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SUPERSEDING
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MILITARY SPECIFICATION

SWITCHES, THERMOSTATIC, (VOLATILE LIQUID), HERMETICALLY SEALED, GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers the general requirements for hermetically sealed volatile liquid thermostatic switches intended primarily for use in equipment requiring rapid temperature response. The operating temperatures and operating temperature ranges of switches covered by this specification shall be as specified (see 3.1 and 6.1.2).

1.2 Classification.

1.2.1 Military part number. The military part number (when applicable) shall consist of the letter "M", the basic number of the specification sheet, and an assigned dash number (see 3.1), as shown in the following example

M 28827/1 -

Military designation — Specification sheet number — Coded dash letters, see individual specification sheet for formulation

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-S-571 - Solder, Tin Alloy Tin-Lead Alloy; and Lead Alloy.

MILITARY

MIL-I-10 - Insulating,Materials, Electrical, Ceramic, Class L.
MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-W-5086 - Wire, Electric, Hookup and Interconnecting, Polyvinyl Chloride-Insulated, Copper and Copper Alloy Conductor.
MIL-C-5541 - Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-C-5809 - Circuit Breakers, Trip-Free, Aircraft, General Specification for.
MIL-T-7928 - Terminals, Lug. Splices, Conductor Crimp Style, Copper, General Specification for.
MIL-A-8625 - Anodic Coatings, For Aluminum and Aluminum Alloys.
MIL-F-14256 - Flux, Soldering, Liquid (Rosin Base).
MIL-F-15160 - Fuses, Instrument, Power, and Telephone

Beneficial comments (recommendations, additions, deletions) and and pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Electronic Systems Command, Attn: ELEX-5043, Washington, DC 20360, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter

MIL-W-16878	-	Wire, Electrical, Insulated, High Temperature (NAVY).
MIL-I-16923	-	Insulating Compound, Electrical, Embedding.
MIL-P-20693	-	Molding Plastic, Polyamide (Nylon), Rigid.
MIL-S-28786	-	Switches, Preparation for Delivery of.
MIL-C-45662	-	Calibration System Requirements.

STANDARDS

FEDERAL

FED-STD-H28	-	Screw-Thread Standards for Federal Services.
~~FED-STD-406~~	-	Plastics. Methods of Testing

MILITARY

MIL-STD-105	-	Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-202	-	Test Methods for Electronic and Electrical Component Parts.
MIL-STD-454	-	Standard General Requirements for Electronic Equipment.
MIL-STD-1276	-	Leads, Weldable, for Electronic Component Parts.
MIL-STD-1285	-	Marking of Electrical and Electronic Parts.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheet, the latter shall govern (see 6.1).

3.1.1 Switch categories. Switches furnished under this specification shall be category I or II as defined herein.

3.1.2.1 Category I. Switches completely defined by a military specification sheet.

3.1.2.2 Category II. Switches the same as category I, except for minor differences such as terminations, mounting means, or temperature settings, which do not change the basic design or construction of the qualified switch. Category II shall be procured from a source listed on the applicable qualified products list for the particular similar product in category I. Category II switches are nonstandard.

3.2 Qualification. Switches furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.5 and 6.2).

3.3 Material. Material shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the switches to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as guaranty of the acceptance of the finished product.

3.3.1 Fungus resistance. All material shall be inert or fungus resistant in accordance with requirement 4 of MIL-STD-454.

3.3.2 Metals. All metals parts, other than current-carrying parts, shall be of corrosion-resistant material, or shall be suitably protected to resist corrosion. Paint is not acceptable for corrosion protection.

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 which, in contact, 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 similar or suitable abutting surfaces is permitted. The use of dissimilar metals separated by a suitable insulating material is also permitted. Dissimilar metals and compatible couples are defined in 6.3.

3.3.2.2 Magnesium. Magnesium and magnesium alloys shall not be used.

3.3.2.3 Aluminum. Aluminum and aluminum alloys shall be suitably protected against corrosion. When anodized, it shall be in accordance with MIL-A-8625. Internal parts not in contact with the media or subject to wear may be chemically treated in accordance with MIL-C-5541.

3.3.2.4 Solder. Solder shall have a minimum melting point of 100°F above the maximum temperature rating of the temperature switch and shall conform to QQ-S-571. Where solder is employed, flux shall be in accordance with MIL-F-14256. When stainless steel is ued, corrosive flux may be used providing the device is cleaned and the flux is neutralized prior to final assembly..

3.3.3 Nonmetals. Switches shall not be adversely affected by weathering and aircraft, missile, and spacecraft fluids, at the temperature specified for the applicable switch.

3.3.3.1 Plastic. Unless otherwise specified (see 3.1), thermosetting plastics shall be in accordance with MIL-M-14; however, cotton or wood-cell-filled materials shall not be used. Thermoplastics shall not be used for the switchcase or cover. When used for noncase material, thermoplastic material shall be in accordance with Type I of MIL-P-20693. The plastic material used shall be self-extinguishing when tested in accordance with method 2021 or 2022 of FED-STD-406, as applicable, to the thinnest section of the material used. The self-extinguishing requirement applies to all materials for external parts and enclosures regardless of whether the material used is procured to a Military Specification or not.

