

INCH-POUND

MIL-S-22885E

11 March 1992

SUPERSEDING

MIL-S-22885D

20 January 1983

MILITARY SPECIFICATION
SWITCHES, PUSH BUTTON, ILLUMINATED,
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 manually operated illuminated push button switches, switch assemblies (see 6.4.1), and associated modular subassemblies. As used in this specification, the term "switches" shall include the associated modular subassemblies, including switches, indicator lights, actuators, lenses, color filters, panel seals, barriers, and so forth.

1.2 Classification.

1.2.1 Enclosure design. The enclosure design is identified by a single digit in accordance with table I.

TABLE I. Enclosure design.

Symbol	Seal
1	Unsealed
2	Dripproof <u>1/</u>
3	Watertight <u>1/</u>
4	Splashproof <u>1/</u>

* 1/ In accordance with MIL-STD-108.

1.2.2 Temperature characteristic. The temperature characteristic is identified by a single digit, indicating the temperature range of the switch in accordance with table II.

TABLE II. Temperature characteristic.

Symbol	Operating Temperature range	
	Minimum	Maximum
1	-55°C	+85°C

*

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Electronics Supply Center, ATTN: DESC-EMM, Dayton, OH 45444-5283 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1.2.3 vibration grade. The vibration grade is identified by a single digit in accordance with table III.

TABLE III. Vibration grade.

Symbol	Frequency range	Acceleration level
1	10-55 Hz	0.06 inch total excursion, method 201 of MIL-STD-202
2	10-500 Hz	10 g peak, test condition A, method 204 of MIL-STD-202
3	10-2,000 Hz	15 g peak, test condition B, method 204 of MIL-STD-202

1.2.4 Operation. The operation of the switch is identified by a single letter in accordance with table IV.

TABLE IV. Operation.

Operation	Symbol
Momentary action	A
Alternate action	B
Push pull	C
Magnetically held	D
Position indicating, alternate action	E
Position indicating, magnetically held	F
Sequence action	G
Indicator light only	H

★

★ 1.2.5 Color. The color of the lens shall be identified by a single letter in accordance with table V.

TABLE V. Color.

Symbol	Illuminated color
R	Red
G	Green
Y	Yellow
B ^{1/}	Blue
W	White
V	Violet
O	Opaque
H	NVIS Green A
J	NVIS Green B
K	NVIS Yellow
L	NVIS Red

^{1/} Blue is not recommended and should be used only when absolutely necessary.

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1.2.6 Display type. The lens display is designated by a single letter in accordance with table VI.

TABLE VI. Display type.

Symbol	Display
C	Colored background (Shows color both when nonilluminated and illuminated).
W	White background (White until illuminated, then background appears in color).
S	Sunlight readable (Legend not visible until illuminated, then legend appears in color. Background is black).
N	Opaque background, visible legend with illuminating characters.
H	Hidden legend. Same as display type S except contrast requirements do not apply.
B	Hidden legend (black legend on an obscure background) when unlighted. When illuminated, legend is black and the background appears in color. The display shall not appear energized in the unlighted condition.

* 1.3 Military Part or Identifying Number (PIN). The term Part or Identifying Number (PIN) is equivalent to the term part number which was previously used in this specification. The military PIN (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	22885/XX	-XXXX
Military designator	Specification sheet number	Dash number (See specification sheet for formulation)

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, cited in the solicitation (see 6.2).

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SPECIFICATIONS

* FEDERAL

- QQ-N-290 - Nickel Plating (Electrodeposited).
- ZZ-P-765 - Rubber, Silicon.

* MILITARY

- MIL-I-10 - Insulating Compound, Electrical, Ceramic, Class L.
- MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
- MIL-P-997 - Plastic Material, Laminated, Inermosetting, Electric Insulation Sheets, Glass Cloth, Silicone Resin.
- MIL-C-5541 - Chemical Conversion Coatings on Aluminum Alloys.
- MIL-R-5757/10 - Relays, Electromagnetic, Hermetically Sealed, DPDT, Low Level and 2 Amperes.
- 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-S-8516 - Sealing Compound, Polysulfide Rubber, Electric Connectors and Electric Systems, Chemically Cured.
- MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.
- MIL-F-15160 - Fuses, Instrument, Power, and Telephone.
- MIL-I-16923 - Insulating Compound, Electrical, Embedding.
- MIL-M-18012 - Markings for Aircrew Station Displays, Design and Configuration of.
- MIL-P-18177 - Plastic Sheet, Laminated, Thermosetting, Glass Fiber Base, Epoxy-Resin.
- MIL-S-23586 - Sealing Compound, Electrical, Silicone Rubber, Accelerator Required.
- MIL-M-24041 - Molding and Potting Compound, Chemically Cured, Polyurethane.
- MIL-M-24519 - Molding Plastics, Electrical, Thermoplastic.
- MIL-M-25988 - Rubber, Fluorosilicone Elastomer, Oil-and-Fuel-Resistant, Sheets, Strips, Molded Parts, and Extruded Shapes.
- MIL-S-28786 - Switches, Electrical and Fiber Optic, Packaging.
- MIL-G-45204 - Gold Plating, Electrodeposited.
- MIL-I-81023 - Inductor, 28V. D.C. Laboratory Test, General Specification for.
- MIL-I-81550 - Insulating Compound, Electrical, Embedding, Reversion Resistant Silicone.
- MIL-L-85762 - Lighting, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatible.

(See supplement 1 for list of associated specifications.)

STANDARDS

FEDERAL

- FED-STD-H28 - Screw Thread Standards for Federal Services

* MILITARY

- MIL-STD-12 - Abbreviations for Use on Drawings and in Specifications, Standards and Technical Documents.
- MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
- MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
- MIL-STD-454 - Standard General Requirements for Electronic Equipment.
- MIL-STD-889 - Dissimilar Metals.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.
- MIL-STD-1549 - Common Termination System for Electrical and Electronic Parts.
- MIL-STD-45662 - Calibration Systems Requirements.
- MS3338 - Lamp-Incandescent, T-1 Bulb, Based, 28 Volt, Integral Lighting.
- MS25237 - Lamp, Incandescent, Single Contact, Midget Flanged Base (T-1-3/4 Bulb).
- MS25244 - Circuit Breaker, Trip-Free, Push-Pull, 5 Thru 50 Amperes, Type I, Size B.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5000.)

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2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issue of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- * ASTM D4066 - Standard Specification for Nylon Injection and Extrusion Materials.

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

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

- * EIA RS-448 - Standard Test Methods for Electromechanical Switches.

(Application for copies should be addressed to EIA Engineering Department, Standards Sales Office, 2001 Eye Street N.W., Washington, D.C. 20006.)

UNDERWRITERS' LABORATORIES (UL), INC.

- UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

(Application for copies should be addressed to the Underwriters' Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062. Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using federal agencies.)

(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 (except for related associated detail specifications, specifications sheets, or MS standards), the text of this document shall take precedence. Nothing in this document, however, supersedes 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 specifications sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Switch categories. Switches furnished under this specification shall be category I or II as defined in 3.2.1, and 3.2.2, respectively.

3.2.1 Category I switches. Switches completely defined by a military specification sheet (see 3.1). Category I switches shall be ordered in accordance with 6.2.1.

* 3.2.2 Category II switches. Switches, the same as qualified category I switches, except for minor differences which do not change the basic materials, design and construction of the qualified switch and which do not effect performance. Unless otherwise specified (see 3.1), these variations are limited to the addition of legends; variation in size, shape or dimensions of terminations; selected switches with tighter tolerances on illuminated color, luminance or operating characteristics; and variations in illuminated color, display type, or color of bezels, mounting flanges, barriers, and mounting bushings. Category II switches shall be acquired from a source listed on the applicable qualified products list for the particular similar product in category I. Category II switches shall be ordered in accordance with 6.2.2.

3.3 Classification of requirements. The requirements for the switches are classified in accordance with table VII.

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TABLE VII. Classification of requirements.

Requirement	Paragraph
Qualification	3.4
Material	3.5
Design and construction	3.6
Performance	3.7 through 3.42
Marking	3.43
Workmanship	3.44

3.4 Qualification. Category I 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 6.3).

3.5 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 a guaranty of the acceptance of the finished product.

3.5.1 Metals. All metal parts, other than current-carrying parts, shall be of corrosion-resistant material, or shall be suitably protected to resist corrosion.

3.5.1.1 Ferrous material. Ferrous material shall not be used for current-carrying parts except for feed-through terminals in headers.

3.5.1.2 Dissimilar metals and compatible couples. 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 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 MIL-STD-889.

3.5.2 Insulation.

3.5.2.1 Ceramic. Ceramic insulation shall be grade L422 or higher, in accordance with MIL-I-10.

* 3.5.2.2 Plastic. Unless otherwise specified (see 3.1), molded plastic material shall conform to MIL-M-14, thermoplastic material shall conform to ASTM D4066 or MIL-M-24519, and laminated plastic material shall conform to MIL-P-997 or MIL-P-18177. Other types of plastic materials may be used provided the manufacturer submits acceptable evidence of performance to the preparing activity during the qualification test program on the submitted product. The plastic material used shall pass the fungus test specified in MIL-STD-454, requirement 4. The plastic material used in all external switch parts and enclosures shall be tested in accordance with UL94 and classified as 94V-0; this requirement applies to all materials for external parts and enclosures regardless of whether the material used is acquired to a military specification or not.

* 3.5.3 Silicone rubber. All silicone rubber parts shall be in accordance with ZZ-R-765 or MIL-R-25988.

3.5.4 Potting compounds. Unless otherwise specified (see 3.1), potting compounds shall be in accordance with MIL-S-8516, MIL-S-23586, MIL-I-81550, MIL-M-24041, or MIL-I-16923 within their specified temperature ranges.

3.5.5 Finish. Unless otherwise specified in the specification sheet, all external aluminum parts shall be anodized in accordance with MIL-A-8625, or chemically treated in accordance with MIL-C-5541, and all internal aluminum parts shall be chemically treated in accordance with MIL-C-5541. Bezels, mounting flanges, barriers, mounting bushings and associated mounting hardware that are designed to be exposed at the front of the panel after assembly shall have a black lustrous finish.

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3.6 Design and construction. Switches shall be so constructed as to insure proper operation when mounted in any position. The switches shall be of the design, construction, and physical dimensions specified (see 3.1).

3.6.1 Mounting hardware. Each switch shall be provided with mounting hardware as specified (see 3.1). Switches which are mounted by means of a threaded bushing shall include a nonturn device. For direct Government orders, the hardware shall be assembled in proper order or packaged with the switch as specified in MIL-S-28786.

3.6.2 Termination. Termination shall be as specified (see 3.1).

* 3.6.2.1 Solder terminals. Solder terminals shall be treated to facilitate soldering and shall be designed so that wires can be mechanically secured prior to soldering. Coatings such as hot solder dip are acceptable. Silver plating shall not be used as the external coating. Gold plating, when used, shall be .000030 inch to .000100 inch thick. When gold plating is used, a barrier underplating such as nickel or palladium shall be used.

3.6.2.2 Screw terminals. Screw terminals shall be provided with hardware as specified (see 3.1 and 6.2). Lockwashers shall be captive to the screw. For direct Government orders, all terminal hardware shall be assembled in proper order or packaged with the switch as specified in MIL-S-28786.

* 3.6.2.3 Plug-in terminations (not applicable to printed circuit boards). Terminals shall be gold plated in accordance with MIL-G-45204, type II, class 1, over nickel plate .00003 inch to .000150 inch thick. Nickel plate shall be in accordance with QQ-N-290.

3.6.2.4 Common termination system. Switches with common termination system shall be designed in accordance with MIL-STD-1549.

3.6.3 Screw threads. Screw threads on removable threaded parts shall be in accordance with Unified Thread Series of FED-STD-H28. Threading of nonmetallic parts shall not be permitted. Terminal threading engagement shall be at least two full threads.

3.6.4 Weight. The weight shall be as specified (see 3.1).

3.6.5 Actuating mechanism. Unless otherwise specified, the external actuator shall be insulated from all current carrying parts.

* 3.6.6 Lamps. Unless otherwise specified (see 3.1), the lamps shall be flange base T-1, or T-1-3/4. Lamp failure shall not constitute a test failure, unless the lamp is nonreplaceable.

3.6.6.1 Lamp circuitry. The lamp circuits shall be insulated from the switching circuits and from the assembly case and its mounting means.

3.6.6.2 Lamp replacement. The lamps shall be replaceable from the front of the panel. No tools of any type shall be required to replace the lamp.

