



AEROSPACE STANDARD

AS4805™**REV. A**Issued 2007-07
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Superseding AS4805

Solid-State Power Controller, General Standard For

RATIONALE

This document was completely overhauled to fill the need for a solid-state power controller (SSPC) standard in the aerospace industry. The use of SSPCs has become common practice within the industry. The document defines the minimum electrical, environmental, and reliability requirements for these devices in aerospace applications.

1. SCOPE

1.1 Scope

This SAE Aerospace Standard (AS) covers the general requirements for the design, manufacture, and test of 28 VDC, 270 VDC, and 115 VAC solid-state power controllers (SSPCs) for use in electrical power systems. SSPCs conforming to this standard are intended for use in controlling the making and breaking of power circuits for electrically operated equipment and devices, and for providing overload and short-circuit protection. Applications that require SSPCs to have a high level of performance in some areas or may be exposed to harsher electrical or environmental conditions are designated as CLASS A. Applications that utilize SSPCs in moderate level of performance or are exposed to a controlled environment are designated as CLASS C.

Applicability of both MIL-STD-704 and RTCA DO-160G have been considered when determining the performance standards for the designated classes of SSPCs. To support older aircraft platforms, legacy versions of these specifications were also considered as guidance when determining minimum performance given that prior revisions of these specifications may have demanded more stringent performance.

This standard is applicable to products containing one or more SSPCs. Compliance of a product to this standard requires that all SSPCs within the product adhere to one of the two classes defined for each of the performance requirements specified in this document.

1.2 Field of Application

The principal areas of application of SSPCs are in electrical power distribution systems of aircraft, missiles, ground vehicles, spacecraft, and ground support equipment. This does not preclude the use of SSPCs in other applications.

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2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AS5692A ARC Fault Circuit Breaker (AFCB), Aircraft, Trip-Free Single Phase and Three Phase 115 VAC, 400 Hz - Constant Frequency

AS6019 ARC Fault Circuit Breaker (AFCB), Aircraft, Trip-Free 28 VDC

AS33201C Circuit Breaker - Aircraft, Trip-Free, Push-Pull 1/2 thru 20 Amps, Type I, -55 thru +121 °C

2.1.2 ANSI Accredited Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ANSI Z540-1 General Requirements for Calibration Laboratories and Measuring and Test Equipment

ANSI/ESD S20.20 Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric)

2.1.3 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

IEC 62396 Process Management for Avionics - Atmospheric Radiation Effects

2.1.4 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ISO 9000 Quality Management Systems - Fundamentals and Vocabulary

ISO 10012-1 Quality Assurance Requirements for Measuring Equipment; Part 1: Meteorological Confirmation System for Measuring Equipment

2.1.5 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA DO-160G Environmental Conditions and Test Procedures for Airborne Equipment

2.1.6 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-HDBK-217	Reliability Prediction of Electronic Equipment
MIL-HDBK-454	General Guidelines for Electronic Equipment
MIL-HDBK-704	Guidance for Test Procedures for Demonstration of Utilization Equipment Compliance to Aircraft Electrical Power Characteristics
MIL-PRF-38534	Hybrid Microcircuits, General Specification for
MIL-STD-129	Standard Practice for Military Marking
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-202	Test Method Standard for Electronic and Electrical Component Parts
MIL-STD-461	Requirements for Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-704	DOD Interface Standard - Aircraft Electric Power Characteristics
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-883	Test Method Standard Microcircuits
MIL-STD-1472	DOD Design Criteria Standard Human Engineering, Rev. G

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B1.13M-2001 Metric Screw Threads - M Profile

2.2.2 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ISO 68-1:1998 ISO General Purpose Screw Threads - Basic Profile - Part 1: Metric Screw Threads

2.2.3 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-STD-1916 DOD Preferred Methods for Acceptance of Product

2.3 Definitions and Terminology

The definitions listed below are not a complete glossary of SSPC terminology, but rather are intended as definitions of the technical terms as applied within this document.

ACTIVE POWER DISSIPATION: All power dissipated in the power switching circuit path of the device when the switch is in the ON state.

APPLICATION TIME TO RESET: The time interval the reset signal must be applied to cause reset.

ARC FAULT: A high power discharge of electricity between two or more potentials. The discharge translates into heat, which can break down the wire's insulation and possibly trigger an electrical fire.

ARC FAULT DETECTION AND INTERRUPTION: The ability to sense and selectively interrupt only unwanted arcing conditions to reduce the potential of electrical damage or fire. Refer to AS5692A and AS6019.

