

AEROSPACE STANDARD	AS5692™	REV. A
	Issued 2004-10 Revised 2009-12 Reaffirmed 2023-03 Superseding AS5692	
(R) ARC Fault Circuit Breaker (AFCB), Aircraft, Trip-Free Single Phase and Three Phase 115 VAC, 400 Hz - Constant Frequency		

RATIONALE

Update specification to include three phase arc fault circuit breakers update requirements to comprehend three phase requirements.

AS5692A has been reaffirmed to comply with the SAE Five-Year Review policy.

FOREWORD

Thermal circuit breakers are designed to react to the heating effect of current carried by wire; and to protect the wire insulation from thermal damage. These protective devices are not designed to detect or react to the short duration of arcing faults that typically occur outside (before approaching) the defined trip region, or Time versus Current Curve, of the thermal circuit breakers.

In addition, arc impedance can reduce low voltage fault current magnitudes appreciably. AFCBs combine active arc fault detection with thermal overload protection into one package. Supplemented with the arc fault detection, the AFCB provides an equivalent level of thermal protection of existing thermal circuit breakers (typically qualified under AS58091), with the added ability to detect and react to arc fault conditions, thereby mitigating damage that will occur to the wiring system by protracted arcing events.

It is important to note that the primary purpose of the AFCB as stated above is to mitigate damage to the aircraft wiring from the circuit breaker to the first serial load element (examples: LRU, transformer, ballast, rectifier, or connected equipment, etc.). In doing so, the potential of igniting surrounding materials is reduced, but not eliminated. Use of AFCBs for hazard mitigation/prevention beyond its intended function of mitigating damage to the aircraft wiring should be carefully analyzed and evaluated.

NOTE: AS58091 was used as the base document for this AFCB specification as such the tables comprehend future amp rating expansion from ½ to 200A.

1. SCOPE

1.1 Scope

The primary function of this specification is to cover the general requirements for manual reset trip-free arc fault/thermal circuit breakers for use in aircraft electrical systems conforming to MIL-STD-704. As a secondary function, this specification may possibly cover the general requirements for AFCBs for use in primary vehicles, other than aircraft, when mounted directly to the structure.

1.2 Classification

AFCBs shall be the Thermal Type, and classified into different styles. Variations from the basic style of each AFCB shall be indicated by the part number from the appropriate specification sheet (see 3.1).

1.2.1 Styles

AFCB styles shall consist of all part numbers covered by one Aerospace Standard or specification sheet. For example:

- a. All part numbers of AS5692/1 shall be the same style.
- b. All part numbers of AS5692/2 shall be the same style.

The same style classification applies to all Aerospace Standards and specification sheets covered by this specification.

1.2.2 Part Number

The part numbers for AFCBs in accordance with this specification shall conform to part number scheme below. Alphanumeric characters shall be used to designate variations from the basic style of each circuit breaker.

Example of part number scheme (amend p/n to comprehend 2A5)

<u>AS5692/1-DA5VL</u>			
			_____ Pushbutton (1.2.4)
			_____ High Vibration Capability (1.2.6)
			_____ Auxiliary Terminals (1.2.5)
			_____ Amperage Rating (1.2.3)
		_____	Random Vibration Capability (1.2.6)
	_____		Basic part style AS5692/1 (1.2.1)

When a designator for a variation is not applicable it shall be omitted from the part number. Not all letters are applicable for every specification sheet. Refer to the latest specification sheet and QPL for available and qualified configurations.

1.2.3 Amperage Ratings

The amperage rating designator shall be a number specified in each specification sheet to indicate the nominal amperage rating for overload protection.

1.2.4 Pushbuttons

The AFCB pushbutton shall be designated as follows. Standard length pushbutton, as specified in the specification sheet shall have no designator letter.

L - Extra length pushbutton (see 6.3.9)

1.2.5 Auxiliary Switch Terminals

The use of auxiliary switch terminals when allowed by the specification sheet shall be designated as follows. AFCBs with standard terminals only, as specified in the specification sheet, shall have no designator letter.

A - Auxiliary switch terminals

1.2.6 Vibration Level

The vibration level of the AFCB shall be specified in the specification sheet and shall be indicated in the part number by one or more of the following designators. Standard sine vibration capabilities shall have no designator. (see 4.7.11.2).

V - High Level sine capabilities (see 4.7.11.3).

C thru K - Random vibration capabilities (see 4.7.11.1).

1.2.7 Mounting Configurations

Unless otherwise specified, the AFCB mounting configuration shall be designated as follows. Standard bushing mounted circuit breakers shall have no designator.

P - Cover-plate mount.

2. APPLICABLE DOCUMENTS

2.1 Government Specifications, Standards and Handbooks

2.1.1 The following specifications, standards and handbooks form a part of this specification to the extent specified herein.

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

A-A-52080	Tape, Lacing and Tying, Nylon
A-A-52081	Tape, Lacing and Tying Polyester
A-A-52082	Tape, Lacing and Tying, TFE-Fluorocarbon
A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
MIL-I-24768/17	Insulation, Plastic, Laminated, Thermosetting, Glass-Cloth, Silicone-Resin (GSG)
MIL-DTL-81381	Wire, Electric, Polyimide Insulated, Copper or Copper Alloy
MIL-E-17555	Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts); Packaging of
MIL-HDBK-454	General Guidelines for Electrical Equipment
MIL-I-24768/1	Insulation Plastic, Laminated, Thermosetting, Glass Cloth Melamine Resin
MIL-STD-104	Limit for Electrical Insulation Color
MIL-STD-1285	Marking of Electrical and Electronic Parts
MIL-STD-1916	DOD Preferred Methods for Acceptance of Product

