referenced to the signal return) in a 100 MHz bandwidth. This requirement shall apply when the output is at a low level (0.1 to 5.0 mA current).

3.3.4.7 Visual indicators. The power supplies shall light a green light emitting diode (LED) to indicate the status of the output voltage. The power output LED shall be ON when the output status signal is low and shall be OFF when the output status signal is high or off. When specified in the associated detail specification, the power supplies shall light a green LED to indicate prime power is applied. The prime power LED shall be ON when the power interrupt signal is low and shall be OFF when the power interrupt signal is high or off. When specified in the associated detail specification, the power supplies shall light a green LED to indicate the status of internal malfunctions. The malfunction LED shall be ON when the internal malfunction signal is low and is to be OFF when the malfunction signal is high or off. The LED shall have a minimum luminous intensity of 0.4 millicandelas when viewed from a line centered at the indicator and perpendicular to the surface of the power supply. The minimum luminous intensity at 30° (see 3.4.4) shall be 0.2 millicandelas.

TABLE I. Malfunction combinations. 1/

Output malfunction (MF)	Output undervoltage (A)	Overcurrent (B)	Allowed input voltage (C)	On/off remote switch on (D)	Other internal faults (E)	Overvoltage (F)
1	Yes	No	Yes	Yes	-	-
2	-	-	Yes	-	Yes	-
3	-	-	-	-	-	Yes

1/ Dash denotes no requirement. $MF = (A \overline{B} C D) + (C E) + F$

3.3.5 Efficiency. The minimum efficiency of the power supply shall be 70 percent for family A1 and 80 percent for family A2 (see 4.7.2.11).

3.3.6 Internal frequencies. Power supply internal oscillator frequencies shall be 25 kHz or greater.

3.3.7 Time elapsed meter (family A1). When specified by the associated detail specification, the time elapsed meter shall be military qualified (see MIL-M-7793). Electrochemical deposition meters shall not be used.

3.4 Physical requirements.

3.4.1 Size and weight.

3.4.1.1 Family A1. Unless otherwise specified in the associated detail specification or herein, the power supply enclosure shall be in accordance with MIL-E-85726 except for modularity, modules, and backplane interface.

3.4.1.1.1 Enclosure size. Enclosure MCU size shall be in accordance with the associated detail specification. The external size dimensions, excluding cooling interfaces, of the enclosure shall be in accordance with DOD-STD-1788. The enclosure shall come in two, four, six, and eight MCU sizes. MCU size is equivalent to DOD-STD-1788 line replaceable unit (LRU) size.

3.4.1.1.2 Enclosure mass. The maximum weight of the packaged power supply including the enclosure shall be in accordance with table I of MIL-E-85726.

3.4.1.2 Family A2. Family A2 power supply physical characteristics shall be in accordance with appendices B, C, and E of MIL-STD-1389.

3.4.2 Connector locations and contact assignments.

3.4.2.1 Family A1. The input/output connectors shall be in accordance with MIL-E-85726 and the associated detail specification. Connectors shall be installed in accordance with DOD-STD-1788. Connector contact assignments shall be in accordance with the associated detail specification.

3.4.2.2 Family A2. Unless otherwise specified in the associated detail specification, the input/output connectors shall be in accordance with appendices B, C, and E of MIL-STD-1389. Electrical functions and connector contact assignments shall be in accordance with the associated detail specification.

3.4.3 Hold-downs.

3.4.3.1 Family A1. Hold-downs shall be in accordance with the associated detail specification and MIL-E-85726.

3.4.3.2 Family A2 . Hold-downs shall be in accordance with appendices B, C and E of MIL-STD-1389 and the associated detail specification.

3.4.4 Visual indicator location. Location of the visual indicators shall be in accordance with the associated detail specification. Indicators shall be mounted on the power supply surface which is most readily observable when the power supply is installed in its field application. Indicators shall be mounted to permit viewing from a minimum angle of 30° in any direction from a line centered at the indicator and perpendicular to the surface of the power supply.

3.4.5 Modular construction (family A1). Power supplies shall be internally structured and functionally partitioned in a modular format (see 3.11.2). The selection of specific assembly design and packaging techniques shall reflect the reliability and maintainability requirements specified herein and in the associated detail specification.

3.4.5.1 Modules and modular construction. When applied to family A1, the terms "modules" and "modular construction" shall not be construed to mean Standard Electronic Modules (SEM) in accordance with MIL-STD-1389.

3.4.6 Human engineering. Guidelines in applying human engineering design criteria and principles in the design of the power supplies shall be in accordance with MIL-STD-1472.

3.5 Environmental requirements.

3.5.1 Visible degradation. Power supplies shall not show evidence of visible degradation as a result of being exposed to the environmental conditions specified herein (see 4.7.1.2). Deterioration, corrosion, or change in tolerance limits of any internal or external part which could in any manner prevent the power supply from meeting operational service or maintenance requirements shall provide reason for the APSP-QAA to consider the power supply as having failed to withstand the conditions of an environmental exposure. Leakage of electrolyte, impregnating compounds, and so forth shall be considered damage and cause for rejection.

3.5.2 Operating environmental requirements. Power supplies shall perform continuously within the performance limits and under the environmental conditions specified herein. Power supplies shall meet the electrical performance requirements (see 3.3) prior to, during (when applicable) and following the operating environmental tests specified in table II (family A1) and table III (family A2). Power supplies shall not be damaged or degraded by the environmental conditions specified.

TABLE II. Operating environmental requirements (family A1).

Environment	Requirement paragraph	Test paragraph	Method and condition
Temperature and altitude	3.5.2.1.1	4.7.3.2.1	MIL-STD-810, Method 520, Procedure III
Vibration	3.5.2.2.1	4.7.3.3.1	MIL-STD-202, Method 204, Condition C, 2 sweeps per axis MIL-STD-810, Method 514, Procedure I, Category 5
Mechanical shock	3.5.2.3	4.7.3.4.1	MIL-STD-810, Method 516, Procedure I
Long-term stability	3.5.2.4	4.7.3.5	1,000 hours
Radiation hardness	3.5.2.5	4.7.3.6	
Ionizing dose rate		4.7.3.6.1	MIL-STD-883, Method 1023
Total ionizing dose		4.7.3.6.2	MIL-STD-883, Method 1019
Electromagnetic pulse protection	3.6.1	4.7.3.7	MIL-STD-461C Method CS11
Explosive conditions	3.5.2.6	4.7.3.8	MIL-STD-810, Method 511, Procedure I
Generated acoustical noise	3.5.2.7	4.7.3.9	As specified herein
Electromagnetic interference	3.6.1	4.7.4	MIL-STD-462 MIL-STD-461 Part 1, Section 5; Part 2

TABLE III. Operating environmental requirements (family A2).

Environment	Requirement paragraph	Test paragraph	Method and condition
Temperature and altitude	3.5.2.1.2	4.7.3.2.2	Temperature: As specified herein Altitude: MIL-STD-202, Method 105, Test Condition D
Vibration	3.5.2.2.2	4.7.3.3.2	MIL-STD-202, Method 204, Condition C, 2 sweeps per axis MIL-STD-202, Method 214, Condition I, Letter E, 0.5 hour
Mechanical shock	3.5.2.3	4.7.3.4.2	MIL-STD-810, Method 516, Procedure I
Long-term stability	3.5.2.4	4.7.3.5	1,000 hours
Radiation hardness	3.5.2.5	4.7.3.6	
Ionizing dose rate		4.7.3.6.1	MIL-STD-883, Method 1023
Total ionizing dose		4.7.3.6.2	MIL-STD-883, Method 1019
Explosive conditions	3.5.2.6	4.7.3.8	MIL-STD-810, Method 511, Procedure I
Generated acoustical noise	3.5.2.7	4.7.3.9	As specified herein
Electromagnetic interference	3.6.2	4.7.4	MIL-STD-462 MIL-STD-461 Part 1, Section 5; Part 2

3.5.2.1 Temperature and altitude.

3.5.2.1.1 Family A1. Power supplies shall meet the requirements of 3.5.2 under the operating temperature and altitude extremes in accordance with MIL-E-5400, class 2X (see 4.7.3.2.1).

3.5.2.1.2 Family A2. Power supplies shall meet the requirements of 3.5.2 under the following conditions (see 4.7.3.2.2.).

(a) Low temperature. Power supplies shall be subjected to a cooling fin or mounting rib temperature of minus 55°C plus 0 or minus 5°C.

(b) High temperature. Power supplies shall be subjected to a cooling fin or mounting rib temperature of 85°C plus 5 or minus 0°C.

(c) Transient temperature. Power supplies shall be subjected to a cooling fin or mounting rib transient temperature of 105°C plus 5 or minus 0°C. The parts derating (see 3.10.2) shall not apply while operating at this temperature; however, no part shall exceed its maximum rating.

(d) Barometric pressure. Power supplies shall withstand a reduced barometric pressure of 8.00 millimeters of mercury.

3.5.2.2 Vibration. Power supplies shall withstand high frequency vibration and random vibration tests. Power supply output voltages shall remain within specified values during vibration tests. Following the vibration tests, power supplies shall meet the electrical performance requirements and shall show no physical deterioration or damage (see 3.5.2).

3.5.2.2.1 Family A1. Power supplies shall meet the electrical performance requirements following the vibration test. Output voltages shall remain within specified values during vibration. Power supplies shall not exhibit any resonances below 80 Hz (see 4.7.3.3.1).

3.5.2.2.2 Family A2. Power supplies shall meet the electrical performance requirements following the vibration test. Output voltages shall remain within specified values during vibration (see 4.7.3.3.2).

3.5.2.3 Mechanical shock. Power supplies shall meet the electrical performance requirements following the shock test. There shall be no physical damage or deterioration (see 4.7.3.4).

3.5.2.4 Long-term stability. The output voltages of power supplies shall not change more than 0.2 percent from the baseline value during 1000 hours operation at maximum rated continuous operating temperature (see 4.7.3.5).

3.5.2.5 Radiation hardness. Power supplies shall be radiation hardened to the requirements herein and in 3.5.3.7. Power supplies shall meet end-of-life electrical requirements (see 3.5.4.2) following operating exposure to an ionizing dose rate of $1x10^9$ rad (silicon (Si)) per second (sec) (20 to 100 nanoseconds (ns) pulse width) and a total ionizing dose of $3x10^3$ rad Si (see 4.7.3.6). The power supply may shut down during exposure and require the input voltage to be taken to zero and then reapplied before resuming operation.

3.5.2.6 Explosive conditions. Power supplies shall meet the electrical performance requirements following the test (see 3.5.2). The power supply shall not cause ignition of an ambient-explosive-gaseous mixture with air when operating in such an atmosphere (see 4.7.3.8).

3.5.2.7 Generated acoustical noise. When specified in the associated detail specification, the power supplies shall meet the generated acoustical noise acceptance limits specified therein (see 4.7.3.9).

3.5.3 Nonoperating environmental requirements. Power supplies shall meet the electrical performance requirements specified herein or in the associated detail specification following exposure to the non-operating environmental tests of table IV (family A1), or table V (family A2). Power supplies shall not be required to operate continuously during nonoperating environmental tests; however, periodic operation of the power supply may be required by specific test procedures to measure electrical performance.

TABLE IV. Non-operating environmental requirements (family A1). 1/

Environment	Requirement paragraph	Test paragraph	Method and condition
Humidity	3.5.3.1	4.7.3.10.1	MIL-STD-810, Method 507, Procedure III
Temperature shock	3.5.3.2	4.7.3.11	MIL-STD-202, Method 107, Condition B
Mechanical shock	3.5.3.3	4.7.3.12	MIL-STD-810, Method 516, Procedure V
Salt fog	3.5.3.4	4.7.3.13	MIL-STD-810, Method 509, Procedure I
Storage temperature	3.5.3.6	4.7.3.15	As specified herein
Radiation hardness	3.5.3.7	4.7.3.16	MIL-STD-883, Neutron fluence, Method 1017
Solvents	3.5.3.8	4.7.3.17	MIL-STD-202, Method 215
Shelf life	3.5.4.1	-----------	10 years

1/ If specified, power supplies may be operated intermittently during these tests; however, they shall not be operated continuously.

TABLE V. Nonoperating environmental requirements (family A2). 1/

Environment	Requirement paragraph	Test paragraph	Method and condition
Humidity	3.5.3.1	4.7.3.10.2	MIL-STD-810, Method 507, Procedure III
Temperature shock	3.5.3.2	4.7.3.11	MIL-STD-202, Method 107, Condition B
Salt fog	3.5.3.4	4.7.3.13	MIL-STD-810, Method 509, Procedure I
Durability	3.5.3.5	4.7.3.14	As specified herein
Storage temperature	3.5.3.6	4.7.3.15	As specified herein
Radiation hardness Neutron fluence	3.5.3.7	4.7.3.16	MIL-STD-883, Method 1017
Solvents	3.5.3.8	4.7.3.17	MIL-STD-202, Method 215
Shelf life	3.5.4.1	-----------	10 years

1/ If specified, power supplies may be operated intermittently during these tests; however, they shall not be operated continuously.

3.5.3.1 Humidity. Power supplies shall withstand humid atmosphere cycles when tested in accordance with 4.7.3.10.

3.5.3.2 Temperature shock. Power supplies shall meet the electrical performance requirements following the temperature shock (see 4.7.3.11). There shall be no evidence of deterioration or physical damage after temperature shock.

3.5.3.3 Mechanical shock (family A1). Power supplies shall meet the electrical performance requirements following the shock test. There shall be no physical damage or deterioration (see 4.7.3.12).

3.5.3.4 Salt fog. Power supplies shall meet the electrical performance requirements following the effects of exposure to a salt-sea atmosphere. There shall be no physical or chemical degradation. Failure mechanisms shall include pits, crack formation, intergranular attack, and so forth (that is, any concentrated attack that weakens the cross section) (see 4.7.3.13).

3.5.3.5 Durability (family A2). Power supplies shall withstand a minimum of 500 cycles of insertion and extraction into a test fixture that represents a typical card cage rail assembly without loss of mechanical or electrical integrity (see 4.7.3.14). Format C and E power supplies shall also withstand a minimum of 500 cycles of lateral displacement to simulate the use of thermal clamping devices. The lateral displacements may be included in the insertion/extraction sequence or completed after the insertion/extraction cycling. There shall be no exposure of nickel underplating on the module connector contacts when examined under 3X magnification (10X for referee inspection) upon completion of this test. To enhance the visibility of any exposed underplating, the contacts may be dipped in a 5 percent sodium sulfide solution for 2 minutes, plus or minus 15 seconds, and then rinsed prior to examination.

3.5.3.6 Storage temperature. Power supplies shall withstand a storage temperature range of minus 55°C to plus 125°C (see 4.7.3.15).

3.5.3.7 Nonoperating radiation hardness. Power supplies shall meet post-irradiation electrical requirements following exposure to a neutron fluence of $2x10^{12}$ neutrons per centimeter squared (see 4.7.3.16).

3.5.3.8 Solvents. Power supplies using adhesive backed labels shall meet the solvents requirement without the label peeling off of the power supply surface (see 4.7.3.17).

3.5.4 Power supply life.

3.5.4.1 Shelf life. Power supplies shall have a minimum non-operating shelf life of 10 years without refurbishment provided the storage temperature is 40°C or less for a minimum of 95 percent of the storage time. Storage at a temperature between 40°C and 80°C for 5 percent of the time shall not affect shelf life. The useful shelf life shall be extended to at least 20 years if refurbishment is performed at the end of the initial 10 years.

3.5.4.2 End-of-life. Power supplies shall be designed such that component aging effects shall not degrade the operational limits by more than the amount specified in table VI. Parameters not specified in table VI shall not exceed the limits of the electrical performance characteristics specified herein or in the detail specification over the useful life of the power supplies. When any individual power supply fails to conform to the end-of-life requirements in table VI, the power supply is considered to have completed its useful life.

TABLE VI. End-of-life.

Requirement paragraph	Parameter	Initial limit	Total specified end-of-life
3.3.2.3	Total ripple and noise	1.0 percent 100 mVp-p	1.5 percent 150 mVp-p
3.3.2.3.1	Low frequency ripple and noise	0.5 percent 50 mVp-p	0.6 percent 60 mVp-p
3.3.2.3.2	High frequency ripple and noise	0.5 percent 50 mVp-p	0.75 percent 75 mVp-p
3.3.2.5	Static regulation	1.0 percent	1.5 percent
3.3.2.13	Overcurrent maximum	125 percent maximum	127 percent
3.3.2.14	Overvoltage	115 percent	116 percent
3.3.1.16	Input power isolation resistance	10 Megohms minimum	1 Megohm minimum
3.3.2.17	Output power isolation resistance	10 Megohms minimum	1 Megohm minimum
3.3.3.1	Control isolation resistance	100K Ohms	10K Ohms minimum
3.3.4.1	Status isolation resistance	100K Ohms minimum	10K Ohms minimum

3.6 Electromagnetic environmental effects (E^3).

3.6.1 E^3 requirements (family A1). Unless otherwise specified in the associated detail specification, the power supply shall meet the requirements of MIL-STD-461, part 2 for class A1b equipment as modified below.

(1) Conducted emissions. The power supply input power leads shall comply with the emissions requirements of CE01 and CE03.

(2) Conducted susceptibility. The power supply shall operate without malfunction or degradation beyond specified limits when subjected to the susceptibility requirements of CS01, CS02, and CS06. The susceptibility signals for CS01 and CS02 shall be 3 volts peak-to-peak minimum.

(3) Conducted susceptibility, electromagnetic pulse. The power supply shall not exhibit any permanent malfunction or upset when subjected to susceptibility requirements of CS11.

(4) Radiated emissions. The power supply shall comply with the emission requirements of RE01. The requirement for RE02 shall be extended along the standard specification limit to 18 GHz.

(5) Radiated susceptibility. The power supply shall operate without malfunction or degradation beyond specified limits when subjected to the susceptibility frequencies and modulations as outlined in table VII for RS03. The power supply shall operate without malfunction or degradation beyond specified limits when subjected to the susceptibility requirements of RS06.

3.6.1.1 Ground plane interference. The equipment shall meet the following requirements for ground plane interference in accordance with figure 1. No malfunction or degradation of performance shall be produced when noise signals, in accordance with the following requirements, are injected between each ground plane. (Test sample and test ground plane.)

(1) Three volts RMS from 320 Hz to 500 Hz (not to exceed 150 mA RMS current).

(2) One volt RMS from 500 Hz to 20 MHz (not to exceed 150 mA RMS current for frequencies between 500 Hz and 50 kHz, and not to exceed 1 watt from a 50 ohm source for frequencies above 50 kHz).

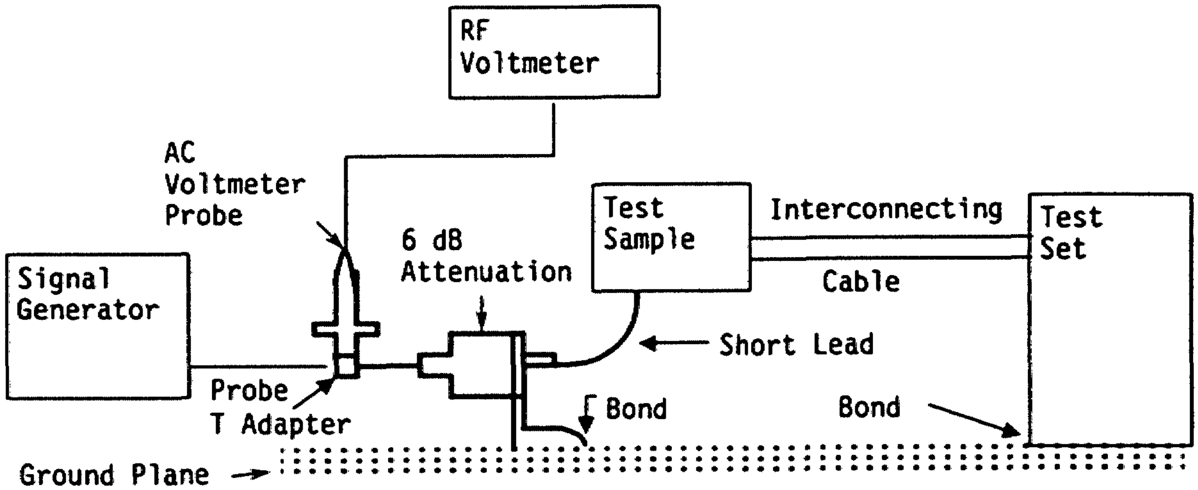
(3) ±8 volt pulses, 70 microseconds wide at 100 pulses per second not to exceed 15 amps peak current.

(4) ±1 volt dc (not to exceed 150 mA current).

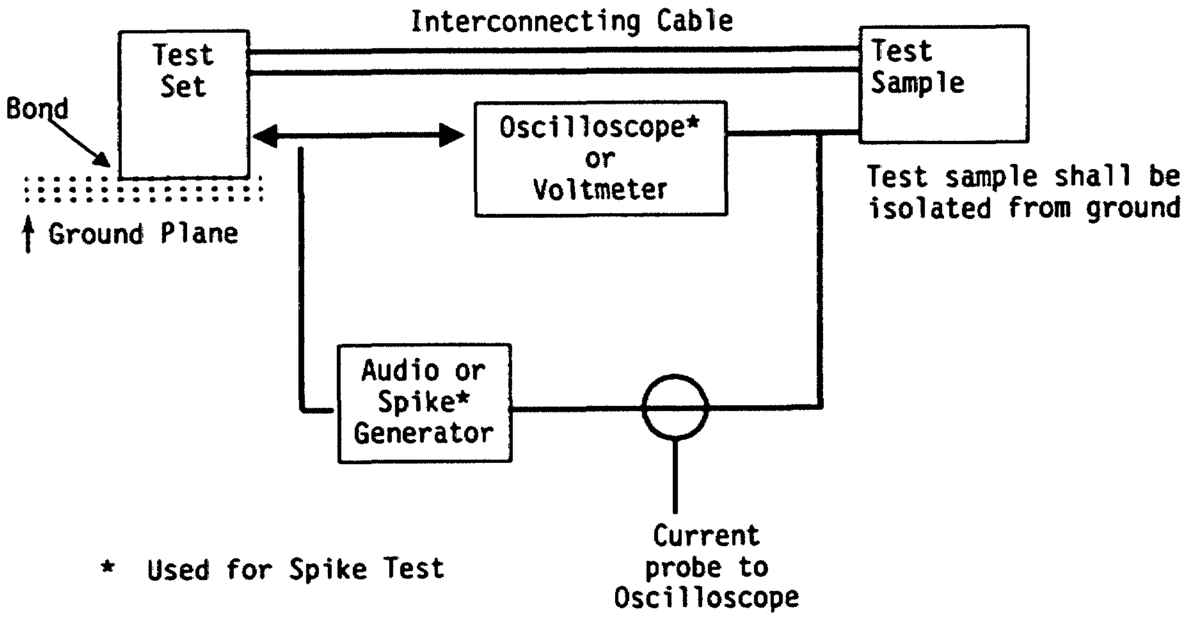
TABLE VII. High level RS03 table.

Frequency 1/ (MHz)	Type	Modulation pulse width	Pulses/sec	Field density 2/ (mw/cm2)	Field strength 3/ (V/m)
0.014-850	AM 4/ 90%	1 kHz sine	wave	0.66 5/	50
215-225	PAM 6/	10 usec	200	10.6 7/	200
215-225	PAM	200 usec	200	10.6	200
400-450	PAM	4 usec	300	10.6	200
850-940	PAM	10 usec	1000	10.6	200
850-940	PAM	125 usec	300	10.6	200
940-1215	PAM	10 usec	1000	10.6	200
1215-1365	PAM	10 usec	3000	10.6	200
1365-2900	PAM	1 usec	1000	10.6	200
2900-3100	PAM	3 usec	1000	10.6	200
2900-3100	PAM	70 usec	200	10.6	200
3100-3500	PAM	10 usec	3000	10.6	200
3100-3500	PAM	50 usec	3000	10.6	200
3500-9000	PAM	1 usec	1000	10.6	200
9000-14000	PAM	p.2 usec	1000	10.6	200
14000-18000	PAM	0.2 usec	50000	10.6	200
33000-33400	PAM	0.2 usec	2000	0.106	20

1/ Frequency ranges listed with more than one modulation shall be repeated as necessary to include all different modulations shown.
2/ Peak power density for PAM signals is defined as the power density as measured with an average power measuring device if the generator is run CW; that is, average power density within the pulse envelope.
3/ Volts per meter equivalent shown for reference only.
4/ Amplitude modulated.
5/ Average power density.
6/ Pulse amplitude modulated.
7/ Peak power density.



Ground Plane Interference Test Setup (50 kHz to 100 MHz)



Ground Plane Interference Test Setup Spike Test (320 Hz to 50 kHz)

FIGURE 1. Ground plane susceptibility requirements.

3.6.2 E^3 requirements (family A2). The power supply shall meet the applicable emission and susceptibility requirements as shown below:

3.6.2.1 Module shielding. Each module shall provide, as a minimum, 40 dB of shielding effectiveness within the frequency range of 1 MHz to 1 GHz.

3.6.2.2 Conducted emissions, frequency domain, input power and return leads. Conducted emissions measured at the input power leads shall not exceed the limits specified on figure 2.

3.6.2.3 Conducted susceptibility, input power and return pins. The power supply modules shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual module specification when subjected to susceptibility signals as described below on the input power and return lines. The requirement is assumed to be met if 3 amperes occur before the specified voltage on figure 3, and for 1 volt (rms) in the frequency range of 100 kHz to 400 MHz.

