



AEROSPACE STANDARD

AS40401™

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Solenoid, Electrical, General Specification for

RATIONALE

AS40401 has been reaffirmed to comply with the SAE Five-Year Review policy.

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Documents

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1. SCOPE:

1.1 Scope:

This specification covers the general requirements for electrical solenoids used to actuate various devices through the conversion of electrical signals into mechanical motion. These solenoids are of the axial stroke type and the rotary stroke type.

1.2 Classification:

Solenoids are classified as follows:

<u>Symbol</u>	<u>Type</u>	<u>Duty</u>	<u>Rotation</u>
I	Pull	Continuous	N/A
II	Pull	Intermittent	N/A
III	Push	Continuous	N/A
IV	Push	Intermittent	N/A
V	Rotary	Continuous	Clockwise
VI	Rotary	Intermittent	Clockwise
VII	Rotary	Continuous	Counterclockwise
VIII	Rotary	Intermittent	Counterclockwise

2. APPLICABLE DOCUMENTS:

2.1 Government documents:

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

SPECIFICATIONS

FEDERAL

Q-C-320 - Chromium Plating (Electrodeposited).

QQ-N-290 - Nickel Plating (Electrodeposited).

QQ-S-365 - Silver Plating, Electrodeposited, General Requirements for.

2.1.1 (Continued):

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.

MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications:

The following document forms a part of this document to the extent specified herein. If the document is DoD adopted, the issue is that listed in the issue of the DODISS cited in the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/NCSL 2540-1 - Calibration Laboratories and Measuring and Testing Equipment - General Requirements.

(Application for copies should be addressed to American National Standards Institute (ANSI), 11 West 42nd Street, New York, NY 10036.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B633 - Zinc on Iron and Steel, Electrodeposited Coatings of.

(Application for copies should be addressed to American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.)

INTERNATIONAL ORGANIZATION FOR STANDARDS (ISO)

ISO 10012-1 - Quality Assurance Requirements for Measuring Equipment - Part 1: Metrological Confirmation System for Measuring Equipment.

(Application for copies should be addressed to American National Standards Institute (ANSI), 11 West 42nd Street, New York, NY 10036.

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence:

In the event of a conflict between the text of this document and the 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.

3. REQUIREMENTS:

3.1 Product specifications or engineering drawings:

The individual item requirements shall be as specified herein and in accordance with the applicable product specification or engineering drawing. In the event of a conflict between the requirements of this specification and the product specification or engineering drawing, the latter shall govern.

3.2 First article inspection:

When specified, samples shall be subjected to first article inspection (see 6.2) in accordance with 4.5.

3.3 Materials:

The materials shall be as specified herein. When a definite material is not specified, a suitable material shall be used which will enable the solenoids to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of acceptance of the finished product.

3.3.1 Fungus resistant materials: Nonmetallic parts of the solenoid shall be inherently nonfungus nutrient or treated to resist fungus growth.

3.3.2 Metals: Metals shall be of a corrosion resistant type, or shall be plated or treated to resist corrosion.

3.3.2.1 Dissimilar metals: When dissimilar metals are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided. The use of dissimilar metals in contact, which tend toward active electrolytic corrosion (particularly brass, copper, or steel used in contact with aluminum or aluminum alloy), is not acceptable. However, metal plating or metal spraying of dissimilar base metals to provide suitable abutting surfaces is permitted. A list of materials is included in 6.3.

3.3.3 Plastic: Plastic material shall be of a type that will enable the solenoid to meet all the performance requirements of this specification.

3.3.4 Wire:

- 3.3.4.1 Magnet wire and lead wire: Magnet and lead wire shall be of a type that will enable the solenoid to meet all the performance requirements of this specification.

3.4 Design and construction:

Solenoids shall be of the design, construction, and physical dimensions specified in 3.1.