MIL-STD-202	Test Method Standard for Electronic and Electrical Component Parts
MIL-STD-704F	Aircraft Electrical Power Characteristics
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-889	Dissimilar Metals

(Copies of specifications, standards, handbooks, drawings and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other Publications

ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 635	Plastics, Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 5948	Molding Compounds, Thermosetting

SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Tel: 977-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP4754	Certification Considerations for Highly Intergrated or Complex Aircraft Systems
ARP4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
AS4373	Test Methods for Insulated Electric Wire
AS50861	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy
AS7928	Terminals, Lug: Splices, Conductor: Crimp Style, Copper, General Specification For
AS22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy
AS22759/34	Wire, Electrical, Fluoropolymer-Insulated, Cross-Linked Modified ETFE, Normal Weight, Tin-Coated Copper, 150°C, 600 volt
AS25036	Terminal, Lug, Crimp Style, Copper, Insulated, Ring Tongue, Bell Mouthed, Type II, Class 1 (For 105 °C Total Conductor Temperature)
AS50881	Wiring Aerospace Vehicle
AS58091	Circuit Breakers, Trip-Free, Aircraft General Specification For
AS81044	Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarylene Insulated, Copper or Copper Alloy
AS8879	Screw Threads – UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter

Other Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org

Available from American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203, Tel: 800-248-1946 (United States or Canada) or +1-414-272-8575 (International), www.asq.org.

Available from Radio Technical Commission for Aeronautics, Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

AIA/NAS NASM 25027 Nut, Self-Locking, 250 deg. F, 450 deg. F, and 800 deg. F

ANSI/ASC (Z1.4) Procedure and Tables for Inspection by Attributes

DOD/MIL-STD-100 Engineering Drawing Practices

ISO 10012-1 Calibration Laboratories and Measuring Test Equipment – General Requirement

ANSI/NCSL Z540-1 Calibration Laboratories and Measuring Test Equipment – General Requirement

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

RTCA/DO-178B Software Consideration in Airborne Systems and Equipment Certification

RTCA/DO-254 Design Assurance Guidance for Electronic Hardware

2.3 Order of Precedence

In the event of a conflict between the text of this specification and the references cited herein (except for associated detailed specification sheets, specification sheets or AS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification Sheets

The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Qualification

The AFCBs furnished under this specification shall be products that are authorized by the Qualifying Activity for Listing on the applicable Qualified Products List (see 4.5 and 6.2).

3.2.1 First Article Inspection

AFCBs furnished under this specification not covered by specification sheets or not qualified at the time of set for opening bid shall be subjected to the tests specified in 4.5.

3.3 Materials

Suitable materials shall be used that will enable the AFCBs to conform to the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.3.1 Fungus

Materials shall be used which are not nutrients for fungus as specified in Guideline 4 of MIL-HDBK-454. The use of fungus resistant materials is not required for sealing calibration screws, terminals or terminal barriers pending review of the qualifying activity.

3.3.2 Metal

All metals used in the construction of AFCBs shall be corrosion resistant or shall be suitably protected to resist corrosion. The use of dissimilar metals, especially contacts between brass, copper, steel and aluminum or magnesium alloys, shall be avoided. Where contact between dissimilar metals is unavoidable, the metals shall be protected against electrolytic corrosion. Dissimilar metals are defined in MIL-STD-889. When thermostatic bimetals and trimetals are used, corrosion resulting from tests specified herein shall not adversely affect the performance of the AFCB.

3.3.3 Plastics

Plastic materials used in the housing, insulator base, and any internal parts exposed to arcing or surface creepage shall conform to ASTM D 5948 or equivalent and shall not exhibit any deleterious impact on AFCB performance during normal operation or qualification testing. Other types of plastics materials may be used provided the manufacturer submits satisfactory evidence to the activity responsible for qualification.

Plastic materials used by the manufacturer must exhibit evidence of satisfactory performance that the materials are suitable for the purpose intended. The plastic materials used shall neither support combustion nor give off noxious gases when subjected to arcs, such as those caused by interrupting heavy short circuit currents (as defined on the specification sheet), or explosions of gaseous vapors to which the materials may be subjected in service. Plastic materials with cellulose fillers will not be permitted in parts that may be subjected to arcing or surface creepage. Plastic materials used shall be certified to exhibit a minimum ignition time of 90 seconds and a maximum extinguishing time of 90 seconds when tested for flammability in accordance with ASTM D 635.

3.3.4 Protective Treatment

The use of any protective coating that will crack, chip, or scale will not be permitted.

3.3.5 Selection of Materials

Specifications and standards for all materials, parts and Government certification and approval of processes and equipment, which are not specifically designated herein and which are necessary for the execution of this specification, shall be selected in accordance with MIL-STD-970.

3.3.6 Cleaning prior to final assembly

The circuit breakers shall be thoroughly cleaned of loose, spattered, or excessive solder, metal chips, and other foreign material. Burrs, sharp edges and resin flash shall be removed.

3.3.7 Electronic Components

Electronic components selected shall be such that the AFCB shall meet performance requirements and product characteristics specified herein.

3.4 Design and Construction

3.4.1 General

AFCBs shall conform to the applicable specification sheet.

3.4.2 If the design of the arc fault circuit breakers contains software or complex hardware, as a minimum, the software and hardware shall be developed in accordance with RTCA/DO-178B, level C and RTCA/DO-254, level C, respectively.

3.4.3 Mounting Means

The AFCB shall be provided with a suitable mounting means as shown on the applicable specification sheet. If self-locking nuts are used, they shall meet the performance requirements of AIA/NAS NASM 25027. AFCBs that utilize a mounting nut and lockwasher are generally supplied with the mounting nut and lockwasher. AFCBs that utilize a mounting faceplate are generally supplied without the associated mounting screw.