3.6.6.3 Lamp contacts. Lamp contacts shall be of the multiple contact area design to provide for more than one bearing on the mating tip of the applicable lamp when installed. The lamp contacts shall be of suitable material or plated to resist electrolytic corrosion of the contact or the lamp base.

* 3.6.7 Lens. The lens design shall permit the application of legends, and shall permit positioning of the legends in specific relationship to the nonturn device. When specified (see 3.1), lens markings shall conform to the requirements of MIL-M-18012. (When abbreviations are necessary use MIL-STD-12, as applicable.) Snap-on type lens shall not be used for push-pull operative switches. The lens shall be free from defects which will prevent it from meeting luminous distribution and color requirements. Unless otherwise specified, there shall be no high light reflective surfaces on the displays.

3.6.8 Cap color filters. Material for lamp bulb filters in contact with lamps (used to convert clear incandescent lamps to colored lighting) shall be silicone rubber or glass.

3.6.9 Barriers. Mounting and spacing barriers shall be as specified (see 3.1).

3.6.10 Panel seals. Material for panel seals shall be silicone rubber.

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3.7 Solderability (applicable to solderable terminals).

3.7.1 When switches with solid wire terminations of .045 maximum diameter or stranded wire terminations of number 18 AWG or smaller are tested as specified in 4.8.2, the dipped surface of the termination:

- a. Shall be at least 95 percent covered by a continuous new solder coating.
- b. Shall not have pinholes or voids that are concentrated in one area or that exceed 5 percent of the total area.

3.7.2 When switches with solder terminals, solid wire terminations greater than .045 diameter, and stranded wire terminations larger than number 18 AWG are tested as specified in 4.8.2, the dipped surface of the termination:

- a. Shall have 95 percent of the total length of the fillet, which is between the standard wire wrap and the termination, tangent to the surface of the termination being tested and shall be free from pinholes and voids.
- b. Shall not have a ragged or interrupted line at the point of tangency between the fillet and the termination under test.

3.8 Resistance to soldering heat (applicable to switches with solderable terminals). When switches are tested as specified in 4.8.3, there shall be no deformation or other damage at the conclusion of the test sequence.

3.9 Contact resistance (unless otherwise specified, see 3.1). When measured as specified in 4.8.4.1, the contact resistance shall not exceed 25 milliohms. When measured as specified in 4.8.4.2, the lamp contact resistance shall not exceed 1.0 ohm. After electrical endurance, the contact resistance shall not exceed 1 percent of the load resistance, using the electrical parameters of the electrical endurance test load. Lamp contact resistance is not applicable after electrical endurance.

3.10 Contact bounce (when specified). When switches are tested as specified in 4.8.5, the contact bounce shall be as specified (see 3.1).

3.11 Operating characteristics. When switches are tested as specified in 4.8.6, the operating characteristics shall be as specified (see 3.1). Unless otherwise specified (see 3.1), switch action will be break before make.

3.12 Coincidence of operating and releasing points (when specified) (applicable to multipole switches). When switches are tested as specified in 4.8.7, all poles shall have actuated (transfer of contacts) within the limits specified (see 3.1).

3.13 Permanency of marking (when specified). Following the test specified in 4.8.8, all required markings (see 3.45) shall be legible.

3.14 Terminal strength. When switches are tested as specified in 4.8.9, there shall be no short circuiting, breakage, loosening, rotation of terminals, or damage which will interfere with the electrical or mechanical performance of the switch.

3.15 Strength of actuating means. When switches are tested as specified in 4.8.10, there shall be no damage which will interfere with the electrical or mechanical performance of the switch.

3.16 Strength of actuator (bushing mounted switches). Actuators on bushing mounted switches which receive either snap-in or screw-in pushbuttons shall exhibit no electrical discontinuity or mechanical loosening of the actuator when tested as specified in 4.8.11.

3.17 Strength of mounting bushing (applicable to threaded mounting bushings) (see 3.1). When switches are tested as specified in 4.8.12, there shall be no damage to the switch or loosening or twisting of the bushing relative to the switch.

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3.18 Lens orientation. When screw-in orientable type lenses are specified (see 3.1), the lens shall be capable of rotating a minimum of 350°, after installation, when subjected to the tests specified in 4.8.13. When snap-in pushbuttons are specified (see 3.1 and 6.2), the lens shall not rotate more than 10 degrees between stops, after installation, when subjected to the tests specified in 4.8.13. There shall be no damage to the lens indexing mechanism.

3.19 Thermal shock. When switches are tested as specified in 4.8.14, there shall be no mechanical or electrical damage, or loosening of fastening devices. There shall be no discoloration or deformation of the lens.

3.20 Vibration. When switches are tested as specified in 4.8.15, there shall be no opening of closed contacts or closing of open contacts in excess of 10 microseconds. During the test, the lamp circuit shall have no electrical discontinuity in excess of 10 milliseconds. At the conclusion of the test, there shall be no broken, loose, deformed, or displaced parts.

3.21 Shock.

3.21.1 Method I. When switches are tested as specified in 4.8.16.1, there shall be no opening of closed contacts or closing of open contacts in excess of 10 microseconds. At the conclusion of the test, there shall be no broken, loose, deformed, or displaced parts. No part of the switch shall become displaced from its normal (ready to operate) position during shock testing.

3.21.2 Method II (when specified (see 3.1)). When switches are tested as specified in 4.8.16.2, there shall be no opening of closed contacts or closing of open contacts in excess of 20 milliseconds and the switch shall be retained in the panel by its mounting means. No part of the switch shall become displaced from its normal (ready to operate) position during shock testing. At the conclusion of test, the switch shall be electrically and mechanically operable.

3.22 Acceleration (when specified). When switches are tested as specified in 4.8.17, there shall be no opening of closed contacts or closing of open contacts, and there shall be no mechanical or electrical damage (see 3.1).

3.23 Moisture resistance. When switches are tested in the wet condition as specified in 4.8.18, the insulation resistance shall be not less than 10 megohms. At the end of the drying period, the insulation resistance shall not be less than 1,000 megohms. At the conclusion of the test, there shall be no excessive corrosion, breaking, cracking, spalling, or loosening of terminals, and mounting hardware shall be readily removable. Excessive corrosion is defined as that which interferes with the electrical or mechanical performance and has penetrated the plating and has attacked the base material.

3.24 Dielectric withstanding voltage. When switches are tested as specified in 4.8.19, there shall be no flashover, arcing, breakdown, or current flow in excess of 500 microamperes.

3.25 Seal (applicable to enclosure designs 2, 3 and 4) (see 3.1). When switches are tested as specified in 4.8.20, there shall be no leakage of water through the panel seal, into the lamp module, or into the switch, as determined by visual examination and the dielectric test of 4.8.19.1.

3.26 Marking visibility. When switches are examined as specified in 4.8.21, all required markings shall be legible (see 3.43).

3.27 Salt spray (corrosion). When switches are tested as specified in 4.8.22, there shall be no evidence of excessive corrosion. Excessive corrosion is defined as that which interferes with the electrical or mechanical performance and has penetrated the plating and has attacked the base material.

3.28 Insulation resistance. When switches are tested as specified in 4.8.23, the insulation resistance shall be not less than 1,000 megohms.

3.29 Short circuit. When switches are tested as specified in 4.8.24, there shall be no welding or sticking of contacts, or damage. Switches shall be mechanically and electrically operative at the end of the test.

3.30 Explosion. When switches are tested as specified in 4.8.25, the explosive mixture in the test chamber surrounding and external to the switch shall not explode whether or not explosion occurs within the switch. The switch shall be electrically and mechanically operable at the conclusion of the test.

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3.31 Sand and dust. When specified (see 3.1), switches shall be tested as specified in 4.8.26. There shall be no operating characteristics degradation and the switches shall be mechanically and electrically operative at the conclusion of the tests.

3.32 Overload cycling. When switches are tested as specified in 4.8.27, there shall be no mechanical or electrical failure.

3.33 Electrical endurance. When switches are tested as specified in 4.8.28, no contact shall fail to open or close its individual circuit in proper sequence. The temperature rise shall not exceed 50°C when measured as specified in 4.8.28.3. The contact resistance, unless otherwise specified, shall not exceed 1 percent of the load resistance using the electrical parameters of the electrical endurance test load. After the test, switches shall be electrically and mechanically operative.

* 3.34 Mechanical endurance. Following the test specified in 4.8.29, the switches shall be electrically and mechanically operative. No contact shall fail to open or close its individual circuit in proper sequence. The lamp retention test plug shall remain captive to the lampholder following the test specified in 4.8.29b.

3.35 Intermediate current (when specified) (see 3.1). When switches are tested as specified in 4.8.30, no contact shall fail to close or open its individual circuit in proper sequence as detected by the relay and monitoring device. Switch contact resistance shall not exceed 1 percent of load resistance following electrical life at rated load.

3.36 Low-level life (when specified) (see 3.1). When switches are tested as specified in 4.8.31, the contact resistance of any individual switch circuit shall be less than 3.0 ohms during each contact closure. No contact shall fail to open or close its individual circuit in proper sequence.

3.37 Logic level circuit (when specified, see 3.1). When switches are tested as specified in 4.8.32, there shall be no contact sticks or misses detected by the monitoring device. A voltage of 2.1 volts or greater across the switch terminal shall constitute a contact miss (failure to properly close the circuit). A voltage drop of less than 90 percent of the open-circuit voltage shall constitute a contact stick (failure to properly open the circuit).

3.38 EMI/RFI shielding (when applicable) (see 3.1). When switches are tested as specified in 4.8.33.1, screen to mounting surface resistance shall not exceed 1 ohm. When switches are tested as specified in 4.8.33.2, the shielding attenuation shall be not less than 60 dB over the frequency range from 100 to 1,000 MHz, unless otherwise specified (see 3.1).

3.39 Illuminated colors. When switches are tested as specified in 4.8.34, the illuminated colors of the lens shall be in accordance with table VIII and figure 1.

* 3.40 Luminance. When switches are tested as specified in 4.8.35, the measured photometric brightness in foot lamberts shall be as specified (see 3.1).

* 3.41 Sunlight readability (when specified) (see 3.1). When switches are tested as specified in 4.8.36, the average contrast ratio of each lighted legend character to the background shall be 0.6 minimum unless otherwise specified (see 3.1); and the average contrast ratio of each unlighted legend character to the background shall have an absolute value less than or equal to 0.1 unless otherwise specified (see 3.1).

* 3.42 Night vision imaging system (NVIS) compatibility (when specified, see 3.1). When switches are tested as specified in 4.8.37, the chromaticity, luminance, and spectral radiance output of the illuminated display shall be NVIS compatible as specified in MIL-L-85762: NVIS green A and NVIS green B colors shall meet all class A and class B equipment requirements for illuminated controls. NVIS yellow color shall meet all class A and class B equipment requirements for caution signals. NVIS red color shall meet all class B equipment requirements for warning signals.

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TABLE VIII. Illuminated chromaticity limits. 1/

	x	y
Red	.695	.285
	.703	SL 2/
	.655	.325
	.660	SL 2/
Green	.260	.570
	.300	.630
	.160	.660
	.200	.720
Yellow	.562	.415
	.570	SL 2/
	.596	.382
	.605	SL 2/
Blue	.150	.260
	.220	.260
	.220	.320
	.150	.320
White	.400	.420
	.460	.420
	.400	.380
	.460	.380
Violet	.480	.280
	.480	.320
	.530	.280
	.530	.320

1/ The chromaticities of the color lenses expressed as "x" and "y" coordinates on the CIE chromaticity diagram shall be within areas bounded by the coordinates listed for each color.

2/ SL - Spectrum locus (where intersected by other coordinate pair).