Modulation: 30 Hz to 50 kHz continuous wave
50 kHz to 400 MHz 80 percent amplitude modulation, 800 Hz sine wave

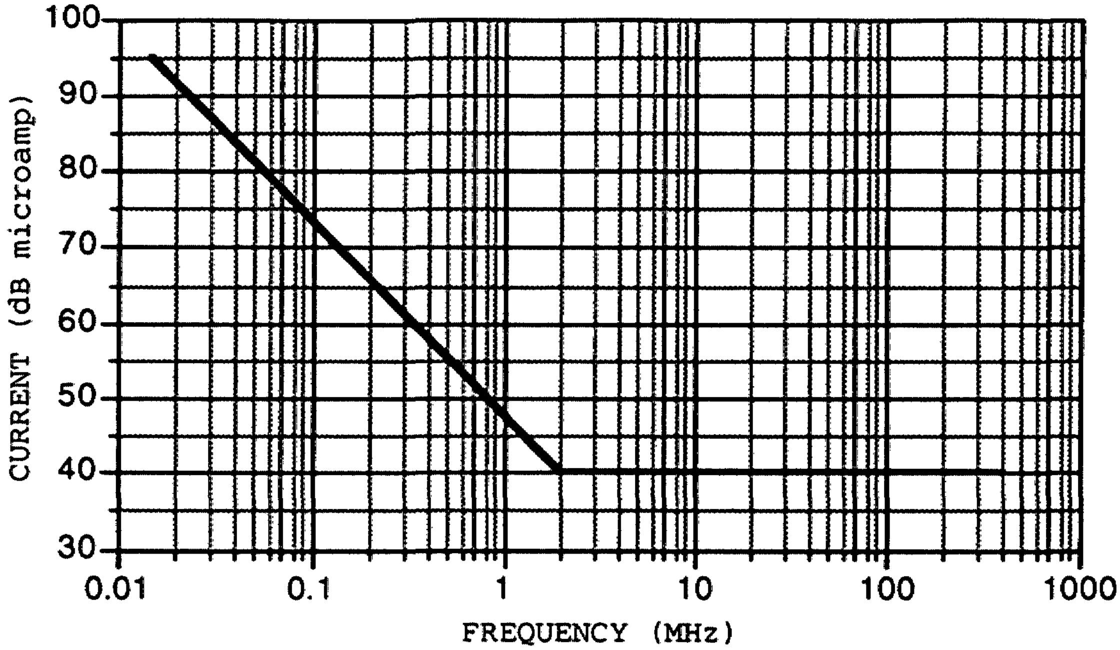


FIGURE 2. Conducted emmisions limit, input power and return pins.

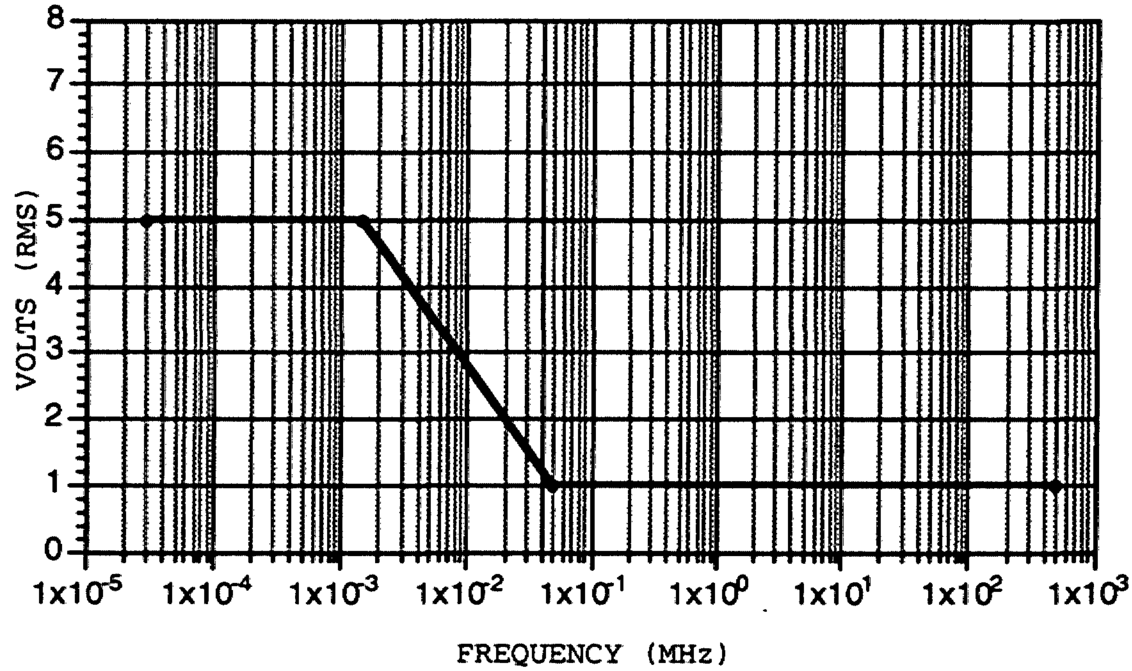


FIGURE 3. Conducted susceptibility limit, input power and return pins.

3.6.2.4 Conducted susceptibility, all pins. The modules shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual module specification when each pin is subjected to a damped sinusoid with Imax as described on figure 4, at a minimum of 10 pulses per second.

Current waveform:

$$I = I_{MAX}\, e^{-\frac{\Pi f t}{Q}} \sin(2\Pi f t)$$

Where: f = test frequency
Q = quality factor, 20 ± 5
t = time in seconds

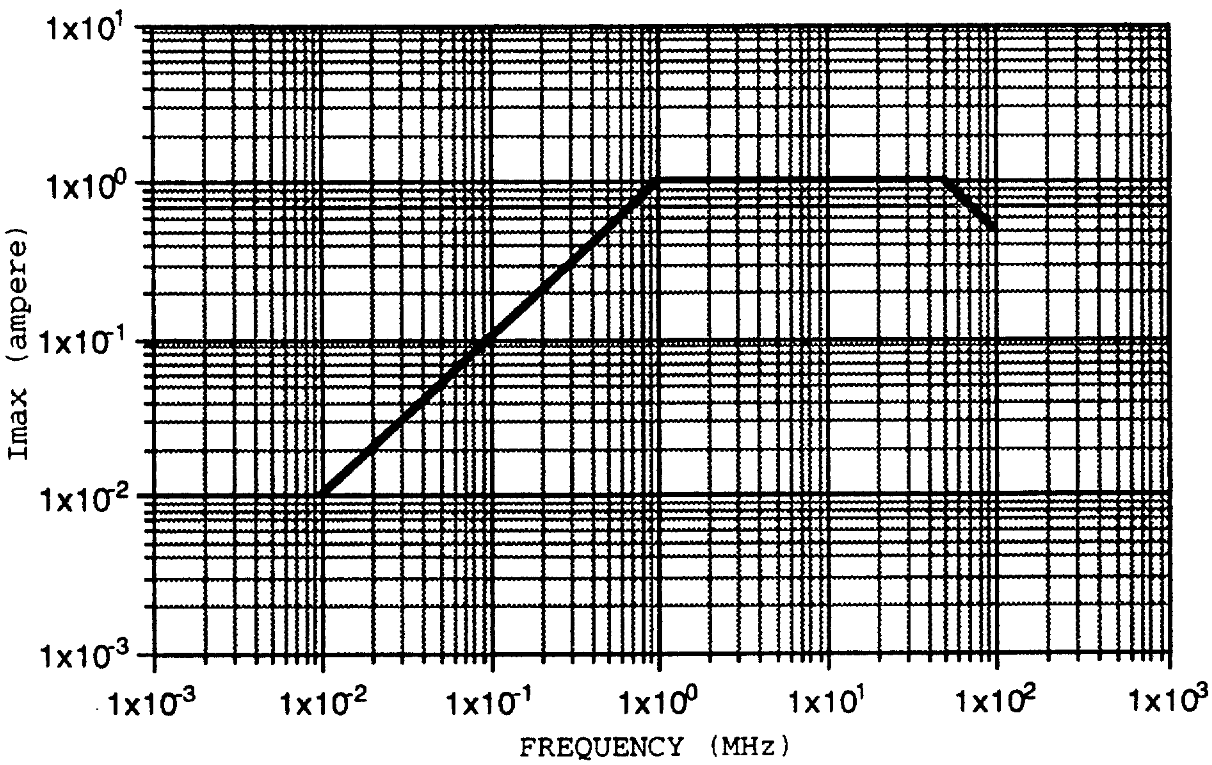


FIGURE 4. Conducted susceptibility limit power supply modules.

3.6.2.5 Radiated emissions, magnetic field. The magnetic field emissions of any power supply module shall not exceed the level as specified on figure 5, at 10 centimeters distance from the module case and connector.

3.6.2.6 Radiated susceptibility, magnetic field. The modules shall not exhibit any malfunction, degradation of performance, or deviation from specified indication, beyond the tolerances indicated in the individual module specification when subjected to a magnetic field as specified on figure 5, as measured at a distance of 10 centimeters from the module face and connector.

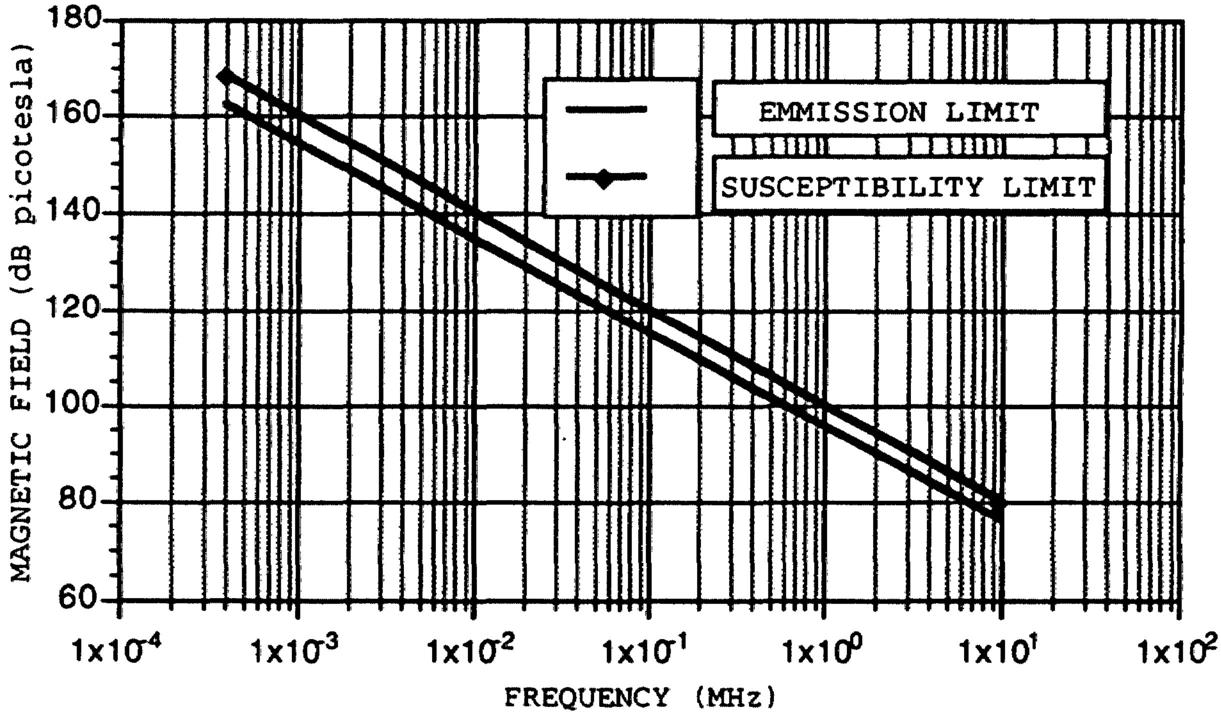


FIGURE 5. Radiated magnetic field limit emissions and susceptibility.

3.6.2.7 Radiated susceptibility, electric field. The modules shall not exhibit any malfunction, degradation of performance, or deviation from specified indication, beyond the tolerances indicated in the individual module specification when subjected to an electric field at the levels and modulations specified below.

1 MHz to 400 MHz	40 V/m rms, 90 percent amplitude modulated, 800 Hz sine wave	
200 MHz to 18 GHz	60 V/m rms, (under the modulation envelope), 800 Hz square wave	
	Pulsed -	2 usec pulse width 50 kHz PRF 800 Hz square wave

3.6.2.8 Electrostatic discharge. The modules shall not exhibit any malfunction, degradation or performance, or deviation from specified indication, beyond the tolerances indicated in the individual module specification when each pin is subjected to a 4 kilovolt discharge and when the module case surface is subjected to a 25 kilovolt discharge sourced from a 150 picofarad (±5 percent) capacitor in series with a 150 ohm (±5 percent) non-inductive resistor.

3.7 Reliability.

3.7.1 Reliability requirement.

3.7.1.1 Family A1. Each power supply shall have a minimum predicted MTBF of 40,000 hours for Naval sheltered use environment. Minimum predicted MTBF for airborne uninhabited use environment shall be 15,000 hours (see 4.7.5.1.1).

3.7.1.2 Family A2. Each power supply shall have a minimum predicted MTBF of 20,000 hours for Naval sheltered use environment. Minimum predicted MTBF for airborne uninhabited use environment shall be in accordance with the associated detail specification (see 4.7.5.1.2).

3.7.2 Environmental stress screening. Power supplies shall meet the performance requirements following environmental stress screening (also known as preconditioning, burn-in, manufacturing screening). Power supplies shall be 100 percent tested to the stress screening tests as specified in 4.7.5.2. There shall be no evidence of deterioration or physical damage after the stress screening (see 4.7.1.2).

3.8 Maintainability.

3.8.1 Maintenance. Unless otherwise approved by the command or agency concerned, each power supply shall be repairable. Subassemblies of high reliability or relatively low cost shall be considered as nonrepairable. The power supply supplier shall inform the command or agency concerned of those circuits which he proposes as nonrepairable subassemblies, and shall obtain approval therefor.

3.8.2 Service and access. The power supplies shall be designed for maximum ease of maintenance and shall be designed to provide for personnel protection during maintenance (see 3.15). Parts requiring adjustment or replacement shall be readily accessible without major disassembly (see 3.10.7). Test procedures, fault isolation, and subassembly replacement should be simple and capable of being performed by semiskilled, user-trained personnel employing a minimal amount of test equipment and tools. No special tools (in accordance with MIL-STD-454, requirement 63) shall be required for field or depot-level maintenance. Maintenance data for test, fault isolation and repair of the power supplies shall be prepared and submitted in accordance with MIL-STD-2038.

3.8.3 Test points. Each power supply shall have internally accessible test points to the extent necessary in field and depot level maintenance to allow isolation of a failed subassembly without removal of the power supply subassembly. Protection shall be provided in test point circuitry susceptible to damage caused by the grounding of test points.

3.8.4 Part protection. Power supplies shall be designed so that parts will not be susceptible to damage during servicing and maintenance of the power supplies.

3.9 Parts, materials and processes.

3.9.1 Selection. Parts, materials and processes shall be selected in accordance with MIL-E-5400. This shall not relieve the power supply manufacturer (see 6.5.3) of the responsibility for complying with all power supply performance and other requirements set forth herein and in the associated detail specification.

3.9.2 Standard parts. Maximum utilization shall be made of standard parts. Standard parts are those parts specified in:

(a) MIL-STD-454 or

(b) other standards and specifications, as specified here, where approval of these parts prior to use is not required.

3.9.3 Nonstandard parts. Nonstandard parts shall not be used without approval in accordance with MIL-STD-2038.

3.9.4 Choice of parts and materials. The power supply manufacturer shall select and use items having the broadest characteristics and of the greatest allowable tolerances that will fulfill the performance requirements of the power supply. Performance shall not be dependent on the selection of special values for individual parts.

3.9.5 Materials. Materials used in the manufacture of the power supplies shall be in accordance with the requirements specified herein. Materials shall be certified in accordance with applicable Government specifications wherever so listed. When a material is not specified, a material shall be used which will enable the power supplies to satisfy the requirements specified herein. Acceptance or approval of a constituent material shall not be construed as an assurance of the acceptance of the finished product.

3.9.5.1 Encapsulation and embedment. The encapsulation and embedment of electronic parts and assemblies shall be in accordance with MIL-STD-454, requirement 47.

3.9.5.2 Moisture and fungus resistance. Power supplies shall be designed so that the materials used are moisture resistant and non-nutrient for fungus. Fungus nutrient may be used in hermetic assemblies and other accepted and qualified uses. Other fungus nutrient materials, which are deemed necessary, and are approved by the command or agency, shall be treated by a method which will render the resulting exposed surface fungus resistant. For fungus-inert material see requirement 4 of MIL-STD-454.

3.9.5.3 Flammability. Materials used in fabrication of any power supply shall be nonburning or self-extinguishing in accordance with MIL-STD-454, requirement 3. Materials shall be self-extinguishing within 5 seconds after removal of the flame when tested in accordance with MIL-STD-202, method 111.

3.9.5.4 Use of toxic material. Materials which are capable of producing dangerous gases or having other harmful toxic effects over the temperature range of minus 65°C to plus 125°C, or when exposed to fire, shall not be used. The material shall have no adverse effect on the health of personnel when used for its intended purpose. Questions pertinent to this effect shall be referred by the APSP-QAA to the appropriate departmental medical service who will act as an advisor to the APSP-QAA. The power supply manufacturer shall furnish to the APSP-QAA the toxicological data and formulations required to evaluate the safety of the material for the proposed use.

3.9.5.5 Dissimilar metals. The use of dissimilar metals in direct contact with one another shall be avoided where possible. Where dissimilar metals are used, protection against electrolytic corrosion shall be applied in accordance with MIL-STD-889. The preceding does not apply where dissimilar metals are joined to provide information internal to the power supply (for example, temperature sensing).

3.9.5.6 Processes. Materials used in the power supplies shall be corrosion resistant types or shall be processed to resist corrosion. Gold, nickel, rhodium, tin, lead-tin alloys, or sufficiently thick plating of these metals are satisfactory without additional protection or treatment other than buffing or cleaning. Other materials shall have protective finishes in accordance with MIL-E-5400 except as modified herein. The protective treatment of surfaces shall enable the power supplies to meet the requirements specified herein. Acceptance or approval of a protective treatment shall not be construed as an assurance of the acceptance of the finished product.

3.9.5.7 Unacceptable materials. Unacceptable materials in accordance with MIL-E-5400 shall not be used.

3.9.5.8 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the power supplies shall be new and shall be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specified.

3.10 Electrical design and construction.

3.10.1 Component selection. Electronic components and hardware used in power supplies shall have a demonstrated quality level and environmental performance equivalent to or better than that of available military parts. Nonhermetically sealed packaged relays having hermetically sealed equivalents shall not be used. Wet slug tantalum capacitors, except per MIL-C-39006/22, shall not be used.

3.10.1.1 Germanium semiconductors. Germanium semiconductors shall not be used.

3.10.1.2 Discrete semiconductors. Discrete semiconductors used in power supplies shall be in accordance with the requirements of MIL-S-19500 and shall be selected according to the following priority list. Devices listed in (b), (c), and (d) shall be approved by the APSP-QAA prior to use.

(a) MIL-S-19500 JANTX devices listed in MIL-STD-701.

(b) Other MIL-S-19500 JANTX devices.

(c) Devices being considered for a MIL-S-19500 JANTX detail specification. Devices shall be equal to or better than MIL-S-19500 JANTX devices.

(d) Other devices. Devices shall be equal to or better than MIL-S-19500 JANTX devices.

3.10.1.3 Integrated circuits. Integrated circuits shall be in accordance with the following requirements.

3.10.1.3.1 Quality requirements. Integrated circuits shall be in accordance with the requirements of MIL-M-38510, class B. The power supply manufacturer shall use MIL-M-38510 JAN Qualified Products List (QPL) devices when available or acquire other devices in accordance with the "Provisions for use of MIL-STD-883 in conjunction with compliant non-JAN devices" paragraph of MIL-STD-883. Equivalent specifications shall be submitted to the APSP-QAA for approval prior to initial qualification. Equivalent specifications excluding DESC standard military drawings (SMD) shall include:

(a) Screening shall be to MIL-STD-883, method 5004, class B.

(b) Quality conformance shall be demonstrated in accordance with MIL-STD-883, method 5005, groups A, B, C, D, and E (if applicable), class B.

(c) Generic data is acceptable for demonstrating quality conformance in accordance with MIL-STD-883, method 5005, groups C and D, class B. A generic family shall be electrically and structurally similar integrated circuits. They are designed to perform the same type of basic circuit function using the same basic circuit element configuration and differ only in the number of identically specified circuits which they contain. They are designed for the same supply, bias, and signal voltages and for input-output compatibility with each other under an established set of loading rules. They are enclosed in packages of the same construction and outline, differing only in the number of active external package leads included or used, and made from the same materials by use of the same processes.

3.10.1.3.2 Selection requirements. Integrated circuits shall be in accordance with the requirements of MIL-M-38510 and shall be selected according to the following priority list. Devices listed in (b), (c), (d) and (e) shall be approved by the APSP-QAA prior to use.

(a) MIL-M-38510 JAN microcircuits listed in the table of preferred devices in MIL-STD-1562.

(b) Other MIL-M-38510 microcircuits not listed in the tables of logistics or continuous replacements, inactive or suspended military activity, or not recommended under any circumstances in MIL-STD-1562.

(c) Other microcircuits listed in the table of potential standardization candidates in MIL-STD-1562 as preferred for new designs.

(d) DESC SMD microcircuits not listed in the tables of logistics or continuous replacements, inactive or suspended military activity, or not recommended under any circumstances in MIL-STD-1562.

(e) Other microcircuits (see 3.10.1.5).

3.10.1.4 Passive components. Passive components shall be selected according to the following priority list. Devices listed in (c), (d), (f), (g), (h), and (i), shall be approved by the APSP-QAA prior to use.

(a) Established reliability (ER) specification parts (minimum level R if multiple sources exist) listed in MIL-STD-454 requirements 2, 10, 33, 50, 57 and 58. (If multiple sources of level R parts do not exist, level P parts may be used to achieve multiple sources). Passive components shall be as listed in MIL-STD-454 requirements 2, 10, 33, 50, 57 and 58.

(b) ER parts (minimum level M if required to achieve multiple sourcing) listed in MIL-STD-454 requirements 2, 10, 14, 33, 50, 57 and 58.

(c) Other ER parts.

(d) Conventional military specification parts.

(e) ER parts that use the Weibull failure rate prediction method, as specified in MIL-C-39003, shall require a B minimum failure rate level.

(f) Other passive components.

(g) Carbon composition resistors may be used in special applications (high voltage or high current surge) when approved as nonstandard parts. Specifications for these nonstandard parts (including MIL-R-39008 carbon composition resistors) shall include appropriate parametric and quality requirements.

(h) Aluminum electrolytic capacitors, style CUR02, MIL-C-39018/9 can only be used after approval of the nonstandard part request.

(i) Connectors shall be designed to prevent corona discharge. When voltages exceed 315 VDC or 223 VAC, the connectors shall comply with requirement 45 of MIL-STD-454.

3.10.1.5 Other microcircuits. All other microcircuits shall include the following information in the non-standard part specification.

(a) Device nomenclature, marking, configuration, group A electrical requirements for the full military temperature range which will insure form, fit, function, and interchangeability.

(b) The required sampling and screening plans which will allow the procured devices to be in accordance with the "Provisions for the use of MIL-STD-883 in conjunction with compliant non-JAN devices" paragraph of MIL-STD-883. Hybrids shall meet the requirements of MIL-H-38534 for a class B product assurance level.

(c) Hybrid microcircuit suppliers shall be certified to MIL-STD-1772 or in the process of receiving MIL-STD-1772 certification and will be audited by APSP-QAA.

3.10.1.6 Magnetic components. Transformers and inductors shall be in accordance with MIL-STD-454, requirement 14. Only temperature classes V, T, and U of MIL-T-27 shall be used. Magnetic components shall be subjected to 100 percent thermal-shock screening in accordance with MIL-STD-202, method 107, test condition B.

3.10.2 Parts derating. Electrical parts shall not be stressed more than the percentage of their rated value specified in table VIII, in the environments specified in 3.5 (except for the 105°C thermal transient paragraph 3.5.2.1.2(c)), at nominal input voltage and at maximum rated output power. Parts shall not be stressed more than their maximum rated value at maximum input voltage and maximum rated output power. Electrical parts which are stressed more than the indicated percentages shall be approved by the APSP-QAA.

TABLE VIII. Parts derating.

Part type	Derating parameter	Percent of rated (or indicated value)
Resistors		
Carbon composition	Power/voltage	50/80
Film high stability	Power/voltage	50/80
Wirewound accurate	Power/voltage	50/80
Wirewound chassis mounting	Power/voltage	50/80
Variable wirewound	Power/voltage	50/80
Variable non-wirewound	Power/voltage	50/80
Thermistor	Power/voltage	50/80
Tantalum nitride chip	Power/voltage	50/80
Capacitors		
All	Ripple voltage or ripple current	50
Ceramic	Voltage	50
Glass Voltage 50		
Mica:		
Dipped	Voltage	60
Molded	Voltage	40
Film dielectric	Voltage	50
Mylar	Voltage	50
Paper	Voltage	50
Tantalum solid (100 percent current surge test required)	Voltage	50
	Reverse voltage	2 percent of rated DC up to 85°C
	Reverse voltage	1 percent of rated DC from 85°C to 125°C
Tantalum wet (Style CLR 79, MIL-C-39006/22, only)	Voltage	60
	Reverse voltage	0
Tantalum foil	Voltage	50

TABLE VIII. Parts derating - Continued.

Part type	Derating parameter	Percent of rated (or indicated value)
Aluminum Electrolytic (style CUR02, MIL-C-39018/9 only)	Voltage Reverse voltage	70 0
Connectors	Contact current	50 percent of max. rating
	Parallel contacts	37.5 percent of max. rating
	Working voltage	25 percent of dielectric withstanding voltage
Magnetic devices	Hot spot temperature (see 3.12.1)	30°C below insulation rating
	Temperature rise above thermal interface (see 3.12.1)	40°C max.
	Voltage, continuous	60
	Voltage, surge	90
	Voltage, insulation breakdown	25
	Current density	2.0 mA per circ mil 4.0 mA
RF coils Relays	Current density (foil conductors) Current Contact power Contact current (continuous)	per circ mil 50 25 50 resistive 25 inductive

TABLE VIII. Parts derating - Continued.