BACKFEED RESPONSE: The SSPC's reaction when the POWER OUTPUT is exposed to a higher potential than the POWER INPUT and the SSPC is in the OFF STATE.

BACKFEED VOLTAGE: The application of voltage to the output of an SSPC that is open or closed. (Applicable to system architectures where a single load is powered by two SSPCs or when a fault occurs that inadvertently applies voltage to the POWER OUTPUT of the SSPC.)

BLOCKED: A configuration of an SSPC that prevents the ability to RESET the SSPC after a defined number of TRIP RESETS.

BURST MODE MODULATION: Pulse width modulation of an AC signal in full-cycle increments.

CONTROL VOLTAGE: The voltage applied between the CONTROL POWER INPUT terminal and reference ground of the SSPC.

COORDINATION: Refers to the instance where a given overload must trip the lowest rated SSPC in a cascaded system to prevent turn-off of other loads that are not involved or affected by the fault.

CURRENT LIMITING: A protective characteristic of an SSPC that limits the output current to a specified value for a specified period without tripping.

DEFAULT POWER-UP STATE: The state of the SSPC load output when control power is first applied to the SSPC and no control command/signal is received (bus or pulse driven SSPCs).

FAIL-OPEN: A second element used to interrupt an un-commanded current in the event of a failure in the SSPC's primary switch.

FAIL-SAFE: A secondary element used to interrupt an overload current when the primary element fails.

FALL TIME: See [Figure 9](#).

INSTANTANEOUS TRIP: An immediate trip function that prevents damage to the solid-state switch when it is exposed to a fast and high magnitude current pulse that exceeds the SSPC's safe operating area.

CLASS A APPLICATIONS: Applications that require SSPCs that have a high level of performance or may be exposed to harsh electrical or environmental conditions.

CLASS C APPLICATIONS: Applications that utilize SSPCs in moderate level of performance or are exposed to a controlled environment.

LEAKAGE CURRENT: The current delivered into a short circuit at the SSPC POWER OUTPUT when the SSPC is in the OFF state.

LINE VOLTAGE: The voltage applied between the power input terminal of the SSPC and the load ground.

LOCKED: A configuration of the SSPC that prevents from going to the ON state.

NON-REPETITIVE RESET: The minimum specified time interval between trip and reset for which the trip characteristics are valid.

OFF STATE: That condition under which the device prevents power from being passed to the load.

ON STATE: That condition under which, with the turn-on signal applied, the device allows power to be passed to the load.

PEAK LET THROUGH CURRENT: The maximum value of current available to the load through the device prior current limiting or trip event (see [Figure 7](#)).

POWER CONTROLLER: A switching and protection device providing an output power switch which presents a low impedance between its supply and load terminals when in the ON STATE and a high impedance in the OFF STATE. The state of the power switch normally conforms to that represented by a signal externally applied to the controller. The state of the power switch may be represented by an indication signal. The controller trips to isolate the load circuit from the supply on detection of an electrical overload and/or momentarily limits the current to a specified value.

POWER DISSIPATION: All power dissipated in the power switching circuit including power losses due to internal leakage currents, power supplies, control input, status, and reset signals.

QUIESCENT POWER DISSIPATION: Power losses due to internal leakage currents, power supplies, control input, status, and reset signals.

RATED CURRENT: The intended maximum current an SSPC can carry for an indefinite amount of time without tripping.

RISE TIME: See [Figure 9](#).

SAFE STATE: The default state of the SSPC POWER OUTPUT when the commanded input signal is absent, or an internal BIT failure has occurred (possible states: ON/OFF/LAST COMMANDED).

SHORT CIRCUIT: A short circuit is defined as a low impedance applied between the output terminal and ground.

SSPC VOLTAGE DROP: The voltage drop that results from all components and elements between the device's power input and output connections including but not limited to: connector contact resistance, conductors, switching elements, current measurement devices, and device protection.

STABILIZATION TIME: The time required for the SSPC to power up and successfully complete all built-in tests.

THERMAL MEMORY: The ability of an SSPC to consider the thermal energy retained in a wire or device.

TRIP: The automatic interruption of current that results from electrical overloads.

TRIP CURVE CHARACTERISTICS: The trip curve sets the minimum and maximum trip points of the SSPC and is plotted as current versus time. It is typically based on an inverse I^2t relationship to protect the wire and may be a composite of several trip curves designed to protect the SSPC and downstream devices.