- 3.4.1 Coils: Coils shall be evenly wound and insulated to meet the performance requirements specified herein. Coils shall be completely insulated from the frame and other grounded parts, and the coil leads shall not be internally grounded. Coils shall be suitable taped and impregnated as required to prevent damage under prolonged exposure to humidity and salt-fog environmental conditions. Coils shall be securely anchored to the frame or other stationary parts in a manner that will prevent coil movement or strain on the coil leads.
- 3.4.2 Terminal: Terminals, including connectors, solder-type, pig-tail, or lead-in wires shall be as specified in 3.1. Terminals shall be constructed of corrosion-resistant material or shall be suitably plated to resist corrosion during service.
- 3.4.2.1 Plug-in terminals: Plug-in terminals shall conform to the arrangements of dimensions necessary for proper mating with the applicable connectors or sockets. The mounting arrangement of the solenoid shall be so designed that the weight of the solenoid will be supported and the stability of its mounting will be provided by mounting means other than the electrical terminals of the socket. Solenoids with plug-in terminals shall have the electrical and environmental tests, specified in section 4, performed with the appropriate or specified socket or connector assembled to the solenoid.
- 3.4.2.2 Terminal marking: When specified (see 3.1), terminals shall be permanently and legibly marked.
- 3.4.3 Case: Unless otherwise specified (see 3.1), the coil housing shall be enclosed and shall be electrically isolated from any electrical circuit and shall be magnetically shielded.
- 3.4.4 Mounting: The mounting means shall be an integral part of the solenoid housing or shall be securely attached thereto in a manner which will prevent any movement between the solenoid and the mounting means in service use.
- 3.4.5 Armature or plunger travel: The armature or plunger shall be provided with sufficient travel to completely activate the load equipment as required. Unless otherwise specified (see 3.1), positive stops shall be provided at both extremes of travel and shall be sufficiently spring loaded to force the armature and load to the normal or deenergized position with the coil deenergized and under maximum load conditions and temperature extremes.

- 3.4.6 Installation provisions: Clearances shall be provided for installation of power cables and mounting hardware. Unless otherwise specified (see 3.1), special installation tools shall not be required by virtue of the solenoid design.
- 3.4.7 Solid state components: Diodes and other solid state devices shall be of sufficient ratings to withstand peak reverse voltage transients of the utilizing electrical power system. The minimum and maximum peak inverse volts (PIV) shall be as specified in 3.1.
- 3.4.8 Weight (when specified, see 3.1): Solenoids shall not exceed the specified weight.
- 3.4.9 Tolerances: Unless otherwise specified, all electrical, environmental, and mechanical parameters contained in this specification shall have a tolerance of $\pm 10\%$.
- 3.5 Electrical requirements:
- 3.5.1 Electrical characteristics:
- 3.5.1.1 Operating force (torque) (see 4.7.2.1): The operating force (torque) shall be as specified in 3.1. The term "force" is applicable to solenoids having linear output motion. The term "torque" is applicable to solenoids having rotary output motion.
- 3.5.1.2 Compensated actuating voltage (see 4.7.2.2): The solenoid shall be in the energized position.
- 3.5.1.3 Deactuating voltage (or current) (when specified, see 3.1 and 4.7.2.3): The solenoid shall be in the energized position with more than maximum deactuating voltage (or current) applied, and shall be in the deenergized position with less than minimum deactuating voltage (or current) applied.
- 3.5.1.4 Operate and release time (when specified, see 3.1 and 4.7.2.4): The time required for the solenoid to complete the energized function or to revert to the deenergized position shall not exceed the values specified.
- 3.5.1.5 Coil current (see 4.7.2.5): The coil current shall not exceed the specified requirements (see 3.1).
- 3.5.1.6 DC coil resistance (see 4.7.2.6): The dc coil resistance shall be as specified (see 3.1).
- 3.5.2 Insulation resistance (see 4.7.3): The insulation resistance (unless otherwise specified, see 3.1), shall be 1,000 megohms, minimum, except that the insulation resistance between coil and case at the maximum specified ambient temperature shall be 500 megohms, minimum.
- 3.5.3 Dielectric withstanding voltage (see 4.7.4): There shall be no evidence of damage, arcing, breakdown, or leakage current in excess of 0.5 milliamperes.
- 3.5.4 Mounting stud and terminal strength (see 4.7.5): The mounting studs and terminals shall not loosen, nor shall there be any other damage when subjected to the static values of tension and torque specified in table I. Wire lead terminals shall meet the specified pull requirements.

TABLE I. Tension and torque leads for solenoid wire leads, solder lug or hook, stud or screw, and mounting studs.

Wire terminals		Threaded terminals or mounting studs				
Diameter (inches)	Pull tension (lbs)	Size	Pull tension (lbs)		Torque (inch-pounds)	
			Terminals	Mounting studs	Terminals	Mounting studs
.035 to .047	4.5	4	5	7	4.4	5
		6	30	25	10.0	12
Less than .035	2.0 ±0.2	8	35	35	20.0	20
		10	40	50	32.0	40
		.250	50	60	75.0	80
		.313	70	80	100.0	160
		.375	100	115	150.0	275

3.5.5 Static spring return force (when specified; see 3.1 and 4.7.6): The static spring return force shall fall within the specified limits.