3.4.4 Actuator of Push-Pull AFCBs

The portion of the actuator visible when the AFCB is in the closed position shall be colored in accordance with the specification sheet and shall expose a white band when in the open or thermally tripped position. If a secondary indication for an arc fault trip condition is provided, it shall be in accordance with the specification sheet. The exterior portion of the actuator shall be insulated from all current-carrying parts. The actuator shall not work out to an intermediate position, give a false trip indication, or be removable from the AFCB. An intermediate position is a position where the white band of the actuator is partially or fully exposed yet the circuit breaker remains in the ON (closed) position. Push-Pull AFCBs shall be designed to permit manual opening of the circuit breaker by pulling out the actuator.

3.4.5 Terminals

Terminal construction shall be as specified on the applicable specification sheet and shall be designed for use with terminal lugs conforming to AS25036 and AS7928.

3.4.5.1 Terminal Hardware

Lockwashers captive to the terminal screws shall be supplied only when specified on the applicable specification sheet. AFCBs may be supplied without terminal hardware, with terminal hardware supplied in bulk, or packaged separately, according to customer instructions.

3.4.6 Housing

The AFCB mechanisms shall be enclosed in a housing securely attached to the insulator base and to the mounting plate when one is used. The housing may be integral with the insulator base.

3.4.7 Ratings

The ratings of push-pull AFCBs shall be as specified on the applicable specification sheet. Ratings of ½ amp shall be clearly indicated, i.e. 7 ½ or 7.5, not 7 (where the ½ or 0.5 would be implied) unless specified on the specification sheet.

3.4.8 Trip Indication and Reset

The AFCBs shall be so designed that when the AFCB contacts open automatically on fault condition (thermal overload or arc fault trip), the actuator shall indicate the operation by moving to the tripped position, as shown on the applicable specification sheet. The white color specified on the applicable specification sheet for the trip indicator on a push-pull shall conform to Class 1 of MIL-STD-104. AFCBs shall have an indication to distinguish between a thermal overload and an arc fault trip when required by the specification sheet.

3.4.8.1 Reset Mechanism

The reset mechanism shall be so designed that retaining the actuator in the closed position after automatic tripping occurs shall not adversely affect subsequent performance of the AFCB.

3.4.9 Arc Fault Trip Free Mechanism

If an arc fault trip indication is required by the specification sheet, the mechanism for arc fault trip indication shall be so designed that retaining the indicator in the closed position after automatic tripping occurs shall not adversely affect subsequent performance of the AFCB.

3.4.10 Position

AFCBs shall operate satisfactorily when mounted in any axis or plane.

3.4.11 Mounting Screw Clearance

The mounting screws shall be capable of being screwed into the AFCB a minimum depth, as shown on the applicable specification sheet. The mounting nuts shall be backed or provided with other means to prevent mounting screws of excess length from interfering with the operation of the circuit breaker. Screws of excess length shall not fracture the housing or the explosion-preventative seal.

3.4.12 Creepage and Clearance Distance

The minimum creepage path and the minimum clearance between current-carrying parts and any part of the current breaker other than insulating materials, and also between current-carrying parts of opposite polarity, shall be 3/16 and 1/8 inch respective.

3.4.13 Tamper-Proof Calibration

AFCBs shall be so constructed that tampering with the calibration is not possible without dismantling the device or breaking a seal.

3.4.14 Ambient Temperature

3.4.15 Unless otherwise specified (see 3.1), AFCBs shall be designed to provide thermal protection within one of the following continuous ambient temperature conditions:

Condition A-55 to 71 °C

Condition B-55 to 121 °C

The electronics of the AFCB shall comply with RTCA/DO-160 as specified herein or per the applicable specification sheet.

3.4.16 Grounding

AFCBs shall be grounded as required per the specification sheet. The AFCB shall meet all specification requirements with 2 ohms or greater resistance to ground unless otherwise specified in the applicable specification sheet.

3.4.17 Bonding

AFCBs shall provide a provision for bonding and verification as required by the specification sheet.

3.5 Interchangeability

All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The drawing number requirements of DOD-STD-100 shall govern changes in the manufacturer's part number.

3.6 Screw Threads

Screw threads on removable or replaceable threaded parts shall be as specified in MIL-S-8879. Threading of non-metallic parts is not permitted.

3.7 Performance

The AFCBs shall perform satisfactorily when subjected to tests specified in Section 4, and there shall be no breakage, malfunction, or evidence of any damage that would impair the ability of the AFCBs to meet the requirements of the specification. Although upon completion of the test there shall be no damage that degrades device basic function or performance, cosmetic damage may be deemed as acceptable

3.7.1 Examination of Product

The AFCBs shall show no evidence of defects when examined in accordance with 4.7.1.

3.7.2 Dielectric Withstanding Voltage

The AFCBs shall exhibit no evidence of breakdown or subsequent malfunction when tested in accordance with 4.7.2, 4.7.2.1, and 4.7.2.2.

3.7.3 Insulation Resistance

Unless otherwise specified, the insulation resistance of AFCBs shall not be less than 100 megohms when tested in accordance with 4.7.3.

3.7.4 Strength of Actuator

AFCB actuators shall not show evidence of breaking, cracking or jamming when tested in accordance with 4.7.4.1 or 4.7.4.2. The AFCB shall also meet the performance requirements defined when tested in accordance with 4.7.4.3.

3.7.5 Strength of Threaded Parts

The threaded parts of the AFCB shall be tested in accordance with 4.7.5. Upon completion of the test, the threaded parts of the AFCB shall not be damaged.

3.7.6 Operating Force

The force necessary for operation of the AFCB shall be within the limits specified on the applicable specification sheet when tested in accordance with 4.7.6. The minimum operating force shall not be less than 15 percent of the specified maximum value unless otherwise specified on the applicable specification sheet.