TRIP RESET: The restoration of the tripped SSPC to a state from which it can be turned ON.

TRIP TIME: The time lapse between the application of an overload or fault and when the output current drops below the 10% value of rated output current.

TURN-OFF SIGNAL: The control signal level or digital signal that commands and holds the SSPC in the OFF state.

TURN-OFF TIME: See [Figure 9](#).

TURN-ON SIGNAL: The control signal level or digital signal that commands and holds the SSPC in the ON state.

TURN-ON TIME: See [Figure 9](#).

ZERO VOLTAGE TURN-ON (ZVTO) AND ZERO CURRENT TURN-OFF (ZCTO): A characteristic that requires the SSPC to turn ON and turn OFF only at the half-cycle crossing point, regardless of when the control signal is applied or removed (AC SSPCs only).

2.4 SSPC Interface List and Definitions

The following provides a listing, along with definitions, of the device's primary and secondary interfaces. The primary interfaces are the minimum required for all devices procured under this specification. The secondary interfaces are the optional inputs and outputs available to the user. The secondary interfaces required must be specified in the detail specification sheets. The associated interface definitions are provided to minimize any misunderstanding that might occur between the user and supplier as to the function of the interface specified.

PRIMARY INPUTS: The primary inputs are the minimum required for device procurement under this specification.

1. **ON/OFF CONTROL:** A discrete two-level signal or digital signal that commands the device output ON or OFF. Application of the ON command will cause the device output to close, allowing power to flow from the source to the load. Application of the OFF command will cause the device output to open removing power from the load.
2. **POWER INPUT:** The power received from the source, to be controlled by the device for connection to the utilization equipment.
3. **REFERENCE GROUND:** The return line for discrete signals and control electronics.

SECONDARY INPUTS: The secondary inputs are additional capabilities available to the user, the characteristics of which must be defined in the detail specification sheet.

1. **CONTROL POWER INPUT:** This input is separate from the POWER INPUT and provides power to the control circuitry of the SSPC. It does not supply power to the POWER OUTPUT.
2. **ADDRESS:** A digital signal that provides a logical or physical address to the device for incorporation in the device memory.
3. **BIT INITIATE:** A signal which commands a "self-test" of the device as defined in the detail specification sheet. This test must not affect the device output switch condition.
4. **CONFIGURATION DATA:** An analog or digital signal requesting a reading of device parameters such as rating, part number, modification status, address/installation position, trip level/time setting, and limit level/time as defined in the detail specification sheet. For devices with programmable characteristics.
5. **ENABLE DISCRETE:** A discrete input signal that, when true, allows the device to change state based on the ON/OFF control signal.
6. **PROGRAMMABLE CONFIGURABILITY:** The ability to physically set the device characteristics by digitally sending settings, use of an external component or signal, pin-strapping, or other external fixed connections. These are Inputs that allow changes in the device's default settings.
 - a. **OVERCURRENT TRIP SETTING:** Flexible adjustment of the trip threshold and time response curve to tune the SSPC for various wire sizes and load types.
 - b. **ARC TRIP SENSITIVITY THRESHOLD RATING:** Flexible adjustment of the arc fault detection threshold to tune the SSPC for specific load performance profiles.

- c. PWM FREQUENCY: Specifies a free-running PWM frequency to support loads that can be modulated.
 - d. PWM DUTY CYCLE: Specifies the on-time of the SSPC as a fraction of a single PWM period.
 - e. RESET COUNT LIMIT: Specifies the number of allowable resets before the user/system is blocked out from further resets.
 - f. SOFT START: The ability to enable power limiting for loads with large in-rush currents.
 - g. LOCK: A signal or setting preventing the SSPC from entering the ON state.
7. RESET: An “edge sensitive” signal or digital signal that, when applied, closes the device output reconnecting power to the load and restoring the device to a predetermined state, as defined by the specification. (The ON/OFF control signal can also be used for resetting purposes in conjunction with or in lieu of the RESET signal.)
8. SERIAL ENABLE: A discrete input or digital signal that enables or requests serial output information, as defined in the detail specification sheet, to be sent.
9. TRIP INHIBIT: A discrete input or digital command that inhibits the normal device trip characteristics. When applied, it overrides some or all the device’s internal preprogrammed trip characteristics as defined in the detail specification sheet.
10. TRIP SYNCHRONIZATION INPUT: A discrete input or digital command used to coordinate tripping of an SSPC with another SSPC.
11. MODE OF OPERATION: A discrete input or a digital signal that allows for different power controller operation and reset performance depending on the system mode of operation (e.g., this could be Weight on Wheels [WOW] for an aviation system).