3.3.3.2 Ceramic. Ceramic insulating material shall conform to MIL-I-10, Grade L411 or better.

3.3.3.3 Potting compounds. Potting compounds used in contact with the atmosphere shall be in accordance with MIL-I-16923 and shall be compatible with the design requirements of the switch.

3.3.4 Weldability. Leads designed for weldability shall conform to requirements of MIL-STD-1276, type K.

3.3.5 Screw terminals. Screw terminals shall be provided with hardware as specified (see 3.1 and 6.1.2). Lockwashers shall be captive to the screw. For direct Government orders, all terminal hardware shall be assembled in proper order.

3.4 Design and construction.. Switches covered by this specification shall be of the design, construction, and physical dimensions specified (see 3.1 and 6.1.2). Switches shall be so constructed as to ensure proper operation when mounted in any position.

3 4 1 Tamperproof calibration. Unless otherwise specified (see 3.1 and 6.1.2), the switches shall be sealed in such a manner that any tampering with the calibration after final adjustment by the manufacturer shall require dismantling of the switch or the breaking of a seal The seal shall not be easily broken by manual force or without the use of any device considered a tool, for example, screwdriver, pliers, soldering iron, and so forth.

3.4.2 Solder terminals. Solder terminals shall be treated to facilitate soldering. The terminal design shall be such that a mechnical connection can be made prior to soldering Acceptable solder terminal designs are turret, hook, pierced, or post type.

3 4 3 Mounting. Mounting shall be as specified (see 3.1 and 6.1.2). Stud mounting shall have threads in accordance with FED-STD-H28.

3.4 4 Weight. Weight shall be as specified (see 3.1 and 6.1.2).

3.5 Electrical ratings. The electrical ratings shall be as specified (see 3.1 and 6 1.2)

3 6 Solderability (when applicable, see 3.1). When switches are tested as specified in 4.7.2, 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. There shall be no pinholes, voids, and so forth A ragged or interrupted line at the point of tangency between the fillet and the terminal under test shall be considered a defect. After the test, there shall be no evidence of fracture, loosening of parts, or any other mechanical failure of the switches

3.7 Calibration. When switches are tested as specified in 4 7.3, the operating points for the opening and closing temperature shall be within the tolerances specified (see 3.1 and 6.1 2)

3.8 Proof temperature. When switches are tested as specified in 4.7.4, there shall be no evidence of damage and the operating points shall be within the tolerance specified

3 9 High temperature exposure. When switches are tested as specified in 4.7.5, the operating points shall be within the tolerance specified in 4.7.5.

3.10 Low temperature exposure When switches are tested as specified in 4 7 6, the operating points shall be within the tolerances specified in 4.7.6.

3 11 Time constant. When switches are tested as specified in 4 7 7, the time required for the switch to actuate shall be as specified (see 3.1)

3 12 Proof pressure (when specified, see 3.1) When switches are tested as specified in 4 7.8, there shall be no evidence of leakage or damage, and the operating points shall be within the tolerances specified (see 3.1).

3 13 Seal (hermetic). When switches are tested as specified in 4 7.9, the leakage rate shall not exceed 1×10^{-8} standard atmosphere cubic centimeters per second (atm cc/sec).

3.14 Dielectric withstanding voltage. Unless otherwise specified (see 3.1 and 6.1 2), when switches are tested as specified in 4.7.10, there shall be no flashover, arcing, or current flow in excess of 1 milliampere .

3 15 Insulation resistance . When initially measured as specified in 4.7.11, the insulation resistance between all insulated terminals and enclosures shall be not less than 1000 megohms

3.16 Contact resistance. Unless otherwise specified (see 3.1 and 6.1.2.), when measured as specified in 4.7.12, the initial contact resistance shall not exceed 100 milliohms; following the endurance test, contact resistance shall not exceed 250 milliohms.

3.17 Connector torque (applicable to switches with electrical connectors). When switches are tested as specified in 4.7.13, there shall be no loosening, rotation, distortion, short circuit or other damage. The operating points shall be within the tolerances specified (see 3.1)

3.18 Terminal strength (when applicable). When switches are tested as specified in 4.7.14, there shall be no breakage, loosening, or rotating of terminals, and no damage to the switch body.

3.19 Short circuit (when specified, see 3.1). When switches are tested as specified in 4.7.15, there shall be no welding or sticking of contacts, or other damage. Switches shall be mechanically and electrically operative at the end of the test.

3.20 Vibration Unless otherwise specified (see 3.1 and 6.1.2), when switches are tested as specified in 4.7.16, closing of open contacts and opening of closed contacts shall not exceed 250 microseconds. The operating points shall be within the tolerance specified (see 3.1)

3.21 Shock. Unless otherwise specified (see 3.1 and 6.1 2), when switches are tested as specified in 4 7 17, there shall be no change in operation, or evidence of broken, deformed, displaced, or loose parts.

3 21.1 Method I (shock, specified pulse) (see 3.1 and 6.1.2) When switches are tested as specified in 4.7.17.1, closing of open contacts and opening of closed contacts shall not exceed 250 microseconds, unless otherwise specified (see 3.1 and 6.1.2).