3.7.7 Calibration

The AFCB's thermal overload and arc fault trip performance shall be within the limits specified on the applicable specification sheet, and 4.7.7, when tested and calibrated in accordance with 4.7.7

3.7.8 Endurance

The AFCB shall make and break the specified number of cycles with the current without failure as defined in the applicable specification sheet when tested in accordance with 4.7.8.

3.7.9 Overload and Arc Fault Cycling

The AFCB shall make and break the test cycles specified without failure, when tested in accordance with 4.7.9.

3.7.10 Reclosing

Manual reset AFCBs shall remain open after being tripped automatically for one hour showing no electrical continuity when tested in accordance with 4.7.10.

3.7.11 Vibration

The AFCBs shall be tested in accordance with 4.7.11 with the vibration levels and test conditions specified in the applicable specification sheet. If no vibration level is specified in the applicable specification sheet, the sine vibration with test condition A shall be performed (see 4.7.11.2). The AFCB main contacts shall not trip or show any electrical discontinuity in excess of 10 microseconds, nor shall the arc fault circuit cause a trip. Upon completion of the vibration test, AFCBs shall show no evidence of physical damage and shall meet the requirements of the 200% overload calibration test performed at 25 °C in accordance with 4.7.7.3, the guillotine test in accordance with 4.7.7.6.1, Source A, Circuit 2, and the dielectric withstanding voltage test in accordance with 4.7.2. For three phase AFCB, each phase must be tested separately while other phases carry rated current.

3.7.12 Mechanical Shock

The AFCB main contacts shall not change state when tested in accordance with 4.7.12. Upon completion of the test, the device under test (DUT) shall meet the requirements of 200% overload calibration of 4.7.7.3 at 25 °C, and the guillotine test when tested in accordance with 4.7.7.6.1, Source A, Circuit 2. For three phase AFCB, each phase must be tested separately while other phases carry rated current.

3.7.13 Acceleration

The AFCB main contacts shall not change state when tested in accordance with 4.7.13. Upon completion of the test, the DUT shall meet the requirements of 200% overload calibration of 4.7.7.3 at 25 °C, and the guillotine test when tested in accordance with 4.7.7.6.1, Source A, Circuit 2. For three phase AFCB, each phase must be tested separately while other phases carry rated current.

3.7.14 Interrupting Capacity

The AFCB performance shall be as specified in the applicable specification sheet when tested in accordance with 4.7.14 and 4.7.14.1. During the interrupting capacity tests the AFCB may fail safe. For the purpose of this test, an AFCB that has failed safe is a device that is unable, because of electrical damage, to carry a continuous current or an electrical load. In addition, for an AFCB that has failed safe, with the AFCB in the closed or reset position, the leakage current between the load and line terminal(s) shall be less than 1 milliamp at 300 VAC, unless otherwise specified by the individual specification sheet. Unless the DUT enters a fail-safe condition, following the last operation of this test, the circuit breaker shall meet the requirements for dielectric withstanding voltage (4.7.2) and 200% overload calibration at 25 °C per 4.7.7.3, the allowable circuit breaker tripping time shall be within 120% of the upper limit specified in the applicable specification sheet, and there shall be no dielectric breakdown. The DUT shall also meet the requirements of the guillotine test when tested in accordance with 4.7.7.6.1, Source A, Circuit 2. NOTE: The ground connection must be restored for post testing after testing to 4.7.14.1.

3.7.14.1 Interrupting Capacity Fail Safe

In the case that an AFCB has failed safe, the design of the fail safe point cannot affect other performance characteristics, such as higher level overloads specified on the applicable specification sheet, to the extent that the device does not meet other performance requirements of this specification or the applicable specification sheet.

3.7.15 Sand and Dust

The AFCB performance shall be as specified in this specification when tested in accordance with 4.7.15. At the conclusion of this test, the circuit breaker shall be held in at 500% of rated load, thus causing the DUT to trip free. On three phase AFCB's, each phase shall be tested separately. Failure to trip within 10 seconds shall constitute failure. The DUT shall meet the requirements for 200% overload calibration at 25 °C when tested in accordance with 4.7.7.3. The DUT shall also meet the requirements of the guillotine test when tested in accordance with 4.7.7.6.1, Source A, Circuit 2.

3.7.16 Corrosion

The AFCB performance shall be as specified in this specification when tested in accordance with 4.7.16. At the conclusion of this test, the DUT shall be held in at 500% of rated load, thus causing the DUT to trip free. On three phase AFCB's, each phase shall be tested separately. Failure to trip within 10 seconds shall constitute failure. The DUT shall then meet the requirements for 200% overload calibration, per 4.7.7.3, at 25 °C, except that the tripping time shall be within 80% of the lower limit and 120% of the upper limit specified. All hardware shall be removable without damage to the DUT or hardware. The DUT shall also meet the requirements of the guillotine test when tested in accordance with 4.7.7.6.1, Source A, Circuit 2.

3.7.17 Moisture Resistance

The AFCB performance shall be as specified in this specification when tested in accordance with 4.7.17.

3.7.18 Explosion

Ignition of the explosive mixture outside the AFCB shall constitute failure when tested in accordance with 4.7.18.

3.7.19 Voltage Drop

Voltage drop across the AFCB greater than that specified on the applicable specification sheet shall constitute failure when tested in accordance with 4.7.19. Voltage drop shown on the specification sheet is a beginning of life value, unless otherwise indicated on the specification sheet.