PRIMARY OUTPUTS: The primary outputs are the minimum required for device procurement under this specification.

- 1. POWER OUTPUT: The power received from the source and provided by the device to the utilization equipment when all specified control and protection parameters have been satisfied.
- 2. STATUS OUTPUT: A discrete output signal or digital signal that provides actual state (ON/OFF) of the output power switch of the device.

SECONDARY OUTPUTS: The secondary outputs are additional capabilities available to the user, the characteristics of which must be defined in the detail specification sheet.

- 1. BUILT-IN TEST (BIT): An analog, digital, or digital data bus output that indicates an internal device fault has occurred. This signal should be provided either in response to a BIT initiate request or upon a known failure occurrence during normal operation without benefit of a BIT initiate request.
- 2. CONFIGURATION DATA: A digital signal in response to a configuration data request that provides a reading of device parameters such as rating, part number, modification status, address/installation position, trip level/time setting, and limit level/time as defined in the detail specification sheet. (For devices with programmable characteristics.)
- 3. CURRENT LEVEL THRESHOLD: An analog or digital signal indicating either that the current has exceeded a predefined level, or a discrete range of current levels as defined in the detail specification sheet.
- 4. INTEND TO TRIP: An analog or digital signal indicating either that the device intends to trip allowing the system or user to take corrective action prior to power being disconnected from the load or that the device would trip but has been inhibited. With a digital device, the type of intended trip could also be provided.
- 5. OVERCURRENT TRIP: A discrete signal or digital data bus output that indicates that the device has tripped due to an overcurrent condition. (This may be achieved by use of the STATUS output.)

6. OVERTEMPERATURE TRIP: A discrete signal or digital data bus output that indicates that the device has experienced a protective trip due to the internal temperature exceeding a predefined temperature.
7. TRIP SYNC OUTPUT: A discrete output or digital command used to coordinate the tripping of other SSPCs.
8. STATUS DATA: A digital or set of analog signals that can be read or provided in response to a data request.
 - a. Operating State: ON/OFF/LOCKED/BLOCKED/TRIPPED
 - b. SSPC Output Voltage
 - c. SSPC Output Current
 - d. SSPC Health
 - e. SSPC Input Voltage

3. REQUIREMENTS

3.1 Performance and Qualification

SSPCs furnished under this standard shall be products that have been verified to have met the performance and qualification requirements as specified herein. Applicability of performance requirements shall be evaluated as specified in [Table 14](#).

3.2 Materials

Materials shall be used which will enable the SSPC to meet the performance requirements of this standard. Materials used shall be self-extinguishing and shall not support combustion, give off noxious gases in harmful quantities, give off gases in quantities or rates enough to cause explosion of sealed enclosures, cause contamination to any part of the SSPC, or form current-carrying tracks when subjected to any of the tests specified herein. The selection of materials shall be such as to provide a shelf-life of at least 10 years without affecting the operation of the SSPC.

3.2.1 Fungus-Resistant

Materials used in the construction of SSPCs shall be fungus inert. Use Guideline 4 of MIL-HDBK-454.

3.2.2 Metals

Metals shall be of a corrosion-resistant type or shall be plated or treated to resist corrosion. Use Guideline 15 of MIL-HDBK-454.

3.2.2.1 Plated Finishes

Use of tin plating is prohibited internally and externally. Use of tin-lead finishes or other tin-alloy finishes are acceptable provided the minimum lead content is 3%.

Use of zinc plating is prohibited internally and externally.

Use of cadmium plating is prohibited internally and externally.

3.2.2.2 Dissimilar Metals

Use Guideline 16 of MIL-HDBK-454 to select metals that will be in contact with each other. When dissimilar metals are used in contact with each other, protection against electrolysis shall be provided.

3.3 Design and Construction

SSPCs shall be designed to ensure proper operation in any attitude when mounted to a suitable heat sink if required. The construction of SSPCs shall preclude mechanical or electrical damage, flaking of the finish, loosening of the terminals, or deterioration of marking when subjected to the test methods of this standard.

3.3.1 Visual and Mechanical Examination

The SSPC shall meet the dimensions and weight defined in the manufacturer's SSPC specification sheet or outline drawing.