Part type	Derating parameter	Percent of rated (or indicated value)
	Contact current (surge)	80
	Coil energize/ dropout voltage	vendor's nominal rating
	Vibration	75 3/
Switches	Contact current	resistive 50 inductive 25
	Contact voltage	50
Transistors, bipolar, power, and FET	Power1/	50
	Forward current	50
	Reverse voltage across and junction	
	Continuous	75
	Transient peak	80
	Junction temperature	110°C (see 3.12.1)
Diodes		
Switching, general purpose, rectifier, thyristor	Current (surge)	70
	Current (continuous)	60
	Voltage, peak inverse	65
Zener	Power	50
All	Junction temperature	110°C (see 3.12.1)
Microcircuits	Current	70
Linear	Voltage (signal)	75
	Voltage (surge)	80
	Voltage, reverse junction:	
	Signal	65
	Surge	85

TABLE VIII. Parts derating - Continued.

Part type	Derating parameter	Percent of rated (or indicated value)
Microcircuits, continued Digital 2/	Supply voltage	Hold to vendor's nominal rating
	Fan out	80
All	Junction temperature	110°C (see 3.12.1)

1/ Maximum ratings as determined by the safe operating area (SOA) curves for power switching transistors shall not be exceeded.

2/ Many families of digital microcircuits exhibit additional characteristics which may require derating (for example, toggle frequency, hold times).

3/ This derating includes any contribution by the device mounting.

3.10.3 Internal wiring and cabling. The use of internal wiring and cabling shall be minimized to the greatest extent possible. When internal wiring and cabling is required, it shall be in accordance with MIL-STD-454, requirements 45, 69 and 71.

3.10.4 Printed-wiring and printed-wiring assemblies. Printed-wiring and printed-wiring assemblies shall conform to the following requirements. Equivalent materials, processes, and requirements shall be utilized only when approved by the APSP-QAA. These equivalent materials, processes, and requirements shall be documented and forwarded to the APSP-QAA for review and approval. The board will be laid out to prevent corona and electrical breakdown as specified in requirement 45 of MIL-STD-454.

3.10.4.1 Rigid printed-wiring boards. The design of rigid printed-wiring boards shall be in accordance with MIL-STD-275. The quality of rigid printed-wiring boards shall be in accordance with MIL-P-55110.

3.10.4.2 Printed-wiring assemblies. The design and quality of printed-wiring assemblies shall be in accordance with MIL-STD-2000.

3.10.4.3 Flexible printed wiring and assemblies. The design and quality of flexible printed-wiring and assemblies shall be in accordance with MIL-P-50884, type 1, class B.

3.10.5 Thick film multilayer interconnect boards (MIBs) and assemblies. All thick film MIBs and assemblies shall conform to the following requirements. Equivalent materials, processes, and requirements shall be utilized only when approved by the APSP-QAA. These equivalent materials, processes, and requirements shall be documented and forwarded to the APSP-QAA for review and approval.

3.10.5.1 Thick film MIBs. The design of thick film MIBs shall be in accordance with MIL-STD-1389, appendix F. The quality of thick film MIBs shall be in accordance with the requirements of MIL-M-28787, appendix B (see 6.5.6).

3.10.5.2 Thick film MIB assemblies. The design and quality of thick film MIB assemblies shall be in accordance with MIL-STD-1389, appendix H (see 6.5.6).

3.10.6 Internal adjustments. No externally accessible adjustments shall be permitted. Any output adjustment devices (other than pin programming) shall be internal to the power supply and shall be designated as factory, depot, or shop adjust only. If adjustment entails a moving part (for example, a potentiometer), the part shall be secured after adjustment to prevent movement during vibration and shock.

3.10.6.1 Range of adjustments. The range of all adjustments to the power supply shall be such that no damage can be induced as a result of the adjustment being set anywhere in its range.

3.10.7 Failure limitation. The design shall limit failures to the power supply in which the fault occurs. That is, a failure in one power supply shall not induce a subsequent failure outside of the failed power supply. The design shall limit failure propagation within the power supply to the greatest extent possible.

3.10.8 Powered socket. Power supplies shall not be removed from, or inserted into, a powered socket. Marking on the power supply shall contain this precautionary information.

3.10.9 Design of the power supply for stability. The power supply shall be designed to maximize the stability of the power supply when operating with airborne power source impedances (instability, if it occurs, is caused by the source impedance being higher than the power supply negative input impedance and forming a negative resistance oscillator). To achieve this stability, the design shall utilize features such as damping to minimize the gain or peaking at resonance of its input filter network and shall incorporate self turn-off under low input voltage conditions (see 3.3.1.7).

The manufacturer shall measure the power supply input impedance over the input voltage range from maximum down to power supply turn-off and over a frequency range of 50 Hz to 100 kHz or up to the voltage feedback loop gain crossover frequency (whichever is greater) to evaluate the design. An accurate computer model of the input network will be generated by the manufacturer. The measured data and computer model and curves obtained from this computer model shall be submitted to the APSP-QAA for evaluation. The associated detail specification shall define the criteria for an acceptable model. The computer model will be made available to system manufacturers utilizing the APSP power supplies.

3.11 Mechanical design and construction.

3.11.1 General design features. The power supplies shall be designed such that their physical characteristics enhance their ability to meet the electrical performance requirements when exposed to the environments specified in 3.5 (see 3.3). The designs shall incorporate features which will provide for operational use, repair, handling and storage without the use of special tools, handling equipment or techniques. Design and construction shall be in accordance with MIL-E-5400 except as specified herein or in the associated detail specification.

3.11.2 Internal modularity (family A1).

3.11.2.1 Connectorized. The internal modules of the power supply shall be configured such that all input and output terminations are made through connectors or solderless terminals. Keying shall be provided such that each module type is uniquely keyed. Connectors used on internal modules shall withstand 100 insertions and extractions without degradation.

3.11.2.2 Modular interchangeability. Power supply types shall be designed such that maximum commonality of internal modules is achieved among power supply types. Internal modules of a given type shall be mechanically and electrically interchangeable regardless of the power supply in which they are used when operated within the required power supply design limits.

3.11.3 Power supply interchangeability. Power supplies of a given type shall be mechanically and electrically interchangeable regardless of the system in which they are used when operated within the required power supply design limits.

3.11.4 Conformal coating.

3.11.4.1 Family A1. Unless otherwise approved by the APSP-QAA, printed-wiring board assemblies shall be conformally coated in accordance with MIL-C-28809 and MIL-I-46058, except that silicone resin shall not be used. The conformal coating shall be a continuous, homogeneous, fully cured material which covers all components, leads, and circuitry, except grounding surfaces. The coating thickness may vary with the irregularity of the surface.

3.11.4.2 Family A2. The conformal coating shall be in accordance with the conformal coating requirements of MIL-STD-1389, appendix H. The conformal coating shall be a continuous, homogeneous, fully cured material which covers all components, leads, and circuitry, except grounding surfaces. The coating thickness may vary with the irregularity of the surface.

3.11.5 External connections. The method of external connection to the power supplies shall be as specified herein and in the associated detail specification (see 3.4.2). When multiple connector contacts are specified for an interface function (such as an output) for current capacity, redundancy, and so forth, all multiple contacts for each function shall be used to interface the power supply to external sources and loads.

3.11.6 Mounting (family A1). The power supplies shall be designed for mounting in accordance with the requirements of MIL-E-85726.

3.11.7 Finishes and protective treatments. The finishes and protective treatment of surfaces shall enable the power supply to meet the requirements specified herein. Acceptance or approval of a finish or protective treatment shall not be construed as an assurance of the acceptance of the finished product.

3.11.7.1 Family A1. External aluminum alloy surfaces of the power supply shall be anodized in accordance with MIL-A-8625 (type optional) or chromate conversion coated in accordance with MIL-C-5541 (class optional). External chromate conversion coated surfaces and steel surfaces of the power supply shall be painted. Painting of anodized surfaces is optional. The finished color of all external surfaces, except the mounting surface, shall be Lusterless Gray Color No. 36231 of FED-STD-595. The surface finish of the power supply shall be free of any imperfections that have a detrimental effect upon the performance of the unit.

3.11.7.2 Family A2. MIL-STD-889 shall be used in the selection of finishes and protective treatments to insure galvanic corrosion protection.

3.11.7.2.1 Frame surface. Frame surface treatments shall be as specified in appendices B, C and E of MIL-STD-1389.

3.11.8 Keying (family A1). Power supply connectors shall be keyed in accordance with the associated detail specification and MIL-C-38999 or MIL-C-83527.

3.11.9 Mechanical configuration requirements (family A2). The power supply mechanical configurations are specified in appendices B, C and E of MIL-STD-1389. Power supplies shall be capable of meeting the requirements specified in 3.11.9.1 through 3.11.9.6.5.4 without mechanical or electrical degradation (see 4.7.6).

3.11.9.1 Depth. Unless otherwise specified in the associated detail specification, the only parts of the power supply that extend below the interface plane are the keying pins, contacts, and pin shields. When specified in the associated detail specification, the body of the power supply on multiple increment power supplies is permitted to extend below the interface plane within the limits specified in appendices B, C and E of MIL-STD-1389.

3.11.9.2 Rib structure. The power supply ribs shall perform the following functions.

(a) Alignment during insertion or extraction.

(b) Retention.

(c) Cooling.

The rib configuration is shown in appendices B, C and E of MIL-STD-1389.

3.11.9.2.1 Rib strength. Individual power supply ribs shall withstand a torque of 10 inch-pounds (1.1 newton-meters) minimum maintained for 10 to 15 seconds (see 4.7.6.1).

3.11.9.3 Pin shields. Power supplies shall be provided with pin shields to protect the contacts. Details of pin shields are specified in appendices B, C and E of MIL-STD-1389. Power supplies are required to have pin shields adjacent to each outside row of power supply contacts. Pin shields shall be of a nonconducting material or, if of a conducting material, the outside surface of the shield shall be treated in a manner that will prevent conduction into the base conducting material.

3.11.9.3.1 Pin shield retention. The pin shield shall withstand, without visible separation from its base, a force of 4 pounds (18 newtons) minimum (see 4.7.6.2). The requirement shall be met after exposure to all manufacturing process temperatures, including preconditioning.

3.11.9.4 Fin and header structure. The power supply fin for format B and the header structure for formats C and E shall be as specified in appendices B, C and E of MIL-STD-1389.

3.11.9.4.1 Power supply torque. Format B power supplies shall withstand a 6 inch-pound (0.68 newton-meter) minimum torque and format C and E power supplies shall withstand a 25 inch-pound minimum torque (2.83 newton-meters) (see 4.7.6.3).

3.11.9.4.2 Header torque. Format B power supplies shall withstand a 6 inch-pound (0.68 newton-meter) minimum torque and format C and E power supplies shall withstand a 10 inch-pound (1.1 newton-meter) header torque without detrimental effect to the mechanical or electrical properties of the power supply (see 4.7.6.4).

3.11.9.4.3 Fin/header cantilever load. Power supplies shall withstand a force of 2 pounds (9 newtons) minimum for format B and 5 pounds (22 newtons) for formats C and E (see 4.7.6.5).

3.11.9.5 Connector. The power supply connector shall be as specified in appendices B, C and E of MIL-STD-1389 for the applicable format. Connectors shall be in accordance with MIL-C-28754 and the requirements specified herein. Multiple increment power supplies may increase contact row quantities with each row of contacts complete.

3.11.9.5.1 Connector integrity, format B. Each assembled format B power supply and connector shall withstand a minimum axial force along the contact pin length in either direction equal to the product of 12 ounces (3.3 newtons) minimum multiplied by the number of contacts without any visible separation or bending (see 4.7.6.6). (For example, 12 ounces (3.3 newtons) minimum multiplied by 40 contacts equals 480 ounces (133 newtons)). The total computed force shall be applied simultaneously to all power supply connector contacts simulating power supply insertion and extraction.

3.11.9.5.2 Connector integrity, formats C and E. Each assembled format C or E power supply and connector shall withstand without damage or visible separation a minimum axial force normal to the interface plane equal to 100 pounds (445 newtons) on insertion and 4 ounces (1.1 newtons) per contact on extraction (see 4.7.6.6). The total computed force shall be applied simultaneously to all power supply contacts simulating power supply insertion and extraction.

(a) On insertion, a 100 pounds plus 5 or minus 0 pounds (445 newton plus 22.3 or minus 0 newton) force shall be uniformly applied at two locations on the top surface of the header. These two locations are centered on the header width and are located 0.75 inch (19.1 mm) to 1.25 inches (31.8 mm) from both ends of the header. This force shall be uniformly applied by two plates (0.5 inch (12.7 mm) square) forcing the power supply connector interface plane against a plate with clearance provisions for the row of contacts.

(b) On extraction, a 4.0 ounce plus 0 or minus 0.1 ounce (1.1 newton plus 0 or minus 0.03 newton) force per contact shall be applied at the two extractor holes. A suitable means of clamping the body of the power supply connector shall be employed to prevent extraction of the power supply from the test fixture. The force shall be obtained in 2 to 10 seconds and maintained for 10 to 15 seconds.

3.11.9.5.3 Contacts. The number of contacts on the power supply and their location shall be as specified in the associated detail specification. The contact configuration is controlled (see figure 6) only on that part of the contact protruding from the power supply connector surface (the interface plane).

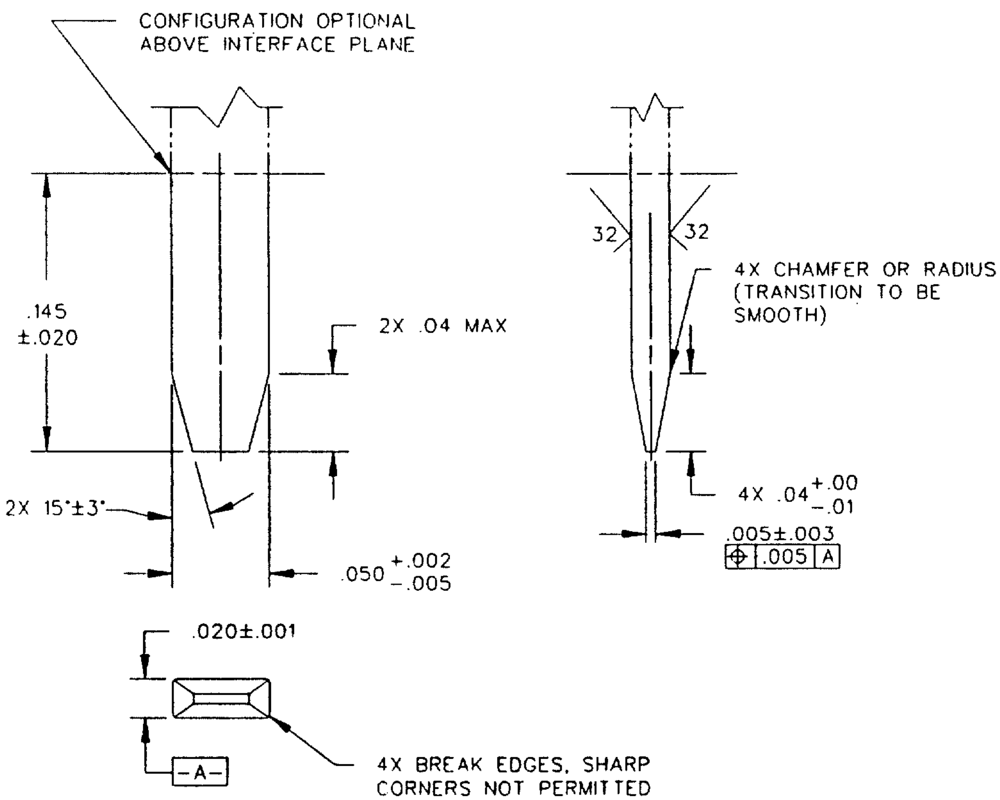
3.11.9.5.4 Connector contact integrity. Each contact as mounted in the connector shall withstand an axial force of 20 ounces (5.6 newtons) minimum applied in 2 to 10 seconds along the length of the contact blade in either direction and maintained for 10 to 15 seconds (see 4.7.6.7).

3.11.9.5.5 Contact material. The material used for the power supply contacts shall be a solid metal selected according to the manufacturing process used. Approved materials are those specified in MIL-C-28754.

3.11.9.5.6 Contact plating. The contact shall be gold plated in accordance with MIL-G-45204, type II, grade C, class 1. Contacts shall have nickel underplating of 0.00005 inch (0.00127 mm) minimum in accordance with QQ-N-290, class 1.

3.11.9.6 Keying. Each power supply is assigned an alpha or alpha-numeric key code. The first letter indicates the style and angular position of the keying pin in the alpha keying pin location and the last letter indicates the style and angular position of the keying pin in the beta keying pin location.

3.11.9.6.1 Keying pin orientation. Keying pins shall be orientated to agree with the basic angle specified for the power supply by the code letters on figures 7, 8, and 9. The code letters indicate the only possible first and last letters, in that order of the power supply key code for the combination of keying pin styles indicated on that particular figure. Code letter combinations other than those shown entirely on figures 7, 8, or 9 are not allowed. Power supply keying pin styles and orientations shall be taken entirely from either figure 7, 8, or 9; no other combinations (such as mixing an alpha orientation from figure 7 and a beta orientation from figure 8) are allowed. Figure 10 is an example of power supply keying pin configuration and specifies the tolerance for angular positioning.



Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.001	0.025	0.005	0.127	0.020	0.508	0.050	1.270
0.002	0.051	0.01	0.25	0.04	1.02	0.145	3.683
0.003	0.076						

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 6. Family A2 blade contact.

BETA LOCATION / ALPHA	A,J 0°	B,K 45°	C,L 90°	D,M 135°	E,N 180°	F,P 225°	G,Q 270°	H,R 315°
A,J 0°	A-A A-J J-A J-J	A-B A-K J-B J-K	A-C A-L J-C J-L	A-D A-M J-D J-M	A-E A-N J-E J-N	A-F A-P J-F J-P	A-G A-Q J-G J-Q	A-H A-R J-H J-R
B,K 45°	B-A B-J K-A K-J	B-B B-K K-B K-K	B-C B-L K-C K-L	B-D B-M K-D K-M	B-E B-N K-E K-N	B-F B-P K-F K-P	B-G B-Q K-G K-Q	B-H B-R K-H K-R
C,L 90°	C-A C-J L-A L-J	C-B C-K L-B L-K	C-C C-L L-C L-L	C-D C-M L-D L-M	C-E C-N L-E L-N	C-F C-P L-F L-P	C-G C-Q L-G L-Q	C-H C-R L-H L-R
D,M 135°	D-A D-J M-A M-J	D-B D-K M-B M-K	D-C D-L M-C M-L	D-D D-M M-D M-M	D-E D-N M-E M-N	D-F D-P M-F M-P	D-G D-Q M-G M-Q	D-H D-R M-H M-R
E,N 180°	E-A E-J N-A N-J	E-B E-K N-B N-K	E-C E-L N-C N-L	E-D E-M N-D N-M	E-E E-N N-E N-N	E-F E-P N-F N-P	E-G E-Q N-G N-Q	E-H E-R N-H N-R
F,P 225°	F-A F-J P-A P-J	F-B F-K P-B P-K	F-C F-L P-C P-L	F-D F-M P-D P-M	F-E F-N P-E P-N	F-F F-P P-F P-P	F-G F-Q P-G P-Q	F-H F-R P-H P-R
G,Q 270°	G-A G-J Q-A Q-J	G-B G-K Q-B Q-K	G-C G-L Q-C Q-L	G-D G-M Q-D Q-M	G-E G-N Q-E Q-N	G-F G-P Q-F Q-P	G-G G-Q Q-G Q-Q	G-H G-R Q-H Q-R
H,R 315°	H-A H-J R-A R-J	H-B H-K R-B R-K	H-C H-L R-C R-L	H-D H-M R-D R-M	H-E H-N R-E R-N	H-F H-P R-F R-P	H-G H-Q R-G R-Q	H-H H-R R-H R-R

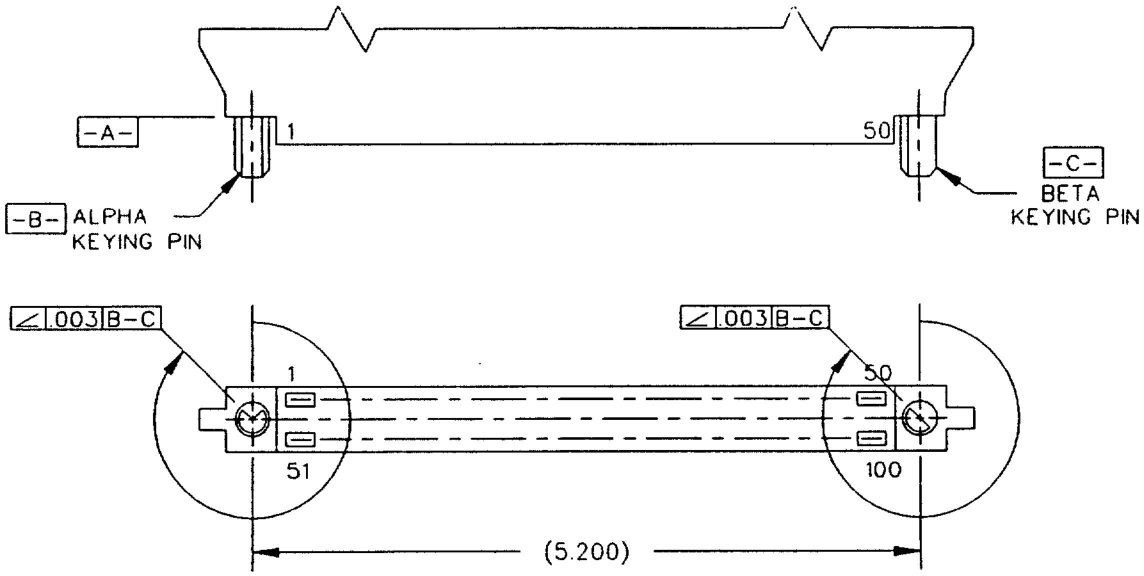
FIGURE 7. Family A2 style 1/2 keying chart (viewing connector as shown on figure 10).

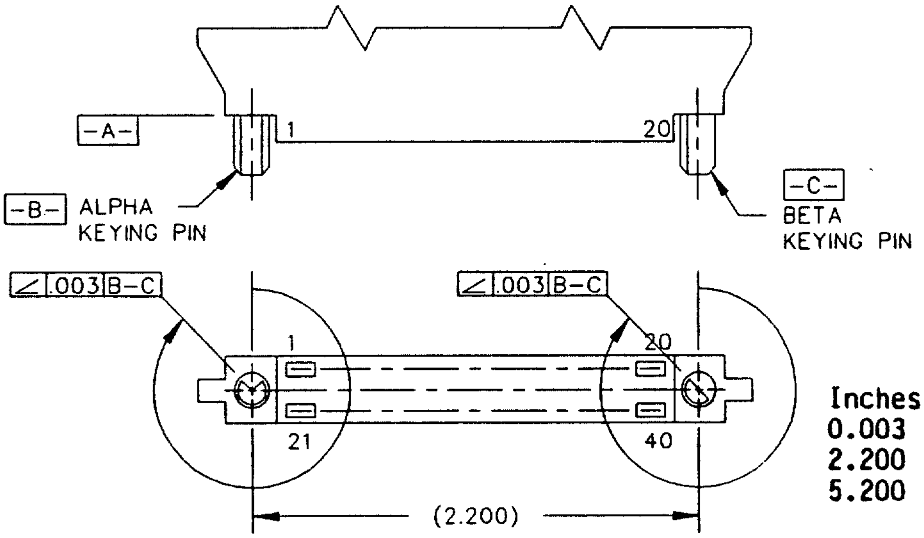
BETA LOCATION / ALPHA	S 0°	T 45°	U 90°	V 135°	W 180°	X 225°	Y 270°	Z 315°
S 0°								
T 45°	T–S	T–T	T–U	T–V	T–W		T–Y	T–Z
U 90°	U–S	U–T	U–U	U–V	U–W			U–Z
V 135°	V–S	V–T	V–U	V–V	V–W			
W 180°		W–T	W–U	W–V	W–W			
X 225°			X–U	X–V	X–W			
Y 270°				Y–V	Y–W			
Z 315°					Z–W			

FIGURE 8. Family A2 style 1/1 keying chart (viewing connector as shown on figure 10).

BETA LOCATION ALPHA	S 0°	T 45°	U 90°	V 135°	W 180°	X 225°	Y 270°	Z 315°
S 0°	S-S	S-T	S-U	S-V		S-X	S-Y	S-Z
T 45°								
U 90°						U-X		
V 135°						V-X	V-Y	
W 180°						W-X	W-Y	W-Z
X 225°	X-S					X-X	X-Y	X-Z
Y 270°	Y-S	Y-T				Y-X	Y-Y	Y-Z
Z 315°	Z-S	Z-T	Z-U			Z-X	Z-Y	Z-Z

FIGURE 9. Family A2 keying chart (viewing connector as shown on figure 10).





Inches	mm
0.003	0.076
2.200	55.880
5.200	132.080

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 10. Family A2 keying pin orientation.

3.11.9.6.2 Keying pin locations. There are two keying pin locations on each power supply, one designated alpha and one designated beta. The alpha and beta keying pin locations are near the lowest and highest numbered connector contacts in the first row, respectively, as illustrated on figure 10.

3.11.9.6.3 Keying pin styles. Keying pin styles shall be as specified on figure 11.

3.11.9.6.4 Keying pin sets. Only the keying pin styles and keying pin locations specified in table IX are permitted.

TABLE IX. Keying pin styles and locations.