3.7.20 Transit Drop

The AFCB performance shall be as specified in this specification when tested in accordance with 4.7.20. Upon completion of the test there shall be no damage to the DUT through handling and manipulation of the breaker as detected by visual inspection that compromises device performance (including but not limited to chips or cracks in the circuit breaker housing; while cosmetic damage may be deemed as acceptable). In addition, each DUT shall be tested in accordance with and meet the requirements of 4.7.2, 200% overload calibration at 25 °C of 4.7.7.3, and guillotine testing per 4.7.7.6.1, Source A, Circuit 2, of this specification.

3.7.21 Temperature and Pressure

The AFCB performance shall be as specified in this specification when tested in accordance with 4.7.21.1, 4.7.21.2, 4.7.21.3 and 4.7.21.4.

3.7.22 Magnetic Effect

The AFCB performance shall be as specified in this specification when tested in accordance with 4.7.22.

3.7.23 Electromagnetic Compatibility

The AFCB shall not trip or otherwise malfunction when tested in accordance with 4.7.23. After signal injection, but prior to first removal of power, each DUT shall be tested in accordance with and meet the requirements of guillotine testing per 4.7.7.6.1, Source A, Circuit 2.

3.7.24 Maximum Power

The AFCB performance shall be within the limits specified on the applicable specification sheet when tested in accordance with 4.7.24.

3.7.25 Power Quality and Interruptions

The AFCB performance shall be as specified in this specification when tested in accordance with 4.7.25.

3.7.26 Reverse Installation

The AFCB performance shall be as specified in the applicable specification sheet when tested in accordance with 4.7.26.

3.8 Markings

All AFCBs shall be permanently and legibly marked as shown on the applicable specification sheet. The markings shall remain legible during and after all the tests specified in this specification.

3.8.1 Push-Pull Actuators

3.8.2 The exposed end of the push-pull actuator shall be marked with a white, raised or depressed, number indicating the applicable current rating of the AFCB as shown on the applicable specification sheet.

3.8.3 Terminals

The line and load terminals shall be clearly and permanently marked or identified "LINE" or "1," and "LOAD" or "2," adjacent to the terminals, when shown on the applicable specification sheet. A ground point or ground connection shall be clearly and permanently marked or identified "GND" or neutral identified "N." Refer to the specification sheet for other detailed terminal marking instructions.

3.8.4 Multi-phase breakers

Primary terminal identification shall be the same as for single phase breakers, as identified above, except that for the phase identification shall be identified by a letter prefix reading consecutively from right to left as defined in the specification sheet.

3.9 Identification of Product

Each AFCB shall be permanently and legibly marked for identification as follows:

- Part No. (see 1.2.2)
- Manufacturer's name or trademark
- Date code (YYWW) (0212 = week 12 of 2002)

3.10 Workmanship

The AFCB, including all parts and accessories, shall be constructed and finished in a careful and workmanlike manner in accordance with good design and sound practice. Particular attention shall be given to neatness and thoroughness of soldering, wiring, impregnation of coils, marking of parts and assemblies, and freedom of parts from burrs and sharp edges (see 4.7.1).

4. QUALITY ASSURANCE PROVISIONS:

Throughout this section, Device Under Test (DUT) refers to a single phase or three phase 115 VAC, 400 Hz AFCB.

4.1 Responsibility for Inspection

Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the manufacturer may use their own or another facilities' equipment suitable for the performance of the inspection requirements specified herein, unless disapproved by the qualification authority. The qualification authority reserves the right to perform any of the inspections set forth in the specification where such inspections deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for Compliance

All items must meet all requirements of Sections 3 and 5. The inspection set forth in this specification shall become a part of the manufacturer's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the manufacturer of the responsibility of assuring that all products or supplies submitted to the qualification authority for acceptance comply with all requirements of the specification. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the qualification authority to accept defective material.

4.1.2 Test Equipment and Inspection Facilities

The manufacturer shall establish and maintain a calibration system in accordance with ISO 10012-1, ANSI/NCSL Z540-1.

4.2 Classification of Inspections

The inspections specified herein are classified as follows:

- Materials inspection (4.3)
- Qualification (4.5)
- Quality conformance inspection (4.6)

4.3 Materials Inspection

Material inspection shall consist of certification that the materials are in accordance with the requirements of 3.3.

4.4 Inspection Conditions

Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the General Requirements of MIL-STD-202. If the temperature tolerance is not specified in test conditions, the tolerance shall be $\pm 5^\circ\text{C}$. Room temperature is defined as $25^\circ\text{C} \pm 2^\circ\text{C}$.

4.4.1 Calibration

Calibration tests shall be performed at a temperature specified on the applicable specification sheets with the temperature maintained at a constant value. Test sample units with leads and terminals attached shall be maintained at the specified ambient temperature for 1 hour prior to application of the specified current during all calibration tests. Test circuit may be in accordance with Figure 1. Calibration tests shall be conducted at all voltages and frequencies shown on the specification sheet where applicable. (Refer to Table 1 for test set up)

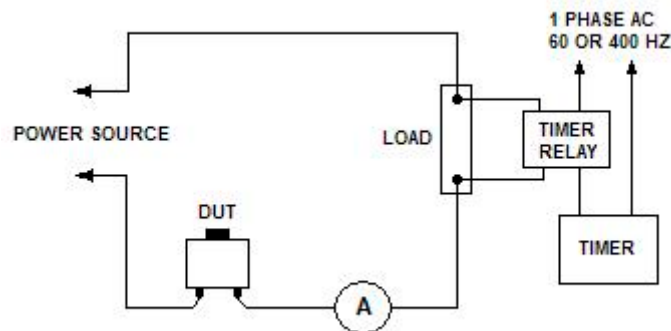


FIGURE 1 – CALIBRATION TEST CIRCUIT

4.4.1.1 Production Calibration

For calibration tests performed during production only (not for qualification or quality conformance tests), it will be permissible to use test methods so designed as to expedite calibration testing, provided the manufacturer can demonstrate that the results are comparable to the calibration tests specified herein.