3.4 Functional and Electrical Performance

The SSPC shall meet the performance as specified in the detailed specification sheet for the following electrical characteristics as applicable.

3.4.1 Voltage Drop

Voltage Drop testing shall be as specified in [4.8.8](#).

3.4.1.1 Voltage Drop (28 VDC SSPC)

The SSPC VOLTAGE DROP of a single device from the SSPC input connection to the SSPC output connection should be less than or equal to the voltage drop values in [Table 1](#).

Table 1 - 28 VDC maximum voltage drop at rated current

SSPC Rated Current (amps)	Voltage Drop (volts)
<30	≤0.25
≥30 to <60	≤0.35
≥60	≤0.60

For cascaded SSPCs within a single enclosure, each SSPC within the enclosure should also comply with [Table 1](#). The block diagram in [Figure 3](#) provides an example of a LRU with cascading power controllers.

3.4.1.2 Voltage Drop (115 VAC SSPC)

The SSPC VOLTAGE DROP of a single device from the SSPC input connection to the SSPC output connection should be less than or equal to the voltage drop values in [Table 2](#).

Table 2 - 115 VAC Maximum voltage drop at rated current

SSPC Rated Current (amps)	Voltage Drop (volts)
<10	≤0.60
≥10 to ≤30	≤1.2
>30 to <50	<1.8

3.4.1.3 Voltage Drop (270 VDC SSPC)

The SSPC VOLTAGE DROP of a single device from the SSPC input connection to the SSPC output connection should be less than or equal to the voltage drop values in [Table 3](#).

Table 3 - 270 VDC maximum voltage drop at rated current

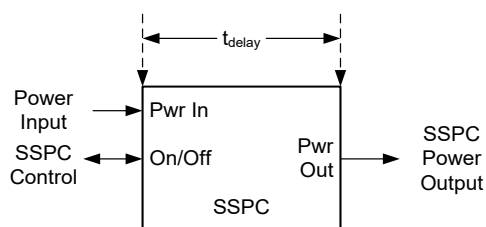
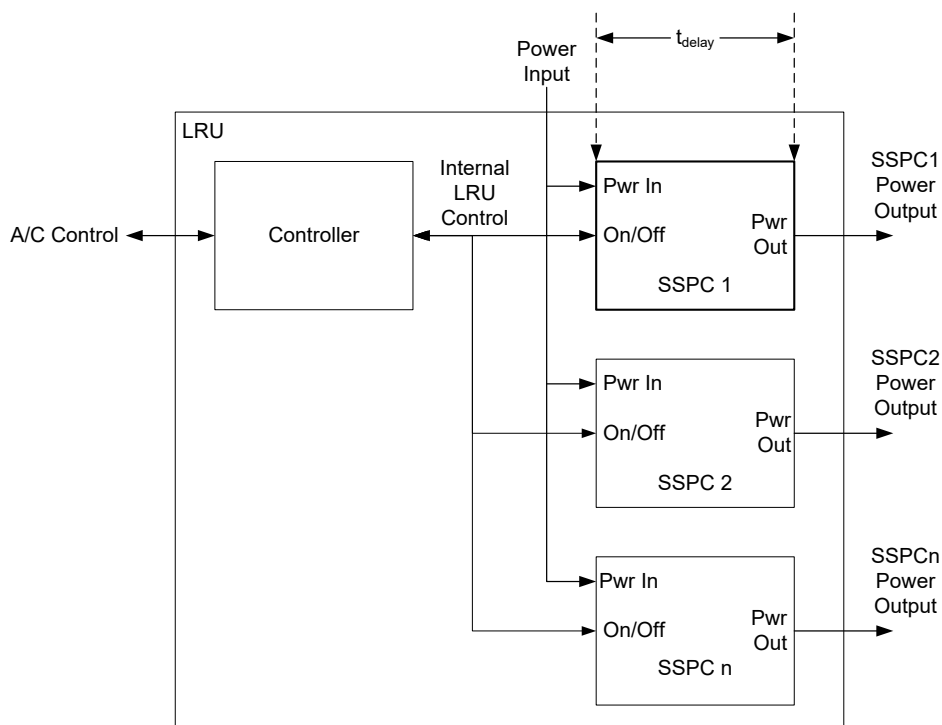
SSPC Rated Current (amps)	Voltage Drop (volts)
$\leq 60\text{A}$	≤ 0.35
$> 60\text{A}$	≤ 0.5

3.4.2 Control Signal

When using an analog or discrete Control Signal, the Control Signal shall turn on and turn off the SSPC output at the signal thresholds specified by the manufacturer. The control signal shall be tested as specified in [4.8.5](#).

