



Department of Transportation  
**Federal Aviation Administration**  
Aircraft Certification Service  
Washington, D.C.

**TSO-C178**

Effective  
Date: 03/03/06

# Technical Standard Order

**Subject:** Single Phase 115 VAC, 400 Hz Arc Fault Circuit Breakers

1. **PURPOSE.** This technical standard order (TSO) is for manufacturers of single phase 115 VAC, 400 Hz arc fault circuit breakers (AFCBs) applying for a TSO authorization or letter of design approval (LODA). In it, we (the Federal Aviation Administration or FAA) tell you what minimum performance standards (MPS) your AFCB must first meet for approval and identification with the applicable TSO marking.
2. **APPLICABILITY.** This TSO affects new applications submitted after its effective date.
3. **REQUIREMENTS.** New models of AFCBs identified and manufactured on or after the effective date of this TSO must meet the MPS in SAE International's Aerospace Standard (AS) 5692, *Arc Fault Circuit Breaker (AFCB), Aircraft, Trip-Free Single Phase 115 Vac, 400 Hz—Constant Frequency*, dated October 2004, and the additional requirements of this document.
  - a. **Functionality.** This TSO's standards apply to equipment intended to provide an equivalent level of thermal protection of existing thermal circuit breakers, with the additional capability to detect and react to arc fault conditions, thus diminishing damage to wiring systems by prolonged arcing, which could start a fire.
  - b. **Additional Functional Requirements.** AFCBs may have separate indication of thermal and arcing faults to assist in fault isolation and performing proper repairs.
  - c. **Failure Condition Classification.** Failure of the function defined in paragraph 3.a of this TSO is a *major* failure condition. Develop the system to, at least, the design assurance level equal to this failure condition classification.

**NOTE:** A *major* failure condition reduces the ability of the airplane or the crew to cope with adverse operating conditions. There is a significant reduction in safety margins or functional capabilities; a significant increase in crew workload or in conditions impairing crew efficiency; discomfort to the flight crew or physical distress to passengers or cabin crew, possibly including injuries.
  - d. **Functional Qualification.** Demonstrate the required performance under the test conditions and procedures specified in SAE AS 5692, Section 4.

**e. Environmental Qualification.** Test the equipment according to RTCA, Inc. document RTCA/DO-160E, *Environmental Conditions and Test Procedures for Airborne Equipment*, dated December 9, 2004, or most current revision.

**f. Software Qualification.** If the article includes a digital computer, develop the software according to RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 1, 1992.

**g. Hardware Qualification.** If the article includes aircraft products or appliances incorporating custom micro-coded components, such as application specific integrated circuits (ASIC), programmable logic devices (PLD), field programmable gate arrays (FPGA), or similar electronic components in the design, develop the hardware using FAA advisory circular (AC) 20-152, *RTCA, Inc., Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware*.

**h. Deviations.** We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of performance and safety. Apply for a deviation under Title 14 of the Code of Federal Regulations (14 CFR) § 21.609.

#### **4. MARKING.**

**a.** Mark at least one major component permanently and legibly with all the information in 14 CFR § 21.607(d), except for:

(1) 14 CFR § 21.607(d)(2). Use the name, type, and part number. Do not use the optional model number; and

(2) 14 CFR § 21.607(d)(3). Use the date of manufacture. Do not use the optional serial number.

**b.** Also, mark the following permanently and legibly, with at least the manufacturer's name, subassembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools),

(2) Each interchangeable element, and

(3) Each subassembly of the article that you determined may be interchangeable.

**c.** If the component includes a digital computer, then the part number must include hardware and software identification. Or, you can use a separate part number for hardware and software. Either way, you must include a means to show the modification status.

**NOTE:** Similar software versions, approved to different software levels, must be differentiated by different part numbers.

**d.** If applicable, identify deviations granted to the article by marking “Deviation. See installation/instruction manual (IM)” after the TSO number. You may abbreviate the marking to “Dev. See IM.”

**e.** When applicable, identify the equipment as an incomplete system or that the appliance performs functions beyond those described in paragraphs **3** and **3.a** of this TSO.

**5. APPLICATION DATA REQUIREMENTS.** As a TSO manufacturer-applicant, you must give the FAA aircraft certification office (ACO) manager responsible for your facilities a statement of conformance, specified in 14 CFR § 21.605(a)(1), and one copy each of the following technical data to support our design and production approval as required by 14 CFR § 21.605(a)(2). (LODA applicants submit the 14 CFR § 21.605(a)(2) required data through their civil aviation authorities:)

**a.** Operating instructions and equipment limitations in an installation/instruction manual (IM), sufficient to describe the equipment’s operational capability. Describe any deviations in detail. If needed, identify equipment by part number, version, revision, and criticality level of software, classification for use, and environmental categories.