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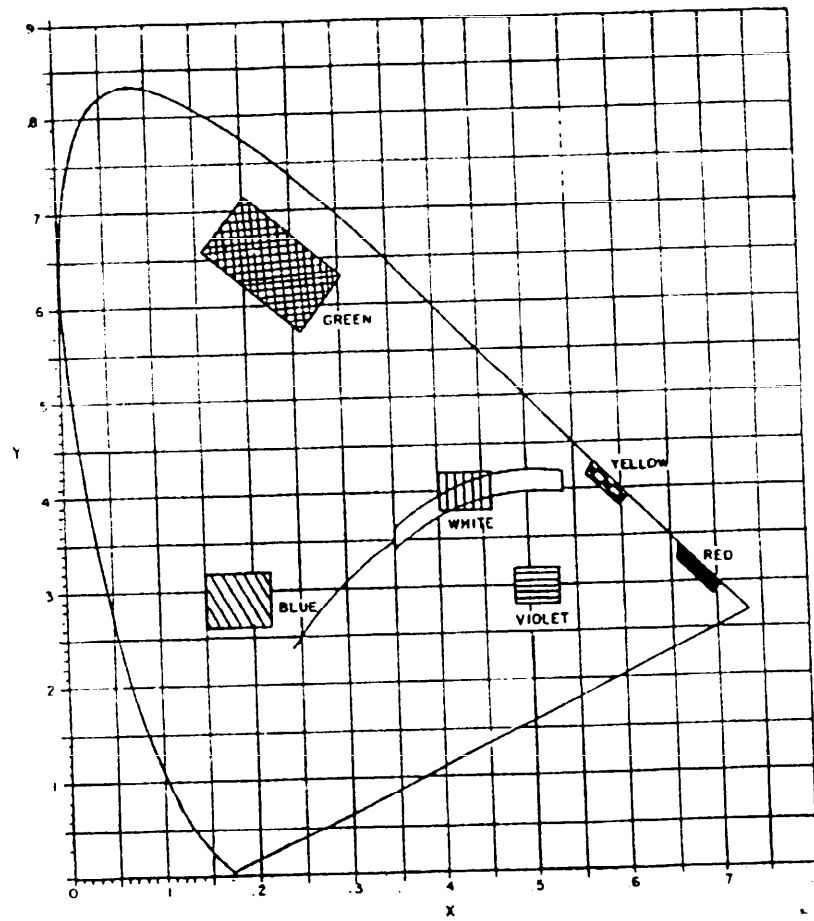


FIGURE 1 CIE (Commission Internationale de l'Éclairage) chromaticity diagram, class B.

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* 3.43 Stray lights (when specified) (see 3.1). The display lighting system shall be so housed as to minimize stray light and to shield all lamp filaments from direct view. When switches are tested as specified in 4.8.38, the stray light emitted shall not exceed 0.20 foot lamberts in any direction.

* 3.44 Field of view. When switches are tested as specified in 4.8.39, the visibility of any signal, legend, symbology or alpha- numerics shall not be restricted by the periphery of the enclosure for the display.

3.45 Marking.

3.45.1 Identification of product. Switches shall be marked in accordance with MIL-STD-1285 as follows:

- a. Military PIN (category I only).
- b. Manufacturer's part number (category II).
- c. Manufacturer's name or trade mark.
- d. Source code (if space is available).
- e. Date code.
- f. Terminal identification (see 3.1).

* g. Night vision imaging system (NVIS) type and class as specified in MIL-L-85762 (when applicable).

3.45.2 Terminal identification (see 3.1). Terminals shall be marked to indicate the contact arrangement of the switch. When specified (see 3.1), terminal markings shall be augmented by a circuit schematic. There shall be no overmarking of the terminal identification.

3.46 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-STD-45662, except that the requirement for out of tolerance evaluators is not applicable.

* 4.1.2 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

- a. Materials inspection (see 4.3).
- b. Qualification inspection (see 4.5).
- c. Inspection for category II switches (see 4.6).
- d. Quality performance inspection (see 4.7).

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

TABLE IX. Materials inspection.

*

Material	Requirement paragraph	Applicable specification
Ceramic	3.5.2.1	MIL-I-10
Plastic	3.5.2.2	MIL-M-14, MIL-P-997, MIL-P-18177, MIL-M-24519, MIL-STD-454, UL94, ASTM D4066
Rubber	3.5.3	ZZ-R-765, MIL-R-25988
Potting compounds	3.5.4	MIL-S-8516, MIL-S-23586, MIL-I-81550, MIL-M-24041, MIL-I-16923
Metal plating or protective coating	3.5.5, 3.6.2.1 and 3.6.2.3	MIL-A-8625, MIL-C-5541, MIL-G-45204, QQ-N-290

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.

4.5 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3), on sample units produced with equipment and procedures normally used in production.

4.5.1 Sample size. The number of switches to be subjected to qualification inspection shall be as specified in table X.

4.5.2 Inspection routine. Sample units of switches shall be subjected to the qualification inspection specified in table X, in the order shown. All sample units shall be subjected to the inspection of group I. The sample units shall then be divided as specified in table X and subjected to the inspection for their particular group. All applicants for qualification approval under this specification shall demonstrate that each of their items conforms to all the requirements specified in the applicable documents (see 3.1), singularly and in combination with all other previously qualified items, regardless of manufacture.

4.5.3 Failures. One or more failures shall be cause for refusal to grant qualification approval. Lamp failure shall not be considered a unit failure, if when the lamp failure is noted, immediately a new lamp is installed and the lamp functions, test shall then be continued, as required. A lamp or LED failure for a nonreplaceable item however (see 3.1), shall be considered a unit failure.

4.5.4 Extent of qualification.

4.5.4.1 Single submission. Qualification shall be restricted to the type submitted.

4.5.4.2 Group submission. The extent of qualification shall be in accordance with the applicable specification sheet (see 3.1).

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TABLE X. Qualification table.

Inspection	Requirement paragraph	Test method paragraph
<u>Group I (all sample units)</u>		
Visual and mechanical examination	3.1, 3.5, 3.6 3.45 and 3.46	4.8.1
Solderability (when applicable) <u>1/</u>	3.7	4.8.2
Resistance to soldering heat (when applicable) <u>1/</u>	3.8	4.8.3
Contact resistance	3.9	4.8.4
Contact bounce (when specified, see 3.1)	3.10	4.8.5
Operating characteristics	3.11	4.8.6
Coincidence of operating and releasing points (when specified)	3.12	4.8.7
Permanency of marking (when specified) <u>1/</u>	3.13	4.8.8
<u>Group II (4 sample units)</u>		
Terminal strength (2 sample units)	3.14	4.8.9
Strength of actuating means (2 sample units)	3.15	4.8.10
Strength of actuator (when applicable)	3.16	4.8.11
Strength of mounting bushing (2 sample units) (when applicable)	3.17	4.8.12
Lens orientation (when applicable)	3.18	4.8.13
Thermal shock	3.19	4.8.14
Vibration	3.20	4.8.15
Shock <u>2/</u>	3.21	4.8.16
Acceleration (when specified, see 3.1)	3.22	4.8.17
Moisture resistance	3.23	4.8.18
Dielectric withstanding voltage	3.24	4.8.19
Operating characteristics	3.11	4.8.6
Seal (enclosures 2, 3 and 4)	3.25	4.8.20
Marking visibility	3.26	4.8.21
<u>Group III (2 sample units)</u>		
Salt spray (corrosion)	3.27	4.8.22
Dielectric withstanding voltage (enclosure 3)	3.24	4.8.19
Insulation resistance (enclosure 3)	3.28	4.8.23
Operating characteristics (enclosure 3)	3.11	4.8.6
<u>Group IV (2 sample units)</u>		
Short circuit	3.29	4.8.24
Dielectric withstanding voltage	3.24	4.8.19
Operating characteristics	3.11	4.8.6
Seal (enclosures 2, 3 and 4)	3.25	4.8.20
Marking visibility	3.26	4.8.21
<u>Group V (2 sample units)</u>		
Explosion	3.30	4.8.25
Sand and dust (when specified, see 3.1)	3.31	4.8.26
Operating characteristics	3.11	4.8.6
Seal (enclosures 2, 3 and 4)	3.25	4.8.20

See footnotes at end of table

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TABLE X. Qualification table - continued.

Inspection	Requirement paragraph	Test method paragraph
<u>Group VI 3/</u>		
Overload cycling (all group VI sample units)	3.32	4.8.27
Electrical endurance 3/	3.33	4.8.28
Resistive load, dc	3.33	4.8.28.2
Inductive load, dc	3.33	4.8.28.2
Motor load, dc	3.33	4.8.28.2
Lamp load, dc	3.33	4.8.28.2
Resistive load, ac 4/	3.33	4.8.28.2
Inductive load, ac 4/	3.33	4.8.28.2
Lamp load, ac 4/	3.33	4.8.28.2
Motor load, ac 4/	3.33	4.8.28.2
Contact resistance	3.9	4.8.4
Dielectric withstanding voltage 5/	3.24	4.8.19
Operating characteristics	3.11	4.8.6
<u>Group VII (2 sample units)</u>		
Mechanical endurance	3.34	4.8.29
Intermediate current (when specified, see 3.1) 6/	3.35	4.8.30
Low-level life (when specified, see 3.1) 6/	3.36	4.8.31
Logic level circuit (when specified, see 3.1) 6/	3.37	4.8.32
Operating characteristics	3.11	4.8.6
EMI/RFI shielding (when specified)	3.38	4.8.33
Seal (enclosures 2, 3 and 4)	3.25	4.8.20
<u>Group VIII (2 for each color)</u>		
Illuminated colors	3.39	4.8.34
Luminance	3.40	4.8.35
Sunlight readability (when specified, see 3.1)	3.41	4.8.36
NVIS compatibility (when specified, see 3.1)	3.42	4.8.37
Stray lights (when specified, see 3.1)	3.43	4.8.38
Field of view	3.44	4.8.39

- 1/ Two sample units only. These 2 sample units shall be used for group IV inspections.
- 2/ Additional qualification of identical switches for method II (high-impact) shock will require four additional sample units for submission to groups I and II tests, using method II for the shock test.
- 3/ Two sample units for each electrical load (see 3.1).
- 4/ Unless otherwise specified, ac tests are to be 60 Hz. Where different current ratings for 60 and 400 Hz are shown (see 3.1), both 60 and 400 Hz tests are to be performed.
- 5/ Sea level dielectric withstanding voltage test (see 4.8.19) is to be conducted only on those units which are tested for sea level electrical endurance (see 4.8.28). Altitude dielectric withstanding voltage test (see 4.8.19) is to be conducted on those units which were tested for altitude electrical endurance tests (see 4.8.28).
- 6/ Two additional sample units.

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4.5.5 Retention of qualification. To retain qualification, the contractor shall forward the reports listed below to the qualifying activity. The qualifying activity will establish the initial reporting date. The reports shall consist of:

- * a. At 12-month intervals, a summary of the results of the tests performed for inspection of product for delivery, group A, for category I and II switches, indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.
- b. At 36-month intervals, the results of tests performed for periodic inspection, group B, including the number and mode of failures. If the test results indicate nonconformance with 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.

Failure to submit a report within 30 days after the end of each period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time that the inspection data indicates noncompliance of the product to meet the requirements of this specification.

In the event that no production of category I and II switches 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 during two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit each type of switch for which qualification is sought to testing in accordance with the qualification inspection requirements.

4.6 Inspection requirements for category II switches (see 3.2.2). Inspection requirements for category II switches shall be performed by the contractor after award of contract, and prior to production. Additional tests to verify suitability of the variations from the category I switches shall be performed as specified (see 6.2.2).

4.7 Quality conformance inspection.

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

* 4.7.1.1 Inspection lot. An inspection lot shall consist of all category I and category II switches of the same specification sheet, of the same enclosure design, temperature characteristic, vibration grade, shock type, and design and construction, produced under essentially the same conditions, and offered for inspection at one time. Similar switches conforming to these requirements but having different circuitry may be combined to form a lot.

4.7.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table XI, in the order shown.

* 4.7.1.2.1 Sampling plan. Statistical sampling shall be in accordance with tables XI and XII. Separate, randomly selected groups of samples are required for subgroups 1, 2 and 3. For acceptance there shall be zero occurrences of defects.

* 4.7.1.2.1.1 Subgroup 1. A sample of parts shall be randomly selected in accordance with table XII, minor defect sampling plan.

* 4.7.1.2.1.2 Subgroup 2. A sample of parts shall be randomly selected in accordance with table XII, major defect sampling plan.

* 4.7.1.2.1.3 Subgroup 3 (contact bounce) (when applicable, see 3.1). Two samples shall be selected randomly from each inspection lot.

* 4.7.1.2.1.4 Subgroup 4 (NVIS compatibility) (when applicable, see 3.1). The lot shall be 100 percent inspected to the subgroup 4 NVIS compatibility test.

* 4.7.1.2.2 Rejected lots. If an inspection lot is rejected, the lot shall be 100 percent inspected for the defects noted. The contractor may correct the defects or remove the defective units from the lot. The lot shall then be sampled again in accordance with table XII. For acceptance, there shall be zero occurrences of defects. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots.

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TABLE XI. Group A inspection.