Location Alpha (a)	Location Beta (b)	Style of Combination	Notes
Style 1	Style 2	Style 1/2	See figure 6
Style 1	Style 1	Style 1/1	See figure 7
Style 2	Style 2	Style 2/2	See figure 8

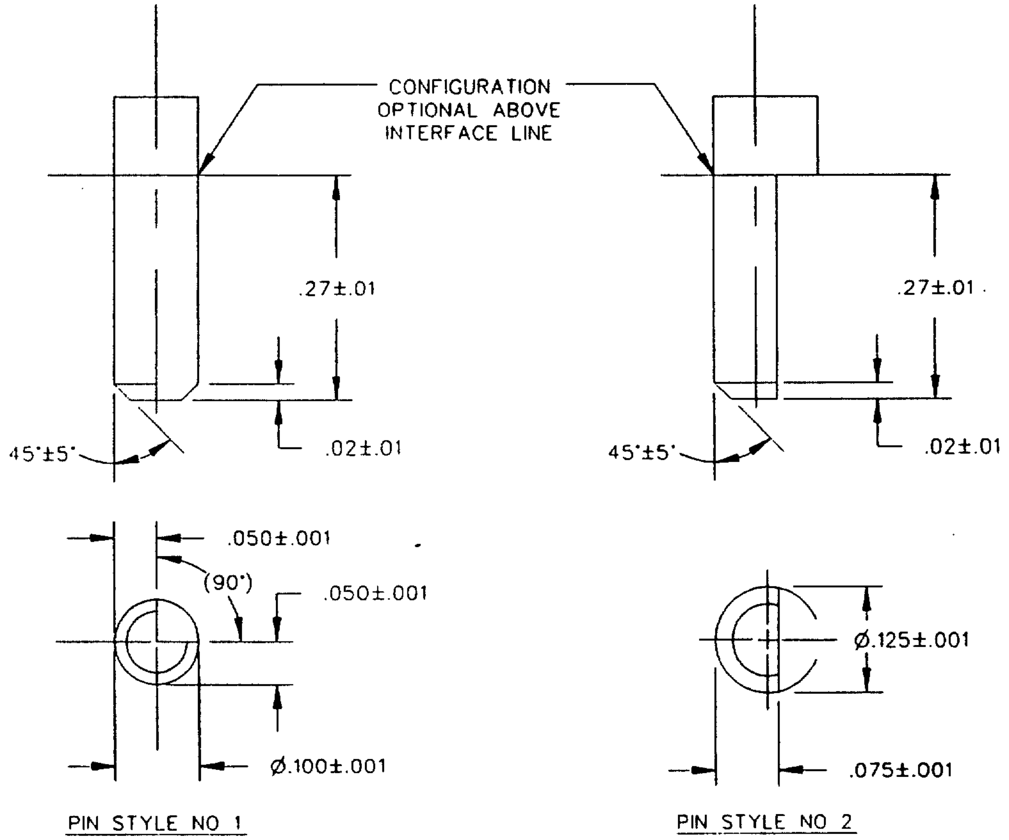
3.11.9.6.5 Keying pin integrity requirement. When installed in the power supply, the keying pins shall meet the following integrity requirements.

3.11.9.6.5.1 Keying pin torque. Each keying pin shall withstand a torque of 20 inch-ounces (0.14 newton-meter) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds (see 4.7.6.8).

3.11.9.6.5.2 Keying pin pullout. Each keying pin shall withstand a pullout force of 9 pounds (40 newtons) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds (see 4.7.6.9).

3.11.9.6.5.3 Keying pin cantilever load. Each keying pin shall withstand a cantilever load of 10 pounds (45 newtons) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds (see 4.7.6.10).

3.11.9.6.5.4 Keying pin pushout. Each keying pin shall withstand a pushout force of 40 pounds (178 newtons) minimum (see 4.7.6.11). The force shall be applied in the opposite direction to the force in 3.11.9.6.5.2. This test applies only to connectors whose design permits keying pin pushout.



Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.001	0.025	0.02	0.51	0.075	1.905	0.125	3.175
0.01	0.25	0.050	1.270	0.100	2.540	0.27	6.86

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 11. Family A2 keying pin styles.

3.12 Thermal design and construction.

3.12.1 Component temperatures.

3.12.1.1 Critical component temperatures (CCT). The CCT is the maximum component temperature allowed for a power supply operating at the worst case temperature (71°C plus 5 or minus 0°C ambient for family A1 or a rib temperature of 85°C plus 0 or minus 5°C for family A2) and altitude conditions. The CCT (junction for semiconductors, winding hot spot for transformers, and case hot spot for other passive components) shall be in accordance with 3.12.1.1.1 through 3.12.1.1.3. In no case shall the CCT exceed the absolute maximum specified operating temperature (see 4.7.7).

3.12.1.1.1 Semiconductors. The CCT for semiconductor devices shall be 110°C.

3.12.1.1.2 Transformers and inductors. The CCT for transformers shall not exceed the following values for the different classes of MIL-T-27.

3.12.1.1.2.1 Class V, MIL-T-27. The CCT shall not exceed 125°C.

3.12.1.1.2.2 Class T or U, MIL-T-27. The CCT shall not exceed 140°C.

3.12.1.1.3 Other parts. The CCT of other parts shall not exceed the individual component's maximum specified operating temperature minus 20°C and shall be specified on the component's hottest external area.

3.12.1.2 Transient critical component temperature (TCCT). The TCCT is the maximum component temperature allowed for a power supply operating under worst case transient temperature and altitude conditions specified in 3.5.2.1. The TCCT shall be 20°C greater than that specified in 3.12.1.1. In no case shall the TCCT exceed the absolute maximum specified part operating temperature (see 4.7.7).

3.12.2 Thermal requirements.

3.12.2.1 Family A1. Unless otherwise specified herein or in the associated detail specification, the power supply thermal requirements shall be in accordance with MIL-E-85726 except the input power capability given in table V of MIL-E-85726 shall be interpreted as the enclosure power dissipation capability. Cooling air mass flow rate and inlet to outlet pressure drop shall be in accordance with the associated detail specification, but in no case shall they exceed the maximum allowed by MIL-E-85726. Unless otherwise specified herein or in the detail power supply specification, the inlet air temperature shall be 27°C plus or minus 5°C and the outlet air temperature shall be 71°C maximum. For the purpose of testing, analysis, and prediction, the total heat generated by the power supply shall be removed through the power supply cooling air.

3.12.2.2 Family A2. Unless otherwise specified herein or in the associated detail specification, thermal requirements shall be in accordance with appendices B, C and E of MIL-STD-1389.

3.12.3 Thermal grease. Internal construction of the power supply shall minimize the use of thermal grease to the greatest extent possible. Silicone thermal grease shall not be used for heat transfer without approval of the APSP-QAA.

3.12.4 Air seal seating area (family A1). The location and dimensions of the inlet air seal seating area reserved shall be in accordance with DOD-STD-1788, figure 4.

3.12.5 Leakage (family A1). Maximum allowable cooling air leakage rate shall be not greater than 0.1 percent of the maximum flow rate specified in the associated detail specification when tested in accordance with 4.7.7.3.

3.13 Proprietary parts, processes, or techniques. A power supply shall not be designed such that utilization of proprietary parts, processes, or techniques will result in restricting or eliminating additional power supply designs from meeting the same performance requirements. Proprietary parts are considered to be non-standard parts (see 3.9.3) and usage shall be minimized to the greatest extent possible.

3.14 Identification and marking.

3.14.1 Power supply marking. Power supplies shall be identified and marked with appropriate identifiers as specified herein. The following minimum information shall be marked on the power supplies:

(a) Certification mark.

(b) Power supply part number, revision letter and amendment number.

(c) Power supply key code.

(d) Manufacturer's identification and manufacturer's power supply assembly number.

(e) Serial number.

(f) Date code.

(g) Electrostatic discharge (ESD) marking.

(h) Precautionary and safety marking (family A1).

(i) Input voltages (family A1).

(j) Output voltages (family A1).

(k) Output currents (family A1).

(l) Hold-down fastener torque.

(m) Name (family A2).

(n) Connector contact information.

(o) Extractor fin identification (family A2).

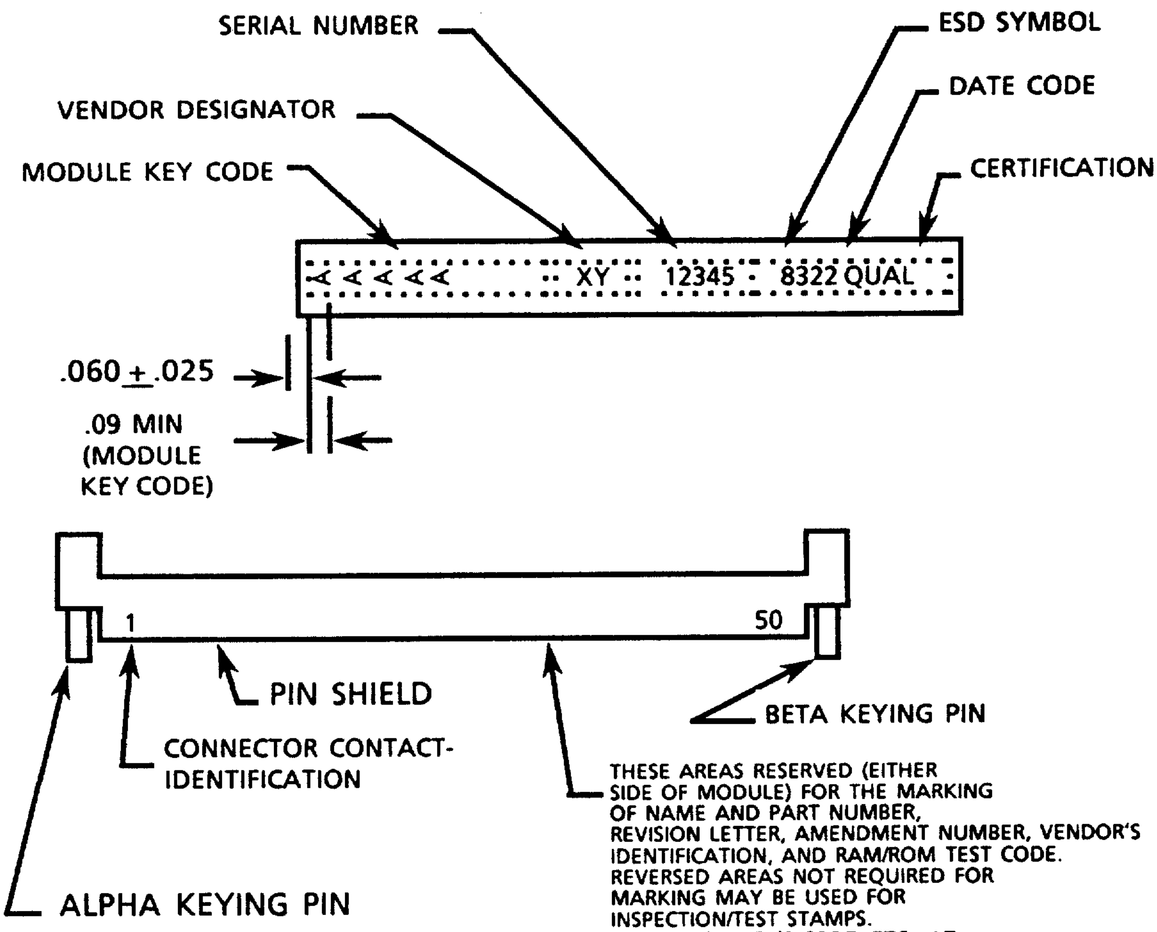
(p) Internal subassembly marking.

Markings shall be a minimum of 0.06 inch (1.52 mm) high (excluding keycode for family A2) and applied in accordance with MIL-STD-130. Markings shall be a contrasting color to the surrounding power supply area. All marking shall be permanent and legible in accordance with MIL-STD-1285.

3.14.1.1 Marking location.

3.14.1.1.1 Family A1. The marking shall be located as specified herein and in the associated detail specification.

3.14.1.1.2 Family A2. The marking shall be located as shown on figure 12 or as specified in the associated detail specification.



inches	mm
.025	.635
.060	1.524
.09	2.29

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The 0.060 spacing between fin end and the module key code shall be measured between the first letter of the key code and that part of the fin nearest the alpha end of the module having a width of 0.150 inch (3.810 mm) minimum.

FIGURE 12. Family A2 marking areas.

3.14.1.2 Certification mark. All power supplies which meet the requirements of this specification and the associated detail specifications shall have the qualification certification mark "QUAL" marked in accordance with the associated detail specification. Authorization to mark "QUAL" must be obtained from the APSP-QAA (see 6.11). Items furnished under contracts or purchase orders which either permit or require deviation from the conditions or requirements specified herein, or in the associated detail specification, shall not bear "QUAL". In the event the item fails to meet the requirements of this specification and the associated detail specification, the manufacturer shall remove the "QUAL" from the sample tested and also from all items represented by the sample. The "QUAL" certification mark shall not be used on power supplies acquired to contractor drawings or specifications.

3.14.1.3 Power supply part number and revision status. The power supply part number, revision letter, and amendment number shall be marked as specified herein (see 6.10) and in the associated detail specification. This information is located in the same area as the manufacturer's identification. All APSP part numbers will be assigned by the SEM-DRA. Requests for part number assignment shall be prepared and submitted in accordance with MIL-STD-2038. A power supply shall be marked with the revision status of the associated detail specification to which it was tested when manufactured.

3.14.1.4 Key code.

3.14.1.4.1 Family A1. Each power supply shall be marked with a key code assigned in accordance with MIL-STD-2038. Keying and key codes shall be in accordance with 3.11.8.

3.14.1.4.2 Family A2. Each power supply shall be marked with a key code assigned in accordance with MIL-STD-2038. Keying and key codes shall be in accordance with 3.11.9.6.

3.14.1.5 Manufacturer's identification. Each power supply shall be marked with either the manufacturer's identification code or manufacturer's name. The manufacturer's code, if used, shall be a numerical code as listed in Handbook H4-2. The power supply shall be marked with the manufacturer's power supply assembly number. In addition, a revision level, dash number or other appropriate designation shall be included with the power supply assembly number to identify the level to which the power supply was constructed.

3.14.1.6 Serial number. Each power supply shall have a serial number including the manufacturer's designation marked on the surface of the power supply. The serial number shall consist of five digits with significant digits prefixed with zeros as required. The serial number shall be affixed to the power supply prior to electrical acceptance tests.

3.14.1.6.1 Serial number sequence. Each power supply manufacturer shall serialize each power supply. The serial number for any given key code shall start with number 1 and continue in numerical sequence as many times as the power supply is manufactured, regardless of contract or customer.

3.14.1.6.2 Manufacturer's designation. A single or double alpha character will be assigned to each manufacturer contracted to produce power supplies. The designation shall be prefixed to the serial number. Request for a manufacturer designation shall be submitted to the SEM Design Review Activity (SEM-DRA) (see 6.7).

3.14.1.7 Date code. Each power supply shall be marked with a four-digit date code designating the year and week of manufacture. The first two digits of the code shall be the last two numbers of the year and the third and fourth digits of the code shall be the calendar week. When the number of the week is a single digit, it shall be preceded by a zero. The date code for a given power supply shall be the calendar week in which the last major manufacturing assembly process occurred prior to the final acceptance inspection, plus or minus 1 week.

3.14.1.8 Electrostatic discharge (ESD). Power supplies that are determined by the manufacturer or by the APSP-QAA activity to be sensitive to ESD by prior knowledge of device technologies or by testing to this specification shall be marked in the areas specified by the APSP-QAA or in the associated detail specification with the ESD identifier specified in MIL-STD-1285. If the minimum symbol size specified in MIL-STD-129 cannot be met, the size shall be maximized for the particular fin configuration.

3.14.1.9 Precautionary and safety marking.

3.14.1.9.1 Family A1. Unless otherwise specified in the associated detail specification, precautionary and safety markings shall read:

"CAUTION
*OPERATE WITH COOLING AIR
*HAZARDOUS LINE VOLTAGE
*DISCONNECT POWER BEFORE
REMOVING OR INSTALLING UNIT"

When required, additional precautionary and safety labels (installation and removal instructions, high surface temperature caution, and so forth) shall be specified in the associated detail specification or approved by the APSP-QAA.

3.14.1.9.2 Family A2. Unless otherwise specified in the associated detail specification, precautionary and safety marking shall read:

"CAUTION
*DISCONNECT POWER BEFORE
REMOVING OR INSTALLING UNIT"

When the power supply size is multiple thickness and if space permits, the caution note shall be on the top of the power supply. When required, additional precautionary and safety labels (see 3.14.1.9.1) shall be specified in the associated detail specification or approved by the APSP-QAA.

3.14.1.10 Input voltage (family A1). The input voltage of the power supply shall be indicated in accordance with the types of input power (see 3.3.1).

3.14.1.11 Output voltage (family A1). Each output voltage of a power supply type shall be listed with programming levels separated by slashes and outputs separated by commas. For example, the output voltages for a dual output, programmable power supply may be listed as:

Output voltage: 5.0/5.2 V.

3.14.1.12 Output currents (family A1). The minimum and maximum rated currents for each output listed in 3.14.1.11 shall be marked in the same sequence as the output voltage levels. For example:

Output current: 1 to 10 A.

3.14.1.13 Mounting fastener torque (family A1). Each power supply shall be marked with the hold-down fastener torque requirements as specified herein or in the associated detail specification.

3.14.1.14 Name (family A2). Each power supply shall be marked with its name. The name and manufacturer's identification shall be orientated such that both are readable from the same point of view. The name marked on the power supply shall agree with the name in the title of the associated detail specification; however, abbreviation in accordance with MIL-STD-12 is permissible. The SEM-DRA is responsible for generation of an approved name. The names in Cataloging Handbook H6 shall be used if they appropriately describe the power supply. When Cataloging Handbook H6 does not list a name which appropriately describes the power supply, a name shall be developed in accordance with MIL-STD-961.

3.14.1.15 Connector contact identification (family A2). Each connector shall have contacts identified by numbers on the connector pinshield as indicated herein (see figure 10) or in the individual slash sheets of MIL-C-28754.

3.14.1.16 Extractor fin identification (family A2). Fins on format B multiple thickness power supplies which are used for extraction must be marked. See appendix B of MIL-STD-1389.

3.14.1.17 Internal subassembly marking. Internal modules shall be marked with the following information:

(a) Part number, revision letter, and amendment number.

(b) Serial number.

(c) Manufacturer's identification.

(d) Date code.

3.15 Safety (personnel hazard). Safety (personnel hazard) shall be in accordance with requirement 1 of MIL-STD-454 and as specified herein (see 3.3.1.14).

3.16 Workmanship. Workmanship of the power supply shall be in accordance with military specifications and standards as specified herein. General workmanship (workmanship pertaining to those areas of the power supply not specifically stated herein) shall be in accordance with requirement 9 of MIL-STD-454.

3.16.1 Metallic surfaces. Metallic surfaces shall be free of burrs, cracks and sharp edges. Voids, blowholes, fissures, or porosity that is discernible by the unaided eye shall not exceed 10 percent of the total metallic surface area. Connector contacts, keying pins, ribs and fins shall not be bent or damaged.

3.16.1.1 Scratches. Scratches or modifications on the surface of aluminum parts which have been processed in accordance with MIL-A-8625 shall be treated with chemical film in accordance with MIL-C-5541 and painted to match the finish color. Racking points only will be allowed on aluminum surfaces which have been treated in accordance with MIL-A-8625, type II, class 2. Scratches or modifications on other metallic surfaces shall be repaired using a protective coating that will guard against corrosion and will match the finish color. The area of repair shall not exceed 5 percent of the total surface area of the power supply.

3.16.2 Nonmetallic surfaces. Nonmetallic surfaces shall be free of cracks, foreign material, and sharp or rough edges. Voids, blisters, pinholes, or mold marks shall not exceed 10 percent of the total molded or potted surface area.

3.16.2.1 Molded or potted surfaces. Molded or potted surfaces shall be continuous, homogeneous and fully cured and shall cover all components, leads, and circuitry. Pits, pinholes, or voids not exceeding 0.030 inch (0.76 mm) diameter and 0.010 inch (0.25 mm) deep or scratches not exceeding 0.020 inch (0.51 mm) wide by 0.5 inch (12.70 mm) long and 0.010 inch (0.25 mm) deep are permissible, provided no components or circuitry are exposed. Maximum concentration of defects shall not exceed 5 percent of the total nonmetallic surface area.

3.16.3 Soldering and printed-wiring assemblies. Soldering and printed-board assemblies workmanship shall be in accordance with MIL-STD-2000. For power supplies, any item requiring approval or concurrence by the contracting officer shall also require approval by the APSP-QAA.

3.17 Documentation. When specified in the contract or purchase order, documentation shall be prepared (see 6.3). The power supplies shall conform to the released drawings.

3.18 Request for deviation or waiver. Requests for deviation or waiver from the materials, processes and requirements specified herein and from any applicable drawings, specifications, publications, and materials or processes referenced herein shall be submitted to the APSP-QAA and the command or agency concerned in accordance with MIL-STD-481 for approval.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier (see 6.5.3) is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the supplier's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the supplier of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 APSP-QAA verification. All quality assurance operations performed by the supplier will be subject to APSP-QAA verification. Failure of the supplier to promptly correct deficiencies discovered by him or of which he is notified shall be cause for suspension of acceptance until corrective action has been made or until conformance of product to prescribed criteria has been demonstrated.

4.2 Classification of inspection. Examination and inspection of the power supply shall be classified as follows:

(a) Qualification inspection (see 4.4).

(b) Quality conformance inspection (see 4.5).

4.3 Inspection conditions. Inspections shall be performed in accordance with the test conditions specified herein.

4.3.1 Standard test conditions. Unless otherwise specified by the APSP-QAA, tests shall be performed in an area having a relative humidity of up to 95 percent and a barometric pressure of between 24 and 32 inches (610 and 813 mm) of mercury. Temperature of the test area shall be maintained at 25°C plus or minus 5°C.

4.3.2 Thermal test conditions.

4.3.2.1 Family A1. Unless otherwise specified in the associated detail specification or herein, environmental test procedures shall be performed with the power supply mounted in a rack, tray, or shelf in accordance with the requirements of DOD-STD-1788. The ambient temperature shall be the ambient air temperature immediately surrounding the power supply. For test purposes, ambient temperature shall be the average of the temperature of the ambient air above the top and below the bottom surfaces of the power supply measured 25 mm (or midway between the power supply and any adjacent surface, whichever is less) from the surface at the center of the surface area. Air velocities immediately surrounding the avionics equipment shall be not greater than those caused by natural (free) convection effects. Cooling air bulk inlet temperature shall be as specified herein. Cooling air flow rate and delivery pressure shall be in accordance with the associated detail specification. Inlet cooling air relative humidity shall be not greater than 40 percent.

4.3.2.2 Family A2. Unless otherwise specified in the associated detail specification or herein, environmental test procedures shall be performed with the power supply mounting and temperature conditions in accordance with appendices B, C, and E of MIL-STD-1389. Power supply cooling shall be through the power supply ribs.

4.3.3 Test equipment. The ratio of specification tolerances to test equipment accuracy shall at least be 10:1 for tolerances of 3 percent or greater and at least 4:1 for tolerances of less than 3 percent. Exceptions, due to accuracy limitation of available test equipment, shall be specified in the associated detail specification. Deviations to either of the ratios as specified herein or the specified exceptions shall be recorded and approved in accordance with appendix A. Test equipment shall be accurately calibrated. Frequency of recallibration shall be in accordance with MIL-STD-45662. The test equipment may be laboratory instruments connected in a breadboard arrangement, a console type of equipment, or an automatic tester. Test setups are provided for laboratory instruments in the associated detail specification. The test equipment specified in the associated detail specification is typical of equipment adequate to perform the tests and shall be deemed as satisfying all accuracy requirements. Test equipment shall be in accordance with MIL-STD-1665 and the associated detail specification. Test equipment not specified in MIL-STD-1665 may be utilized for testing power supplies, provided accuracy tables for the equipment specified in the test procedure are submitted to the APSP-QAA for approval.

4.3.4 Gauges. The supplier shall provide gauges as necessary to ensure that each power supply meets all dimensional requirements. The Government representative shall be permitted to use any of the supplier's manufacturing gauges at no cost to the Government and shall be permitted to check such gauges when necessary. However, the fact that manufacturing gauges may have been so checked does not relieve the supplier of the responsibility of meeting all dimensional requirements.

4.3.5 Calibration standards. Standards used for calibration of inspection and test equipment shall be of an accuracy at least four times greater than the accuracy of the equipment being calibrated.

4.3.6 Electrostatic discharge. The supplier shall protect electrical and electronic parts, assemblies, and equipment from ESD in accordance with MIL-STD-1686 and DOD-HDBK-263.

4.4 Qualification inspection. Qualification inspection shall be performed by the APSP-QAA or its designated representative (see 6.5.2). Qualification inspection shall be conducted in accordance with the procedures described herein.

4.4.1 Initial qualification tests. Tests shall be performed to determine the capability of the power supply to meet the requirements specified herein and in the associated detail specification. The tests specified in table X (for family A1) and table XI (for family A2) and in the associated detail specification shall be performed on the quantity of samples listed. These samples shall be electrically and mechanically interchangeable with production power supplies but need not necessarily be manufactured under production conditions. Materials and processes shall be equivalent (equivalency shall be approved by the APSP-QAA prior to submittal) to those used in production. The supplier is not required to perform the tests marked "Q" in the associated detail specification, however, the samples shall meet the "Q" test requirements and will be tested for compliance by the APSP-QAA during qualification testing (including periodic check). Unless otherwise specified, it remains as the supplier's option to perform any test in addition to the required quality conformance testing.

TABLE X. Qualification inspection (family A1).

Inspection or test 1/	Requirement paragraph	Test paragraph	Qual samples 4/ Initial	Periodic
Visual	3.4, 3.11, 3.14, 3.16	4.7.1.1	3	2
Initial electrical	3.3	4.7.2	3	2
Temperature & altitude	3.5.2.1.1	4.7.3.2.1	3	2
EMP 5/	3.6.1	4.7.3.7	3	2
EMI 5/	3.6.1	4.7.4	1	1
Long-term stability	3.5.2.4	4.7.3.5	1	0
CCT/TCCT	3.12.1	4.7.7.1	1	0
Vibration 2/	3.5.2.2.1	4.7.3.3.1	1	1
Mechanical shock				
Operating 2/	3.5.2.3	4.7.3.4.1	1	1
Nonoperating	3.5.3.3	4.7.3.12	1	1
Generated acoustical noise	3.5.2.7	4.7.3.9	1	0
Storage temperature	3.5.3.6	4.7.3.15	1	-
Temperature shock	3.5.3.2	4.7.3.11	1	1
Leakage	3.12.5	4.7.7.3	1	1
Explosive conditions	3.5.2.6	4.7.3.8	1	1
Humidity	3.5.3.1	4.7.3.10.1	1	1
Salt fog	3.5.3.4	4.7.3.13	1	1
Radiation hardness 3/				
Operating	3.5.2.5	4.7.3.6	1	0
Nonoperating	3.5.3.7	4.7.3.16	1	0

1/ Individual qualification samples shall be subjected to the environmental sub-groups as indicated in the table. Sequence of testing shall be in the order listed in the table.