4.4.2 Thermal Overload

Tests of the thermal overload may be conducted using alternating current at commercial frequencies.

4.5 Qualification Inspection

Qualification inspection shall be performed at a laboratory acceptable to the qualification authority (6.2) on sample units produced with equipment and procedures normally used in production.

4.5.1 Sample Size

Thirty-three single phase or 23 three phase AFCB specimens as defined in any one specific detail specification shall constitute a sample size. The combination of specimens to be tested shall be determined by the qualifying activity based upon the manufacturer's desired listing. The qualifying activity reserves the right to request additional untested samples to be submitted with the qualification test report.

4.5.2 Test Routine

The qualification and test samples for one and three phase AFCB's shall be subjected to the tests specified in Table 2 and 2A, respectively. All sample units shall be subjected to Test Group I then divided as indicated into the various remaining test groups. At the option of the qualifying activity, the environmental tests consisting of vibration, mechanical, shock, acceleration, sand and dust, corrosion and moisture resistance (4.7.11, 4.7.12, 4.7.13, 4.7.15, 4.7.16, and 4.7.17) may be omitted when qualifying additional ratings under a specification sheet provided that two amperage ratings of the same sample style have previously completed these tests satisfactorily. Qualification of additional circuit breaker styles or amperage ratings by similarity to circuit breakers previously qualified may be determined by the qualifying activity.

NOTE: 36 inches minimum of appropriate gauge wire with lugs per Table 1 shall extend from each terminal of the DUT.

TABLE 1 – CALIBRATION TEST CIRCUIT COMPONENTS

(a) AFCB capacity (amperes)	Wire Size (AWG designation)	(b) Insulated terminal lug (MS Part Number)
1 and below	20	AS25036-103
2 to 6 included	18	AS25036-103
7 to 10 included	16	AS25036-108
11 to 15 included	14	AS25036-108
16 to 20 included	12	AS25036-112
21 to 25 included	10	AS25036-112
26 to 40 included	8	AS25036-115
41 to 50 included	6	AS25036-119
51 to 60 included	6	AS25036-121
61 to 90 included	4	AS25036-124
91 to 120 included	2	AS25036-127
121 to 150 included	0	AS25036-133
151 to 200 included	00	AS25036-136

NOTE: Test wires shall conform to AS22759, AS81044, MIL-DTL-81381, or AS5086. Test terminals shall conform to AS7928. Ammeter: Accuracy within 0.5% at full scale.

- (a) For a DUT with nominal amperage ratings between steps of the above Table 1, use the wire of the next large physical wire size.
- (b) For Group A or B quality conformance test terminal lead lugs may be spade or electrical spring clamp type provided the electrical resistivity and thermal conductivity are equivalent to AS25036 ring type terminals.

TABLE 2 – SINGLE PHASE REQUIREMENTS TEST TRACEABILITY MATRIX

Tests and Sample 33 Units	Requirement Paragraph	Test Paragraph
<u>Test Group I – 33 sample units</u>		
Examination of product	3.7.1	4.7.1
Dielectric withstanding voltage	3.7.2	4.7.2
Insulation resistance	3.7.3	4.7.3
Minimum limit of ultimate trip	3.7.7	4.7.7.1
Maximum limit of ultimate trip	3.7.7	4.7.7.2
Overload calibration	3.7.7	4.7.7.3
Guillotine-Source A, Circuit 2	3.7.7	4.7.7.6.1
<u>Test Group II – 1 sample unit</u>		
Voltage drop	3.7.19	4.7.19
Temperature/altitude dielectric strength	3.7.2	4.7.2.2
Trip-free calibration	3.7.7	4.7.7.4
Strength of threaded parts	3.7.5	4.7.5
Mechanical cycling (endurance)	3.7.8	4.7.8.3
Operating force	3.7.6	4.7.6
<u>Test Group III – 1 sample unit</u>		
Voltage drop	3.7.19	4.7.19
Reclosing	3.7.10	4.7.10
Overload & arc fault cycling	3.7.9	4.7.9
Vibration	3.7.11	4.7.11
Corrosion	3.7.16	4.7.16
<u>Test Group IV – 1 sample unit</u>		
Ambient effect on calibration	3.7.7	4.7.7.5
Trip-free calibration	3.7.7	4.7.7.4
Acceleration	3.7.13	4.7.13
Sand and dust	3.7.15	4.7.15
<u>Test Group V – 1 sample unit</u>		
Magnetic Effects	3.7.22	4.7.22
Endurance – Inductive Load (ac)	3.7.8	4.7.8.1.1
Operating force	3.7.6	4.7.6
<u>Test Group VI – 1 sample unit</u>		
Endurance – Resistive load (ac)	3.7.8	4.7.8.1.2
Operating force	3.7.6	4.7.6
<u>Test Group VII – 1 sample unit</u>		
Mechanical shock	3.7.12	4.7.12
Moisture resistance	3.7.17	4.7.17
Operating force	3.7.6	4.7.6
Impact force on push button	3.7.4	4.7.4.3
Strength of actuator	3.7.4	4.7.4
<u>Test Group VIII – 1 sample unit</u>		
Interrupting capacity (available current short circuit ac)	3.7.14	4.7.14 Table VII-A
Dielectric withstanding voltage	3.7.2	4.7.2
<u>Test Group IX – 1 sample unit</u>		
Interrupting capacity (available current close-in ac)	3.7.14	4.7.14 Table VII-B
Dielectric withstanding voltage	3.7.2	4.7.2

TABLE 2 – SINGLE PHASE REQUIREMENTS TEST TRACEABILITY MATRIX (CONT.)