3.4.3 Device Turn-ON and Turn-OFF Propagation Delay

Turn-ON and Turn-OFF propagation delay only applies to the delayed response time of a single SSPC whether it is stand-alone (see [Figure 1](#)) or part of a multichannel LRU (see [Figure 2](#)).

**Figure 1 - Single SSPC example****Figure 2 - Multichannel SSPC LRU example**

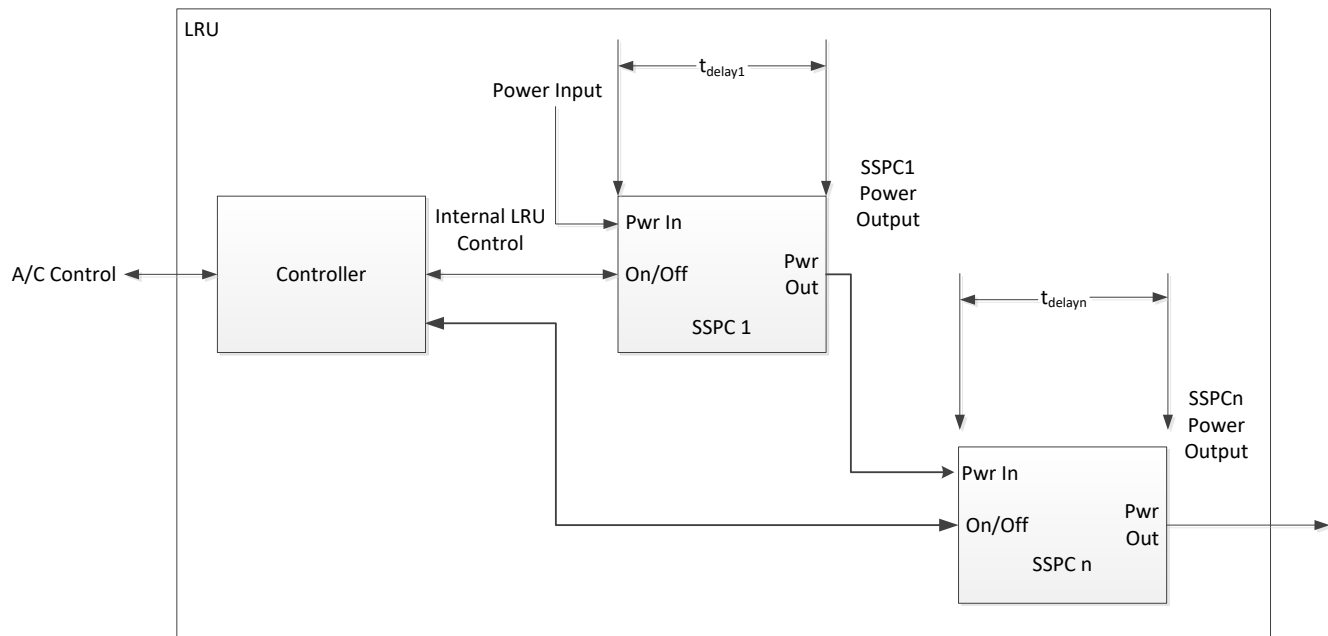


Figure 3 - LRU example with cascading SSPCs

The SSPC shall be tested for propagation delay as specified in [4.8.6](#).

3.4.3.1 Class A Performance

A DC SSPC shall change state (OFF to ON, ON to OFF) with a $t_{\text{delay}} \leq 10$ ms from receipt of a valid command until the new state is achieved.

For AC SSPC devices, the SSPC shall change state from OFF to ON or ON to OFF with a t_{delay} of one AC frequency cycle or 10 ms, whichever is greater.

3.4.3.2 Class C Performance

The DC SSPC shall change state (OFF to ON, ON to OFF) with a $t_{\text{delay}} \leq 50$ ms from receipt of a valid command until the new state is achieved.

For AC SSPC devices, the SSPC shall change state from OFF to ON or ON to OFF with a $t_{\text{delay}} \leq 50$ ms.

3.4.4 Voltage Measurement Reporting Accuracy

If reporting is required, the SSPC shall report the POWER INPUT and POWER OUTPUT bus voltage with a $\pm 5\%$ full scale accuracy over the operating temperature range.