Inspection	Requirement paragraph	Method paragraph	Sampling plan
<u>Subgroup 1</u> Visual and mechanical examination	3.1, 3.5, 3.6, 3.45 and 3.46	4.8.1	See 4.7.1.2.1.1 <u>1/</u>
<u>Subgroup 2</u> Seal (enclosures 2, 3 and 4) Operating characteristics Contact bounce (when applicable) Dielectric withstanding voltage Contact resistance Illuminated colors Luminance Sunlight readability (when applicable)	3.25 <u>2/</u> 3.11 3.10 3.24 3.9 3.39 3.40 <u>3/ 4/</u>	4.8.20 4.8.6 4.8.5 4.8.19.1 4.8.4 4.8.34 4.8.35 <u>3/ 4/</u>	See 4.7.1.2.1.2 <u>3/</u>
<u>Subgroup 3</u> Contact bounce (when applicable)	3.10	4.8.5	See 4.7.1.2.1.3 <u>5/</u>
<u>Subgroup 4</u> NVIS compatibility (when applicable)	<u>6/</u>	<u>6/</u>	See 4.7.1.2.1.4 <u>6/</u>

- 1/ At the option of the contractor, in-process inspection may be used to meet the materials (see 3.5) and design and construction requirements (see 3.6) provided they meet the acceptance criteria and all of the contractor's in-process control data on these tests are made available to the Government upon request. Only one sample unit per lot need be inspected for compliance to physical dimensions.
- 2/ Dielectric test and external inspection only.
- 3/ At the option of the contractor, incoming or in-process inspection by photometric measurement of raw materials may be used to meet the illuminated color, luminance, and sunlight readability requirements provided that they meet the acceptance criteria and all of the contractor's in-process control data on these tests are made available to the Government upon request.
- 4/ Visually inspect switches with sunlight readable displays in each lot against the appropriately colored standard switch. The switches used as visual standards shall be certified annually by performing the sunlight readability test.
- 5/ Two sample units per lot shall be tested for contact bounce (when applicable).
- 6/ 100 percent test switches for light leak using NVIS viewing device in accordance with MIL-L-85762.

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TABLE XII. Zero defect sampling plan.

Lot size	Number of switches to be tested	
	Subgroup 2 (Major) <u>1/</u>	Subgroup 1 (Minor) <u>1/</u>
1 - 8	All	5
9 - 15	13	5
16 - 25	13	5
26 - 50	13	5
51 - 90	13	7
91 - 150	13	11
151 - 280	20	13
281 - 500	29	16
501 - 1,200	34	19
1,201 - 3,200	42	23
3,201 - 10,000	50	29
10,001 - 35,000	60	35

1/ Major and minor defects are defined in section 6. Inspection for minor defects is applicable to visual and mechanical examination only.

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4.7.2 Periodic inspection. Periodic inspection shall consist of group B. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.7.2.1.4), delivery of products which have passed group A shall not be delayed pending the results of these periodic inspections.

4.7.2.1 Group B inspection. Group B inspection shall consist of the inspections specified in table XIII, in the order shown. When a manufacturer has similar products qualified under different specification sheets, the qualifying activity may authorize group B tests which do not require redundant testing on the similar features of these products. Group B inspection shall be performed on sample units selected from inspection lots which have passed group A inspection. A manufacturer's normal quality control tests, production tests, environment tests, and so forth may be used to fulfill all or part of group B inspections; however, all of group B inspections shall be completed as specified.

4.7.2.1.1 Sampling plan. Group B inspections shall be completed in accordance with table XIII within 36 months after the date of notification of qualification and within each subsequent 36-month period. The sample units shall be selected either from stock or a current production lot unless the Government considers it more practical to select a sample from current production. Switches selected from stock shall have been produced after the date of notification of qualification or subsequent to the date code of the previous group B inspection sample units. Group B inspection shall be performed on sample units produced using the same manufacturing facilities and processes as units normally offered for acquisition. When there has been no production of a particular type of switch for 36 months or more, sample units shall be selected from the next production lot presented for acceptance and for each subsequent 36-month period. When the specification sheet covers more than one part number, the PIN(s) subjected to group B inspection shall be same PIN(s) specified for qualification; however, the group B inspection sample unit(s) need not be submitted to inspections not specified for qualification.

4.7.2.1.2 Failures. If one or more sample units fail to pass group B inspection, the sample shall be considered to have failed. Lamp failure shall not be considered a unit failure, if when the lamp failure is noted, immediately a new lamp is installed and the lamp functions, test shall then be continued, as required. A lamp or LED failure for nonreplaceable item however (see 3.1), shall be considered a unit failure.

4.7.2.1.3 Disposition of sample units. Sample units which have been subjected to group B inspection shall not be delivered on the contract or order, but shall be kept on hand until the next inspection period for submittal to the qualifying activity if so requested.

* 4.7.2.1.4 Noncompliance. If a sample fails to pass group B inspection, the contractor shall notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, and so forth, and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group B inspection shall be repeated on additional sample units (complete inspection, or the inspection which the original sample failed, at the option of the Government.) Group A inspection may be reinstituted; however, final acceptance shall be withheld until the group B reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the contracting officer and the qualifying activity.

4.7.3 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.

4.8 Methods of inspection.

4.8.1 Visual and mechanical inspection. Switches and associated modular sub-assemblies 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, 3.5, 3.6, 3.45 and 3.46).

4.8.1.1 Switching characteristic. The switching operation shall be examined by use of suitable test circuits for compliance with the applicable requirements (see 3.1).

4.8.1.2 Lamp circuit. The lamp circuit shall be examined for continuity and operation for compliance with the requirements as specified (see 3.1).

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TABLE XIII. Group B Inspection.

Inspection	Require- ment paragraph	Method paragraph	Sample numbers										
			1	2	3	4	5	6	7	8	9	10	11
Solderability (when applicable)	3.7	4.8.2	x	x									
Strength of mounting bushing (when applicable)	3.17	4.8.12 <u>2</u> /	x	x									
Lens orientation	3.18	4.8.13	x	x									
Shock <u>3</u> /	3.21	4.8.16	x	x									
Moisture resistance	3.23	4.8.18	x	x									
Salt spray (corrosion)	3.27	4.8.22			x	x							
Overload cycling	3.32	4.8.27					x	x	x	x			
Electrical endurance	3.33	4.8.28											
Inductive load, dc <u>4</u> /	3.33	4.8.28.2							x	x			
Resistive load, ac <u>5</u> /	3.33	4.8.28.2					x	x					
Mechanical endurance <u>6</u> /	3.34	4.8.29									x	x	
Low-level life (when applicable)	3.36	4.8.31									x	x	
EMI/RFI shielding (when applicable) <u>7</u> /	3.38	4.8.33									x	x	
Color	3.39	4.8.34											x
Luminance	3.40	4.8.35											x
Sunlight readability (when applicable)	3.41	4.8.36											x
NVIS compatibility (when applicable)	3.42	4.8.37											x
Dielectric withstanding voltage	3.24	4.8.19					x	x	x	x			
Operating characteristics <u>8</u> /	3.11	4.8.6	x	x	x	x	x	x	x	x	x	x	
Seal (when applicable)	3.25	4.8.20	x	x							x	x	
Marking visibility	3.26	4.8.21	x	x	x	x							

1/ Two samples for each color.2/ Torque shall be applied to the switch body only.3/ When method II (high impact) shock is applicable, two additional sample units are required for submission to sample number one and two tests, using method II for the shock test.4 If rated for use at altitude, test at rated altitude only.5/ Test at maximum temperature rating only. If resistive ac load was not required for qualification inspection (see 3.1), test resistive dc load.6/ When low level life is specified, the low level life test shall be performed. When low level life is not specified, the mechanical endurance test shall be performed.7/ The shielding efficiency test is not required provided the manufacturer has not made any changes in the design, construction, or material of the switch since the last EMI/RFI shielding efficiency group C inspection or initial qualification (whichever came later).8/ On samples 3 and 4, applicable only to enclosures 3 and 4.

4.8.2 Solderability (applicable to solderable terminals, see 3.7). 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: A minimum of two switch and two lamp terminals shall be tested. When lamp terminals are located only on recessed planes and cannot be readily dipped, separate specimens of the lamp terminals may be tested.

b. Examination of terminals: Method for evaluation of lugs and tabs shall apply.

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4.8.3 Resistance to soldering heat (applicable to switches with solderable terminals, see 3.9). Switches shall be tested in accordance with method 210 of MIL-STD-202. The following details shall apply:

- a. Number of terminals to be tested: A minimum of two terminals of closed contacts per switch and two indicator light terminals (the indicator light terminals may be tested separately).
- * b. Depth of immersion in molten solder: Terminals shall be immersed to within 2.0 to 2.5 mm (.079 to .099 inch) of the switch body.
- c. Test condition letter: B.
- d. Cooling time prior to final examinations and measurements: Not applicable.
- e. Examinations and measurements:

Before - None

After - Internal examination not required. Samples shall be subjected to Group IV testing in the qualification table.

4.8.4 Contact resistance (see 3.9). Switch contacts shall be tested in accordance with method 307 of MIL-STD-202.

4.8.4.1 Switch contact resistance. The following details shall apply:

- a. Measurements shall be made between the terminals of the contacts of the same pole forming a switching circuit. Three measurements shall be made on each pair of switch contacts. The switch contacts shall be operated once between each measurement.
- b. Test current: 0.1 ampere ± 5 percent. After electrical endurance, use the electrical parameters of the electrical endurance test load.
- c. Open-circuit test voltage: 6 ± 1 V dc. After electrical endurance, use the electrical parameters of the electrical endurance test load.
- d. Number of test actuations: Three.
- e. Number of measurements per actuation: One measurement.

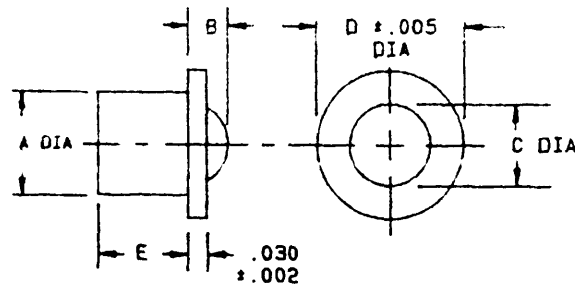
4.8.4.2 Lamp contact resistance. The following details shall apply:

- a. Preparation for test: Lamp circuit continuity shall be established using the applicable test plug (see figure 2).
- b. Test current: 0.1 ampere ± 5 percent.
- c. Test voltage: 6 ± 1 V dc.
- d. Number of test plug insertions: Three.
- e. Number of measurements per insertion: One measurement.

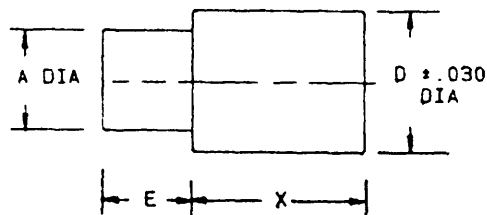
4.8.5 Contact bounce (see 3.10) (when specified). The switch shall be connected to a test circuit in accordance with figure 3. The switch shall be mechanically operated at a velocity 6 ± 2 inches per second. The contacts under test shall be closed five times and the duration of the contact bounce shall be monitored. The duration of the contact bounce shall be defined in accordance with figure 4. Any contact bounce which exceeds the maximum value specified (see 3.1), shall constitute failure. The test shall be repeated until all sets of contacts have been measured for contact bounce.

4.8.6 Operating characteristics (see 3.11). Switches shall be measured for operating characteristics in accordance with the applicable requirements (see 3.1).

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LAMP CIRCUIT RESISTANCE TEST PLUG



LAMP RETENTION TEST PLUG

Inches	MM
.002	0.05
.005	0.13
.010	0.25
.030	0.76
.060	1.52
.072	1.83
.080	2.03
.104	2.64
.115	2.92
.130	3.30
.181	4.60
.247	6.27
.285	7.24

Lamp	A ±.002 dia	B ±.005	C ±.030 dia	D dia	E ±.010	X
T-1	.155	.060	.080	.181	.104	See note 4
T-1 3/4	.247	.072	.130	.285	.260	

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Both the lamp circuit resistance test plug and the lamp retention test plug may be of multi-piece construction providing, when assembled, it meets the specified requirements.
4. The "X" dimension shall be adjusted to provide a total weight of 5 +1, -0 gram.
5. The test plug material shall be 1/2 hard brass for the lamp circuit resistance test plug.
6. Test plug may be suitably plated to resist corrosion.