2/ These tests may have their testing order reversed.

3/ These tests may be performed at any point during qualification inspection after completion of all tests within a subgroup provided they are immediately preceded by tests that satisfy the 100 percent and sample electrical requirements specified in the detail power supply specifications.

4/ Three power supplies of each type shall be submitted for initial qualification and 2 samples of each power supply type shall be submitted for periodic qualification.

5/ For periodic testing, these tests will be performed on the sample which undergoes vibration and mechanical shock and will be first in the sequence.

TABLE XI. Qualification inspection (family A2).

Inspection or test 1/	Requirement paragraph	Test paragraph	Qual samples 4/ Initial	Qual samples 4/ Periodic
Visual	3.4, 3.11, 3.14, 3.16	4.7.1.1	3	2
Initial electrical	3.3	4.7.2	3	2
Temperature & altitude	3.5.2.1.2	4.7.3.2.2	1	2
EMP 5/	3.6.1	4.7.4	1	1
Long-term stability	3.5.2.4	4.7.3.5	1	0
CCT/TCCT	3.12.1	4.7.7.2	1	0
Vibration 2/	3.5.2.2.2	4.7.3.3.2	1	1
Operating mechanical shock 2/	3.5.2.3	4.7.3.4.2	1	1
Mechanical	3.11.9	4.7.6	1	1
Durability	3.5.3.5	4.7.3.14	1	1
Generated acoustical noise	3.5.2.7	4.7.3.9	1	0
Storage temperature	3.5.3.6	4.7.3.15	1	-
Temperature shock	3.5.3.2	4.7.3.11	1	1
Explosive conditions	3.5.2.6	4.7.3.8	1	1
Humidity	3.5.3.1	4.7.3.10.2	1	1
Salt fog	3.5.3.4	4.7.3.13	1	1
Radiation hardness 3/				
Operating	3.5.2.5	4.7.3.6	1	0
Nonoperating	3.5.3.7	4.7.3.16	1	0

1/ Individual qualification samples shall be subjected to the environmental sub-groups as indicated in the table. Sequence of testing shall be in the order listed in the table.

2/ These tests may have their testing order reversed.

3/ These tests may be performed at any point during qualification inspection after completion of all tests within a subgroup provided they are immediately preceded by tests that satisfy the 100 percent and sample electrical requirements specified in the detail power supply specifications.

4/ Three power supplies of each type shall be submitted for initial qualification and 2 samples of each power supply type shall be submitted for periodic qualification.

5/ For periodic testing, these tests will be performed on the sample which undergoes vibration and mechanical shock and will be first in the sequence.

4.4.1.1 Test data. The initial qualification samples shall be accompanied by test data showing compliance with the performance characteristics of the associated detail specification (25°C, 100 percent and sample tests). Any deviation shall require prior written approval from the APSP-QAA. The supplier shall retain data for a minimum of 1 year after completion of all applicable tests and identified by type and serial number of the power supply.

4.4.1.2 Inspection and test procedures. The supplier shall prepare inspection and test procedures for all inspections and tests performed, including inspections and tests of incoming materials, in-process inspections and tests, and final inspections and tests. Final inspection and test procedures shall be submitted to the APSP-QAA for approval. These procedures shall include as a minimum the following:

(a) Quantity to be inspected or tested.

(b) Parameters of materials to be inspected and tested.

(c) Limits of acceptance and rejection.

(d) Equipment to be utilized in making inspections and tests.

(e) Detailed instructions on how to perform inspections and tests.

(f) Data to be recorded.

4.4.2 Failure rate prediction and parts derating. The supplier shall submit information to permit evaluation of the failure rate prediction as defined herein (see 3.7.1) and of parts derating. This failure rate data shall be supplied with the initial qualification samples to the APSP-QAA.

4.4.3 Thermal analysis. Each power supply type shall have a thermal analysis (see 4.7.7) performed by the supplier prior to submission of initial qualification samples. This thermal analysis is to predict or verify that the designs meet the thermal requirements herein (see 3.12). The detailed thermal analysis shall be submitted to the APSP-QAA with the initial qualification samples.

4.4.4 Design conformance. The supplier shall prepare and maintain power supply assembly drawings. The drawings shall consist of a pictorial view of the power supply printed wiring board assemblies specifying component location and identification, printed wiring boards, power supply structure, electrical schematic, parts list, and any other features necessary for power supply assembly. A note or detail view shall denote orientation of polar diodes, capacitors, and symmetrical multi-lead components. The APSP-QAA shall review power supply designs prior to or during initial qualification tests for conformance to all applicable specifications. This review shall be performed from scale drawings of the printed circuit boards, assembly drawings, the parts lists, the schematics and logic diagrams, and all other documentation used by the manufacturer to build the power supplies. The manufacturers shall submit the design package prior to or with the initial qualification samples. Complete design disclosures shall be made for APSP-QAA use only.

4.4.4.1 Change control. After successful initial qualification, the supplier shall forward to the APSP-QAA and the command or agency concerned, all changes to documents that impact design, qualification or correlation status. These changes shall be submitted to APSP-QAA for approval. All changes to test procedures and manufacturing flow charts shall be approved by the APSP-QAA.

4.4.5 Periodic check. Periodic checks shall be performed to verify that the supplier is manufacturing power supplies that meet all requirements specified herein and in the associated detail specification. Periodic checks shall be performed on sample power supplies selected at random by the Government quality assurance representative from power supplies produced during the 12 month period since the last submission and shall be performed by the APSP-QAA or its designated representative. Each sample of two power supplies submitted for periodic check shall be subjected to those functional and environmental tests listed in the periodic column of table X or table XI. Additional tests as listed in the initial column may be performed as deemed necessary by the APSP-QAA. Upon request, the supplier shall make available to the APSP-QAA a cross-reference matrix of date code versus serial number versus contract, by power supply part number, on all power supplies delivered. The matrix shall be updated with each submittal.

4.4.5.1 Submission schedule. The supplier shall submit periodic check samples at 12 month intervals following successful completion of initial qualification inspection. After the first two periodic check intervals, the periodic check may (at the discretion of the APSP-QAA) be changed to have the interval increased to 18 months. Criteria for this decision shall be past performance, design changes made, and engineering judgment. If production is interrupted and the 12 or 18 month interval is exceeded, the supplier shall submit the first two power supplies produced when production resumes.

4.4.5.2 Noncontinuous production. When production has been discontinued during a qualification period and periodic check samples are not submitted on a timely basis, qualification status shall only be maintained upon receipt of a letter of intent that power supply production will be resumed within an 18 month period.

4.4.6 Acceptance and rejection criteria. Successful completion of initial qualification inspection or periodic checks shall be based on no defects which may affect function, reliability, or interchangeability (as determined by the APSP-QAA). The supplier and command or agency concerned shall be notified in writing of the test results within 10 days following completion of testing. In case a qualification sample does not successfully pass the tests, the supplier shall be notified at the time of failure.

4.4.7 Corrective action. Upon notification of failure of qualification inspection, the supplier shall submit a letter indicating the corrective action. The corrective action may or may not require a resubmission. After approval by the APSP-QAA and completion of corrective action, the qualification status will be reinstated as appropriate.

4.4.8 Correlation. Test equipment shall be correlated by the APSP-QAA or its designated representative in accordance with the appendix. Power supplies submitted to the APSP-QAA for qualification may be used for correlation samples.

4.4.9 Quality assurance requirements. The supplier shall develop and maintain a quality program in accordance with MIL-Q-9858 (see 6.3). The program should include, as a minimum, information on the following topics:

(a) Manufacturing flow chart.

(b) Inspection and test procedures.

(c) Manufacturing instructions.

(d) Process control procedures.

(e) Process certifications.

(f) Workmanship samples.

(g) Accumulation and analysis of defect data.

(h) Power supply assembly drawings.

(i) Electrostatic discharge control program.

4.4.9.1 Manufacturing flow chart. A manufacturing flow chart shall be prepared and submitted to the APSP-QAA for review and approval. This flow chart shall start with the receipt of materials and show in graphic form the sequence of manufacturing operations, inspections, and tests performed in producing the power supplies, and shall end with the shipment of the completed power supplies. The flow chart shall include references to the procedures and instructions to be followed at each operation and shall include the stations at which workmanship samples are located and defect data is recorded. This chart shall have a title, a document number, revision status, and approval blocks.

4.4.9.2 Manufacturing instructions. There shall be instructions provided for each manufacturing operation. These instructions shall be in the form of written procedures and visual aids. These instructions are not required to be submitted to the command or agency concerned, but shall be submitted to the APSP-QAA for review. These instructions shall be retained at the manufacturing facilities of the supplier until final acceptance by the Government of all power supplies manufactured in conformity therewith. These instructions shall be used in support of inspection by personnel of the command or agency concerned and Government inspectors to ensure compliance with all quality assurance provisions herein. Use of the information in this manner shall be on a proprietary basis.

4.4.9.3 Processes requiring certification. The following processes (if used in the manufacturing of power supplies) shall be certified to their applicable military specifications:

(a) Nickel plating: QQ-N-290.

(b) Gold plating: MIL-G-45204.

(c) Anodizing: MIL-A-8625.

(d) Resistance welding of electronic circuit modules: MIL-W-8939.

(e) Special technological processes.

Process certification will be approved by the APSP-QAA.

4.4.10 Workmanship samples. The supplier shall prepare workmanship samples for the evaluation of in-process workmanship. These samples may be in the form of drawings, photographs, or hardware and shall be available for review and approval by the command or agency concerned. Samples shall be maintained as standards of quality.

4.4.11 Maintenance data. Maintenance data for test, fault isolation, and repair of the power supplies shall be prepared by the supplier and submitted to APSP-QAA for review.

4.4.12 Retention of qualification. Upon successfully completing initial qualification inspection, a supplier retains qualification status until one of the following occurs:

(a) Change of design (including components, materials, and processes).

(b) Failure of periodic check.

(c) Failure to submit samples and associated data on a timely basis (maximum interval under no production conditions will be 18 months) (see 4.4.5).

4.5 Quality conformance inspection. The following quality conformance inspection requirements apply.

4.5.1 Quality conformance criteria. Quality conformance acceptance of a power supply shall be based on no defects. The inspection and test plan in table XII (for family A1) or table XIII (for family A2) shall be used. Any characteristic failing to conform to the requirements specified herein and in the associated detail specification shall be considered a defect. Power supplies subjected to quality conformance inspection shall be completed samples requiring no other manufacturing steps.

4.5.2 Sampled quality conformance inspection. For sample (S) tests, acceptance or rejection of a lot shall be based on the sampling procedures specified in tables XII and XIII as applicable. If a failure occurs in a sampled electrical quality conformance inspection, the entire inspection lot shall be screened for that parameter before shipment of the lot. Power supplies failing during the screen shall be rejected.

4.5.3 One hundred percent inspection. For 100 percent quality conformance inspection parameters (X tests), any power supply not meeting the requirements specified herein and in the associated detail specification shall be rejected.

4.5.4 Failure analysis. Failure analysis shall be conducted by the supplier on all power supplies that fail tests required by the quality conformance test plan in accordance with 4.5.1. Component failure analysis is not required on failed parts resulting from recurring failure modes provided that component analysis has been performed on prior failures and the necessary and acceptable corrective action has been determined.

4.5.5 Inspection lot. An inspection lot shall consist of all power supplies produced for quality conformance inspection at any one time. An inspection lot may be defined in a contract or purchase order.

TABLE XII. Quality conformance inspection and test plan (family A1).

Inspection	Requirement paragraph	Test paragraph	Sampling
Electrical requirements at 25°C fin or rib temperature	3.7.2	4.7.5.2	100 percent for "X" test in accordance with the associated detail specification.
Environmental stress screening 1/	3.7.2	4.7.5.2	100 percent
Electrical requirements at +25°C 2/	3.3	4.7.2	100 percent for "X" tests in accordance with the associated detail specification. Sample per note 2/.
Visual:			Two power supplies or 20 percent of the inspection lot, whichever is greater.
Profile dimensions	3.4.1	4.7.1.1	
Keying position	3.11.8	4.7.1.1	
Marking	3.14	4.7.1.1	
Workmanship	3.16	4.7.1.1	

1/ Environmental stress screening shall be completed prior to the final 25°C electrical inspection.

2/ For those parameters which are to be sample inspected, two power supplies or 1 percent of the inspection lot, whichever is greater, shall be randomly selected from each inspection lot. The electrical parameters which are marked "S" in the associated detail specification shall be tested for these power supplies at 25°C ambient. If failures occur, the entire lot shall be screened for the parameter which failed.

TABLE XIII. Quality conformance inspection and test plan (family A2).

Inspection	Requirement paragraph	Test paragraph	Sampling
Electrical requirements at 25°C fin or rib temperature	3.7.2	4.7.5.2	100 percent for "X" test in accordance with the associated detail specification.
Environmental stress screening 1/	3.7.2	4.7.5.2	100 percent
Electrical requirements at +25°C 2/	3.3	4.7.2	100 percent for "X" tests in accordance with the associated detail specification. Sample per note 2/.
Visual: Profile dimensions Marking Keying Workmanship	 3.4.1 3.14 3.11.9.6 3.16	 4.7.1.1 4.7.1.1 4.7.1.1 4.7.1.1	Two power supplies or 20 percent of the inspection lot, whichever is greater.

1/ Environmental stress screening shall be completed prior to the final 25°C electrical inspection.

2/ For those parameters which are to be sample inspected, two power supplies or 1 percent of the inspection lot, whichever is greater, shall be randomly selected from each inspection lot. The electrical parameters which are marked "S" in the associated detail specification shall be tested for these power supplies at 25°C ambient. If failures occur, the entire lot shall be screened for the parameter which failed.

4.6 Inspection of packaging. Sample packages and packs and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and documents specified therein.

4.7 Test procedures.

4.7.1 Visual examination. Power supplies shall be examined with no more than a 10 power magnification lens to ensure compliance with this specification and the associated detail specification.

4.7.1.1 Initial visual examination. The following characteristics shall be examined to ensure initial compliance:

(a) Power supply profile. Dimensions and weight shall be checked to ensure that they are within specified tolerances.

(b) Keying. Keying positions shall be checked to ensure correct positioning.

(c) Marking. Markings shall be checked to ensure completeness, correct positioning, and legibility.

(d) Workmanship. Workmanship shall be checked to ensure compliance with 3.16.

4.7.1.2 Visual degradation examination. Power supplies shall be visually examined upon completion of each operating and nonoperating environmental test (see 4.7.3) after the power supply has returned to standard conditions.

4.7.2 Electrical performance tests. The initial electrical requirements of each power supply shall be tested to the extent specified in the associated detail specification. Following each test specified in table X (family A1) and table XI (family A2), the electrical quality conformance tests shall be performed as specified herein and in the associated detail specification. When the electrical tests to be performed are not specified, the 100 percent quality conformance inspection tests shall be performed.

4.7.2.1 Step input current test. For the purposes of this test (see 3.3.1.11.1), neither the power "off" period nor the power "on" period shall be less than one second.

4.7.2.2 Input harmonic current test. For the purposes of testing, the input power source shall not have a harmonic voltage content in percent RMS at any frequency which is greater than 25 percent of the allowable RMS harmonic current percentage at any frequency (see 3.3.1.12). If the input power source does not meet this harmonic voltage requirement, then the voltage distortion must be factored into the result of the harmonic current measurement. The accuracy of measurement of harmonic currents shall be plus or minus 5 percent of the harmonic being measured.

4.7.2.3 Power factor test. The power factor requirement shall apply when the power supply is operated at rated load (see 3.3.1.13). Power factor shall be computed by real power divided by apparent power, as indicated in the following formula:

$$\text{Power factor} = \frac{W}{\left(V_1^2 I_1^2 + V_2^2 I_2^2 + V_3^2 I_3^2\right)^{1/2}}$$

where

W = watts

VA, VB, VC = RMS line-to-neutral voltages

IA, IB, IC = RMS line currents

4.7.2.4 Total ripple and noise measurement. The total ripple and noise shall be measured differentially using a device whose 3 dB bandwidth shall extend from a minimum frequency, no higher than 10 Hz, to at least 20 MHz (see 3.3.2.3).

4.7.2.4.1 Low frequency ripple and noise measurement. The low frequency ripple and noise shall be measured differentially using a device whose 3 dB bandwidth shall extend from a minimum frequency, no higher than 10 Hz, to 10 kHz plus or minus 20 percent (see 3.3.2.3.1).

4.7.2.4.2 High frequency ripple and noise measurement. The high frequency ripple and noise shall be measured differentially using a device whose 3 dB bandwidth shall extend from 10 kHz plus or minus 20 percent to 20 MHz plus or minus 10 percent (see 3.3.2.3.2).

4.7.2.5 Common mode output current measurement. The common mode output current (see 3.3.2.4) measurement shall be made using a current measuring device whose bandwidth is at least 20 MHz. A 10 uF plus or minus

10 percent plastic film (or equivalent) capacitor shall be connected between the power supply output and its return. The return shall be connected to the power supply chassis. The current measuring device shall be connected around the wire going from the output return to chassis.

4.7.2.6 Static line and load regulation test. Line and load regulation (see 3.3.2.5) shall be measured for all combinations of minimum and maximum line voltage and no load (or minimum load) and full rated load. For multiple output power supplies, the load regulation shall be measured as above as well as measuring that a load change on one output has a minimal effect on another output (cross regulation).

4.7.2.7 Dynamic load regulation test. The step change in load current shall be equal to 10 percent of the power supply full rated load current (see 3.3.2.7). Unless otherwise specified in the associated detail specification, the step change shall occur in 60 us or less. The positive step change shall be applied at any nominal load current between 10 and 90 percent of full rated load. The negative step change shall be applied at any nominal load between 20 and 100 percent. When required, dynamic load regulation for load step changes greater than 10 percent shall be specified in the associated detail specification.

4.7.2.8 Dynamic line regulation test. The step change in input voltage shall be equal to 21 percent of the nominal input voltage and applied to the nominal input voltage with a rise time between 50 and 500 us (see 3.3.2.8).

4.7.2.9 Line transient test. Transient voltages shall be applied to the input lines and the outputs checked for transient response in accordance with 3.3.2.21.

4.7.2.9.1 AC line overvoltage transient test. An AC transient voltage (see 3.3.1.3) of an amplitude given in the associated detail specification with a rise time of zero to 2 cycles of the input line frequency, a fall time of zero to 32 cycles, and a duration at maximum amplitude of 5 cycles plus or minus 1 cycle shall be superimposed on the input 115 VAC RMS line-to-neutral of any one phase. The waveform of the AC transient shall be in phase with the line-to-neutral voltage of the line on which it is superimposed.

4.7.2.9.2 AC line undervoltage transient test. An AC transient voltage (see 3.3.1.3) of an amplitude given in the associated detail specification with a rise time of zero to 2 cycles of the input line frequency, a fall time of zero to 32 cycles, and a duration at maximum amplitude of 5 cycles plus or minus 1 cycle shall be superimposed on the input 115 VAC RMS line-to-neutral of any one phase. The waveform of the AC transient shall be 180 degrees out of phase with the line-to-neutral voltage of the line on which it is superimposed.

4.7.2.9.3 DC line overvoltage transient test. A DC transient voltage of an amplitude given in the associated detail specification with a rise time of zero to 0.1 ms, a fall time of zero to 40 ms, and a duration at maximum amplitude of 10 ms plus or minus 1 ms shall be superimposed on any DC input line pair on which the DC voltage is applied (see 3.3.1.3). The waveform of the DC transient shall be applied so as to increase the line-to-line voltage of the line pair on which it is superimposed.

4.7.2.9.4 DC line undervoltage transient test. A DC transient voltage of an amplitude given in the associated detail specification with a rise time of zero to 0.1 ms, a fall time of zero to 50 ms, and a duration at maximum amplitude of 50 ms plus or minus 5 ms shall be superimposed on any DC input line pair (see 3.3.1.3). The waveform of the DC transient shall be applied so as to decrease the line-to-line voltage of the line pair on which it is superimposed.

4.7.2.10 Susceptibility to common mode noise. Common mode noise with plus or minus 15 Vpk shall be applied between chassis ground and each control signal and return lead pair. The power supply shall not change state (see 3.3.3.3). The noise shall have a frequency between direct current and one megahertz.

4.7.2.11 Efficiency measurement. The efficiency shall be measured at nominal input voltage and at maximum rated output load current (see 3.3.5).

4.7.3 Environmental test procedures. Test procedures for environmental exposures to determine conformance to the requirements specified in 3.5 shall be in accordance with the following subparagraphs and the associated detail specification.

4.7.3.1 Test procedures.

4.7.3.1.1 Family A1. Unless otherwise specified herein or in the associated detail specification, cooling air shall be supplied whenever the power supply is operating and not be supplied whenever the power supply is nonoperating. Unless otherwise specified, cooling air shall be turned on or off within 10 seconds of the time when the power supply is turned on or off. Unless otherwise specified in the associated detail specification or herein, the cooling air inlet bulk temperature shall be 27°C plus 5 or minus 0°C. Cooling air power supply outlet temperature shall be no greater than plus 71°C. Cooling air pressure drop and mass flow rate shall be in accordance with the associated detail specification. A power supply shall not be required to be mounted on a rack, shelf, or tray during environmental exposure for those environments which do not require electrical operation. Unless otherwise specified in the associated detail specification or herein, power supply operation shall be with nominal input voltage and full rated load. Standard enclosure test orientation shall be in accordance with MIL-E-85726.

4.7.3.1.2 Family A2. Unless otherwise specified in the associated detail specification, test procedures for environmental exposures shall be as specified herein.

4.7.3.2 Temperature and altitude.

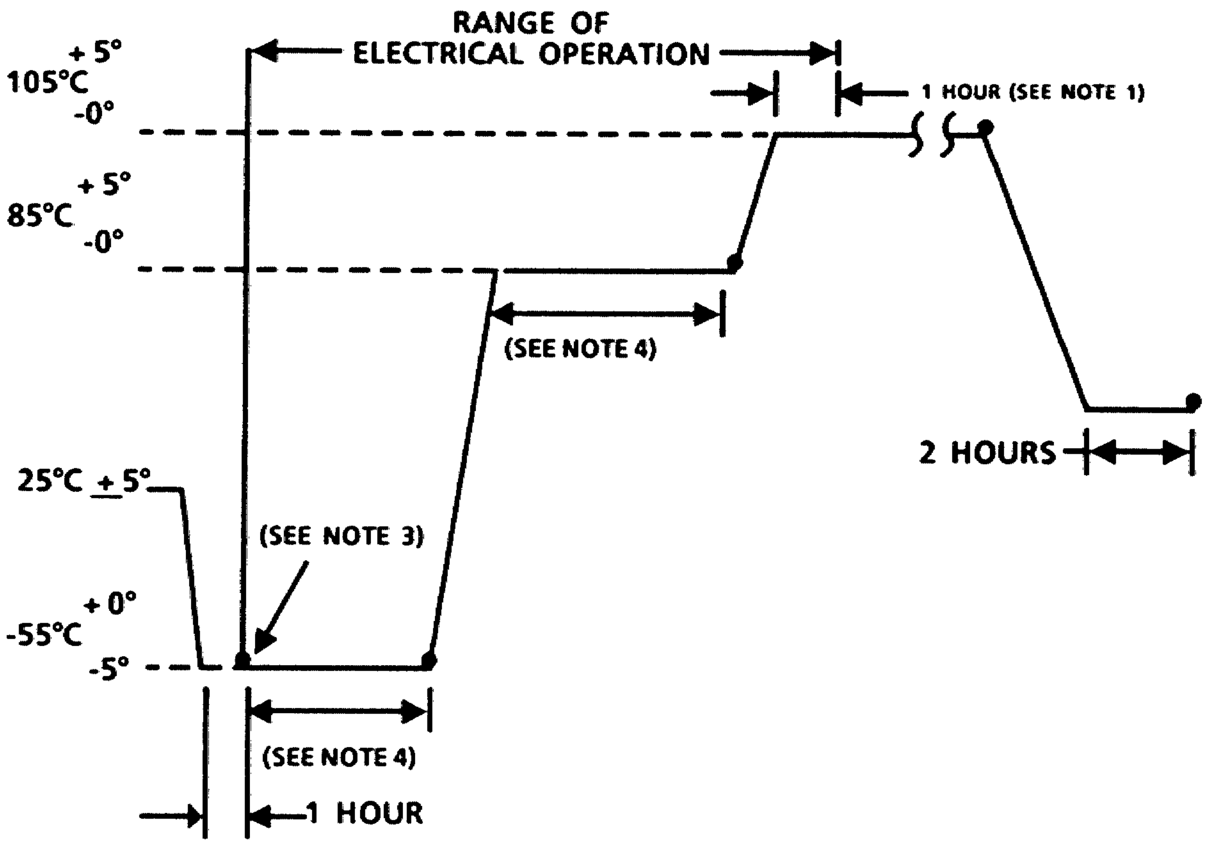
4.7.3.2.1 Family A1. Power supplies shall be temperature and altitude tested in accordance with MIL-STD-810, method 520, procedure III. Test levels shall be in accordance with MIL-STD-810, table 520.0-V, for supplemental cooling air flow. Inlet mass flow rate shall be in accordance with the associated detail specification. The test cycle shall be in accordance with MIL-STD-810, table 520.0-VI and figure 520.0-5. Power supplies shall meet the specified performance (see 3.5.2.1.1).

4.7.3.2.2 Family A2. Power supplies shall be subjected to the specified operating temperature requirements (see 3.5.2.1.2). Power supplies with multiple fins or ribs shall have the temperatures measured on the cooling fin or rib in accordance with appendices B, C, or E of MIL-STD-1389. The power supply shall be set up, operated, temperature cycled and tested according to the associated detail specification and the temperature cycle specified on figure 13.

(a) Low temperature test. The temperature of the power supply thermal interface shall be reduced to the low temperature specified in 3.5.2.1.2 in approximately 5 minutes. This temperature must be maintained for a minimum of 4 hours plus 0.25 hour for each increment greater than the basic format size. The power supply environment shall be controlled to prevent frost or moisture buildup on the power supply. The power supply is then tested and must meet the initial electrical requirements of the associated detail specification for the temperatures specified in 3.5.2.1.2.