Voltage Measurement Accuracy testing/analysis shall be as specified in [4.8.12](#).

3.4.5 Current Measurement Reporting Accuracy

If reporting is required, the SSPC shall measure current with a minimum accuracy of $\pm 5\%$ of SSPC maximum rating plus $\pm 5\%$ of actual current over the full operating temperature range.

Current Measurement Accuracy testing/analysis shall be as specified in [4.8.13](#).

3.4.6 Operating Voltage Range

When tested as specified in [4.8.4.1](#), [4.8.4.2](#), [4.8.4.3](#), and [4.8.4.4](#), SSPCs shall operate with the following supply voltage variations in accordance with the testing specified in RTCA DO-160G Section 16. For military aircraft applications, supply voltage variations shall be in accordance with MIL-STD-704.

3.4.6.1 28 VDC SSPC Operating Voltage Range

Per [Table 4](#), 28 VDC SSPCs shall fully comply with all performance requirements specified in [Table 15](#) under the following operating conditions.

Table 4 - 28 VDC SSPC operating voltage requirements

	CLASS A Performance		CLASS C Performance	
	Voltage (VDC)	Duration (minutes)	Voltage (VDC)	Duration (minutes)
Abnormal Low Operating Voltage	10	1	N/A	N/A
Low Line Operating Voltage	18	Continuous	18	Continuous
High Line Operating Voltage	30.5	Continuous	30.5	Continuous
Abnormal High Operating Voltage	32.2	Continuous	32.2	5

Wide voltage range SSPCs (CLASS A Performance) shall not be damaged or report a failure when powered by line voltages inside of the envelope of 0 to 10 VDC for 7 seconds. The normal voltage range SSPC (CLASS C Performance) shall not be damaged by line voltages inside of the envelope of 0 to 18 VDC for 7 seconds.

3.4.6.2 115 VAC SSPC Operating Voltage Range

Per [Table 5](#), 115 VAC SSPCs shall fully comply with all performance requirements specified in [Table 15](#) under the following operating conditions.

Table 5 - 115 VAC SSPC operating voltage requirements

	CLASS A		CLASS C	
	Voltage (VAC)	Duration (seconds)	Voltage (VAC)	Duration (seconds)
Abnormal Low Operating Voltage	97	300	N/A	N/A
Low Line Operating Voltage	100	Continuous	100	Continuous
High Line Operating Voltage	122	Continuous	122	Continuous
Abnormal High Operating Voltage	134	Continuous	134	60

Wide voltage range SSPCs (CLASS A Performance) shall not be damaged by line voltages inside of the envelope of 0 to 97 VAC for 7 seconds. Testing shall be performed at 60 VAC and 10 VAC for 7 seconds.

The normal voltage range SSPC (CLASS C Performance) shall not be damaged by line voltages inside of the envelope of 0 to 100 VAC for 7 seconds. Testing shall be performed at 60 VAC and 10 VAC for 7 seconds.

3.4.6.3 270 VDC SSPC Operating Voltage Range

Per [Table 6](#), 270 VDC SSPCs shall fully comply to the performance requirements specified in [Table 15](#) under the following operating conditions.

Table 6 - 270 VDC operating voltage requirements

	CLASS A		CLASS C	
	Voltage (VDC)	Duration (minutes)	Voltage (VDC)	Duration (minutes)
Abnormal Low Operating Voltage	220	1	N/A	N/A
Low Line Operating Voltage	235	Continuous	250	Continuous
High Line Operating Voltage	290	Continuous	290	Continuous
Abnormal High Operating Voltage	320	5	320	5

Wide voltage range SSPCs (CLASS A Performance) shall not be damaged by line voltages inside of the envelope of 0 to 220 VDC for 7 seconds.

The normal voltage range SSPCs (CLASS C Performance) shall not be damaged by line voltages inside of the envelope of 0 to 250 VDC for 7 seconds.

3.4.7 Operating Frequency Range (115 VAC Components)

Wide frequency range SSPCs (CLASS A Performance) shall operate normally over the frequency range of 360 to 800 Hz (45 to 65 Hz for commercial power systems).

Normal frequency range SSPCs (CLASS C Performance) shall operate normally over the frequency range of 360 to 440 Hz (45 to 65 Hz for commercial power systems).

Operating Frequency Range testing shall be as specified in [4.8.26](#).