FIGURE 2. Test plug.

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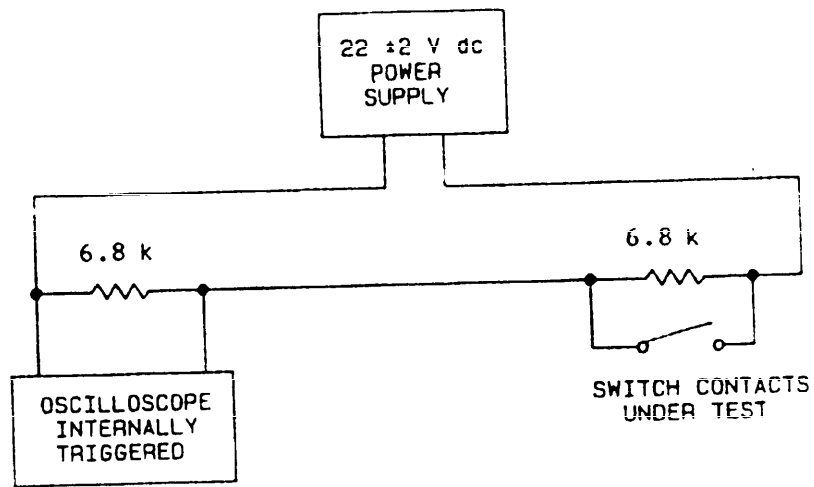


FIGURE 3. Contact bounce test circuit.

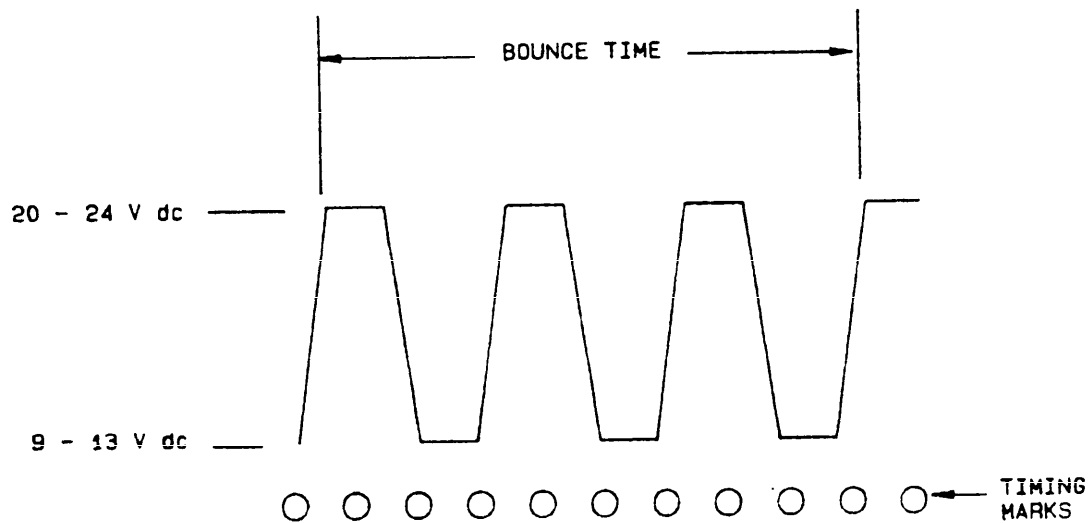


FIGURE 4. Typical recording of contact bounce.

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4.8.7 Coincidence of operating and releasing points (see 3.12) (when specified). Coincidence of operating and releasing points of all poles of a multipole switch shall be determined with suitable indicating circuits. The switch shall be rigidly held in a suitable fixture allowing the actuator to be moved in its intended manner. The actuator shall be advanced and retracted slowly and uniformly with no external vibratory influence while passing through the operating and releasing points, at a rate not exceeding 0.001 inch or 1 degree per second.

4.8.8 Permanency of marking (see 3.13) (when specified). Switches shall be tested in accordance with MIL-STD-202, method 215. The following details shall apply:

- a. Portion of switch to be brushed: Brush strokes of each solvent solution shall be evenly divided between required identification, terminal, and circuit schematic markings.
- b. Mechanical or electrical damage: Not applicable.

4.8.9 Terminal strength (see 3.14). Switches shall be mounted by their normal mounting means. The switches shall be examined after the test for evidence of breakage, loosening of terminals, or damage to the body of the switch. A circuit, such as a pilot light shall be used to monitor for short circuiting during the test. No terminal shall be tested in more than one direction.

4.8.9.1 Screw terminals. Screw terminals shall be subjected to the tests specified in 4.8.9.1.1 and 4.8.9.1.2.

4.8.9.1.1 Pull. The terminals shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition: A.
- b. Direction of the pull: Along the axis of the terminal screw, perpendicular to the axis of the terminal screw, and in the direction most likely to cause failure.
- c. Static force: See table XIV.

TABLE XIV. Static values of force.

Thread size	Force in pounds
4 - 40	5
6 - 32	30
8 - 32	35
10 - 32	40
10 - 24	40
$\frac{1}{2}$ - 28	50

4.8.9.1.2 Torque. Terminals of the switches shall be tested in accordance with method 211 of MIL-STD-202. The following exception shall apply:

Test condition: E, except that for thread size 10-24, the torque shall be 24.0 pound-inches.

4.8.9.2 Solder terminals. Switches shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition: A.
- b. Applied force: 5 pounds.
- c. Direction of force: Parallel to the long axis of the terminal, perpendicular to the long axis of the terminals, and in the direction most likely to cause failure.

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4.8.9.3 Wire-lead terminals. Switches shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition: A.
- b. Applied force: 15 pounds.
- c. Direction of force: In any direction (including the one most likely to cause failure).

4.8.9.4 Integrated wire terminals. Unless otherwise specified (see 3.1), integrated wire terminals shall be tested as follows:

- a. Applied force: 15 pounds.
- b. Duration: 5 seconds minimum.
- c. Number of terminals to be tested: 2.
- d. Direction of applied force:
 - (1) With the long dimension of the terminal contact vertical, the specified pull shall be applied directly downward.
 - (2) With the long dimension of the terminal contact horizontal, the specified pull shall be applied directly downward.
- e. A terminal shall be tested only once in one direction.

4.8.10 Strength of actuating means (see 3.15). With the switches mounted by their normal mounting means, a static load of 25 pounds shall be gradually applied to the pushbutton and maintained for a period of one minute. The force resulting from application of the static load shall be in a direction to cause actuation of the switch.

4.8.11 Strength of actuator (bushing mounted switches, see 3.16). With the switch mounted by its normal means, a torque of 5 pound-inches in a plane perpendicular to bushing or actuator and about the centerline of the actuator shall be applied to the actuator for a period of one minute.

4.8.12 Strength of mounting bushing (applicable to threaded mounted bushings) (see 3.17). Switches shall be mounted on a metal panel by their normal mounting means with the hardware specified. A torque of 15 pound-inches shall be applied to the mounting nut for 5 seconds maximum. The switch body shall be subjected to a torque of 5 pound-inches for 5 seconds maximum with the nonturn device normally mounted. Before testing of the nonturn device, the mounting nut shall be tightened with a maximum torque of 5 ounce-inches.

4.8.13 Lens orientation (single lamp bushing mounted switches) (see 3.18). With the pushbuttons mounted in an actuator which has met the requirements of 4.8.11, a torque of 5 pound-inches shall be applied to the plastic lens in a plane perpendicular to and about the centerline of the pushbutton for a period of 1 minute. After the test, the lens indexing mechanism shall be examined for evidence of damage.

4.8.14 Thermal shock (see 3.19). Switches shall be tested in accordance with method 107 of MIL-STD-202. The following details shall apply:

- a. Test condition: A.
- b. Measurements before and after cycling: Not applicable.
- c. Examinations after test: Switches shall be examined for mechanical and electrical damage and loosening of rivets or other fastening devices.

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4.8.15 Vibration (see 3.20). Switches shall be tested in accordance with MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition:
 - (1) For vibration grade 1 - Method 201 (10-55 Hz).
 - (2) For vibration grade 2 - Method 204, test condition A (10-500 Hz).
 - (3) For vibration grade 3 - Method 204, test condition B (10-2,000 Hz).
- b. Tests and measurements prior to vibration: Not applicable.
- * c. Mounting: Switches with lamps shall be rigidly mounted by their normal means on a rigid metal panel. The mounting fixture shall be free from resonances over the test frequency range. Switches that are designed to mate with connectors shall be tested using the complete connector assembly. If switches incorporate an edge-lit panel mounting spacer, one-half of the sample units shall be mounted with the spacer in front of the panel. The remaining half shall be mounted with the spacer behind the panel or without the spacer, as applicable.
- d. Electrical load conditions: The electrical load shall consist of the monitor circuit only. In addition, magnetically held units shall be tested with 80 percent rated dc voltage applied to coils.
- e. Measurements during vibration: All open and closed contact circuits shall be monitored for contact chatter in accordance with method 310, test condition A, of MIL-STD-202. The lamp circuits shall be monitored by a similar circuit capable of detecting discontinuities of 10 milliseconds or greater. Half of the units shall be tested with the actuating means in one position and the other half of the units shall be tested with the actuating means in an alternate position. Open circuits may be connected in parallel and monitored for closing, and closed circuits may be connected in series and monitored for opening. In the event of indication of contact instability, the test shall be modified by successive testing in the same plane to monitor contacts, switch by switch, to determine if a switch is defective.
- f. Test and measurements after vibration: Switches shall be examined for evidence of broken, deformed, displaced or loose parts.

4.8.16 Shock (see 3.21). Switches shall be tested as specified in 4.8.16.1, and in addition, when specified (see 3.1), switches shall also be tested as specified in 4.8.16.2. The following details and exceptions shall apply to method I and method II.

- a. Electrical load conditions: The electrical load shall consist of the monitor circuit only.
- b. Half of the units shall be tested with the actuating means in one position and the other half of the units shall be tested with the actuating means in an alternate position. Open circuits may be connected in parallel and monitored for closing and closed circuits may be connected in series and monitored for opening. In the event of indication of opening or closing of contacts greater than that allowed, 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. Magnetically held units shall be tested with 80 percent rated dc voltage applied to coils.
- c. Measurements before the test: Not applicable.
- * d. Mounting: Switches shall be mounted by their normal mounting means. If switches incorporate an edge-lit panel mounting spacer, one-half of the sample units shall be mounted with the spacer in front of the panel. The remaining half shall be mounted with the spacer behind the panel or without the spacer, as applicable.

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4.8.16.1 Method I. Switches shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

- a. Test condition: B (75 G's, half-sine).
- b. Measurements during test: Switch contact stability shall be continuously monitored in accordance with method 310, test condition A of MIL-STD-202.
- c. Measurement after test: Switches shall be examined for evidence of broken, deformed, or displaced parts.
- d. Mounting: Switches shall be mounted on a rigid metal panel.

4.8.16.2 Method II (when specified). Switches shall be tested in accordance with method 207 of MIL-STD-202. The following details shall apply:

- a. Measurements during test: Unless otherwise specified (see 3.1), switch contact stability shall be continuously monitored in accordance with method 310, test condition E of MIL-STD-202.
- b. Measurement after test: Switch shall be electrically and mechanically operable.
- c. Mounting: The standard mounting fixture shown on figure 207-4A of method 207 of MIL-STD-202 shall be used.

4.8.17 Acceleration (when specified) (see 3.1 and 3.22). Switches shall be tested in accordance with method 212 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition: A.
- b. Acceleration force: 20 G.
- c. The switches shall be monitored for opening of closed contacts and closing of open contacts with a circuit such as a pilot lamp. Half of the units shall be tested with the actuating means in one position and the other half of the units shall be tested with the actuating means in an alternate position (see 3.1 and 6.2). Magnetically held units shall be tested with 80 percent rated dc voltage applied to coils.

4.8.18 Moisture resistance (see 3.23). Switches shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting: By normal mounting means on a corrosion-resistant metal panel (extending beyond the switch) positioned 15 degrees from vertical. Half of the units shall be tested with the actuating means in one position and the other half of the units shall be tested with the actuating means in an alternate position.
- b. Polarization: During steps 1 to 6 inclusive, a polarizing voltage of 100 V dc shall be applied between current carrying parts and the metal panel. The negative polarity shall be applied to the metal panel. Steps 7a and 7b are not applicable.
- c. Load voltage: Not applicable.
- d. Final measurements: Within 5 minutes after conclusion of the test and while the switches are still wet, insulation resistance shall be measured as specified in 4.8.23.
- e. Examinations after test: Switches shall be examined for evidence of corrosion, breaking, cracking, or spalling. Mounting hardware shall be removed at the end of the test.
- f. Distilled or deionized water may be used for this test.