**b.** Installation procedures and limitations in an IM, sufficient to ensure that the AFCB, when installed according to the installation procedures, still meets this TSO’s requirements. The limitations must identify any unique aspects of the installation. Finally, the limitations must include a note with the following statement:

The conditions and tests for TSO approval of this article are minimum performance standards. Those installing this article, on or in a specific type or class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only if performed under 14 CFR part 43 or the applicable airworthiness requirements.

- c.** Schematic drawings of the installation procedures.
- d.** Wiring diagrams of the installation procedures.
- e.** List of components, by part number, that make up the arc fault circuit breaker complying with the standards in this TSO. Include vendor part number cross-references, when applicable.
- f.** A component maintenance manual (CMM), covering periodic maintenance, calibration, and repair, for the continued airworthiness of installed the AFCB. Include recommended inspection intervals and service life. Describe the details of deviations granted, as noted in paragraph **5.a** of this TSO.
- g.** Material and process specifications list.

**h.** The quality control system (QCS) description required by 14 CFR §§ 21.143 and 21.605(a)(3) including functional test specifications. The QCS tests each production article to ensure compliance with this TSO. (Not required for LODA applicants.)

**i.** Manufacturer's TSO qualification test report.

**j.** Nameplate drawing with the information required by paragraph **4** of this TSO.

**k.** A list of all drawings and processes, including revision level, to define the article's design. For a minor change, follow the directions in 14 CFR § 21.611(a).

**l.** An environmental qualifications form as described in RTCA/DO-160E for each component of the system.

**m.** If the article includes a digital computer: a Plan for Software Aspects of Certification (PSAC), software configuration index, and software accomplishment summary. We recommend that you submit the PSAC early in the software development process. Early submittal allows us to quickly resolve issues, such as partitioning, determining software levels, and other concerns that may occur.

**n.** If the article includes a complex custom micro-coded component: a Plan for Hardware Aspects of Certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary.

**6. MANUFACTURER DATA REQUIREMENTS.** In addition to the data given directly to us, have the following technical data available for review by the responsible ACO or civil aviation authority:

**a.** The functional qualification specifications for qualifying each production article to ensure compliance with this TSO.

**b.** Equipment calibration procedures.

**c.** Corrective maintenance procedures within 12 months after TSO authorization.

**d.** Schematic drawings.

**e.** Wiring diagrams.

**f.** Material and process specifications.

**g.** The results of the environmental qualification tests conducted per RTCA/DO-160E.

**h.** If the article includes a digital computer, the appropriate documentation defined in RTCA/DO-178B, including all data supporting the applicable objectives in RTCA/DO –178B, Annex A, Process Objectives and Outputs by Software Level.

**i.** The appropriate hardware life cycle data consummated with design assurance level as defined in RTCA/DO-254, Appendix A, Table A-1, if the article includes a complex custom micro-coded component.

**7. FURNISHED DATA REQUIREMENTS.** If furnishing one or more articles to one entity (such as an operator or repair station), provide the following for each article manufactured under this TSO:

**a.** One copy of the data in paragraphs **5.a** through **5.f** of this TSO and any other data needed for the proper installation, certification, and use or continued airworthiness of AFCBs.

**b.** One copy of the data in paragraphs **5.k** through **5.n**, if the appliance performs functions beyond those described in paragraph **3.a** of this TSO.

**8. HOW TO GET REFERENCED DOCUMENTS.**

**a.** Order copies of RTCA documents from RTCA Inc., 1828 L Street NW, Suite 805, Washington DC 20036-4001. You can also order them online at [www.rtca.org](http://www.rtca.org).

**b.** Order copies of SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Telephone (724) 776-4970, or fax (724) 776-0790. You can also order copies online at [www.sae.org](http://www.sae.org).

**c.** Order copies of 14 CFR part 21, Subpart O, from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh, PA 15250-7954. Telephone (202)-512-1800 or fax (202) 512-2250. You can also get copies from the GPO website online at [www.access.gpo.gov](http://www.access.gpo.gov). Select “GPO Access,” then “Online Bookstore”. Under “Browse by Subject” select “Aviation”, and then under “Code of Federal Regulations” select “Part 1-59”.

**d.** You can find a current list of technical standard orders on the FAA Internet website Regulatory and Guidance library at [www.airweb.faa.gov/rgl](http://www.airweb.faa.gov/rgl). You will also find advisory circulars and the TSO Index of Articles at the same site.

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