3.21.2 Method II (high-impact shock) (see 3.1 and 6.1.2). When switches are tested as specified in 4.7.17.2, closing of open contacts and opening of closed contacts shall not exceed 5 milliseconds, unless otherwise specified (see 3.1 and 6.1 2).

3.22 Overload cycling When switches are tested as specified in 4.7.18, there shall be no mechanical or electrical failure

3.23 Endurance When switches are tested as specified in 4.7.19, each contact shall open and close its circuit in proper sequence during each cycle. During and after the cycling, there shall be no evidence of malfunction, damage, or leakage, and the operating points shall be within the tolerances specified (see 3.1).

3.24 Salt spray (corrosion). When switches are tested as specified in 4.7.20, switches shall show no evidence of destructive corrosion. After the test, any mounting hardware (if applicable) shall be readily removable. NOTE: Destructive corrosion shall be construed as being any type of corrosion which in any way interferes with the mechanical or electrical performance, or in the case of plated metals, corrosion which has passed through the plating and attacked the base metal.

3.25 Marking. Switches shall be marked in accordance with MIL-STD-1285 with the military part number or the manufacturer's part number when specified (see 6.1.2), date code, and the manufacturer's trademark or code symbol.

3.26 Workmanship Switches shall be processed in such a manner as to be uniform in quality and shall be free from cracked or displaced parts, sharp edges, burrs, and other defects which will affect life, serviceability, or appearance

4. QUALITY ASSURANCE PROVISIONS

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

4.1 1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the contractor The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-C-45662.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows

a. Materials inspection (see 4.3).
b. Qualification inspection (see 4.5).
c. Quality conformance inspection (see 4 6)

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table V, used in fabricating the switches, are in accordance with the applicable referenced specification or requirements prior to such fabrication.

TABLE V. Materials inspection.

Component material	Requirement paragraph	Applicable specification
Fungus resistant	3.3 1	MIL-STD-454
Aluminum	3.3.2 3	MIL-A-8625 MIL-C-5541
Solder	3.3 2.4	QQ-S-571
Solder flux	3.3.2.4	MIL-F-14256
Plastic	3.3.3.1	MIL-M-14 MIL-P-20693 FED-STD-406
Ceramic	3 3 3.2	MIL-I-10
Potting compounds	3 3 3 3	MIL-I-16923

4 4 Inspection conditions. Unless otherwise specified herein, all tests and measurements required by this specification shall be made at room ambient conditions, in accordance with the "GENERAL REQUIREMENTS" of MIL-STD-202

4 5 Qualification inspection Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6 2) on sample units produced with equipment and procedures normally used in production

4 5 1 Sample size Twelve switches shall be subjected to qualification inspection.

4 5.2 Inspection routine The sample shall be subjected to the inspections specified in table VI, in the order shown. Sample units shall be grouped as shown in table VI.

4.5.3 Failures. One or more failures shall be cause for refusal to grant qualification approval.

4 5 4 Extent of qualification.

4 5 4.1 Single submission. Qualification shall be restricted to the switch submitted.

4 5.4.2 Group submission If samples satisfactorily pass the qualification inspection, other switches from the same manufacturer that have the same operation or reverse operation, and the same design, construction, switching characteristics, and physical dimensions will be considered qualified by the Government without further qualification inspection.

4 5.4.2 1 Additional qualification. Qualification will be extended to switches of the same design and construction as qualified switches, provided the following criteria are met under the following conditions

a. The shock rating is the same or less.
b. The altitude rating is the same or less.
c. The vibration rating is the same or less
d. The endurance rating is the same or less.
e. The acceleration rating is the same or less
f. The high temperature is not above that of the qualified switch with the highest setting.
g. The lowest temperature setting is not lower than that of the qualified switch with the lowest setting.
h. Switches are the same contact action or reverse contact action as the qualified type.

TABLE VI Qualification inspection

Examination or test	Requirement paragraph	Method paragraph
Group I (12 sample units)		
Visual and mechanical examination	3.1, 3.3, 3.4, 3.25 and 3.26	4.7.1
Solderability 1/ (when applicable)	3.6	4.7.2
Calibration	3 7	4.7.3
Proof temperature	3.8	4.7.4
Time constant	3.11	4.7.7
Proof pressure (when specified)	3.12	4.7.8
Seal	3 13	4.7.9
Dielectric withstanding voltage	3 14	4.7.10
Insulation resistance	3.15	4.7.11
Contact resistance	3.16	4.7.12
Group II (2 sample units from group I shall be included and identified in this group)		
Salt spray (corrosion)	3 24	4.7.20
Group III (4 sample units from group I)		
High temperature exposure	3.9	4 7.5
Low temperature exposure	3 10	4 7.6
Connector torque (when applicable)	3 17	4.7.13
Terminal strength (when applicable)	3 18	4.7 14
Short circuit (when applicable)	3 19	4.7.15
Group IV (6 sample units from group I)		
Vibration	3 20	4.7 16
Shock	3.21	4 7.17
Overload cycling	3 22	4.7.18
Endurance 2/	3 23	4 7.19
Group V (all sample units from groups III and IV)		
Visual and mechanical examination	3.1, 3 3, 3 4 3 25 and 3.26	4 7.1
Calibration	3 7	4 7.3
Proof temperature	3 8	4.7.4
Time constant	3.11	4.7.7
Proof pressure (when specified)	3 12	4.7.8
Seal	3.13	4 7.9
Dielectric withstanding voltage	3.14	4 7.10
Insulation resistance	3.15	4.7.11
Contact resistance	3.16	4.7.12

1/ Three sample units only.
2/ Three sample units of the lowest temperature setting for which qualification is sought and three sample units of the highest setting for which qualification is sought (see 3.1).