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4.8.19 Dielectric withstanding voltage (see 3.24). Switches shall be tested in accordance with 4.8.19.1 and, when applicable, in accordance with 4.8.19.2.

4.8.19.1 At atmospheric pressure. Switches shall be tested in accordance with method 301 of MIL-STD-202. These tests shall be performed with the switch contacts in normal position, and shall then be repeated for each other contact operating position. The following details shall apply:

- a. Test potential: 1,000 volts rms.
- b. Duration of application: 1 minute for qualification and group B tests; 5 seconds for group A tests.
- c. Points of application:
 - (1) Between each terminal and exposed noncurrent carrying metal or grounded parts.
 - (2) Between adjacent terminals of mutually insulated circuits.
 - (3) Between all unconnected contact terminals of the same pole. This measurement is not applicable after electrical endurance.
- d. Examination after test: Switches shall be examined for evidence of arcing, flashover, breakdown of insulation, and damage.

4.8.19.2 At reduced barometric pressure. Switches rated for operation above 10,000 feet shall be tested as specified in 4.8.19.1 and in accordance with method 105 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test voltage: Unless otherwise specified, 400 volts rms.
- b. Test condition: Unless otherwise specified, C.

* 4.8.20 Seal (when applicable) (see 3.1). Switches shall be tested as specified in 4.8.20.1, 4.8.20.2, or 4.8.20.3. If switches incorporate an edge-lit panel mounting spacer, one-half of the sample units shall be mounted with the spacer in front of the panel. The remaining half shall be mounted with the spacer behind the panel or without the spacer, as applicable. Following the test, switches shall be examined for water leakage and subjected to the dielectric withstanding voltage test.

4.8.20.1 Splashproof (applicable to enclosure design 4) (see 3.25). With the switch mounted by its normal means, the switch shall be subjected to the splashproof test of MIL-STD-108.

4.8.20.2 Watertight (applicable to enclosure design 3) (see 3.25). Switches shall be properly mounted with the specified mounting hardware in the bottom of an open container. The switches shall be subjected to the watertight test of MIL-STD-108. While submerged, the switches shall be manually operated for three complete cycles of operation.

* 4.8.20.3 Dripproof test (applicable to enclosure design 2) (see 3.25). With the switch mounted by its normal means, the switch shall be subjected to the dripproof test of MIL-STD-108, 15 degrees method, with a 5 gallon quantity of water flowing over the specimen for a period of 5 minutes duration. The water shall be directed within 12 inches above the test specimen.

4.8.21 Marking visibility (see 3.26). Switches shall be examined for legibility of required marking.

4.8.22 Salt spray (corrosion) (see 3.27). Switches shall be tested in accordance with method 101 of MIL-STD-202 with associated mounting and terminal hardware assembled. The following details and exceptions shall apply:

- a. Test condition: A.
- b. Post test: Switches shall be examined for evidence of warping, cracking, excessive corrosion, or other damage.

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4.8.23 Insulation resistance (see 3.28). Switches shall be tested in accordance with method 302 of MIL-S1D-202. The following details shall apply:

- a. Test condition: B.
- b. Points of measurement:
 - (1) Between each terminal and exposed noncurrent carrying metal or grounded parts.
 - (2) Between adjacent terminals of mutually insulated circuits.
 - (3) Between all unconnected contact terminals of the same pole.

These tests shall be performed with the switch in normal position, and shall then be repeated for other operating positions.

4.8.24 Short circuit (see 3.29 and 3.1). Switches shall be tested as specified in 4.8.24.1, method I, or when specified (see 3.1), switches shall be tested as specified in 4.8.24.2, method II.

4.8.24.1 Method I. The switch shall be inserted in a circuit calibrated to supply current equal to 60 times the rated resistive load at the lowest rated dc voltage specified (see 3.1). The switch shall be connected in series to a thermal-type circuit breaker or a fuse in accordance with figure 5. A circuit breaker shall be used for switches having a rated resistive load of 10 amperes or greater, and a fuse for switches having a rated resistive load less than 10 amperes. The wire shall be of a size for single use in free air as specified in table XV as 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 cable and fuses shall be in accordance with MIL-F-15160 and table XV. If the rated load of the switch does not coincide with a circuit breaker or fuse current rating, the next larger breaker or fuse shall be employed. Calibration shall be made with a substitute circuit breaker (or equivalent fuse), less the test switch and with the switch leads in the circuit. With both the switch under test and the circuit breaker in a closed position as shown on figure 5, 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. For double-throw switches, half the switches shall be tested in one position, and the remaining half shall be tested in the other position.

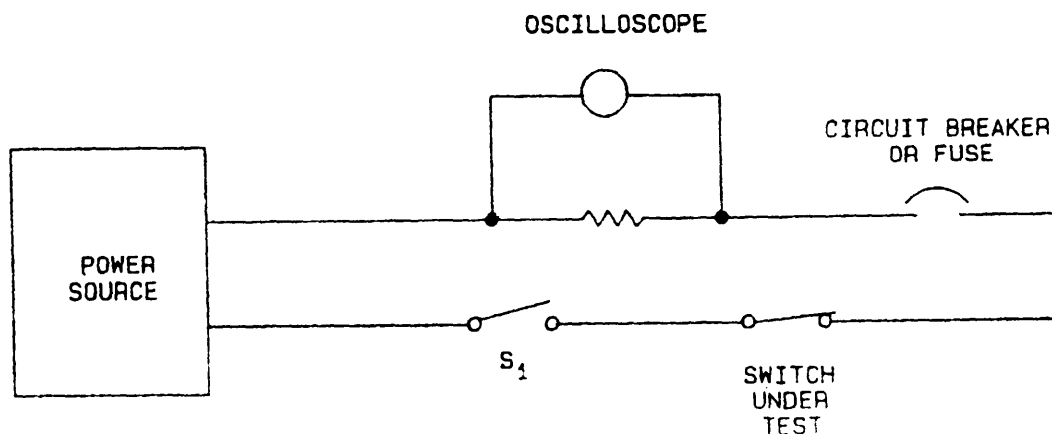


FIGURE 5. Circuit diagram for short circuit test.

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TABLE XV. Short circuit and electrical endurance wire size, and circuit breaker or fuse designations.

Resistive rating at lowest voltage, in amperes	Wire size	Circuit breaker or fuse
Less than 10	AN-20	MIL-F-15160/2, characteristics A rating, as applicable
10	AN-18	MS25244-10
15	AN-18	MS25244-15
18	AN-16	MS25244-20
20	AN-16	MS25244-20
25	AN-14	MS25244-25
30	AN-14	MS25244-30
40	AN-12	MS25244-50

4.8.24.2 Method II. Method II is similar to method I except as follows: The calibrated circuit shall be closed by the switch under test, and after the circuit breaker or fuse interrupts the circuit, the test switch shall be manually opened. This procedure shall be repeated 10 times. After each closure, the test switch shall be returned to the "off" position, and the switch contacts shall be checked for proper opening by any suitable continuity test method. The circuit breaker shall be reset or the fuse replaced after each closure. The switch contacts under test must open after each closure operation, and there shall be no mechanical failure or damage to the switch case.

4.8.25 Explosion (see 3.30). Switches shall be tested in accordance with MIL-STD-202, method 109. The following detail shall apply:

- a. Electrical load: Switches shall be operated at their rated inductive current and at their maximum rated dc voltage.
- * b. The switches, including the lamp circuits, shall be checked for electrical and mechanical operation at the conclusion of the test.

4.8.26 Sand and dust (when specified) (see 3.1 and 3.31). Switches shall be tested in accordance with method 110 of MIL-STD-202. The following details apply:

- a. The second 6-hour test at 63°C (145°F) shall be performed immediately after reaching stabilization in step 2.
- b. During exposure to sand and dust, the switches shall be mechanically operated at a frequency of 60 ±5 cycles per minute for 2,500 cycles.
- c. Post test examination: Switches shall be examined for operating characteristics and circuit continuity.

4.8.27 Overload cycling (see 3.32). Each switch to be tested for electrical endurance shall first be tested for overload cycling at room ambient conditions, using the same voltage, electrical frequency, and the same pairs 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 be five to six cycles of operation (see 6.4.12) per minute. Fifty cycles of operation shall be performed. The duty cycle shall be approximately 50 percent on, 50 percent off.

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4.8.28 Electrical endurance (see 3.33). Switches shall make and break the specified electrical load for 25,000 cycles of operation (see 6.4.12) unless otherwise specified (see 3.1).

4.8.28.1 Conditions.

- a. Unless otherwise specified (see 3.1), test loads shall be arranged so that an independent load shall be provided for each pole.
- b. Switches shall be continuously monitored and recorded to determine whether any contact has failed to open or close its individual circuit in the proper sequence. The monitoring circuit shall not shunt inductive components of inductive loads or switch contacts.
- c. Temperature rise shall be measured (see 4.8.28.3).
- d. The duty cycle shall be approximately 50 percent on and 50 percent off for resistive, inductive, and motor loads. The duty cycle shall be approximately 30 percent on and 70 percent off for lamp loads.
- e. The cycling rate shall be 10 to 12 cycles per minute.
- * f. When applicable, half of the switches shall be normally open types and the other half shall be normally closed types. For double throw switches, one-half of the switches shall be tested with the load circuit connected to one throw, and the remaining half of the switches shall be tested with the load circuit connected to the other throw.
- g. In any of the specified load tests, each conductor shall be of an applicable size for single use in free air as listed in table XV. If the switch rating under test does not coincide with a wire size, the next larger diameter wire shall be used.
- h. One side of the power supply, one side of the test load, the switch mounting plate, metal case (if applicable), and the actuating member, if metal, shall be connected to a common ground.
- * i. All lamps (or LED's when specified, see 3.1) shall be continuously energized at their maximum rated voltage during cycling. MS3338-6839 or MS25237-327 lamps (or industry equivalent) or industry lamp number 86 shall be used, as applicable.
- j. Temperature conditions during electrical endurance load cycling are as specified in table XVI. Altitude electrical tests shall be conducted at room temperature conditions only. Switches which are tested to resistive, inductive, and lamp loads shall be subjected to the minimum number of operating cycles at maximum temperature as specified (see 3.1). Switches which are tested to motor loads shall be subjected to the minimum number of operating cycles at room ambient conditions.
- * k. The dc power source shall provide the rated or inrush current on resistive loads within 300 microseconds after closing the circuit with a bounceless contact device. Oscillograms shall be provided with the test report documenting this characteristic.
- * l. Electrical tolerances are as follows:
 - Voltage: ± 5 percent for dc
 ± 7 percent for ac
 - Frequency: ± 5 percent
 - Current: ± 5 percent.

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TABLE XVI. Temperature conditions during electrical endurance load cycles.

		Inductive		Resistive		Lamp		Motor	
		AC	DC	AC	DC	AC	DC	AC	DC
		Percent of electrical load cycles							
High temperature	Sea level	100	100	100	100	100	100		
Room ambient temperature	Sea level							100	100
	Altitude	100	100	100	100	100	100		

4.8.28.2 Loads. Voltage, current, frequency, altitude, and operating cycles shall be as specified (see 3.1). The loads are as follows:

- a. Resistive load, dc.
- * b. Inductive load, dc: Inductive dc loads shall use inductors in accordance with MIL-I-81023.
- c. Lamp load, dc: Controlling a tungsten lamp which provides the rated, steady state lamp current. The circuit shall be arranged so as to provide a minimum of 15 seconds cooling time preceding each time a lamp is energized. Only tungsten lamps having a nominal wattage not to exceed 50 watts, at the voltage specified, shall be used to make up the load.
- d. Motor load, dc: The duration of the inrush current shall be not less than .05 second. Only resistive components shall be used. Switches shall make six times the rated load and break the rated load.
- e. Resistive load, ac.
- f. Inductive load, ac: Inductive ac load test circuits shall consist of inductive and resistive load element connected in series. The circuit parameters shall be rated inductive load current at 0.7 ± 0.05 lagging power factor at 115 volts.
- g. Lamp load, ac: Similar to (c) above, except that the rated ac voltage shall be used. Only tungsten lamps having a nominal wattage not to exceed 200 watts, at the voltage specified, shall be used to make up the load.
- h. Motor load, ac: The duration of the inrush shall be not less than .05 second. Only resistive components shall be used. Switches shall make six times the rated load and break the rated load.