Tests and Sample 33 Units	Requirement Paragraph	Test Paragraph
<u>Test Group X – 1 sample unit</u>		
Interrupting capacity (available intermediate current interrupting ac)	3.7.14	4.7.14 Table VII-C
Dielectric withstanding voltage	3.7.2	4.7.2
<u>Test Group XI – 8 sample unit*</u>		
Unwanted Tripping & Operation Inhibition	3.7.7	4.7.7.7
Transit Drop Test	3.7.20	4.7.20
<u>Test Group XII – 1 sample unit</u>		
Interrupting capacity (available current close-in ac)	3.7.14	4.7.14 Table VII-B
Dielectric withstanding voltage	3.7.2	4.7.2
<u>Test Group XIII – 3 sample units</u>		
Strength of actuator	3.7.4	4.7.4
Impact force on push button	3.7.4	4.7.4.3
<u>Test Group XIV – 3 sample unit*</u>		
Reverse Installation	3.7.26	4.7.26
Loose Terminal	3.7.7	4.7.7.6.3
Inductively Coupled Cross Talk Immunity	3.7.7	4.7.7.8
Common Source Feedback Immunity	3.7.7	4.7.7.9
Temperature Pressure Circuit Functionality	3.7.21	4.7.21
Electromagnetic Compatability	3.7.23	4.7.23
Maximum Power	3.7.24	4.7.24
Power Quality	3.7.25	4.7.25
<u>Test Group XV – 2 sample unit*</u>		
Guillotine-Source B, Circuit 2	3.7.7	4.7.7.6.1
Guillotine-Source A, Circuit 1	3.7.7	4.7.7.6.1
Guillotine-Source B, Circuit 1	3.7.7	4.7.7.6.1
<u>Test Group XVI – 2 sample unit</u>		
Wet Arc Source A, Circuit 2	3.7.7	4.7.7.6.2
Wet Arc Source B, Circuit 1	3.7.7	4.7.7.6.2
<u>Test Group XVII – 1 sample unit*</u>		
Interrupt Capacity – Under Loss of Ground (available intermediate current interrupting ac)	3.7.14	4.7.14.1 Table VII-C
<u>Test Group XVIII – 2 sample units</u>		
Explosion (ac)	3.7.18	4.7.18.1
<u>Test Group XIX – 1 sample units*</u>		
Interrupt Capacity – under loss of ground (available current short circuit ac)	3.7.14	4.7.14.1 Table VII-A
<u>Test Group XX – 1 sample unit</u>		
Interrupt capacity – under loss of ground (available current close-in ac)	3.7.14	4.7.14.1 Table VII-B

TABLE 2 – SINGLE PHASE REQUIREMENTS TEST TRACEABILITY MATRIX (CONT.)

Tests and Sample 33 Units	Requirement Paragraph	Test Paragraph
<u>Test Group XXI – extra sample units</u> These AFCBs may be used for repetition of any tests considered advisable by the qualification activity		

TABLE 2A – THREE PHASE REQUIREMENTS TEST TRACEABILITY MATRIX

Tests and Sample Units	Requirement Paragraph	Test Paragraph
<u>Test Group I – 23 sample units</u>		
Examination of product	3.7.1	4.7.1
Dielectric withstanding voltage	3.7.2	4.7.2
Insulation resistance	3.7.3	4.7.3
Minimum limit of ultimate trip	3.7.7	4.7.7.1
Maximum limit of ultimate trip	3.7.7	4.7.7.2
Overload calibration	3.7.7	4.7.7.3
Guillotine-Source A, Circuit 2	3.7.7	4.7.7.6.1
<u>Test Group II – 1 sample unit</u>		
Voltage drop	3.7.19	4.7.19
Temperature/altitude dielectric strength	3.7.2	4.7.2.2
Trip-free calibration	3.7.7	4.7.7.4
Strength of threaded parts	3.7.5	4.7.5
Mechanical cycling (endurance)	3.7.8	4.7.8.3
Operating force	3.7.6	4.7.6
<u>Test Group III – 1 sample unit</u>		
Voltage drop	3.7.19	4.7.19
Reclosing	3.7.10	4.7.10
Overload & arc fault cycling	3.7.9	4.7.9
Vibration	3.7.11	4.7.11
Corrosion	3.7.16	4.7.16
<u>Test Group IV – 1 sample unit</u>		
Ambient effect on calibration	3.7.7	4.7.7.5
Trip-free calibration	3.7.7	4.7.7.4
Acceleration	3.7.13	4.7.13
Sand and dust	3.7.15	4.7.15
<u>Test Group V – 1 sample unit</u>		
Magnetic Effects	3.7.22	4.7.22
Endurance – Inductive Load (ac)	3.7.8	4.7.8.1.1
Operating force	3.7.6	4.7.6
<u>Test Group VI – 1 sample unit</u>		
Endurance – Resistive load (ac)	3.7.8	4.7.8.1.2
Operating force	3.7.6	4.7.6

TABLE 2A – THREE PHASE REQUIREMENTS TEST TRACEABILITY MATRIX (CONT.)