4.5.5 Retention of qualification. To retain qualification, the contractor shall submit a summary of the results of the tests performed for inspection of product for delivery (group A) and a certification of compliance at yearly intervals via the Government quality assurance representative. The summary of group A shall indicate the number and type of failures together with corrective action taken to correct failures. The certification of compliance shall include verification that materials, processes, and quality control have not changed. Failure to submit the group A summary and certification of compliance shall result in loss of qualification. If the summary of the test results indicates nonconformance with the specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

4.6.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection.

4.6.1.1 Inspection lot. An inspection lot shall consist of all switches of the same type produced under essentially the same conditions, and offered for inspection at one time.

4.6.1.2 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table VII, in the order shown.

4.6.1.2.1 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for normal inspection level II. The acceptable quality levels (AQL) shall be as specified in table VII. Major and minor defects shall be as defined in MIL-STD-105.

TABLE VII Group A inspection

Examination or test	Requirement paragraph	Method paragraph	AQL (percent) defective	
			Major	Minor
Visual and mechanical examination	3.1, 3.3, 3.4, 3.25 and 3.26	4.7.1	1.0	4.0
Calibration	3 7	4.7.3	1/	---
Proof temperature	3.8	4.7.4	1/	---
Proof pressure (when specified)	3 12	4 7.8	1/	---
Seal	3 13	4.7.9	1/	---
Dielectric withstanding voltage	3.14	4.7.10	0.65	---

1/ 100 percent inspection required, in process inspection may be used to satisfy this requirement

4.6.1.2.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out 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.

4.6.1.2.3 Disposition of sample units. Sample units which have passed all the group A inspection may be delivered on the contract or purchase order, if the lot is accepted and the sample units are still within specified electrical tolerance.

4.6.2 Packaging inspection. The sampling and inspection of the preservation-packaging, packing and container marking shall be in accordance with the requirements of MIL-S-28786.

4.7 Methods of examination and test.

4.7.1 Visual and mechanical examination. Switches shall be examined to verify that the materials, design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements (see 3.1, 3.3, 3.4, 3.25, and 3.26).

4.7.2 Solderability (applicable to solderable terminals) (see 3.6). Switches shall be tested in accordance with method 208 of MIL-STD-202. The following details and exceptions shall apply:

a. Number of terminals to be tested - All.
b. Depth of immersion in molten solder - Terminals shall be immersed to the maximum extent possible.
c. Examination of terminals - Method for evaluation of lugs and tabs shall apply.
d. Dipping machine - Need not be used.

4.7.3 Calibration (see 3.7). The switch sensing element shall be installed into a circulating liquid bath at an initial temperature of at least 10 degrees below the switch actuating temperature. The temperature shall then be increased until the switch actuates and the actuation point recorded. The temperature of the liquid bath shall then be decreased until the switch deactuates, and the deactuation point recorded. This procedure shall be repeated for a total of two times, and the rate of change shall not exceed one degree per minute within 10 degrees of the switching points. Circulating air ovens shall not be used for calibration unless the actuation point exceeds 600°F.

4.7.3.1 Circulating liquid bath. The test bath shall contain a liquid capable of safely operating at the maximum test temperature consistently within ±0.5°F, and with a maximum viscosity of 20CS at the actuation point of the switch. The bath shall maintain a minimum velocity of 15 feet per minute perpendicular to the sensing probe throughout the test. Bath temperature shall be monitored with a platinum resistance probe and bridge or equivalent devices capable of measuring temperature within ±0.5°F accuracy.

4.7.3.2 Circulating air oven. Air ovens are recommended for test temperatures above 600°F. The oven must maintain an air stream velocity perpendicular to the sensing probe of 5400 feet per minute, and a consistent temperature (±2°F) within the air stream. The air stream temperature shall be monitored with a platinum resistance probe and bridge or equivalent device capable of measuring temperature within ±1°F.

4.7.4 Proof temperature (see 3.8). Switch sensing element shall be exposed to a proof temperature for one minute or as specified, either liquid or air test devices may be used for this test. Following this test, the actuation and deactuation points shall be within the tolerance specified.

4.7.5 High temperature exposure (see 3.9). Switches shall be subjected to the highest non-operating ambient temperature specified (see 3.1) for a minimum of 12 hours. After this period, the temperatures shall be changed to the highest operating temperature specified and held for a minimum of two hours. Then, while at this temperature, the switches shall be tested in accordance with calibration (see 4.7.3).