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4.8.28.3 Temperature rise measurement. The switches tested for electrical endurance at the rated resistive current, shall be tested immediately thereafter for temperature rise. The switch terminal temperature shall be measured using a suitable thermocouple (28-32 AWG), while the switch is continuously carrying its maximum resistive load. The test shall be performed with the switch in still air which has a temperature of $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The temperature measuring thermocouple shall be attached to the terminals which were carrying current during the overload and endurance tests. If wire leads are provided, the measurement shall be made on the copper conductor at the point of the entrance of the leads to the switch. If wire leads are not provided, the connections to the switch shall be made with not less than 1 foot length copper wire of the size used during the endurance test and the measurement shall be made on the terminal at a point adjacent to the insulating medium. The test current shall be passed through the switch without interruption. The terminal temperature shall be recorded at not less than 5 minute intervals, until the temperature has stabilized or until a minimum period of 2 hours has elapsed. The temperature shall be considered stable when three successive readings taken at 5 minute intervals indicate no change in temperature. The ambient temperature shall be measured during the same period at a point sufficiently far from any heat source (including the test switch) to obtain a representative temperature value for the air reaching the switch by convection. The temperature rise shall then be calculated by subtracting the lowest recorded ambient temperature from the highest recorded switch terminal temperature.

4.8.29 Mechanical endurance (see 3.34). Unless otherwise specified (see 3.1), switches shall be tested as follows:

- * a. The switches shall be subjected to 5,000 cycles of operation (see 6.4.12) at $-55^{\circ}\text{C} \pm 2^{\circ}\text{C}$, 10,000 cycles of operation at $85^{\circ}\text{C} \pm 2^{\circ}\text{C}$, and 35,000 cycles of operation at room temperature. The cycling rate shall not exceed 100 cycles of operation per minute and shall not be less than 10 cycles of operation per minute. Each cycle of operation shall be the movement of the actuating means through the entire range of its travel (from free position to full overtravel position and return to the fully released position) causing the switch contacts to change from one position to another and then return to their original position. All switches except those with push-pull operation shall be returned from their depressed position solely by the internal mechanism of the switch. Switches shall be continuously monitored to determine whether any contact has failed to open or close its individual circuit in proper sequence. Lamps shall not be energized.
- b. After tests are conducted as specified in 4.8.29a, a lamp retention test plug in accordance with figure 2 shall be inserted (to complete engagement) and withdrawn five times. The test plug shall then be installed and the lens held so that the base on the test plug points directly downward.
- c. After tests are conducted as specified in 4.8.29b, a modular switch assembly, as applicable, shall be completely engaged and removed from the modular indicator light assembly a minimum of 10 times. The lens lampholder assembly shall be completely removed, relamped and installed a minimum of 100 times. After the tests, the switch shall be examined for any physical damage, that is sticking of switch actuator, loose latching of lens assembly or broken, deformed clips or springs.

4.8.30 Intermediate current (when specified) (see 3.1 and 3.35). One throw of each pole of the switches under test shall be connected into a circuit having a 27 ± 3 , -0 volt dc source and a load consisting of the coil of relay M5757/10-033 of MIL-R-5757/10, or equivalent. Switch performance during the test shall be continuously monitored by a device which indicates failure of the relay to close and open during each cycle of operation. Unless otherwise specified (see 3.1), the number of operations shall be 50,000 cycles. The switch shall be cycled by a mechanical actuating device. During each cycle of operation, the actuating member of the switch shall be moved once to each extreme of its travel. Double-throw switches shall be tested with half of the sample lot controlling the load with the normally open contacts and half controlling the load with the normally closed contacts. Each multipole switch shall be connected with all normally open circuits loaded simultaneously or all normally closed circuits loaded simultaneously. The frequency of actuation shall be compatible with the time response characteristics of the relay monitoring device. Prior to testing, each switch shall be subjected to a 24-hour minimum conditioning in air at the maximum rated temperature. The test shall then be performed at the following operating temperatures:

- a. 25 percent of the test cycles at the minimum temperature specified.
- b. 50 percent of the test cycles at room ambient temperature.
- c. 25 percent of the cycles at the maximum temperature specified.

Switch contact resistance shall be measured following the test using the electrical parameters of the minimum current test load. Three measurements shall be made on each contact subjected to the minimum current test.

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4.8.31 Low level life (when specified) (see 3.1 and 3.36). Switches shall be tested as specified in method 311 of MIL-STD-202. The following details shall apply:

- a. Contact load: Each set of normally open and normally closed contacts shall be connected to individual loads.
- b. Operate cycles: 50,000 at a rate not to exceed 60 cycles per minute with "ON" and "OFF" times approximately equal.
- c. Operating temperatures:
 - (1) 25 percent of the test cycles at the minimum temperature specified.
 - (2) 25 percent of the test cycles at room ambient temperature.
 - (3) 50 percent of the cycles at the maximum temperature specified.

* 4.8.32 Logic level circuit (when specified, see 3.1) (see 3.37). Switches shall be tested in accordance with EIA RS-448, method 17 as follows:

- a. Contact load: Each switch contact shall make, carry, and break a resistive load of 10 ± 1 mA at an open circuit voltage of 5.0 ± 0.5 V dc. Both normally open and normally closed contacts shall be loaded. Contacts shall be connected to individual loads.
- b. Cycles of operation: Unless otherwise specified (see 3.1), the number of operations shall be 50,000 cycles. The actuation rate shall be 120 cycles per minute maximum. Unless otherwise specified (see 3.1), each stroke of the actuating means shall include the full range of travel from free position to full overtravel position and return to the fully released position. The actuation force applied to the switch actuator shall not exceed the force required to reach the extreme position of travel unless so authorized by the manufacturer.
- c. Monitoring: During each closure of the contact, the voltage drop across the switch terminals shall be monitored for a duration of no less than 50 percent of each contact static closure. The switch contacts need not be monitored until 10 milliseconds after the initial contact closure to exclude any contact bounce. During each opening of the contacts, the voltage drop across the switch terminals shall be monitored for a duration of no less than 50 percent of each contact opening. The monitoring device shall either record the number of contact closures at which sticks or misses occur, or discontinue the test when sticks or misses occur.

4.8.33 EMI/RFI shielding (when applicable) (see 3.38). Switches which are equipped with EMI/RFI shielding shall be tested as specified in 4.8.33.1, or when specified (see 3.1), switches shall be tested as specified in 4.8.33.2.

4.8.33.1 Positive grounding. Resistance between the mounting bushing or bezel and the EMI/RFI shield shall be measured in accordance with method 307 of MIL-STD-202. The following details and exceptions shall apply:

- a. Method of connection: Between a suitable exterior point on the mounting surface and the screen (lens may be drilled for access to screen).
- b. Test current: 100 ± 10 milliamperes.
- c. Open circuit test voltage: 6 ± 1 V dc.
- d. Number of measurements per activation: One in free position and one in full plunger overtravel position. There shall be no exterior force applied to plunger during measurement of resistance in free position.

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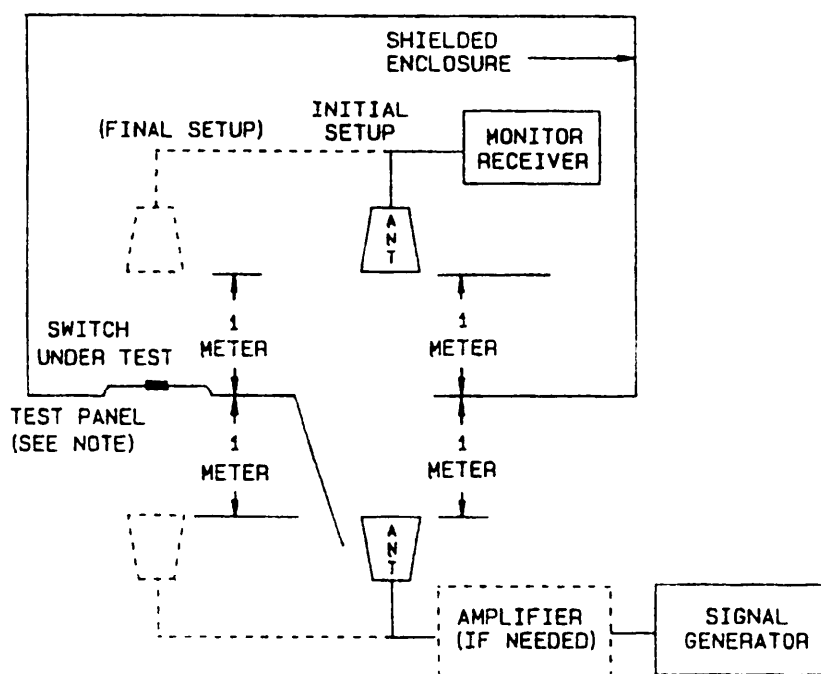
4.6.33.2 Shielding efficiency (when specified, see 3.1). Switches shall be tested utilizing a test setup (or equivalent) as shown on figure 6. Measurements shall be made as follows:

- With the door open and the antennas in the "initial setup" position, establish a test level over the 200 MHz to 1 GHz range such that the received signal level is at least as many dB above the RF ambient level as that of the shielded enclosure attenuation.
- Record the received signal level and the signal generator output level. Repeat measurements at 100, 200, 400, 600, 800 and 1,000 MHz.
- Move the antennas to the final test positions, close the door and with an RF-tight blank panel between the antennas, measure the integrity of the enclosure by setting the signal generator to the same output and record the received signal level for each frequency used in step b. The shielded enclosure attenuation is then calculated using the following equation:

$$\text{Attenuation (dB)} = 20 \log \frac{E_1}{E_2}$$

Where E1 is the receiver reading in step b and E2 is the receiver reading in step c

- Mount the test switch in the blank panel with the rear of the switch outside of the shielded enclosure (toward the signal generator antenna). The switch shall be mounted as it would be for normal installation using the mounting hardware supplied or recommended. Repeat the measurements of step c above and calculate the shielding attenuation of the switch using the new receiver readings.



NOTE: Test panel shall be located in the chamber wall at least 1 meter from any corner and at least 1 meter from floor and ceiling.

FIGURE 6. Block diagram of switch shielding efficiency test.

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4.8.34 Illuminated colors (see 3.39). The chromaticity shall be determined by spectrographic or visual means, as specified below. Unless otherwise specified (see 3.1), lamps used for chromaticity testing shall have a calibrated mean spherical candle power of $.34 \pm .02$ for T-1-3/4 lamps and $.15 \pm .02$ for T-1 lamps.

- a. Method I: Spectrophotometer - flat slab: Chromaticity shall be determined using a spectrophotometer, flat slab material of the same density and thickness of the shaped filter, and necessary calibration filters.
- b. Method II: Spectroradiometric - Chromaticity shall be determined using a spectroradiometer, a complete illuminated push button assembly, calibrated lamps of specified color temperature, and necessary calibration filters.
- c. Method III: Visual comparator - Chromaticity shall be determined by a color comparator, necessary high and low limit plastic or glass filters of known chromaticity, and calibrated light sources of specific color temperature.

4.8.35 Luminance (see 3.40). Unless otherwise specified (see 3.1), all luminance measurements shall be taken in completely dark surroundings. All readings shall be point readings and averaged. Luminance readings shall be taken by a calibrated photoelectric photometer. Luminance may be taken without the legend installed if the legend material is not a significant part of the illumination system. Unless otherwise specified (see 3.1), lamps used for luminance testing shall have a calibrated mean spherical candlepower of $.34 \pm .02$ for T-1 3/4 lamps and $.15 \pm .02$ for T-1 lamps. For points of measurements, see figure 7.