3.5.6 Magnetic effect (when specified; see 4.7.7): The intensity of the magnetic field surrounding the solenoid shall not exceed the value specified (see 3.1).

3.6 Environmental requirements:

3.6.1 Thermal shock (see 4.7.8): There shall be no mechanical, electrical, or operational failure, and no cracking, peeling, or flaking of the finish. During this test, operating force (torque) and deactuating voltage shall be as specified in 3.5.1.1 and 3.5.1.3, respectively. Following the test, the compensated actuating voltage shall be as specified in 3.5.1.2.

3.6.2 Solderability (see 4.7.9): The critical examination area of solid wire lead and pin terminals shall be at least 95 percent covered with a continuous new solder coating in accordance with method 208 of MIL-STD-202. For solder-lug terminals greater than .045 inch (1.14 mm) in diameter, 95 percent of the total length of fillet, which is between the standard wrap wire and the terminal, shall be tangent to the surface of the terminal being tested and shall be free of pinholes, voids, etc. A ragged or interrupted line at the point of tangency between the fillet and the terminal under test shall be considered a failure.

3.6.3 Vibration (see 4.7.10): There shall be no evidence of loosening of parts or mechanical damage to the solenoid. Following this test, the operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be as specified in 3.5.1.1, 3.5.1.2, and 3.5.1.3, respectively.

3.6.4 Shock (see 4.7.11): There shall be no evidence of mechanical or electrical damage, nor shall the test impair the normal operation of the solenoid. Following this test, the operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be as specified in 3.5.1.1, 3.5.1.2, and 3.5.1.3, respectively.

- 3.6.5 Acceleration (when specified; see 3.1) and 4.7.12: The solenoids shall meet the specified requirements. During this test, the compensated actuated voltage and deactuating voltage (or current) shall be as specified in 3.5.1.2 and 3.5.1.3.
- 3.6.6 Moisture resistance: Unless otherwise specified (see 3.1), solenoids shall be tested in accordance with 4.7.13. There shall be no evidence of breaking, cracking, or spalling of the solenoids. Immediately after step 6 of the final cycle, the insulation resistance shall be at least 1 megohm, and the compensated actuated voltage shall be as specified in 3.5.1.2. After the 24 hour drying period, the insulation resistance shall be at least 50 megohms. The operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be as specified in 3.5.1.1, 3.5.1.2, and 3.5.1.3, respectively.
- 3.6.7 Altitude (when specified; see 3.1 and 4.7.14): Following this test the insulation resistance, operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be as specified in 3.5.2, 3.5.1.1, 3.5.1.2, and 3.5.1.3, respectively.
- 3.6.8 High temperature (see 4.7.15): The solenoids shall meet the operating force (torque) requirements specified in 3.5.1.1.
- 3.6.9 Low temperature (see 4.7.16): The solenoids shall meet the operating force (torque) requirements specified in 3.5.1.1.
- 3.6.10 Salt spray (see 4.7.17): There shall be no evidence of corrosion, or peeling, chipping, or blistering of the finish, nor exposure of the base metal when inspected by the unaided eye. Following this test, the insulation resistance, operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be as specified in 3.5.2, 3.5.1.1, 3.5.1.2, and 3.5.1.3, respectively. For sealed or encapsulated solenoids, dielectric withstanding voltage (at sea level) (see 3.5.3) shall be applicable.
- 3.6.11 Sand and dust (when specified, see 3.1 and 4.7.18): Following this test, the operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be as specified in 3.5.1.1, 3.5.1.2, and 3.5.1.3, respectively.
- 3.6.12 Explosion (when specified, see 3.1 and 4.7.19): Solenoids shall not ignite an ambient explosive atmosphere.
- 3.7 Life (see 4.7.20):

The solenoid shall remain mechanically and electrically operative. There shall be no indication of mechanical resonance due to the frequency of the energizing voltage. Following this test, the coil resistance shall be within ± 2 percent of the prelife value, and the insulation resistance and dielectric withstanding voltage (at sea level), shall be as specified in 3.5.2 and 3.5.3, respectively.