4.7.6 Low temperature exposure (see 3.10). Switches shall be subjected to the lowest non-operating ambient temperature specified (see 3.1) for a minimum of 12 hours. After this period, the temperature shall be changed to the lowest operating temperature specified and held for a minimum of two hours. Then, while at this temperature, the switches shall be tested in accordance with calibration (see 4.7.3).

4.7.7 Time constant (see 3.11). The time constant test facility shall consist of a drum containing a circulating liquid. The bath temperature shall be such that the actuation point of the thermal switch is 63 percent of the difference between the ambient temperature at the test facility and the bath temperature, see figure 1. The switch sensing probe shall be immersed in the bath, and the time to actuation recorded. The switch shall be removed from the bath after actuation and cooled to room temperature before each immersion. The test shall be repeated for a total of three times The time constant shall be the average of the three test values.

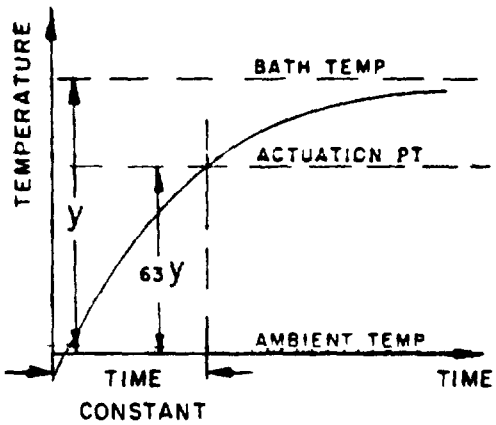

FIGURE 1. Temperature response vs time.

4.7 7.1 Time constant (alternate method). For switches where the bath temperature will exceed 600 °F a flowing air stream of specified velocity and density shall be used as a substitute for the oil bath. The same basic procedures shall apply

4.7.8 Proof pressure (see 3.12). Switches shall be connected to a device supplying the specified media or approved substitute at a pressure which can be varied from zero to at least the proof pressure specified (see 3.1) The pressure shall then be increased to the proof pressure and maintained for one minute There shall be no evidence of leakage or deformation

4.7 9 Seal (see 3 13) Switches shall be tested in accordance with method 112 of MIL-STD-202 The following details shall apply:

a. Test condition - C.
   1. Procedure III or IV; leakage-rate sensitivity - $1x10^{-8}$ atm cm^3/s, for checking gross leaks, test condition B.
   2. For procedure IV - Reduced pressure of the chamber and duration of pressurization - Determination made in accordance with the type of equipment used.
b. Measurements after test - None.

4 7.10 Dielectric withstanding voltage (see 3 14). Switches shall be tested in accordance with 4 7.10.1 and, when applicable (see 3 1 and 6 1.2), in accordance with 4 7.10.2. This test shall be performed with the switch in normal position, and shall then be repeated for other operating positions.

4 7.10 1 At atmospheric pressure Switches shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply·

a. Magnitude of test voltage - 1,000 volts plus twice the working voltage for initial test and 1,000 volts for subsequent tests.
b. Nature of potential - AC.
c. Duration of application of test voltage - 1 minute for qualification tests, 5 seconds for group A tests at 20 percent higher voltage.
d. Points of application of test voltage - Between all terminals and ground.
e. Maximum leakage current - 1 milliampere, unless otherwise specified (see 3 1 and 6 1.2)
f. Examination after test - Switches shall be examined for evidence of arcing and flashover

4.7.10.2 At reduced barometric pressure. Switches designed for operation above 10,000 feet shall be tested as specified in 4.7.10.1, and in accordance with method 105 of MIL-STD-202 The following details and exception shall apply:

a. Method of mounting - Normal mounting means.
b. Test condition - The reduced pressure utilized shall be that of the rated altitude of the switch (see 3.1).
c. Test voltage - 500 volts, unless otherwise specified (see 3.1 and 6.1.2).

4 7 11 Insulation resistance (see 3.15). Switches shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

a. Test condition - B
b. Points of measurement - Between all terminals and frame or ground.

4.7.12 Contact resistance (see 3.16). Switch contacts shall be tested in accordance with method 307 of MIL-STD-202. The following details and exception shall apply

a. Measurements - Between the terminals of the contacts of the same pole forming a switching circuit; for all poles in a switch at each of the temperature settings; between mated contacts for all poles.
b. Test current and maximum test voltage: The test current and test voltage may be any values compatible with the test method employed, but shall not exceed the rated values of the switch (see 3.1).
c. Number of activations prior to measurement - Not applicable.
d. Number of test activations - Three.
e. Number of measurements per activation - One reading after each thermal actuation

4.7.13 Connector torque (applicable to switches with electrical connectors) (see 3.17). Switches shall be mounted by their normal mounting means on a rigid metal fixture. A torque of five foot-pounds shall be applied to the electrical connectors, in a plane perpendicular to its central axis and in the direction which would tighten the mating part, and held for one minute. If the normal mounting means of the switch includes some type of strip or clamp which would permit rotation of the entire switch in its mounting device during this test, the switch shall be held stationary by suitable mechanical restraints while the torque is applied This test is intended as a verification of connector mounting suitability, and is not meant to confirm integrity of connector design or construction. Following this test, switches shall be tested in accordance with calibration (see 4.7 3).