* 4.8.36 Sunlight readability (when specified) (see 3.1 and 3.41). A light source of 3,000° to 5,000° Kelvin color temperature shall be directed at an angle of $\phi_1 = 15^\circ \pm 2^\circ$ to the normal of a diffuse reflectance standard (pressed barium sulphate or PTFE powder (polytetrafluorethylene resin), see figure 8). The size of the light source shall be limited so that $\theta \leq 20^\circ$. A photometer shall be positioned at an angle of $\phi_2 = 15^\circ \pm 2^\circ$ to the normal of the reflectance standard. The light source shall be adjusted to produce 10,000 foot candles illumination on the reflectance standard as measured by the photometer. The reflectance standard shall then be removed and replaced by the viewing surfaces of the display to be tested. Using this test configuration, the luminance of the legend, both illuminated and nonilluminated, plus that of the adjacent background areas shall be measured. Three luminance readings per legend character shall be taken (see figure 7). From these readings, the following contrast ratios can be calculated for each character:

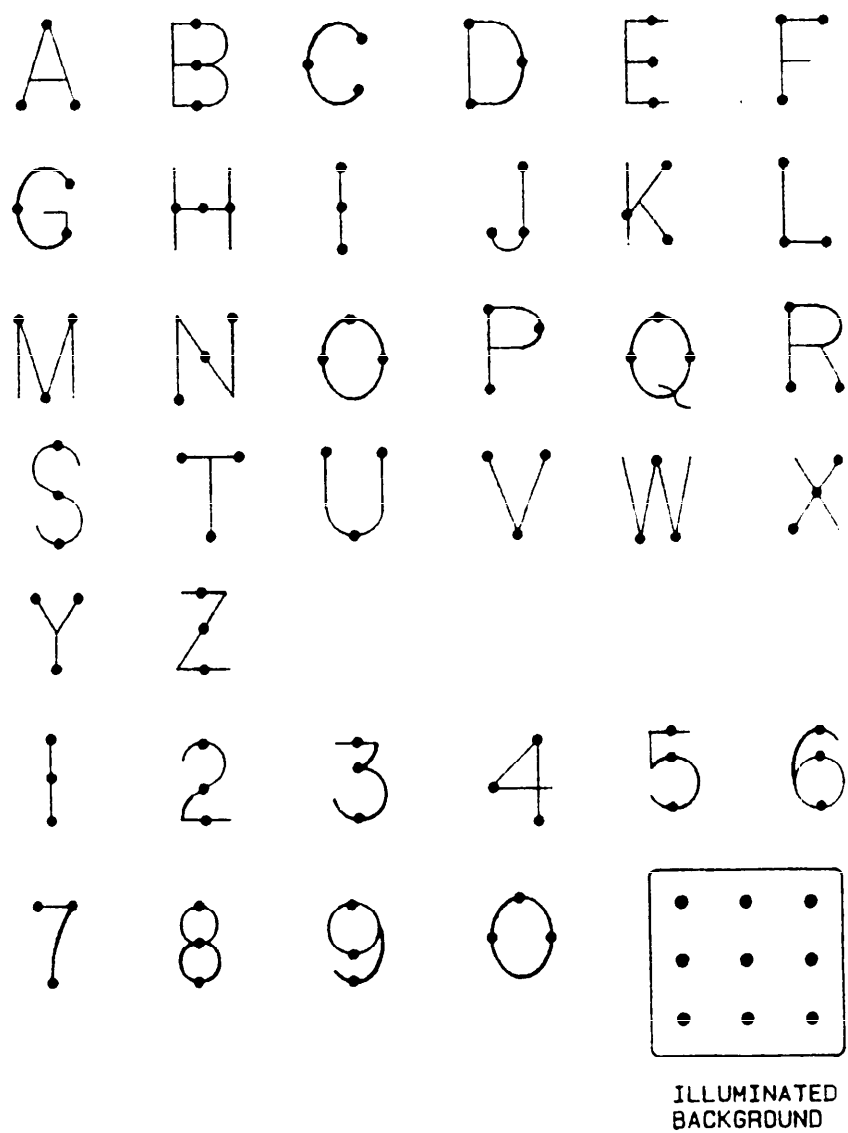
$$\text{The ON/BACKGROUND contrast } C_L = \frac{B_2 - B_1}{B_1}$$

$$\text{The OFF/BACKGROUND contrast } C_{UL} = \frac{B_3 - B_1}{B_1}$$

B1 = Average background luminance
 B2 = Average character luminance, lighted
 B3 = Average character luminance, unlighted

The test shall be repeated with ϕ_1 and $\phi_2 = 30^\circ \pm 2^\circ$. Normal production units shall be tested. The sample units shall have two lines of characters which utilize at least three-fourths of the maximum legend area.

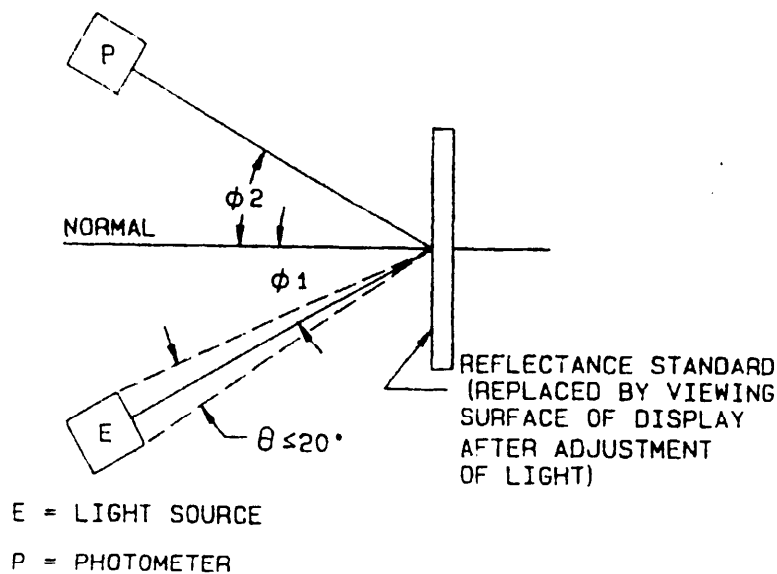
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NOTE: Peripheral points are located midway between center line and edge of display area.

FIGURE 7 Luminance measurement points

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FIGURE 8. Specular reflectance test for sunlight readability.

* 4.8.37 Night vision imaging system (NVIS) compatibility (see 3.42) (when specified, see 3.1). The test procedure for measuring luminance, chromaticity and spectral radiance shall be in accordance with MIL-L-85762 for illuminated controls (for NVIS green A and B), caution signals (for NVIS yellow), and warning signals (for NVIS red).

4.8.38 Stray lights (when specified) (see 3.1 and 3.43). When switches are tested for stray lights, a photometric measurement shall be made on stray light areas as determined from visual inspection. To determine stray light emitted at acute angles to the display face, a flat-white neutrally reflecting surface of 85 ± 5 percent reflecting shall be placed perpendicular to the front face and parallel to the top edge (horizontally) at a distance of 1 inch from the switch. A minimum of five (above display, upper third, center of display, lower third, and below display) sets of brightness-readings shall be made. The brightness readings shall be made perpendicular to the reflecting surface at a distance of one inch in front of the display (or at any point on the reflecting surface that appears to be reflecting stray light from the display). The reflecting surface shall then be positioned parallel to a side edge and at least five more sets of readings shall be made in the same manner as the above. All readings shall fall within the limits specified in 3.43.

4.8.39 Field of view (see 3.44). The switches shall be mounted in a vertical position with the character(s) displayed on the screen. Unless otherwise specified (see 3.1), the screen shall be viewed from a distance of 3 feet, at all angles up to 40° to a line perpendicular to the viewing surface.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-26735.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The switches covered by this specification are intended for use as panel displays and switching devices in alternating and direct current applications. Multipole switches are not to be used on polyphase circuits exceeding 115 volts line to line.

6.2 Acquisition requirements.

6.2.1 Category I switches (items covered by specification sheets and identified by military PIN, see 3.2.1). The acquisition document should specify the following:

- a. Title, number and date of this specification.
- b. Title, number and date of the applicable specification sheet and the PIN.
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

6.2.2 Category II switches (qualified switches with modification, see 3.2.2). The acquisition document should specify the following:

- a. Title, number, and date of this specification.
- b. Title, number, and date of applicable specification sheet.
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
- d. Switch is category II.
- e. Military PIN of qualified switch.
- f. Manufacturer's PIN of modified switch (see 3.43.1(b)).
- * g. Details of the variations from the specification sheet. A copy of the drawing furnished, including the description of the variations from the specification sheet, should be sent to the agent activity specified at the bottom of page 1 of this document.
- * h. Inspection requirements (in addition to group A) - To verify suitability of variations from category I switches. Available manufacturing test data showing compliance may be substituted as meeting these requirements at the option of the contracting activity.
 - (1) Tests to be performed (if any).
 - (2) The laboratory at which inspection is to be performed.
 - (3) Samples and submission of data, if other than that specified.

* 6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved 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 contractors 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 Space and Naval Warfare Systems Command (SPAWAR 003-114), Washington, DC 20363-5100. Information pertaining to qualification of products should be obtained from the Defense Electronic Supply Center (DESC), ATTN: DESC-EOP, Dayton, Ohio 45444-5000, Agent for Administration of the Qualified Products List. Application for qualification tests should be made in accordance with "Provisions Governing Qualification" (see 6.3.1).

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6.3.1 Copies of specifications and "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.4 Definitions.

6.4.1 Switch assembly. Switch assembly is one or more switches that are permanently fixed to a bracket having a common actuating means, that is, lever, rocker, button, or plunger.

6.4.1.1 Manual switch assembly. A manual switch assembly is one or more switches adapted to or intended for hand operation, i.e., to be depressed or operated manually and subject to operator variations.

6.4.2 Actuator. The switch actuator is the mechanism of the switch or housing which, when moved as intended, will operate the contacts.

6.4.3 Actuator free position. Actuator free position is the initial actuator position when there is no external force (other than gravity) applied on the actuator.

6.4.4 Contact separation. The contact separation distance of a switch is the minimum open gap distance between the stationary and movable contacts or live parts connected thereto, with moving contact member in the open position.

6.4.5 Actuating force or torque. Actuating force or torque is the force or torque applied to the actuator to operate the contacts.

6.4.6 Releasing force or torque. The releasing force or torque is the value to which the force or torque on the actuator must be reduced to permit the contacts to return to the unoperated position after operation.

6.4.7 Overtravel force or torque. Overtravel force or torque is the force or torque applied to actuating mechanism to move the actuator to the overtravel limit position.

6.4.8 Contact bounce time. The contact bounce time is the total time between the initial contact and the cessation of contact opening due to transfer mechanism disturbance. Dynamic contact voltages due to resistance fluctuations or "white noise" shall not be included in contact bounce time.

6.4.9 Enclosure. An enclosure is an auxiliary housing providing protection and means for mounting and actuating of the basic switch.

6.4.10 Legend. The inscribed message (words, numbers, symbols, etc.) on the face of the switch which conveys switch function to or signals the operator.

6.4.11 Sunlight readable. A switch with a legend which is visible under direct sunlight conditions when illuminated and hidden when not illuminated.

6.4.12 Cycle of operation. A cycle of operation is the movement of the actuating means through the entire range of its travel, causing the switch contacts to change from one position to another position and then return to their original position. Each stroke of the actuating means includes a full range of travel from free position to full overtravel position and return to the fully released position.

6.4.13 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 MIL-STD-889.

* 6.4.14 Gold contacts. Contacts in which the mating surfaces are gold or gold alloy throughout the rated life of the switch. (In some instances, gold plating may be used for shelf life or multi-rating capability and is fully expected to be destroyed during life.)

* 6.4.15 Silver contacts. Contacts in which the mating surfaces are silver or silver alloy throughout the rated life of the switch.

* 6.4.16 Welder defect. A defect that could result in a failure or that will reduce the usability of the switch for its intended purpose.

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* 6.4.17 Minor defect. A defect that is not likely to reduce the usability of the switch for its intended purpose. It may be a departure from established standards having no significant bearing on the effective use or operation of the switch.

* 6.4.18 Night Vision Imaging System (NVIS). A system which uses image intensifier tubes to produce an enhanced image of a scene in light conditions too low for normal navigation and pilotage.

6.5 Human engineering. Government contracts commonly specify that military standard components be used and that MIL-STD-1472, Human Engineering Design Criteria For Military Systems, Equipment and Facilities, applies. Due to performance and environmental requirements, or other factors, military specification switches frequently do not meet the requirements of MIL-STD-1472. To provide the desired operability, it is suggested that equipment designers select the military specification switches which can most closely conform to the human interface requirements of MIL-STD-1472 without sacrificing reliability.

* 6.6 Subject term (key word) listing.

Controls
Fluorosilicone
Legend
Light, indicator
NVIS
Polytetrafluorethylene

* 6.7 Part or Identifying Number (PIN). See 1.3.

6.8 Changes from previous issue. The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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Air Force - 85

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Navy - OS, AS
Air Force - 99
DLA - ES

User activities:

Army - AR
Navy - MC, SH
Air Force - 19

Preparing activity:

Navy - EC

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Switches, Push Button, Illuminated, General Specification For

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

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b. ORGANIZATION

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