(b) High temperature test. With the power supply operating, the temperature of the power supply interface shall be increased to the high temperature specified in 3.5.2.1.2 in approximately 5 minutes. This temperature must be maintained for a minimum of 4 hours plus 0.25 hour for each increment greater than the basic format size. The power supply is again tested and must meet the initial electrical requirements of the associated detail specification.

(c) Transient temperature test. With the power supply operating, the temperature of the power supply thermal interface shall be increased to 20°C above the high temperature specified in 3.5.2.1.2 and maintained for one (1) hour. The power supply can be tested any time within the next 8 hours under the condition that the temperature is maintained but the power supply is not operating until the test resumes. Electrical test time shall not exceed one hour. The power supply must meet the high temperature end-of-life requirements for the 100 percent electrical tests. After this portion of the test is completed and with the power supply nonoperating, the thermal interface temperature is reduced to 25°C in approximately 5 minutes. This temperature is maintained for a minimum of 2 hours plus 0.25 hour for each increment greater than the basic format size. The power supply is again tested to meet the initial electrical requirements of the associated detail specification for 25°C.



NOTES:
1. The total time allowed for the transient thermal test shall be 1 hour of power supply operation plus eight hours of nonoperating storage plus 1 hour for electrical tests.
2. Electrical tests shall be performed at the indicated nodes (●).
3. Following a one hour temperature stabilization period, the power supply shall be energized.
4. The temperature must be maintained for a minimum of 4 hours plus 0.25 hour for each increment greater than the basic format size.

FIGURE 13. Operating temperature cycle.

(d) Barometric pressure. Power supplies shall be subjected to the reduced barometric pressure specified in 3.5.2.1.2. Power supplies shall be tested in accordance with MIL-STD-202, method 105, test condition D. Power supplies shall be mounted such that the power supply ribs are in contact with the wall of the test chamber. This is the only cooling other than convection. The pressure shall vary at a maximum rate of 0.5 inch (13 mm) of mercury per second. Power supplies shall be held at the specified pressure for 30 minutes and then, at that pressure, shall meet the electrical tests specified in the associated detail specification. Upon removal from the chamber, power supplies shall show no evidence of deterioration or physical damage and shall meet the 25°C initial electrical requirements specified in the associated detail specification.

4.7.3.3 Vibration.

4.7.3.3.1 Family A1. Power supplies shall be subjected to separate high frequency and random vibration specified in 3.5.2.2.1 in accordance with 4.7.3.3.1.1 and 4.7.3.3.1.2. The power supply shall be mounted to a rigid fixture by its normal mounting means. Power supplies shall be energized with a load current greater than or equal to 10 percent of the rated output current. Monitoring of power supply performance during a vibration test is required (see 3.5.2.2.1).

4.7.3.3.1.1 High frequency vibration. Power supplies shall be subjected to high frequency vibration in accordance with MIL-STD-202, method 204, test condition C, two sweeps per axis.

4.7.3.3.1.2 Random vibration. Power supplies shall be subjected to random vibration tests in accordance with MIL-STD-810, method 514, procedure I, category 5. Test duration on each axis shall consist of 30 minutes exposure to functional test inputs as shown on figure 14, followed by 60 minutes at the endurance test input level shown on figure 14, and followed by an additional 30 minutes of functional test level.

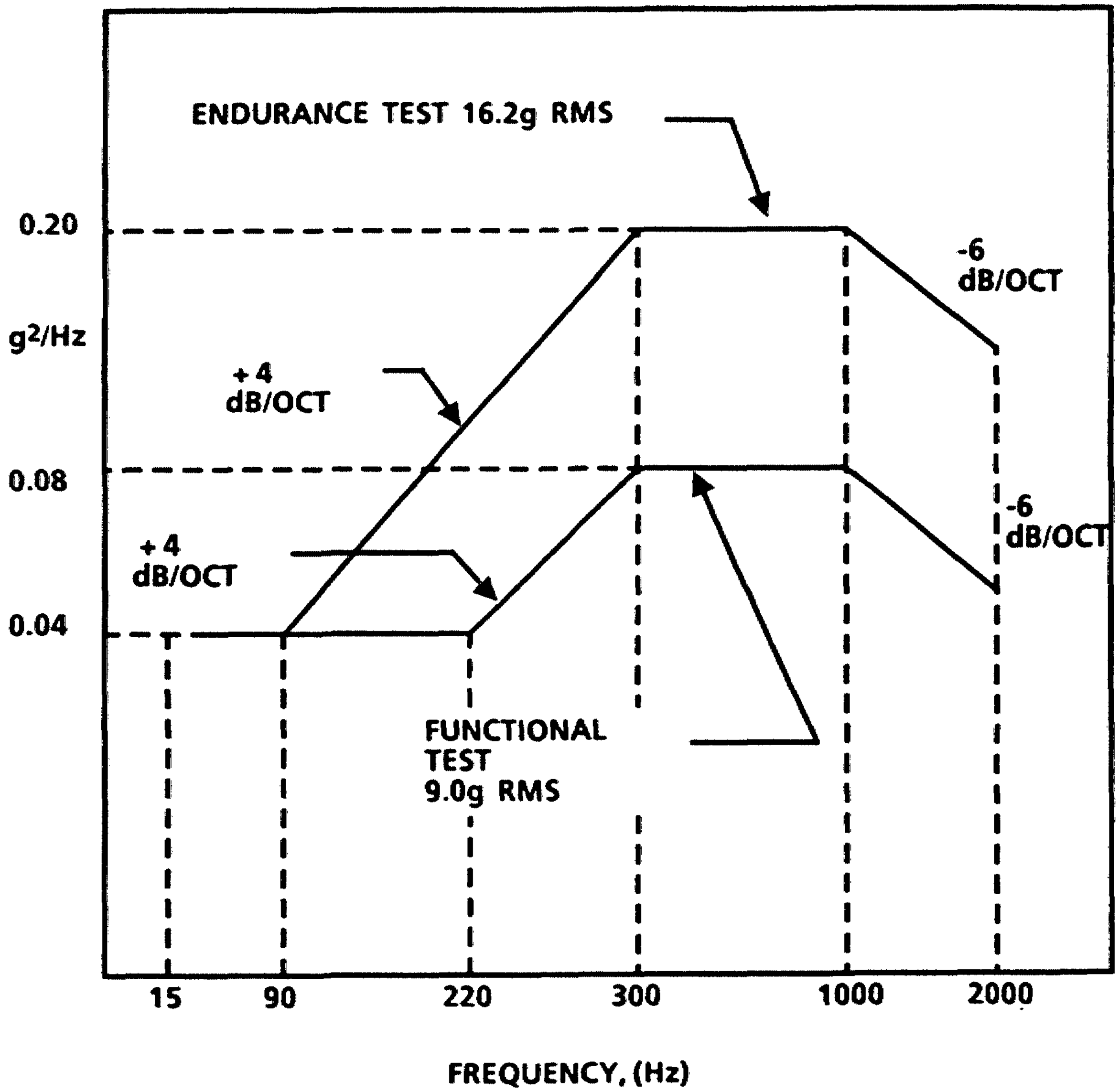


FIGURE 14. Random vibration test conditions.

4.7.3.3.2 Family A2. Power supplies shall be subjected to separate high frequency and random vibration specified in 3.5.2.2.2 in accordance with 4.7.3.3.2.1 and 4.7.3.3.2.2. Power supply connectors shall be inserted into a backplane utilizing appropriate mating connectors. The power supplies shall be securely clamped along both ribs. Power supplies shall be monitored during the vibration tests. At the completion of each axis of vibration during the test, power supplies shall be visually examined for damage (see 4.7.1.2).

4.7.3.3.2.1 High frequency vibration. Power supplies shall be subjected to high frequency vibration in accordance with MIL-STD-202, method 204, test condition C, two sweeps per axis.

4.7.3.3.2.2 Random vibration. Power supplies shall be subjected to random vibration in accordance with MIL-STD-202, method 214, test condition I, letter E, for 0.5 hour each axis.

4.7.3.4 Mechanical shock.

4.7.3.4.1 Family A1. Power supplies shall be shock tested in accordance with MIL-STD-810, method 516, procedure I. Test level and duration shall be in accordance with I-3.3.c(1)(b) of procedure I for functional test of flight vehicle equipment. Power supplies shall be energized with a load current greater than or equal to 10 percent of the rated output current. Monitoring of power supply performance during a shock test is not required (see 3.5.2.3).

4.7.3.4.2 Family A2. Power supplies shall be shock tested in accordance with MIL-STD-810, method 516, procedure I, except that peak acceleration shall be 50 g. Test level and duration shall be in accordance with I-3.3.c(1)(b) of procedure I for functional test of flight vehicle equipment. Power supplies shall be energized with a load current greater than or equal to 10 percent of the rated output current. Monitoring of power supply performance during a shock test is not required (see 3.5.2.3).

4.7.3.5 Long-term stability. Each power supply shall be operated for a minimum of 1,000 hours under isothermal ambient conditions, 71°C plus 5 or minus 0°C ambient temperature at full rated load current and nominal input voltage. The baseline output voltages shall be measured 20 hours plus or minus 2 hours after initial power supply turn on (3.5.2.4).

4.7.3.6 Radiation hardness. The test sample shall consist of power supplies which have been subjected to and passed the electrical requirements specified in the associated detail specification for the 100 percent and sample acceptance tests using the initial electrical limits at 25°C. Post-irradiation electrical tests shall be the same electrical requirements, using the end-of-life limits at 25°C (see 3.5.4.2). The test sample shall be subjected to the following sequence and levels of radiation exposure (see 3.5.2.5).

(a) Ionizing dose rate: 1×10^9 Rads (Si)/sec (20 ns to 100 ns pulse width).

(b) Total ionizing dose: 3 kilorad (Si).

Radiation hardness assurance requirements are satisfied if power supplies pass the end-of-life requirements after each radiation exposure. The combination of these radiation exposure environments is considered destructive and, therefore, test sample power supplies subjected to them shall not be used in, or shipped for use in, any operational system. For the purpose of this specification, all terms used in the following referenced test methods, such as "module", "semiconductor device", "integrated circuit" or "part", and so forth, meaning the part under test or irradiation, shall be interpreted or construed as meaning the power supply.

4.7.3.6.1 Ionizing dose rate. Power supplies shall be tested in accordance with MIL-STD-883, method 1023. The radiation pulse width shall be 20-200 ns with 200 rad (Si) maximum absorbed total dose per pulse. All references in method 1023 to linear integrated circuit and linear microcircuit shall be applied to the power supply under test. Power supplies shall be operated during irradiation as specified in the associated detail specification. A failure is defined as a permanent change in any specified power supply current of greater than 5 percent of the pre-radiation reading, the measurements being taken in the test fixture prior to removal of any bias after the radiation pulse. Power supplies must pass the 25°C end-of-life electrical tests as specified in 3.5.4.2.

4.7.3.6.2 Total ionizing dose. Power supplies shall be tested in accordance with MIL-STD-883, method 1019. Power supplies shall be operated at full rated load during irradiation. Post-irradiation electrical tests shall be performed within 12 hours of time of exposure.

4.7.3.7 EMP protection (family A1). Power shall be subjected to the limit specified in 3.6.1.

4.7.3.8 Explosive conditions. Power supplies shall be subjected to explosive tests in accordance with MIL-STD-810, method 511, procedure I. Test altitude shall be 70,000 feet. For family A1, ambient temperature shall be plus 71°C. For family A2, rib temperature shall be 85°C. The power supply cover shall be removed during the test (see 3.5.2.6).

4.7.3.9 Generated acoustical noise. The power supply shall be tested for generated acoustical noise in accordance with the method described herein.

4.7.3.9.1 Test apparatus. The test apparatus shall consist of an anechoic type test chamber, suitably formed and proportioned to produce, as closely as possible, a diffuse sound field, the sound energy density of which is very nearly uniform throughout the enclosure. A pentagonal chamber configuration is recommended. Acute angles of adjacent chamber walls shall be avoided whenever possible. Acoustical generation reproduction and measuring equipment shall be suitable to accomplish these tests.

4.7.3.9.2 Test procedure. Noise levels at the "Operator's position" shall be measured by slowly moving the measuring microphone in a 2 foot diameter circle centered on the most probable position for an operator. The average noise levels in each octave band, determined by an arithmetic average of the minimum and maximum sound pressure levels found on the circle, shall not exceed the noise level criteria for the "Operator's position" specified in table XIV. Noise levels on the "25 foot radius circle", centered on the geometric center of the test equipment, shall be measured at a height of 5 feet, 8 inches at 12 positions equally spaced every 30°. The maximum sound pressure levels in each octave band at each of these measurement positions shall not exceed the noise level criteria for the "25 foot radius circle" specified in table XIV. If any dimensions of the test equipment exceed 25 feet, the radius of the measurement circle shall be increased from 25 feet to 50 feet and the noise level criteria for the "25 foot radius circle" shall be reduced by 6 dB in each octave band. The criteria for the "Operator's position" shall remain unchanged. All noise measurements shall be made with a sound level meter and an octave band filter set meeting the requirements of S1.4 and S1.11, respectively. The "C" weighting network (flat frequency response) of the sound level meter shall be used in making all measurements. Ambient background noise levels shall be at least 10 dB below the octave band noise levels produced by the test equipment at all measurement positions.

TABLE XIV. Noise level criteria.

Octave band center frequencies (Hz)	Octave band sound pressure levels (dB ref, 0.0002 dynes/square cm) Operator's position	25 ft radius circle
63	76	66
125	70	60
250	64	54
500	60	50
1000	57	47
2000	55	45
4000	53	43
8000	52	42

4.7.3.10 Humidity.

4.7.3.10.1 Family A1. Humidity tests shall be in accordance with MIL-STD-810, method 507, procedure III. The power supply shall be in the normal use configuration. Electrical testing shall be performed within one hour following the conclusion of the exposure to the humid environment and power supplies shall meet the specified performance (see 3.5.3.1) requirements.

4.7.3.10.2 Family A2. Power supplies shall be subjected to humid atmosphere cycles as specified in 3.5.3.1. Power supplies shall be tested in accordance with MIL-STD-810, method 507, procedure III, except that the power supply shall not be operated until all humidity cycling has been completed. Power supplies shall be mounted in the humidity chamber with the power supply span at a 45° angle to a horizontal plane. At the conclusion of the exposure to the humid environment, excess water shall be shaken and wiped from the external surfaces of the power supply and the mechanical requirements of the power supply shall be tested within 1 hour after removal from the test chamber. Power supplies shall also be tested to the end-of-life requirements of the 100 percent electrical acceptance tests and all isolation tests specified in the associated detail specification after allowing a 4 hour stabilization period at room temperature in a free convection atmosphere. There shall be no evidence of deterioration or physical damage.

4.7.3.11 Temperature shock. Power supplies shall be subjected to temperature shock as specified in 3.5.3.2. Power supplies shall be tested in accordance with MIL-STD-202, method 107, test condition B with temperature extremes of minus 55°C (exception) and 125°C. Power supplies shall pass the electrical tests of 3.3 with no evidence of deterioration or physical damage.

4.7.3.12 Mechanical shock (family A1). Power supplies shall be shock tested in accordance with MIL-STD-810, method 516, procedure V. Monitoring of power supply performance during a shock test is not required (see 3.5.3.3).

4.7.3.13 Salt fog. Power supplies shall be subjected to salt fog as specified in 3.5.3.4. Power supplies shall be tested in accordance with MIL-STD-810, method 509, procedure I. At the conclusion of exposure to the salt fog environment, excess water shall be shaken from the external surfaces of the power supplies. Power supplies shall be examined with the aid of a ten power magnification lens following storage for 48 hours at room ambient conditions to allow for evaporation of excess moisture. Failure mechanisms shall include pits, crack formation, intergranular attack, and so forth; that is, a concentrated attack that weakens the cross section. Surface corrosion products shall not be evidence of failure.

4.7.3.14 Durability (family A2). Power supplies and contacts shall be subjected to 500 cycles of mating as specified in 3.5.3.5 at the rate of not more than 10 cycles per minute. During the test, power supplies shall be mounted so that the insertion and extraction forces are transmitted directly from the fin or header to the connector. Formats C and E power supplies shall be inserted into a backplane meeting the requirements of MIL-A-28870. For modules which exercise the lateral displacement option (floating), the card cage test system shall provide a clearance of 0.006 plus or minus 0.001 inches (0.15 plus or minus 0.03 mm) between the surface of the module guide rib and the interfacing rail surface on the card cage. For modules which do not exercise the lateral displacement option (nonfloat), the clearance above should only be 0.0030 plus 0.0005 or minus 0.0000 inches (0.076 plus 0.013 or minus 0.000 mm) between the surface of the guide rib and the interfacing rail surface on the card cage. The clamping pressure in both cases shall be 75 pounds per square inch to each guide rib. Power supplies shall be forced against the rail surface on each cycle after power supplies are seated into the backplane. The clamping force shall be removed prior to extraction of the power supplies. The clamping force shall be uniformly applied to the power supply guide ribs on the surface opposite the one in contact with the rail surface. There shall be no exposure of nickel underplating on the power supply connector pins upon completion of the tests.

There shall be no exposure of nickel underplating on the module connector contacts when examined under 3X magnification (10X for referee inspection) upon completion of this test. To enhance the visibility of any exposed underplating, the contacts may be dipped in a 5 percent sodium sulfide solution for 2 minutes, plus or minus 15 seconds, and then rinsed prior to examination. Following the test, all formats shall pass the electrical tests specified in 3.3.

4.7.3.15 Storage temperature. Power supplies shall be subjected to low and high nonoperating temperatures as specified in 3.5.3.6 to ensure storage without protective packaging for service use.

(a) Low temperature. Power supplies shall be placed in a chamber and the temperature reduced until minus 55°C is reached with a transfer time between temperature excursions of approximately 5 minutes. The temperature shall be maintained for a period of 24 hours. At the end of the low temperature test, power supplies shall meet the 25°C initial electrical requirements specified in the associated detail specification.

(b) High temperature. Power supplies shall be placed in a chamber and the temperature increased with a transfer time between temperature excursions of approximately 5 minutes until 125°C is reached. The temperature shall be maintained for a period of 24 hours. There shall be no evidence of deterioration or physical damage after this test. At the end of the high temperature test, the power supply shall meet the 25°C initial electrical requirements specified in the associated detail specification.

4.7.3.16 Nonoperating radiation hardness. Power supplies shall be tested in accordance with MIL-STD-883, method 1017. Power supplies shall not be operated during irradiation (see 3.5.3.7). The test sample shall consist of power supplies which have been subjected to and passed the electrical requirements specified in the associated detail specification for the 100 percent and sample acceptance tests using the initial electrical limits at 25°C. Post-irradiation electrical tests shall be the same electrical requirements, using the end-of-life limits at 25°C (see 3.5.4.2). Radiation hardness assurance requirements are satisfied if power supplies pass the end-of-life requirements after each radiation exposure. The radiation exposure is considered destructive and, therefore, test sample power supplies subjected to it shall not be used in, or shipped for use in, any operational system. For the purpose of this specification, all terms used in the following referenced test methods, such as "module", "semiconductor device", "integrated circuit", or "part", and so forth, meaning the part under test or irradiation, shall not be interpreted or construed as meaning the power supply.

4.7.3.17 Solvents. Power supplies which use adhesive backed labels shall meet the requirements of 3.5.3.8 when tested in accordance with MIL-STD-202, method 215.

4.7.4 EMI measurements. Each power supply type shall be tested using its primary output polarity and all specified types of input power. The testing requirement as shown in 3.6 and procedures of MIL-STD-462 shall be used to determine conformance to the applicable emission and susceptibility requirements. Data gathered as a result of performing tests in one electromagnetic discipline may be sufficient to satisfy requirements in another. Therefore, to avoid unnecessary duplication, a single test program should be established with similar tests conducted concurrently whenever possible.

4.7.5 Reliability.

4.7.5.1 Reliability prediction. A reliability prediction shall be performed in accordance with MIL-STD-756, task 201, method 2005 (see 3.7.1). MIL-HDBK-217 shall be used as the basic data source. The prediction shall be based on a detailed thermal/electrical/mechanical stress analysis of each part. Unless otherwise specified in the associated detail specification, the reliability prediction shall be made at nominal input voltage and maximum rated output power. Any exceptions as to data or approach shall be defined, justified and submitted to the command or agency concerned and the APSP-QAA for approval.

4.7.5.1.1 Family A1. The reliability predictions shall include the following MIL-HDBK-217 environments:

(a) Airborne uninhabited environment at 71°C ambient temperature and cooling air in accordance with 4.7.3.1.1.

(b) Airborne (actual use environment) environment in accordance with the associated detail specification.

4.7.5.1.2 Family A2. The reliability predictions shall include the following MIL-HDBK-217 environments:

(a) Airborne uninhabited environment at 85°C rib temperature.

(b) Airborne (actual use environment) environment in accordance with the associated detail specification.

4.7.5.2 Environmental stress screening. Each power supply shall be subjected to random vibration (see figure 15) and thermal cycling environmental stress screening in accordance with MIL-STD-2164. Thermal cycling shall consist of a minimum of twelve cycles with the last three consecutive cycles being failure free. The temperature cycling profile and power supply on and off time shall be as shown on figure 16.

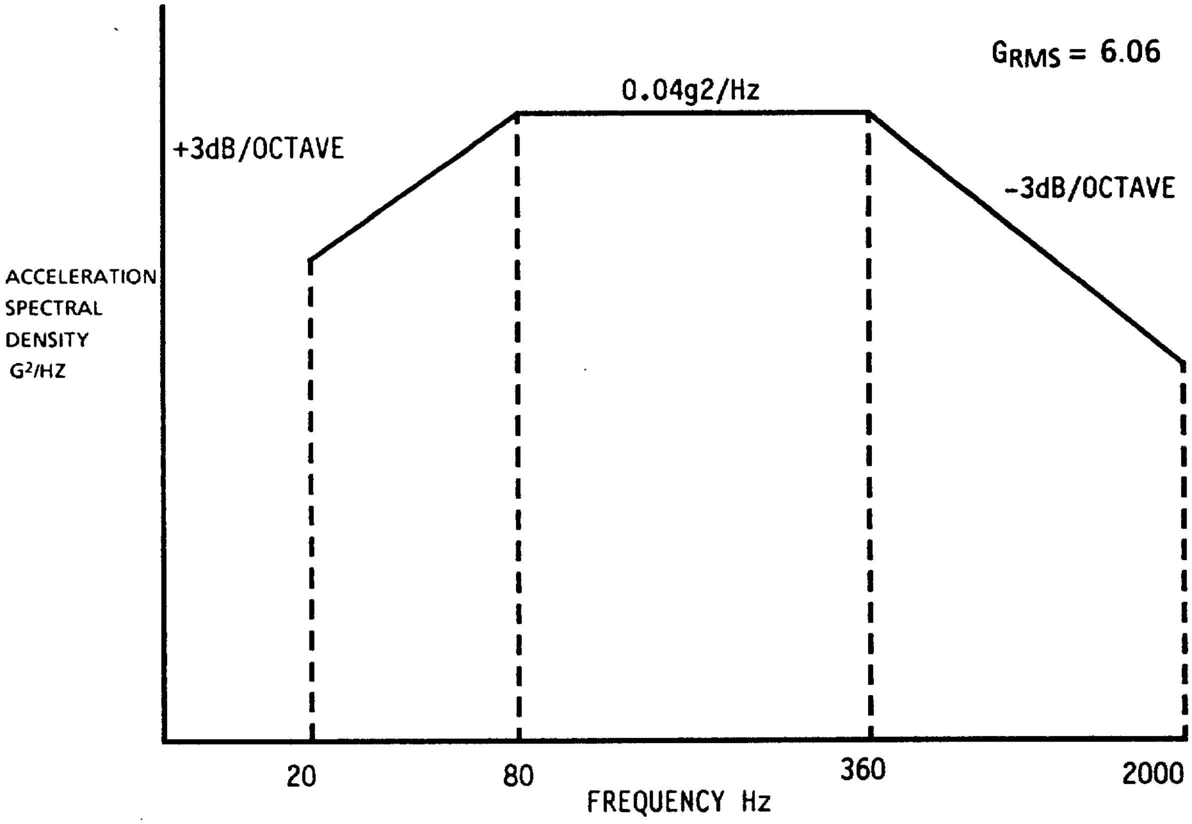
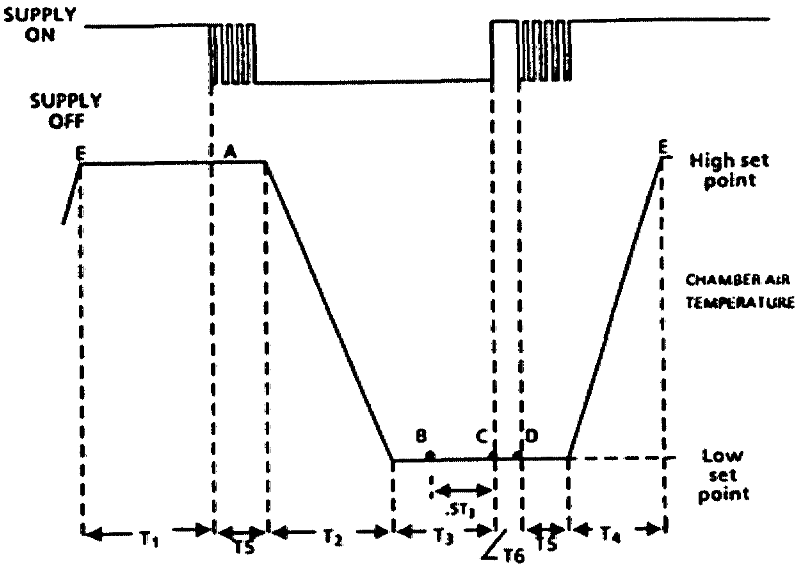


FIGURE 15. Random vibration spectrum.