4.7.14 Terminal strength (when applicable) (see 3.18). Terminals shall be tested in accordance with 4 7.14.1 or 4 7.14 2, as applicable. Unless otherwise specified (see 3 1), switches shall be mounted by their normal mounting means

4.7.14.1 Threaded terminals. Threaded terminals shall be subjected, for one minute to the applicable static values for force and torque specified in table VIII. The force shall be gradually applied as a pull along the axis of the threads, perpendicular to the axis of the threads, and in the direction most likely to cause failure. The torque shall be applied in the direction which will tighten the screws.

TABLE VIII Static values of force and torque.

Thread size	Force (pounds)	Torque (inch-pounds) Steel	1/ Nonferrous
4-40	5	8	5
6-32	30	14	10
8-32	35	22	20
10-32	40	38	32
10-24	40	42	35
1/4-28	50	100	75

1/ The torque values are intended as a test for terminals and not for terminal hardware. Where brass terminal screws are used, it may be necessary to substitute steel screws for the purpose of this test as torque values exceed shear strength of brass screws in certain sizes

4.7.14.2 Solder-lug and wire load terminals. Switches shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply.

a. Test condition letter - A
b. Applied force
   1. Solder lug - 9 pounds.
   2. Wire-lead - 15 pounds, unless otherwise specified (see 3.1).
c. Direction of force - Force shall be applied along three mutually perpendicular axes of the terminal, one direction of which shall be the one most likely to cause failure, unless otherwise specified (see 3.1).

4.7.15 Short circuit (when specified, see 3.1) (see 3.19). Switches shall be inserted in a circuit which has been calibrated using a dummy switch, and which will supply a current equal to 15 times the rated resistive load at the lowest dc voltage specified (see 3.1), when monitored through the switch contacts. Each switch shall be connected in series, by 1-foot lengths of wire, to a thermal-type circuit breaker or a fuse in accordance with figure 2 and table IX. A circuit breaker shall be used for switches having a rated resistive load of 5 amperes or greater, and a fuse for switches having a rated resistive load less than 5 amperes. The wire shall be of a size for use in free air as listed in MIL-W-5086 and table IX, determined by the rated resistive load of the switch (see 3.1). If the rated load of the switch does not coincide with a wire size, the next larger wire size shall be used. The terminals shall be in accordance with MIL-T-7928. The circuit breaker shall be in accordance with MIL-C-5809 and table IX, and fuses shall be in accordance with MIL-F-15160 and table IX, and of the same current rating as the resistive current rating of the switch. Calibration shall be made without the circuit breaker (or fuse), test switch, or switch leads in the circuit. With both the switch under test and the circuit breaker in a closed position, and with switch S_2 in the position shown on figure 2, the circuit shall be closed manually by switch S_1. A minimum of 2 minutes shall elapse between the successive closings of the switch. The test shall be conducted five times.

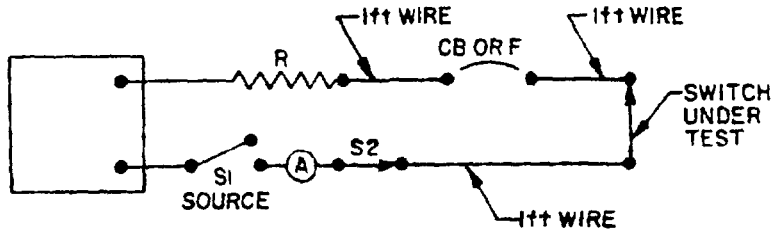

FIGURE 2 Circuit diagram for short circuit test.

TABLE IX Short circuit wire sizes and circuit breaker or fuse designations

Resistive rating at lowest voltage, amperes	Specification MIL-W-5086 wire size	Circuit breaker or fuse
Less than 5 - - - - - -	AN-20	MIL-F-15160/2, characteristic A, rating, as applicable
5 - - - - - -	AN-20	MS25017-5
7 5 - - - - -	AN-18	MS25017-7
10 - - - - - -	AN-18	MS25017-10
15 - - - - - -	AN-18	MS25017-15
18 - - - - - -	AN-16	MS25017-20
20 - - - - - -	AN-16	MS25017-20
25 - - - - - -	AN-14	MS25017-25
30 - - - - - -	AN-14	MS25017-30
40	AN-12	MS25017-50

4.7.16 Vibration (see 3 20). Switches shall be tested in accordance with 4.7.16.1 or 4.7 16.2, as specified (see 3.1). The following details and exceptions shall apply:

a. Tests and measurements prior to vibration - Not applicable
b. Mounting - Switches shall be mounted by their normal mounting means on a rigid metal panel. The mounting fixture shall be free from resonances over the test frequency range.
c. Electrical load conditions - The electrical load shall consist of the monitor circuit only.
d. Measurements during vibration - Switch contact stability shall be continously monitored during vibration If more than one contact pair is being monitored simultaneously by one chatter indicator, open contact pairs shall be connected in parallel and closed contact pairs shall be connected in series during this test In the event of indication of a contact opening greater than specified, the test shall be modified so that switches may be individually tested to determine if a switch is defective.
e. Measurements after vibration - Calibration (see 4.7.3).
f. Examination after test - Switches shall be examined for change in actuated position, and evidence of broken, deformed, displaced or loose parts