3.4.8 Pulse Width Modulation (PWM)

Pulse Width Modulation is a modulation technique that generates variable width pulses. This technique is typically used to regulate power to a load for lighting, heating, and motor control. Two adjustable variables in PWM are frequency and duty cycle, which may be included as a programmable feature of the SSPC. For SSPCs that have Pulse Width Modulation capability, testing shall be as specified in [4.8.21](#).

The PWM requirements are applicable only if the SSPC is specified to be used in PWM mode. Frequencies and duty cycles are application dependent, so the specific SSPC detail specification shall supersede any requirements in this document.

3.4.8.1 Pulse Width Modulation (28 VDC and 270 VDC Components)

Unless otherwise specified, the SSPC PWM frequency should be adjustable from 0.1 to 200 Hz minimum, with a minimum of 128 increments within the range. The accuracy of the selected PWM frequency should be less than or equal to 2% of the selected PWM frequency for DC SSPCs.

The SSPC duty cycle should be adjustable from 5 to 95% minimum, in 1% maximum increments and $\pm 1\%$ accuracy.

3.4.8.2 Burst Mode Modulation (115 VAC Components)

Unless otherwise specified, the SSPC PWM frequency should provide burst mode modulation from 0.1 Hz to one-half of the 115 VAC source frequency in full-cycle increments with the minimum resolution of one AC cycle. The accuracy of an AC SSPC output signal should be accurate to within one AC cycle.

3.4.9 Off State Leakage Current (28 VDC, 270 VDC, 115 VAC)

When tested as specified in [4.8.9](#), the leakage current limit shall not be exceeded.

For a given SSPC, the SSPC power output leakage current shall be less than or equal to that indicated in [Table 7](#) when the SSPC in the OFF state, and the SSPC input voltage is at the maximum continuous operating voltage. These values are derived from MIL-STD-1472, 5.7.9.1.5 and Table XXXIV.

Table 7 - Maximum acceptable leakage current matrix

		Maximum Acceptable Leakage Current Matrix
SSPC Voltage Rating	28 VDC	40 mA
	115 VAC	8.5 mA
	270 VDC	40 mA

3.4.10 Open Circuit Output Voltage (28 VDC, 270 VDC, 115 VAC)

When tested as specified in [4.8.10](#), the open-circuit output voltage limit shall not be exceeded.

For a given SSPC, the open-circuit output voltage shall be less than or equal to that indicated in [Table 8](#) when the SSPC in the OFF state, and the SSPC input voltage is at the maximum continuous operating voltage. These values are derived from MIL-STD-1472, 5.7.9.1.5 and Table XXXIV. The voltmeter used to measure this voltage shall have a minimum impedance of 1 MΩ and 1000 pF.

Table 8 - Maximum acceptable open circuit output voltage matrix

		Maximum Acceptable Open Circuit Output Voltage Matrix
SSPC Voltage Rating	28 VDC	6 VDC
	115 VAC	30 VAC
	270 VDC	30 VDC

3.4.11 Instantaneous Trip

The SSPC shall not be damaged after exposure to ten consecutive instantaneous trip events applied at 1-minute intervals (1 minute maximum between events).

Instantaneous Trip testing shall be as specified in [4.8.15](#).

3.4.11.1 Instantaneous Trip (28 VDC Components)

The SSPC shall not be damaged when its POWER OUTPUT terminal is subjected to a direct short and its POWER INPUT terminal is connected to a power source capable of supplying 20 times rated current with a peak rate of rise of ≥ 2.5 A/ μ s to the 20 times current value (rate of rise based on 20 feet of 10 AWG wire [1 mΩ/ft and 0.25 μ H/ft] source impedance).

3.4.11.2 Instantaneous Trip (115 VAC Components)

The SSPC shall not be damaged when its POWER OUTPUT terminal is subjected to a direct short and its POWER INPUT terminal is connected to a power source capable of supplying 20 times rated current with a peak rate of rise of ≥ 15 A/ μ s to the 20 times current value (rate of rise based on 20 feet of 10 AWG wire [1 mΩ/ft and 0.25 μ H/ft] source impedance).

3.4.11.3 Instantaneous Trip (270 VDC Components)

The SSPC shall not be damaged when its POWER OUTPUT terminal is subjected to a direct short and its POWER INPUT terminal is connected to a power source capable of supplying 20 times rated current with a peak rate of rise of ≥ 25 A/ μ s to the 20 times current value (rate of rise based on 20 feet of 10 AWG wire [1 mΩ/ft and 0.25 μ H/ft] source impedance).