NOTES:

1. T1 = T3 = 2 hours. The temperature at points E and 8 apply to the power supply ambient temperature (family A1) or the average fin or rib temperature (family A2). However, the power supply shall be considered to have reached thermal stability only when the part with the greatest thermal inertia has a rate of change of less than 5°C per hour or is within 5°C of the ambient temperature. Thermal stability shall be attained a minimum of 20 minutes prior to points A or C. Cooling air shall be on except during T2 and T3 (see 4.7.3.1).
2. For T2 and T4, the average rate of change of the chamber ambient temperature shall be a minimum of 5°C per minute.
3. T5 = 10 minutes maximum. T6 = 2 minutes minimum.
4. The thermal cycle shall begin at point 5 with the power supply energized at the maximum rated load and nominal input voltage.
5. At point A, turn the power supply off and on 5 times for a maximum time of 1 minute in each state. Monitor the output status signal (see 3.3.4.4). Alternately, verify output voltage for compliance with 3.3.2.5.
6. Turn the power supply off and reduce the temperature to point B..
7. At point C, the power supply shall be turned on. Monitor the output status signal (see 3.3.4.4).
8. At point D, turn power supply off and on 5 times for a maximum time of 1 minute in each state. Monitor the output status signal (see 3.3.4.4).
9. Increase the temperature to point E and repeat the cycle.
10. The power supplies shall be energized at the maximum rated load and nominal input voltage during the power on time of the test cycle.

FIGURE 16. Thermal cycling screen.

4.7.5.2.1 Thermal cycling (family A1). The test chamber high and low set point temperatures shall be plus 71°C and minus 55°C, respectively. Cooling air high and low temperatures at the power supply inlet shall be plus 54°C and minus 54°C, respectively.

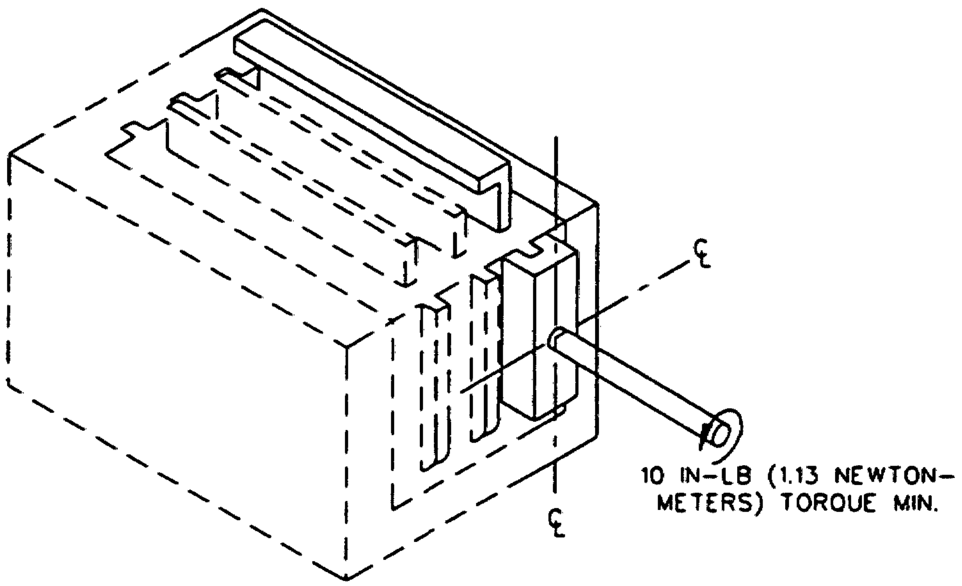
4.7.5.2.2 Thermal cycling (family A2). The test chamber low and high set point temperatures shall be such that the power supply achieves -55°C and +85°C rib temperatures for the duration of the low and high temperature soak periods, respectively. The power supply rib temperature shall be monitored continuously, and the fixture shall allow the average rib temperature to increase and decrease, at the same average rate, with the chamber air temperature.

4.7.5.3 Disposition of failures. Disposition of power supplies which do not successfully complete the thermal cycling and random vibration shall be covered by the supplier's plan of control (see 4.4.9).

4.7.6 Mechanical integrity tests (family A2). Following the tests specified in 4.7.6.1 through 4.7.6.11, the power supply shall meet all the configuration requirements specified herein, in the associated detail specification, and the electrical requirements of 3.3.

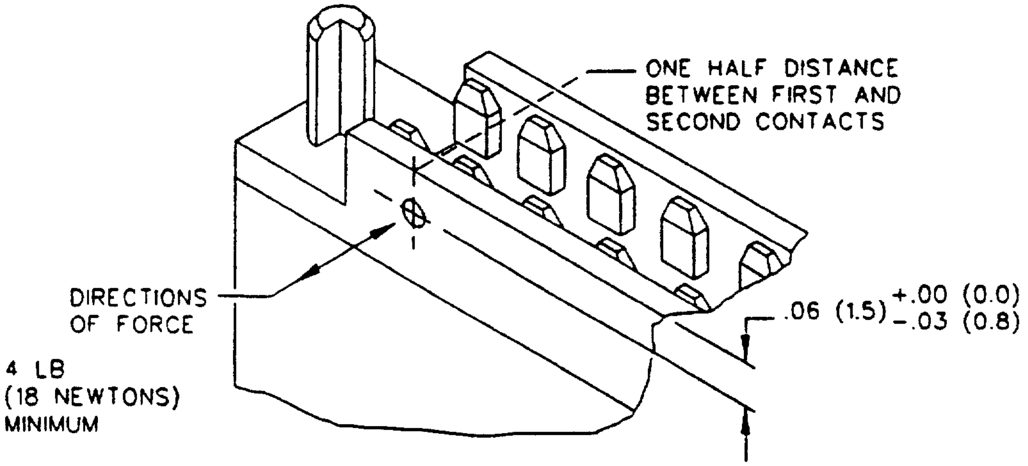
4.7.6.1 Rib strength. The individual power supply ribs shall withstand the torque specified in 3.11.9.2.1 applied in a direction perpendicular to the plane of the ribs and along the full length of the rib using a method similar to that shown on figure 17. The torque shall be applied at a rate such that the specified torque is applied in 2 to 10 seconds from the time the torque is first applied to the rib and maintained for 10 to 15 seconds.

4.7.6.2 Pin shield retention. Each pin shield shall withstand the force specified in 3.11.9.3.1. The force shall be applied to each end of each pin shield in a direction normal to a plane passing through the centerline of both keying pins in each of two directions 180° apart. The point of application of the force shall be midway between the first and second electrical contacts on each end up 0.06 inch plus 0 or minus 0.03 inch (1.5 mm plus 0 or minus 0.8 mm) from the bottom edge of the pin shield (see figure 18). The rate of application of force shall be such that the specified force is applied in 2 to 5 seconds and maintained for 10 to 15 seconds at 25°C plus or minus 5°C. For multiple span power supplies employing connectors having rows of 50 contacts, the foregoing tests are also required at points opposite the midpoint between contacts 25 and 26 and contacts 75 and 76.



NOTES:
1. Required for all formats.
2. Metric equivalents are given for general information only.
3. Metric equivalents are in parenthesis.

FIGURE 17. Rib strength.



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Metric equivalents are in parentheses.
4. On power supplies with 20 contact row connectors, the force is applied at 4 different points for a total of 8 measurements. On power supplies with 50 contact row connectors, the force is applied at 6 different points for a total of 12 measurements.
5. Required for all formats.

FIGURE 18. Pin shield retention.

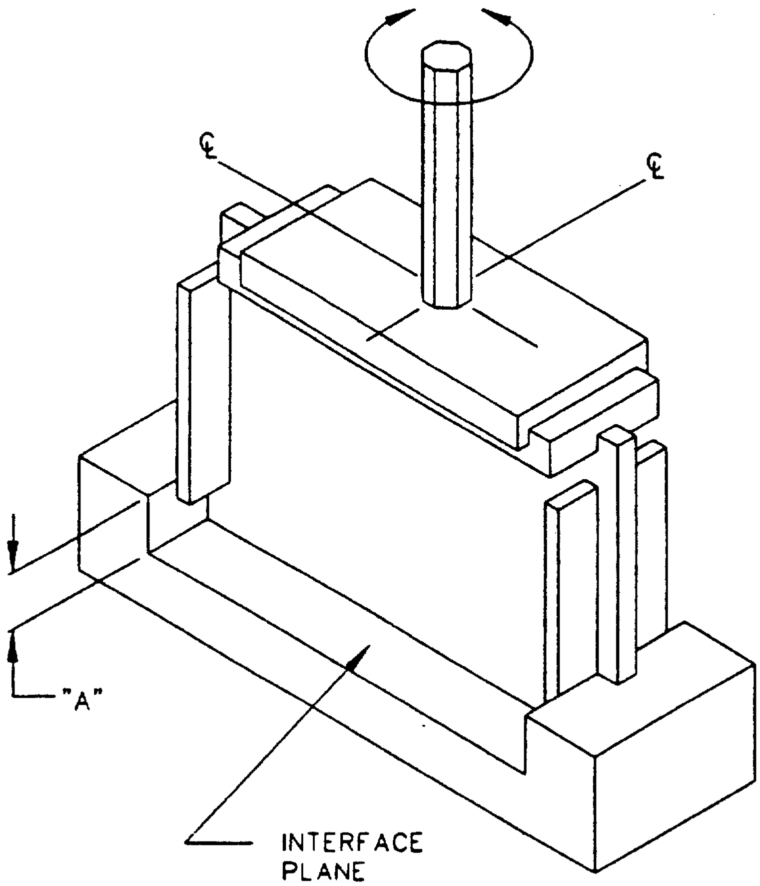
4.7.6.3 Power supply torque. The power supply shall be mounted in a fixture which restrains the movement of the base of the power supply (see figure 19) and shall have a torque as specified in 3.11.9.4.1 applied to the power supply fin or header in each of two opposing directions. The torque shall be applied at a rate such that the specified torque is applied in 2 to 10 seconds from the time the torque is first applied to the power supply fin or header and maintained for 10 to 15 seconds. During the period of time in which torque is applied, the power supply shall be rigidly supported within a zone between the interface plane and 0.50 inch (12.7 mm) above the interface plane for format B, or 1.0 inch (25.4 mm) above the interface plane for formats C and E.

4.7.6.4 Header torque. With the power supply restrained as specified in 4.7.6.6, the torque specified in 3.11.9.4.2 shall be applied in both directions along the header on format C and E power supplies (see figure 20). The torque shall be applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

4.7.6.5 Fin/header cantilever load. The force specified in 3.11.9.4.3 shall be applied at the center of the fin or header along the centerline between the two extractor holes and perpendicular to the plane of the fin or header in two directions (see figure 21). The power supply shall be rigidly supported along the power supply ribs within a zone between the interface plane and 0.50 inch (12.7 mm) above the interface plane. The specified force shall be applied in 2 to 10 seconds from the time the force is first applied and maintained for 10 to 15 seconds.

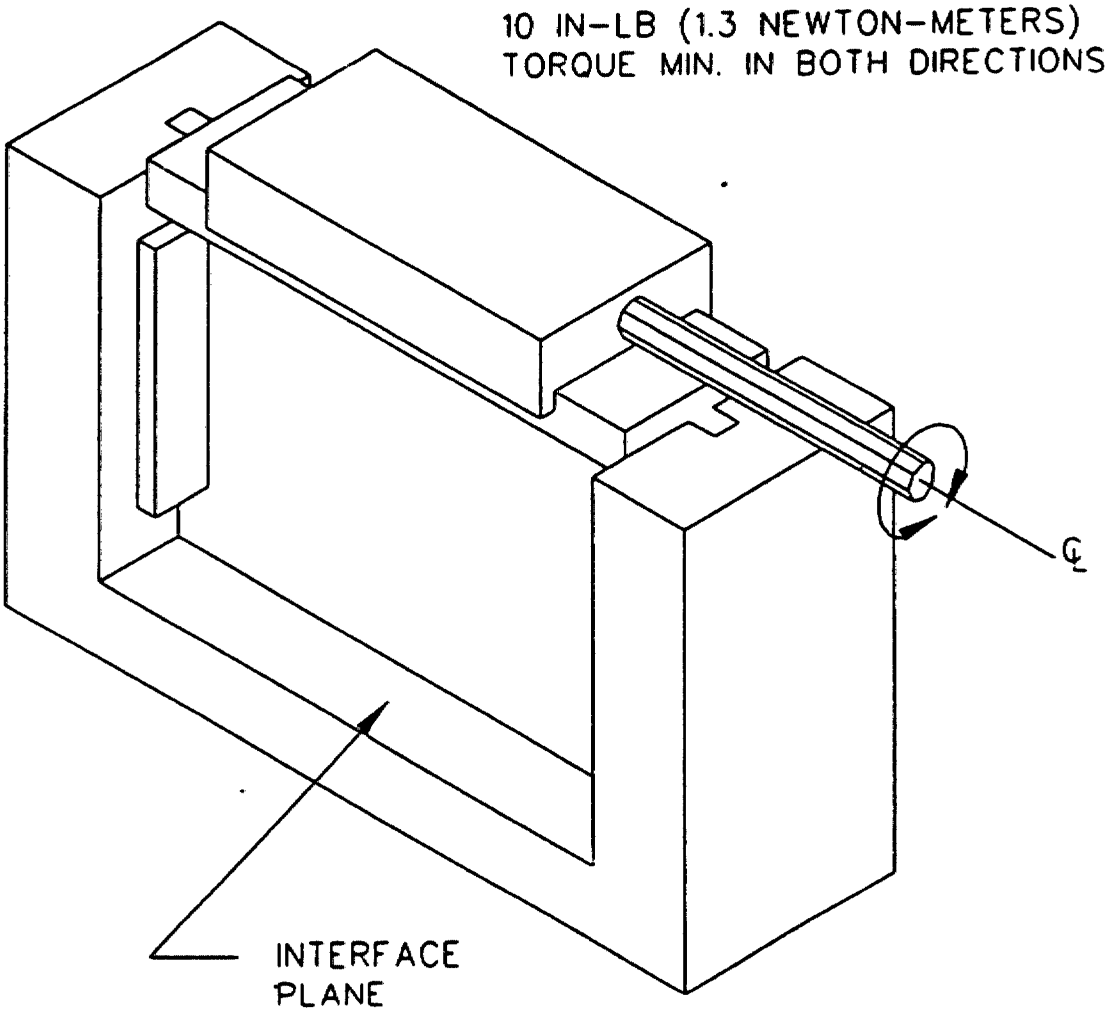
4.7.6.6 Connector integrity. With the power supply ribs supported to prevent movement of the unit, the force specified in 3.11.9.5 shall gradually be applied to the connector in both directions of the longitudinal axis of the contact. The force shall be applied at a rate such that the specified force is applied in 2 to 10 seconds from the time the force is first applied to the connector and maintained for 10 to 15 seconds.

FORMATS B: 6 IN-LB (0.68 NEWTON-METERS) TORQUE MIN. IN BOTH DIRECTIONS.
FORMATS C, E: 25 IN-LB (2.82 NEWTON-METERS) TORQUE MIN. IN BOTH DIRECTIONS.



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Metric equivalents are in parenthesis.
4. "A" is 0.5 inch (12.7 mm) for format B, and 1.0 inch (25.4 mm) for formats C and E.

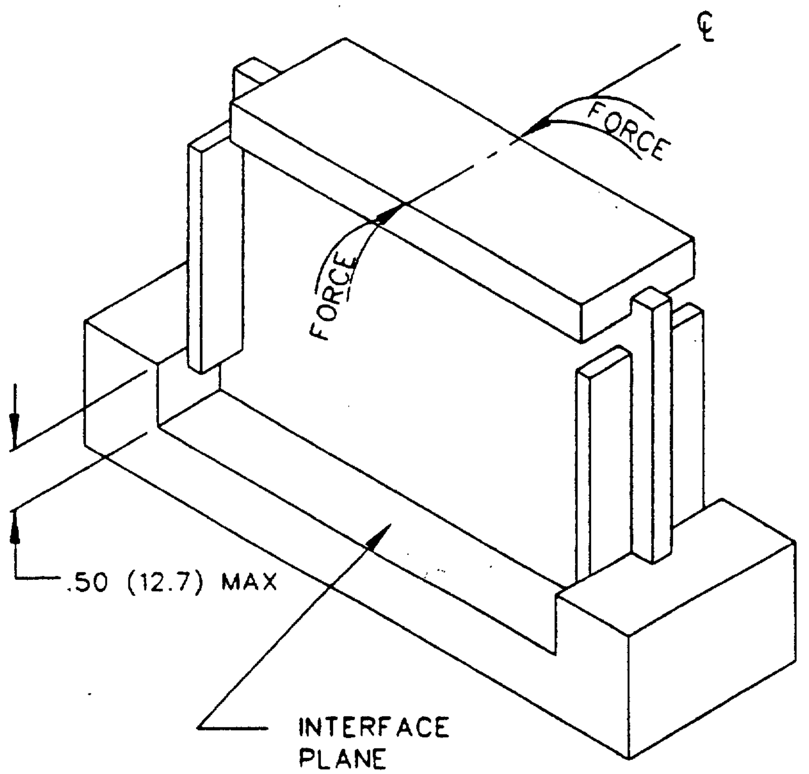
FIGURE 19. Power supply torque.



NOTES:
1. Metric equivalents are given for general information only.
2. Metric equivalents are in parenthesis.

FIGURE 20. <u>Header torque</u>.

FORMAT B: 2 LB (9 NEWTONS)
FORMATS C, E: 5 LB (22.3 NEWTONS)
MINIMUM IN BOTH DIRECTIONS



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Metric equivalents are in parenthesis.

FIGURE 21. Fin/header cantilever load.

4.7.6.7 Connector contact integrity. With the body of the connector supported to prevent movement of the connector, the force specified in 3.11.9.5.4 shall be gradually applied to each contact in the connector individually in both directions of the longitudinal axis of the contact. The force shall be applied at a rate such that the specified force is applied in 2 to 10 seconds from the time the force is first applied to the contacts and maintained for 10 to 15 seconds.

4.7.6.8 Keying pin torque. With the power supply supported to prevent rotation of the unit about the longitudinal axis of the keying pin to be tested, the torque specified in 3.11.9.6.5.1 shall be applied in a plane perpendicular to the longitudinal axis of the keying pin. The torque shall be applied such that the specified torque is applied in 2 to 10 seconds from the time torque is first applied to the pin and maintained for 10 to 15 seconds. The longitudinal axis of the keying pin is considered the center of the keying pin diameter extending the length of the keying pin.

4.7.6.9 Keying pin pullout. With the power supply supported to prevent movement of the unit, the force specified in 3.11.9.6.5.2 shall be applied to the keying pin in the longitudinal axis of the keying pin. The force shall be applied at a rate such that the specified force is applied in 2 to 10 seconds from the time the force is first applied to the keying pin and maintained for 10 to 15 seconds.

4.7.6.10 Keying pin cantilever load. With the power supply supported to prevent movement of the unit, the force specified in 3.11.9.6.5.3 shall gradually be applied perpendicular to the longitudinal axis of the keying pin at a minimum distance of 0.200 inch (5.08 mm) from the interface surface. The force shall be applied at a rate such that the specified force is applied in 2 to 10 seconds from the time the force is first applied to the keying pin and maintained for 10 to 15 seconds. The keying pin under test shall have no external support along the keying pin length extending from the interface surface during the test.

4.7.6.11 Keying pin pushout. With the power supply body supported to prevent movement of the unit, the force specified in 3.11.9.6.5.4 shall be applied to the keying pin in the longitudinal axis of the keying pin. The force shall be applied at a rate such that the specified force is applied in 2 to 10 seconds from the time the force is first applied to the keying pin and maintained for 10 to 15 seconds. The force shall be applied in the opposite direction to the force in 4.7.6.9.

4.7.7 Thermal measurements. Component temperature verification shall be performed by the APSP-QAA in accordance with 4.7.7.1 through 4.7.7.2 (see 3.12.1 and 4.4.3).

4.7.7.1 Family A1.

4.7.7.1.1 CCT. With the power supply operating in accordance with the associated detail specification (if no circuit is specified, the long term stability test circuits shall be used), the temperatures of the components shall be monitored while operating in accordance with 4.7.3.1.1. The CCT of any component shall not exceed the maximum allowable component temperature (see 3.12.1.1).

4.7.7.1.2 TCCT. The TCCT shall be tested during test cycle time 210 to 240 minutes of the temperature and altitude test procedure of 4.7.3.2. The power supply shall operate at full load with all input voltages maintained constant during power supply operation. The temperature of the components shall be monitored. The TCCT of any component shall not exceed the maximum allowable component temperature (see 3.12.1.2).

4.7.7.2 Family A2. Power supplies shall be set up in thermal test fixtures, operated according to the associated detail specification (if no circuit is specified, the life test circuit shall be used), and tested to the requirements described below. Unless otherwise specified in the associated detail specification, all power shall be dissipated through each thermal interface individually without any heat loss from the other interfaces. The fin or rib temperatures shall be monitored as near as possible to the thermal interface without disrupting the integrity of the thermal interface (see 3.12.1).

4.7.7.2.1 CCT. With the power supply operating at its class high thermal interface temperature, the temperatures of components shall meet the requirements of critical component temperature in 3.12.1.1.

4.7.7.2.2 TCCT. With the power supply operating at its class high thermal interface temperature, the temperature shall be raised 20°C above the class high temperature in approximately 5 minutes and maintained for 1 hour. The power supply component temperature shall meet the requirements of the transient critical component temperatures in 3.12.1.2.

4.7.7.3 Leakage (family A1). The power supplies shall meet the leakage requirements of 3.12.5 with the cooling air system pressurized to no less than 2 inches of water at a temperature of 21°C plus or minus 5°C. The power supply shall be mounted by its usual means with elastomeric air seals mating with the sealing area. The elastomeric seal material shall be ZZ-R-765, class 3B, grade 50 or equivalent.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of reference documents listed in section 2, see 5.4 and 6.6.)

5.1 Process method. The method of preservation shall be in accordance with method IIb of MIL-P-116 and the requirements specified herein. Preservation and packing shall be in accordance with level A of MIL-STD-2073-1.

5.2 Preservation.

5.2.1 Cleaning. Power supplies shall be cleaned in accordance with MIL-P-116, process C-1.

5.2.2 Drying. Power supplies shall be dried in accordance with MIL-P-116.

5.2.3 Preservation application. Contact preservatives shall not be used.

5.2.4 Desiccants and humidity indicators. Desiccant shall be provided in accordance with MIL-P-116. Humidity indicators are not required.

5.2.5 Interior package. A power supply shall be contained in a snug-fitting carton in accordance with PPP-B-00636, class weather resistant; type, variety, grade, and style optional; normal requirements. Box closure shall be in accordance with method IV of the appendix to PPP-B-00636.

5.2.6 Barrier. The interior package shall be enclosed in a sealed bag in accordance with MIL-B-117, type I, class E, style 1. Electrostatic discharge protective packaging shall be accomplished in accordance with MIL-P-116. Power supplies requiring protection from electrostatic field forces shall be enclosed in sealed bags conforming to MIL-B-117, type I, class A, style 2.

5.3 Packing.

5.3.1 Cushioning. Cushioning shall be provided by shock and vibration-absorbing materials or devices that adequately protect the power supplies from physical damage during handling, shipment, and storage.

5.3.2 Exterior package. An exterior package shall be provided which conforms to PPP-B-00636, class weather resistant, type, variety, grade, and style optional, special requirements. Closure of the exterior package shall be in accordance with method V of the appendix to PPP-B-00636 and shall not damage the barrier bag. Exterior containers shall be of a minimum tare and cube consistent with the protection required.

5.4 Alternate packaging. Alternate packaging approaches shall be submitted to the command or agency concerned for approval.

6. NOTES

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

6.1 Intended use. Power supplies specified herein are intended for use in military systems and subsystems.

6.2 Acquisition requirements. Acquisition documents must specify the following:

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

(b) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see section 2).

(c) Title, number, and date of the associated detail specification and the part number.

(d) Levels of preservation, packaging, and packing required (see section 5).

(e) QUAL certification, as required (see 3.14.1.2).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
4.4.1.1	DI-NDTI-80809	Test/inspection reports	---
4.4.2	DI-R-7082	Reliability predictions report	---
4.4.4	DI-DRPR-81000	Product drawings and associated lists	---
4.5.4 6.8.2	DI-RELI-80255	Failure summary and analysis report	---
4.4.9	UDI-R-23743	Quality program plan	---
4.4.11	DI-T-25837	Document, maintenance requirement	10.4.3f Applies without exceptions

The above DID's were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.3.1 Data requirements for qualification. Data items identified in this specification are required to be delivered to the APSP-QAA for the purpose of facilitating qualification testing. The data will not be disclosed outside the Government nor duplicated, used, or disclosed, in whole or in part, for any purpose other than to evaluate the power supply submitted for qualification testing (see 6.3.1.1). Generally, these data requirement deliveries coincide with qualification submission schedules and are not a function of power supply acquisitions. Deliverable data required (but not restricted to those listed) by this specification for qualification are cited in the following paragraphs.

Paragraph no.	Data requirement title
3.10.4	Printed-wiring and printed-wiring assemblies (equivalent materials, processes and requirements)
4.4.1	Initial qualification tests
4.4.1.1	Test data
4.4.1.2	Inspection and test procedures
4.4.2	Failure rate prediction and parts derating
4.4.3	Thermal analysis
4.4.4	Design conformance (design package)
4.4.4.1	Change control
4.4.5	Periodic check (cross reference matrix)
4.4.5.2	Noncontinuous production
4.4.7	Corrective action
4.4.9	Quality assurance requirements
4.4.9.1	Manufacturing flow chart
4.4.9.2	Manufacturing instructions
4.4.9.3	Processes requiring certification
4.4.11	Maintenance data
10.5, appendix	Notification
50.3, appendix	Test procedure documentation
60.4, appendix	Correlation requirements
70.2, appendix	Recorrelation criteria

6.3.1.1 Rights in technical data. All data and information provided for use or specified to be delivered for qualification purposes will be furnished for use by the APSP-QAA only. This data must be delivered to the requirements of SD-6, "Provisions Governing Qualification" and therefore no DID's are required.

6.4 Qualification. With respect to products requiring qualification, awards will be made only to power supply contractors (1) whose products are, at the time set for opening of bids, qualified for inclusion in Qualified Products List QPL No. 29590 or (2) who have at least one power supply listed on the QPL-29590 at the time set for opening of bids and deliver with their bid a statement of certification that the procured item(s) will be qualified prior to the required delivery date. The attention of the power supply contractor is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts of purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Avionics Center, Code 812, 6000 East 21st Street, Indianapolis, IN 46219-2189. Application for qualification tests should be made in accordance with SD-6, "Provisions Governing Qualification."