4.7.16.1 Vibration, high frequency

a. Method 204 of MIL-STD-202
b. Test condition letter - A, B, C, or D as specified (see 3.1).
c. Method of determining resonance, and measurements during test - All checks for resonance and contact disturbance shall be conducted with the switches being cycled between actuation and deactuation at a switching rate of three cycles per minute, with the temperature rise and decay rate not exceeding 10 degrees per minute within 10 degrees of the switching points
d. Switches shall be subjected to two cycles of operation at each of the following frequencies - 5, 10, 20, 40, 80, 100, and every 100 Hz to and including 2,000 Hz, except that test condition A shall be to 500 Hz. If resonance is detected, the switches shall be vibrated for 20 minutes at each resonance observed.
e. Contact disturbances shall be monitored within 10 percent of the switching points on a multi-channel recording device with a minimum response of 2,000 Hz at tape speeds (inches per second) sufficient to indicate a 250 microsecond time interval.
f. The recordings need not be submitted with the qualification test report. However, the report shall state that the test was successfully accomplished, the recordings shall be maintained by the manufacturer for the three year period, and the recording shall be made available upon request by the preparing activity

4.7.16.2 Vibration, random.

a. Method 214 of MIL-STD-202
b. Test condition II, letter E, 1.5 hours.

4.7.17 Shock (see 3.21) Switches shall be tested in accordance with 4.7.17.1 and, in addition, to 4.7 17.2, when specified (see 3 1). The following details and exception shall apply to both methods

a. Contact chatter shall be monitored in accordance with method 310 of MIL-STD-202.
b. Mounting - Switches shall be mounted by their normal mounting means.
c. Electrical load conditions - The electrical load shall consist of the monitor circuit only.
d. Temperature conditions - Half of the switches shall be tested in the deactuated position at 10°C below the actuation temperature, and half the switches shall be tested in the actuated position at 10°C above the deactuation temperature.
e. Measurements during shock - Switch contact stability shall be continuously monitored during shock. If more than one contact pair is being monitored simultaneously by one chatter indicator, open contact pairs shall be connected in parallel and closed contact pairs shall be connected in series during this test. In event of indication of a contact opening greater than specified, the test shall be modified by applying successive identical blows in the same plane to monitor contacts, switch by switch, to determine if a switch is defective.
f. Measurements after shock - Switches shall be tested in accordance with calibration (see 4.7.3).
g. Examination after test - Switches shall be examined for evidence of broken, deformed, displaced, or loose parts.

4.7.17.1 Method I, specified pulse.

a. Method 213 of MIL-STD-202.
b. Test condition - C.
c. Allowable contact opening or closure - 250 microseconds maximum.

4.7.17.2 Method II, high impact.

a. Method 207 of MIL-STD-202.
b. Allowable contact opening or closure - 5 milliseconds maximum.

4.7.18 Overload cycling (see 3.22). Each switch shall be tested for overload cycling using the same voltage, electrical frequency, and the same pair(s) of contacts that will subsequently be used for the electrical endurance test. The switches shall close and open the overload current of a resistive circuit equal to 150 percent of the resistive load rating at the particular voltage and electrical frequency. The cycling rate shall not exceed 6 cycles of operation per minute. Fifty cycles of operation shall be performed. The duty cycle shall be approximately 50 percent on, 50 percent off.

4.7.19 Endurance (see 3.23). Switches shall be subjected to the specified number of cycles of make-and-break operations at a cycling rate of 6 cycles per minute maximum at the specified loads (see 3.1 and 6.1.2).

4.7.20 Salt spray (corrosion) (see 3.24). Switches and their mounting hardware and brackets (if applicable) shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

a. Test condition - B.
b. Measurements after exposure - Following the drying period, the switches shall meet the requirements specified in 3.24. Mounting hardware shall be removed at end of the test.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordnace with MIL-S-28786.

6. NOTES

6.1 Ordering data.

6.1.1 For category I switches. Procurement documents should specify the following.

a. Title, number, and date of this specification.
b. Title, number, and date of the applicable specification sheet and the complete military part number.

6.1.2 For category II switches. Procurement documents should specify the following:

a. Title, number, and date of this specification.
b. Title, number, and date of the applicable specification sheet.
c. Military part number of qualified switch.
d. Manufacturer's part number of modified switch.

e. Details of the variations from the specification sheet.
f. Inspection requirements (to verify variations from category I switches) (see 4.5).
   1. Tests to be performed (if any) (see 4.5).
   2. The laboratory at which inspection is to be performed (see 4.5).
   3. Sample size and submission of data, if other than that specified (see 4.5.1 and 4.5.2).

6.2 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Naval Electronics Systems Command, Attn: ELEX 5043, Washington, D.C. 20360; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), Dayton, Ohio 45444. Application for qualification tests shall be made in accordance with "Provisions Governing Qaulification."(see 6.2.1).