Tests and Sample Units	Requirement Paragraph	Test Paragraph
<u>Test Group VII – 1 sample unit</u>		
Mechanical shock	3.7.12	4.7.12
Moisture resistance	3.7.17	4.7.17
Operating force	3.7.6	4.7.6
Strength of actuator	3.7.4	4.7.4
Impact force on push button	3.7.4	4.7.4.3
<u>Test Group VIII – 1 sample unit</u>		
Interrupting capacity (available current short circuit ac)	3.7.14	4.7.14 Table VII-D
Dielectric withstanding voltage	3.7.2	4.7.2
<u>Test Group IX – 1 sample unit</u>		
Interrupting capacity (available current close-in ac)	3.7.14	4.7.14 Table VII-E
Dielectric withstanding voltage	3.7.2	4.7.2
<u>Test Group X – 1 sample unit</u>		
Interrupting capacity – under loss of ground (available current short circuit ac)	3.7.14	4.7.14 Table VII-D
Dielectric withstanding voltage	3.7.2	4.7.2
<u>Test Group XI – 1 sample unit</u>		
Interrupting capacity – under loss of ground (available current close-in ac)	3.7.14	4.7.14 Table VII-E
Dielectric withstanding voltage	3.7.2	4.7.2
<u>Test Group XII – 8 sample units</u>		
Transit Drop Test	3.7.20	4.7.20
<u>Test Group XIII – 3 sample units</u>		
Unwanted Tripping & Operation Inhibition	3.7.7	4.7.7.7
<u>Test Group XIV – 1 sample unit</u>		
Reverse Installation	3.7.26	4.7.26
Loose Terminal	3.7.7	4.7.7.6.3
Inductively Coupled Cross Talk Immunity	3.7.7	4.7.7.8
Common Source Feedback Immunity	3.7.7	4.7.7.9
Temperature Pressure Circuit Functionality	3.7.21	4.7.21
Electromagnetic Compatibility	3.7.23	4.7.23
Maximum Power	3.7.24	4.7.24
Power Quality	3.7.25	4.7.25
<u>Test Group XV – 1 sample unit</u>		
Guillotine-Source B, Circuit 2	3.7.7	4.7.7.6.1
Guillotine-Source A, Circuit 1	3.7.7	4.7.7.6.1
Guillotine-Source B, Circuit 1	3.7.7	4.7.7.6.1

TABLE 2A – THREE PHASE REQUIREMENTS TEST TRACEABILITY MATRIX (CONT.)

Tests and Sample Units	Requirement Paragraph	Test Paragraph
<u>Test Group XVI – 1 sample unit</u>		
Wet Arc Source A, Circuit 2	3.7.7	4.7.7.6.2
Wet Arc Source B, Circuit 1	3.7.7	4.7.7.6.2

4.5.3 Retention of Qualification

To retain qualification, the manufacturer shall forward at 36 month intervals to the qualifying activity a summary report of the results of Group A and B tests, indicating as a minimum the number of lots which passed and the number of lots which failed, however a complete test report of Group C tests, including the number and type of failures is required by the qualifying activity. The summary shall include those tests performed during the 36-month period. If the summary of the test results indicate nonconformance with the specification requirements, action shall be taken to remove the failing product from the Qualified Products List. Failure to submit the summary shall result in loss of qualification for that product. In addition to the periodic submission of inspection data, the supplier shall immediately notify the qualifying activity, through the local Government representative, at any time during the 36-month period that the inspection data indicates failure of the qualified product to meet the requirements of the specification. In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If there has been no production during the next reporting period the manufacturer may be required by the qualifying activity to perform Group C testing in accordance with 4.6.6.2 on the products.

4.6 Quality Conformance Inspection

4.6.1 Inspection of Product for Delivery

Inspection of product for delivery shall consist of Group A inspection. Except as specified in 4.6.2, delivery of product that has passed Group A inspection shall not be delayed pending results of Group B and C inspection.

4.6.1.1 Inspection Lot

An inspection lot shall consist of all the circuit breakers covered by a single style (see 1.2.1) offered for inspection at one time.

4.6.1.1.1 Group A Inspection

Group A inspection shall consist of the examinations and tests specified in Table 3 and shall be made on the same set of sample units.

4.6.1.1.1.1 Sampling Plan

Statistical sampling and inspection shall be in accordance with MIL-STD-1916 for general inspection Level II. The acceptable quality level (AQL) shall be as specified in Table 3. Critical, major, and minor defects shall be as specified in MIL-STD-1916.

4.6.1.1.1.2 Rejected Lots

If an inspection lot is rejected, the manufacturer may rework it to correct the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

TABLE 3 - ACCEPTANCE TESTS

Test	Inspection Level	Requirement Paragraph	Test Paragraph	AQL Percent Defective		
				Critical	Major	Minor
Product Examination	II	3.7.1	4.7.1	.25	.65	4.0
Dielectric withstanding Voltage	II	3.7.2	4.7.2	N/A	1.0	N/A
Calibration (overload at Minimum and maximum Limit of ultimate trip and 200% rated current only at room temperature)	II	3.7.7	4.7.7	N/A	1.0	N/A
Guillotine test	II	3.7.7.6.1	4.7.7.6.1	N/A	1.0	N/A

NOTE: At the manufacturer's discretion, equivalent test methods may be used to demonstrate performance to the guillotine test requirements in Table 3 based on demonstration and acceptance of equivalency by the qualifying activity.

4.6.2 Periodic Inspection

Periodic inspection shall consist of Group B and C inspection.

4.6.2.1 Group B Inspection

AFCBs shall be tested as specified in Table 4 in the order shown.

TABLE 4 - GROUP B INSPECTION

Test	Requirement Paragraph	Test Paragraph
Insulation resistance	3.7.3	4.7.3
Trip-free calibration 200% (at room temperature)	3.7.7	4.7.7.4
Operating force (at room temperature)	3.7.6	4.7.6

4.6.2.1.1 Sampling Plan

Three sample units shall be selected at random out of every 1000 units or every three months, whichever occurs first, from each style (1.2.2) manufactured. Group B inspection shall be performed on sample units which have passed Group A inspection, unless the qualification authority considers it more practical to select a separate sample.

4.6.2.1.2 Failures

If one or more sample units fail to pass Group B inspection, the sample shall be considered to have failed.

4.6.2.1.3 Disposition of Sample Units

Sample units that have passed Group B inspection may be delivered against open purchase orders.

4.6.2.2 Group C Inspection

AFCBs shall be tested as specified in Table 5 in the order shown.