6.5 Definitions. The following definitions are applicable to terms used herein.

6.5.1 Command or agency concerned. The command or agency concerned is the organizational element of the Government which contracts for articles, supplies or services, or it may be a supplier or subcontractor when the organizational element of the Government has given specific written authorization to such a contractor or subcontractor to serve as agent of the command or agency concerned. A contractor or subcontractor serving as agent of the command or agency concerned should not have the authority to grant waivers, deviations, or exceptions to this specification unless specific written authorization to do so has also been given by the Government.

6.5.2 APSP-QAA. The APSP-QAA performs airborne power supply products QPL maintenance and support. These functions are being performed by the Naval Avionics Center, Code 812, 6000 East 21st Street, Indianapolis, Indiana 46219-2189, telephone 317-353-7812.

6.5.3 Power supply supplier. A power supply supplier is any person, partnership, company, corporation, or associate who owns, operates, or maintains a factory or establishment that produces, on the premises, the power supply required under a contract with the command or agency concerned. If a power supply is manufactured by an organization within the command or agency concerned, that organization should be considered a power supply supplier. Supplier and manufacturer are used interchangeably throughout this specification.

6.5.4 Material Review Board (MRB). The MRB will be comprised of at least three members as follows:

(a) A member of the Government Inspection Agency. This member, or his designated representative, will be the chairman and may approve the qualification of all other members and alternates.

(b) A power supply supplier's representative whose primary responsibility is the quality of the product.

(c) A power supply supplier's representative whose primary responsibility is the design of the product.

Any concurrence of a disposition by the board must be unanimous. A member may have alternates approved by the chairman. An APSP-QAA representative may constitute the fourth MRB member at the discretion of the APSP-QAA.

6.5.5 Specified performance. The terms "specified performance", "specified requirements", and "specified limits" are used interchangeably and refer to all applicable power supply requirements specified herein and in the associated detail specification.

6.5.6 MIL-STD-1389 and MIL-M-28787. References herein to MIL-STD-1389 and MIL-M-28787 are made for requirements as applicable to the power supplies. When these documents are used for family A1, the term "Standard Electronic Module (SEM)" shall be interpreted as Airborne Power Supply Products (APSP), and the term "module" shall be interpreted as power supply.

6.5.7 Power supply thermal interface. For family A1 the thermal interface shall be the mounting surface. For family A2, the thermal interface shall be the fin or rib cooling surface.

6.6 Subcontracted material and parts. The packaging requirements of reference documents listed in section 2 do not apply when material and parts are acquired by the manufacturer for incorporation into the power supplies and lose their separate identity when the equipment is shipped.

6.7 SEM Design Review Activity (SEM-DRA). The SEM activity which is currently responsible for the review and classification of module designs and assigns manufacturers' designations is the Naval Avionics Center, Code 814, 6000 East 21st Street, Indianapolis, IN 46219-2189, telephone 317-353-7814.

6.8 Examples of plans and additional requirements. Test plans, documentation and additional requirements that may be required by the statement of work or contract may include but are limited to the examples specified in 6.8.1 through 6.8.6.

6.8.1 Reliability program plan. A reliability program plan should be prepared that identifies and ties together all program management tasks required to achieve the reliability requirement of 3.7.1. The task description section of MIL-STD-785, task 101, Reliability Program Plan, should be considered in developing the plan. The plan should be submitted to the command or agency concerned for approval.

6.8.2 Failure reporting, analysis, and corrective action. A closed loop system should be established for reporting deficiencies found in accordance with MIL-Q-9858, for analysis of failures to determine cause (see 4.5.4), and for recording corrective action taken. Classification of failures should be in accordance with MIL-STD-2074.

6.8.3 Electronic parts/circuits tolerance analyses. Parts/circuits tolerance analyses should be conducted on each power supply type. These analyses should verify that, given reasonable combinations of specification characteristics and parts tolerance buildup, the power supply being analyzed will perform within specification requirements. Component characteristics (life-drift and temperature) should be factored into the analyses. Results of these analyses and actions taken should be made available to the command or agency concerned.

6.8.4 Environmental stress screening plan. A detailed environmental stress screening test plan should be prepared as part of the reliability program plan and should consider the requirements of task 301 of MIL-STD-785 and NAVMAT P-9492. The test plan should include the 100 percent screening requirements defined herein as thermal cycling (see 4.7.5.2) and random vibration (see 4.7.3.3).

6.8.5 Reliability development/growth test (RDGT) program. A RDGT program should be implemented in accordance with task 302 of MIL-STD-785.

6.8.6 EMI test plan. An EMI test plan should be prepared to implement the testing requirements and procedures of MIL-STD-462 as defined in 3.6. Formal testing is not to commence without approval of the test plan by the APSP-QAA.

6.8.7 Government source inspection. The command or agency concerned should notify the Defense Contract Management Administration Office (DCMAO) representative servicing the command or agency prior to placement of an order invoking this specification. The recommended DCMAO actions should include review of the supplier's quality program and the means employed to control quality and to comply with contract requirements, initiation of required corrective action, and the inspection of the power supplies.

6.9 Nonconforming materials. Any variance of material from this specification and from the associated detail specification should be disposed of in accordance with the decision reached by the MRB (see 6.5.4). The supplier may use in-house established procedures documented in his control plan for such disposition. Records of all such variances and disposition should be retained on file and available for Government review. The APSP-QAA should be notified of MRB decisions which result in the use of nonconforming materials in the manufacture of power supplies and which cause the power supplies to not meet the requirements specified herein or in the associated detail specification.

6.9.1 Disposition of nonconforming material. The disposition of nonconforming material should be in accordance with the decisions reached by the MRB. The dispositions will generally fall into the following categories.

(a) Use as is. Material that, in its present condition, can be used without compromising form, fit, function, performance, reliability, safety, and so forth. The disposition will be made by the MRB.

(b) Repair. Material, after repair, which meets the definition of (a) but does not fully meet drawing and specification requirements. This disposition, including approval of the repair procedure, will be made by the MRB.

(c) Rework. Material which can economically be restored to a conforming condition. This disposition does not require MRB approval.

(d) Scrap. Material not usable in its present condition and which cannot be economically reworked or repaired. This disposition does not require MRB approval.

6.9.2 Shipment of nonconforming material. Power supplies containing nonconforming material should not be shipped until the applicable waiver or deviation has been approved by the command or agency involved or the final MRB disposition has been received. Power supplies requiring a waiver or deviation should not be marked with the qualification certification mark "QUAL".

6.10 Part or identifying number (PIN). The PIN to be used for power supplies acquired to this specification is created as follows:

M	29590	/123	A	(1)
Military specification	Specification number	Detail specification number	Detail specification revision letter	Detail specification amendment number

For example, a power supply could be marked M29590/123A(1). The associated detail specification revision letter and amendment number are not a part of the power supply part number and shall be left blank if none exists. The example part number is not intended to designate a length of field requirement. The length of the part number will vary according to the applicable associated detail specification.

6.11 QUAL marking. The APSP-QAA will notify in writing each power supply supplier on a military part number basis when "QUAL" may be marked on a power supply. Conversely, when a power supply supplier fails to meet all of the requirements herein, and in the associated detail specification, the vendor will be notified in writing to stop marking "QUAL". Such notification will come from the APSP-QAA.

6.12 Subject term (keyword) listing.

Airborne Power Supply Products (APSP)
APSP
Converter, AC to DC
Converter, DC to DC
Standard Hardware Acquisition and Reliability Program (SHARP)
SHARP
Standard Power Supplies (SPS)
SPS

APPENDIX

AIRBORNE POWER SUPPLY PRODUCTS TESTER CORRELATION

10. SCOPE

10.1 Scope. Correlation is the method of proving, for a power supply of a specific military part numbered power supply, that all production testers shall yield test data which matches the correlation data within close tolerance and determines if the power supply meets the requirements of the power supply associated detail specification. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

10.2 Performance. Correlation shall be performed on all production testers used to accept, qualify, or recertify APSP. Successful correlation shall be required to certify the use of a tester and its peripheral equipment (adapter, switching cards).

10.3 Method. Correlation is accomplished by using a common medium between the production tester and the quality assurance provision of the power supply associated detail specification. This medium provides a means of comparing the results of a specific power supply having known recorded parameters with the results of the production testers. This common medium is a power supply hereinafter termed "correlation power supply".

10.4 Responsibility. The APSP-QAA shall be responsible for correlation and shall determine the need for correlation of production testers associated with a given power supply military part number. The APSP-QAA shall also maintain control over the correlation power supplies and only take them to the vendor's facility during the correlation attempts.

10.5 Notification. The testing facility or acquisition activity should notify the APSP-QAA in writing of a correlation requirement as soon as it becomes known.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. CORRELATION CRITERIA

30.1 Correlation criteria. The following are criteria to be used in determining the need for correlation of a production tester for a specific power supply part number.

(a) QUAL certification. QUAL certification for a standard electronic power supply requires that all test systems be correlated.

(b) Accuracy requirements. The associated detail specification has critical parameters with close tolerances requiring accurate measurements.

(c) Environmental sensitivity. Power supply types which are sensitive to parasitic resistance, capacitance, or inductance requiring control of power supply/tester interface.

(d) Test method deviations. Power supplies which are being tested by a tester with a method which deviates from procedures specified in the associated detail power supply drawing or specification.

(e) Factory or field failure. Power supply types which have experienced excessive factory or field failures.

40. CORRELATION AND PROOF POWER SUPPLIES

40.1 Acquisition. The initial developer or supplier shall provide the APSP-QAA with four production power supplies of a specific military part number for correlation and proof power supplies. Or, when agreed to by the APSP-QAA, power supplies submitted for qualification may be used for correlation samples. Prior to the availability of production power supplies, prototype power supplies meeting the above requirements may be submitted. Each power supply shall meet the product design configuration of the drawing or specifications.

40.2 Development. The APSP-QAA shall test the four power supplies to the requirements of the power supply specification. The data shall be recorded and a data file shall be maintained and updated. When the power supplies are tested by a bench setup, all test equipment and associated information shall be recorded. When the power supplies are tested by automatic test equipment (ATE), a copy of the program and a drawing of any required interface circuitry shall be maintained. All data shall be referenced to the applicable test conditions of the power supply specification. The determination to use bench or ATE shall be made by the correlation activity.

APPENDIX

40.2.1 Correlation power supplies. The two power supplies for which correlation sheets are made shall be designated as correlation power supplies. The purpose of the correlation power supplies shall be to obtain comparison data for use in correlating an existing tester. The correlation power supplies shall display a conspicuous identification sticker marked "CORRELATION POWER SUPPLIES".

40.2.2 Proof power supplies. The remaining two power supplies which were tested on a bench test setup or a correlated tester shall be designated as proof power supplies. The proof power supplies shall be used to check out new or modified testers in preparation for correlation testing. The proof power supplies protect the correlation power supplies from damage and are used for laboratory investigation of requested tester deviations. The proof power supplies shall display a conspicuous identification sticker marked "PROOF POWER SUPPLY".

40.3 Repair and retesting of correlation and proof power supplies. A Government designated facility shall be responsible for repairs or modifications to correlation and proof test power supplies. Correlation and proof test power supplies which have been repaired, modified, or otherwise adjusted shall require retesting in a correlation activity laboratory in order to obtain new correlation power supply data which shall supersede previous data.

40.4 Storage and control. Correlation and proof power supplies and their associated data sheets shall be stored by and be under control of the APSP-QAA.

50. TESTER FACILITY REQUIREMENTS

50.1 Facility requirements. A tester facility shall be considered ready to test a correlation power supply and to record correlation data when the facility has complied with the following and received approval from the APSP-QAA.

(a) The tester test document has been written to the required revision of the power supply associated detail specification.

(b) The tester is compatible with its own documentation, which includes a top assembly drawing available to the APSP-QAA upon request.

(c) The top assembly drawing number and the revision status of the production tester and its peripheral equipment is displayed on the applicable equipment.

(d) The production tester and its associated equipment have been serialized and the serial number displayed on each item along with the current calibration tag.

50.2 Tester documentation. The tester documentation shall contain the following:

(a) Manufacturer and model number of each piece of test equipment used.

(b) Serial number of tester to be correlated.

(c) Tester measurement offsets and associated parasitic impedance data, along with an explanation of the derivations.

(d) Test system configuration which includes equipment used, equipment specifications, location of equipment in the test system, and any optional equipment used.

50.3 Test procedure documentation. The tester facility shall prepare a test procedure for each power supply military part number to be correlated. The test procedure shall be submitted to the APSP-QAA for review at least 2 weeks prior to the correlation attempt. The test procedure shall contain the following:

(a) Power supply drawing or specification number and revision to which tester is testing power supplies.

(b) Top assembly drawing number and revision of tester and power supply related peripheral equipment (adapters, switch cards, test tapes, load boards). Drawings of peripheral equipment will be available to APSP-QAA on request.

(c) ATE test program documentation which includes:

(1) System software revision.

(2) List of all files and sub-files.

(3) Test measurement routines.

(4) Order of testing.

(5) Flow charts for particular test sequences, that is, algorithms.

(6) Programming constraints.

(7) Data logging and operator routines.

(8) Test pattern documentation including fault coverage, method used (simulator or manual), test plan description, description of timing associated with each pattern file, and list of all tester pattern files.

(d) A definition of each deviation from the associated detail specification test method which is made in the tester test procedure.

(e) Measurement limits to which tester is testing power supplies.

(f) Determination of tests as sample, 100 percent, or qualification.

(g) Proper order of testing per the associated detail specification.

(h) Comparison of the tester obtained accuracies and required accuracies for each unique test condition of the associated detail specification (this is not required if the method and test equipment used are the same as in the associated detail specification).

(i) Schematic drawing of the test fixture(s) for bench test systems.

60. CORRELATION TESTING

60.1 Correlation testing. The APSP-QAA shall require the following items for correlation testing at the location of the applicable tester facility.

(a) The correlation data sheet for each correlation power supply with the information of section 40. already recorded (supplied by the APSP-QAA).

(b) A copy of the PIN associated detail specification for which the tester is to be correlated.

(c) Tester documentation as specified in section 50.

(d) Two correlation power supplies and two proof power supplies of the military part number for which the tester is to be correlated (supplied by the APSP-QAA).

60.2 Using the proof test power supply. Prior to inserting a correlation power supply into the tester, a proof power supply of the same military part number shall be inserted into the tester to protect the correlation power supply. When automatic testers are used, a proof power supply shall be tested twice to verify the power supply has not been damaged. If this requirement is not met, then the responsible tester facility personnel shall take the necessary corrective action. If the corrective action requires that changes be made in tester documentation, then these changes shall be sent in writing to the APSP-QAA. When the tester test results on the proof power supplies have met the requirements of this appendix, the tester is ready to have a correlation power supply inserted. Correlation testing shall be done by tester facility personnel at the tester facility and witnessed by the APSP-QAA.

60.3 Recording information on the correlation data sheet. The correlation personnel shall properly complete the data and information required on the correlation data sheets corresponding to the two correlation power supplies of the military part number for which the tester is being correlated.

60.4 Correlation requirements. The tester test results shall be considered to have met the correlation requirements when they agree with the requirements of 90.3 through 90.4.

60.4.1 Discrepancies. Test facility personnel shall be responsible for taking corrective action on each discrepancy found. Before correlation data is retaken on the tester, tester facility personnel shall explain to the APSP-QAA in writing the reason for and action taken on each discrepancy. All changes and revisions to tester documentation shall be submitted in writing to the APSP-QAA. Upon approval of these changes by the APSP-QAA, correlation data shall be taken on those test conditions deemed necessary by the APSP-QAA.

60.4.2 Failure on one correlation power supply. If a tester measurement fails the correlation criterion on one correlation power supply only, this measurement shall be repeated on both correlation power supplies. If the same results are obtained, the measurement will not be considered to have failed correlation until the data of the failed power supply has been verified on the APSP-QAA laboratory bench test setup.

60.5 Correlation not successful. When correlation is not successful, the reason and planned corrective action shall be entered in the tester correlation report (see figure 22) and forwarded to the acquisition activity.

60.6 Correlation successful. When correlation is successfully completed, the APSP-QAA shall be required to fill out a correlation report (see figure 22). Upon completion, this report shall be signed by the APSP-QAA. The tester is now ready for official certification which shall be the responsibility of the APSP-QAA.

APPENDIX

<table>
<tr><td colspan="5">TESTER CORRELATION REPORT
AIRBORNE STANDARD POWER SUPPLY</td><td></td></tr>
<tr><td rowspan="6">MODULE
KEY CODE</td><td colspan="4">MIL-P-29590</td><td rowspan="6">☐ YES X & S TESTS
(&Q TESTS FOR NAC)
☐ NO
☐ OTHER</td></tr>
<tr><td>MIL-P-29590</td><td>SHEET NO.</td><td>REV. LTR.</td><td>AMENDMENT NO.</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">EQUIVALENT OR SPECIFICATION CONTROL</td></tr>
<tr><td colspan="2">DWG NO.</td><td colspan="2">REV. LTR.</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">VENDOR AND LOCATION</td><td>CORRELATION
☐ INITIAL
☐ RECORRELATION (DATA RETAKEN)
☐ RECORRELATION (PAPER UPDATE)</td></tr>
<tr><td colspan="5">TEST PROCEDURE</td><td rowspan="3">DATE (DATA TAKEN)</td></tr>
<tr><td colspan="2">NUMBER</td><td colspan="3">REVISION</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td colspan="6">TEST EQUIPMENT CORRELATED</td></tr>
<tr><td colspan="6">VENDOR TESTER PERSONNEL</td></tr>
<tr><td colspan="6">CORRELATION STANDARDS AND SERIAL NOS.</td></tr>
<tr><td colspan="6">COMMENTS</td></tr>
<tr><td colspan="6">AUTHORIZED DEVIATIONS</td></tr>
<tr><td colspan="5">APSP-QAA APPROVAL</td><td>DATE</td></tr>
<tr><td colspan="5">CORRELATION ENGINEER</td><td></td></tr>
<tr><td colspan="5">APSP-QAA APPROVAL</td><td></td></tr>
<tr><td colspan="5"></td><td></td></tr>
</table>

Data sheets available from: Commanding Officer, Naval Avionics Center (Code 812), Indianapolis, IN 46219-2189.

FIGURE 22. Tester correlation report format.

60.7 Report. The APSP-QAA shall send copies of the completed correlation report to the cognizant Government activity at the tester facility and to the acquisition activity.

70. RECORRELATION

70.1 Responsibility. The APSP-QAA shall be responsible for recorrelation of a tester design or any part thereof.

70.2 Recorrelation criteria. The following criteria shall be used to determine the necessity for recorrelation.

(a) The tester or any part thereof has undergone modification which directly influences the electrical testing of power supplies.

(b) Repeated failures of a specific power supply military part number are indicated by tester measurements.

(c) Repeated failures of a power supply of a specific military part number are indicated by system usage.

(d) A power supply of a specific military part number has undergone modification which results in a change in the test procedure, the test results, or the tester, or any part thereof.

(e) Elapse of qualification status criteria as specified in this specification.

The APSP-QAA shall be notified when recorrelation is required.

80. CORRELATION CONTROL DOCUMENTATION

80.1 Information required. For every APSP power supply military part number, the following information shall be documented and maintained by the APSP-QAA.

(a) Tester correlation data.

(b) Tester test equipment data.

(c) Test procedure documentation (see 50.3).

(d) Tester documentation (see 50.2).

(e) Tester correlation report (see figure 22).

90. CALCULATION AND APPLICATION OF TESTER OFFSETS AND CORRELATION TOLERANCES

90.1 General. The tester test results shall be compared to the correlation power supply bench test data plus known tester offsets. The tester results will be considered correlated if they agree with the correlation power supply bench test data plus known tester offsets within the correlation tolerances.

90.2 Tester offsets. A tester measurement offset is a constant quantity with a known physical explanation associated with that tester's measurement of a particular electrical parameter. An offset may be caused by parasitic loading of the power supply by the tester or by a deviation in test method.

(a) Example 1. Power supply transition time is found to be equal to 125 ns as measured in the laboratory with an oscilloscope. On a production tester, the transition time measurement on the same power supply is found to be equal to 145 ns due to 95 pf of parasitic capacitance associated with the tester adapter output pins into which the power supply is plugged. The resultant offset is therefore 20 ns (145 ns minus 125 ns).

(b) Example 2. A power supply test specification states that a voltage is to be measured at a test point. At the test point, this voltage is found to be 9.8 volts (V) as measured in the laboratory. The production tester cannot make measurements at the test point. It must make the voltage measurement at a power supply pin on the other side of a conducting diode. The diode voltage drop is found to be equal to 0.6 V. The output measured by the tester is therefore equal to 9.2 V (9.8 V minus 0.6 V). The tester offset is minus 0.6 V.

(c) Offset. The offset is used for two purposes. First, it serves in the correlation between the bench test data and the tester data on the correlation power supplies. Second, the final programmed tester pass/fail limits are calculated using the offset. This is shown as follows:

Final minimum limit equals the minimum test specification limit plus offset.

Final maximum limit equals the maximum test specification limit plus offset.

90.3 Correlation tolerance. The tester results from the correlation power supply are compared to the results obtained by adding the appropriate tester offsets to the bench test data (taken to power supply test specification) on this same power supply. These results should be identical within a tolerance called the correlation tolerance. Either of two methods is used to calculate the correlation tolerance depending upon the power supply specification parameter requirement. The methods are as follows.

90.3.1 Parameter tolerance equal to or greater than 3 percent. In cases where the parameter tolerance is greater than or equal to 3 percent of the parameter, 22 percent of the parameter tolerance shall determine the correlation tolerance. This can be expressed as follows:

$$\text{Correlation tolerance} = +/-(0.22/2)\left[\frac{\text{max test specification limit - min test specification limit}}{2}\right]$$

$$\text{Correlation tolerance} = +/-0.11\left[\text{max test specification limit - min test specification limit}\right]$$

(a) Example. A test specification states that the requirements for a parameter are tr equals 125 ns plus or minus 15 percent. The maximum limit would be 143.8 ns (125 ns plus 0.15*(125 ns)). The minimum limit would be 106.2 ns (125 ns minus 0.15*(125 ns)). The correlation tolerance is plus or minus 4.14 ns (+/-0.11*(143.8-106.2)). Therefore, the tester measured tr should agree with the bench test measured tr plus tester offset (if applicable) within 4.14 ns. If the upper or lower limit is plus or minus infinity or undefined, then the parameter will not be correlated.

90.3.2 Parameter tolerance less than 3 percent. In cases where the parameter tolerance is less than 3 percent of the parameter, 25 percent of the parameter tolerance plus the bench test equipment accuracy will determine the correlation tolerance. This can be expressed as follows:

$$\text{Correlation tolerance} = \pm \left\{ 0.25 \left[\frac{\text{max test specification limit} - \text{min test specification limit}}{2} \right] + \left[\begin{array}{c}\text{bench test} \\ \text{equipment accuracy}\end{array} \right] \right\}$$

(a) Example. A test specification states that the requirements for a power supply parameter are Vp equals 10 V plus or minus 1 percent. The maximum limit is 10.1 V (10 V plus 0.01(10 V)). The minimum limit is 9.9 V (10 V minus 0.01(10 V)). In addition, the voltmeter used to measure Vp in the laboratory during the recording of correlation data has an accuracy of plus or minus 0.1 percent of full scale as specified by the manufacturer. The accuracy of a 10 V reading is, therefore, plus or minus 0.1 V (plus or minus 0.1 percent times 10 V).

Correlation tolerance = +/- 0.25 ((10.1-9.9)/2) + 0.01

Correlation tolerance = +/-0.035 volt.

90.4 Parameter tolerance undefined in terms of percent. In cases where the parameter tolerance cannot be defined in terms of percent due to the parameter requirement being centered about zero, 22 percent of the parameter tolerance shall determine the correlation tolerance. In cases where the parameter tolerance cannot be defined in terms of percent due to the reading being taken in dB, 1.1 times the sum of the bench test equipment accuracy and the tester test equipment accuracy shall determine the correlation tolerance.

(a) Example. A test specification states that the requirements for a power supply parameter are V offset equals 0 V plus or minus 10 mV. The maximum limit is 10 mV (0 V plus 10 mV). The minimum limit is minus 10 mV (0 V minus 10 mV).

Correlation tolerance = +/-0.22 ((10-(-10))/2)

= +/-2.2 mV.

(b) Example. A test specification states that the requirements for a power supply parameter are gain equals 20 dB plus or minus 2 dB (in the electrical requirements table and in the test table). The test equipment used in the laboratory and the tester test equipment has an accuracy of plus or minus 0.2 dB.

Correlation tolerance = +/-1.1 (0.2 + 0.2)

= +/-44 dB.

For those test conditions where the electrical requirements table limits are specified in dB and the test table limits are specified in volts, the correlation limits shall be determined in volts.

90.5 Test equipment accuracy deviation. In the case where a deviation from the test equipment accuracy requirements specified herein and MIL-STD-165 has been granted either through the power supply specification or through waiver acceptance, 1.1 times the sum of the bench test equipment accuracy and the tester test equipment accuracy shall determine the correlation tolerance. This can be expressed as follows:

Correlation tolerance equals plus or minus 1.1 times (bench test accuracy plus tester test equipment accuracy).

(a) Example. A test specification states that the requirements for a power supply parameter are 8 nA plus or minus 25 percent. The required test accuracy is plus or minus 2.5 percent (plus or minus 25/10). The power supply specification states that the test accuracy may be as great as plus or minus 5 percent. The test equipment used in the laboratory has an accuracy of plus or minus 3 percent on the 10 nA scale. The accuracy of this reading is therefore plus or minus 0.3 nA (plus or minus 0.03 times 10). The test equipment used at the tester facility has an accuracy of plus or minus 4 percent on the 10 nA scale. The accuracy of this reading is therefore plus or minus 0.4 nA (plus or minus 0.04 times 10).

Correlation tolerance = +/-1.1 (0.3 + 0.4)

= +/- 0.77 nA.

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CONCLUDING MATERIAL

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