6.2.1 Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5901 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.3 Intermetallic contact. The finishing of metallic areas to be placed in intimate contact by assembly presents a special problem, since intermetallic contact of dissimilar metals results in electrolytic couples which promote corrosion through galvanic action. To provide the required corrosion protection, intermetallic couples are restricted to those permitted by table X. Table X shows metals and alloys (or plates) by groups which have common electromotive forces (EMF) within 0.05 volt when coupled with a saturated calomel electrode in sea-water at room ambient temperatures. All members of a group are considered as completely compatible, one with other. Compatible couples between groups have been specified in table X based on a potential differences of 0.25 volt maximum. To simplify any arithmetic involved, table X shows in addition to EMF against a calomel electrode, a derived "anodic index" with group 1 (gold, and so forth) as 0 and group 18 (magnesium, and so forth) as 175. Subtraction of a lower group anodic index gives the EMF difference in hundredths of a volt.

6.3.1 Groups. Table X sets up 18 primary groups. It may be noted that neither the metallurgical similarity or dissimilarity of metals is the parameter for selection of compatible couples. All members within a group, regardless of metallurgical similarity, are considered inherently nonsusceptible to galvanic action when coupled with any member within the group; for example, such dissimilar metals as platinum and gold. Similarly, such basically dissimilar alloys as austenitic stainless steel, silver-solder, and low brass (all members of group 5) are inherently nonsusceptible when coupled together.

TABLE X. Compatible couples (see 6.3) 1/

Group No.	Metallurgical category	EMF (volt)	Anodic index (0.01 v)	Compatible couples
1	Gold, solid and plated, gold-platinum alloys, wrought platinum (most cathodic)	+ 0.15	0	○
2	Rhodium plated on silver-plated copper	+ 0.05	10	●○
3	Silver, solid or plated, high silver alloys	0	15	●●○
4	Nickel, solid or plated; monel metal, high nickel-copper alloys	- 0.15	30	●●○
5	Copper, solid or plated; low brasses or bronzes, silver solder; German silver, high copper-nickel alloys; nickel-chromium alloys, austenitic corrosion-resistant steels	- 0.20	35	●●●○
6	Commercial yellow brasses and bronzes	- 0.25	40	●●●○
7	High brasses and bronzes, naval brass, Muntz metal	- 0.30	45	●●●○
8	18 percent chromium type corrosion-resistant steels	- 0.35	50	●●●●○
9	Chromium, plated, tin, plated; 12 percent chromium type corrosion-resistant steels	- 0.45	60	●●●●○
10	Tin-plate, terneplate, tin-lead solder	- 0.50	65	●●●●●○
11	Lead, solid or plated, high lead alloys	- 0.55	70	●●●●●○
12	Aluminum, wrought alloys of the duralumin type	- 0.60	75	●●●●●○
13	Iron, wrought, gray, or malleable; plain carbon and low alloy steels, armco iron	- 0.70	85	●●●●●○
14	Aluminum, wrought alloys other than duralumin type; aluminum, case alloys of the silicon type	- 0.75	90	●●●●●○
15	Aluminum, cast alloys other than silicon type, cadmium, plated and chromated	- 0.80	95	●●●●●○
16	Hot-dip-zinc plate; galvanized steel	- 1.05	120	●○
17	Zinc, wrought, zinc-base die-casting alloys; zinc, plated	- 1.10	125	●
18	Magnesium and magnesium-base alloys, cast or wrought (most anodic)	- 1.60	175	●

1/ Compatible couples - potential difference of 0.25 volt maximum between groups.

6.3.2 Compatibility graphs. Permissible couple series are shown in table X by the graphs at the right. Members of groups connected by lines will form permissible couples. A "O" indicates the most cathodic member of each series, a "•" an anodic member, and the arrow indicates the anodic direction.

6.3.3 Selection of compatible couples. Proper selection of metals in the design of equipment will result in fewer intermetallic contact problems. For example, for sheltered exposure, neither silver nor tin require protective finishes. However, since silver has an anodic index of 15 and tin 65, the EMF generated as a couple is 0.50 volt, which is not allowable by table X. In this case, other metals or plates will be required. It should be noted that, in intermetallic couples, the member with the higher anodic index is anodic to the member with the lower anodic index and will be susceptible to corrosion in the presence of an electrolytic medium. If the surface area of the cathodic part is significantly greater than that of the anodic part, the corrosive attack on the contact area of the anodic part may be greatly intensified. Material selection for intermetallic contact parts, therefore, should establish the smaller part as the cathodic member of the couple, whenever practicable.

6.3.4 Plating. When base metals intended for intermetallic contact form couples not allowed by table X, they are to be plated with those metals which will reduce the potential difference to that allowed by table X.

6.4 Changes from previous issue. Asterisks are not used in this revision, to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:
Army - ER
Navy - EC
Air Force - 85

Review activities:
Army - AV
Navy - SH
Air Force - 11, 17, 99
DLA - ES

User activity:
Navy - AS, MC, OS

Preparing activity:
Navy - EC

Agent:
DLA - ES

(Project 5930-1111)