

DETAIL SPECIFICATION

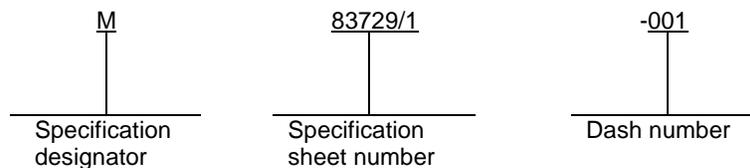
CHOPPERS, ELECTROMECHANICAL
GENERAL SPECIFICATION FOR

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 electromechanical choppers (see 6.5), hereinafter referred to as choppers, designed to convert direct current signals to modified square waves of the same frequency as, and bearing a definite phase relationship to, a driving sine or square wave of alternating current.

1.2 Part or Identifying Number (PIN). The PIN should consist of the letter "M", the specification sheet number, and an assigned dash number (see 3.1) as shown in the following example:



2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government Documents.

2.2.1 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).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC/VAT, Post Office Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MIL-DTL-83729B

SPECIFICATIONS

DEPARTMENT OF DEFENSE

- MIL-DTL-83729/1 - Choppers, Electromechanical, Hermetically Sealed, Single Pole, Double Throw, Break before Make.
- MIL-DTL-83729/2 - Choppers, Electromechanical, Dust Tight, Single Pole, Double Throw, Make before Break.
- MIL-DTL-83729/3 - Choppers, Electromechanical, Hermetically Sealed, Single Pole, Double Throw, Break before Make, Bracket Mount.
- MIL-DTL-83729/4 - Choppers, Electromechanical, Hermetically Sealed, Single Pole, Double Throw, Break before Make.
- MIL-DTL-83729/6 - Choppers, Electromechanical, Hermetically Sealed, Single Pole, Double Throw, Break before Make.
- MIL-PRF-12883 - Sockets and Accessories for Plug-in Electronic Components, General Specification for.
- MIL-DTL-5015 - Connectors, Electrical, Circular Threaded, AN Type, General Specification For
- MIL-DTL-28748 - Connector, Plug and Receptacle, Rectangular, Rack and Panel Solder Type and Crimp Type Contacts General Specification For

STANDARDS

FEDERAL

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

DEPARTMENT OF DEFENSE

- MIL-STD-202 - Test Method Standard, Electronic and Electrical Component Parts.
- MIL-STD-889 - Dissimilar Metals.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.

HANDBOOKS

DEPARTMENT OF DEFENSE

- MIL-HDBK-454 - General Guidelines for Electronic Equipment.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Service, Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues 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).

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

- IEEE315A - Graphic Symbols for Electrical and Electronic Diagrams.

(Application for copies should be addressed to the Institute of Electrical and Electronic Engineers, 445 Hoes Lane, Piscataway, New Jersey, 08855-1331.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications, specification sheets, or MS sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

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

3.1.1 Choppers not covered by specification sheets. The individual item requirements for choppers furnished under this specification and not covered by specification sheets shall be as specified (see 6.2.2).

3.2 First article inspection. Choppers furnished under this specification shall be products which have been tested and have passed the first article inspection specified (see 4.3).

3.3 Inspection of choppers not covered by specification sheets. Choppers furnished under this specification and not covered by specification sheets shall be products which have been tested and have passed the inspection specified in 4.4.

3.4 Materials. Materials shall be as specified herein. However, when a definite material is not specified, the material used shall be of such quality as to ensure that the chopper meets all requirements of this specification. Materials used externally shall be fungus inert, self-extinguishing, and shall not support combustion, nor give off noxious gases in harmful quantities. Materials used internally shall not give off gases in quantities sufficient to cause explosion of sealed enclosures, cause contamination of the contacts or other parts of the chopper that will adversely affect life or reliability, or form current-carrying tracks when subjected to any of the tests specified herein. Cotton-filled or wood-flour-filled materials shall not be used. Ceramic used for external surfaces shall be glazed. The use of silicone or silicone compounds for any purpose is prohibited. The selection of materials shall be such as to provide maximum shelf life. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.4.1 Metals. Metals shall be of a corrosion - resistant type or shall be plated or treated to resist corrosion. The use of mercury or mercury compounds is prohibited. The use of magnesium or magnesium alloys is prohibited (not applicable to contact systems).

3.4.1.1 Plated finishes.

- (a) Pure tin plating is prohibited internally and externally. Tin-lead finish is acceptable, provided that the minimum lead content is 3 percent.
- (b) Pure zinc plating is prohibited internally and externally.
- (c) Pure cadmium plating is prohibited internally and externally,

3.4.2 Dissimilar metals (not applicable to hermetically sealed choppers). 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 tends toward active electrolytic corrosion (particularly brass, copper, or steel used in contact with aluminum or aluminum alloy), is not acceptable. However, metal spraying or metal plating of dissimilar base metals to provide similar or suitable abutting surfaces is permitted. Dissimilar metals are defined in 6.4. In hermetic seals, the 0.25 V difference between the header material and the housing material is not applicable.

3.5 Interface and construction. Choppers shall be of the design, construction, physical dimensions, and weight specified (see 3.1 and 6.2.2). Choppers shall be so constructed as to insure proper operation when mounted in any position, unless otherwise specified (see 3.1 and 6.2.2).

3.5.1 Enclosure. Enclosures shall be hermetically sealed (see 6.5) unless otherwise specified (see 3.1 and 6.2.2). Enclosures may also be sealed or enclosed.

3.5.2 Coil (drive). The coils shall be evenly wound and insulated to meet the performance requirements specified herein. The coils shall be completely insulated from the frame and other grounded parts, and unless otherwise specified (see 3.1 and 6.2.2), coil leads shall not be internally grounded. Coils shall be securely anchored to the frame or other stationary parts in a manner to prevent coil movement or strain on the coil leads.

3.5.3 Contact arrangement. Choppers shall have contact arrangements as specified (see 3.1 and 6.2.2).

3.5.4 Threaded parts. Unless otherwise specified (see 3.1 and 6.2.2), all threaded parts shall be in accordance with FED-STD-H28. Wherever possible, unified screw threads shall be used.

3.5.5 Shielding. The chopper coil shall be shielded and such shielding shall provide effective shielding between the coil and contacts. Shielding connections shall be compatible with the specified base connections (see 3.1 and 6.2.2).

3.5.6 Terminals. The terminal design shall be as specified (see 3.1 and 6.2.2).

3.5.6.1 Plug-in terminations. Plug-in terminations shall conform to the arrangements and dimensions necessary for proper mating with the applicable connectors or sockets covered by MIL-DTL-5015, MIL-DTL-28748, or MIL-PRF-12883. The mounting arrangement of the chopper and its corresponding socket shall be so designed that the entire weight of the chopper will be supported and the stability of its mounting will be provided by an auxiliary mounting means other than the electrical terminals of the socket.

3.5.7 Soldering. Solder and soldering flux shall be of such quality as to enable the choppers to meet all requirements of this specification. When a soldering operation is used for sealing, the use of flux shall be held to a minimum. All flux and loose or spattered solder shall be removed. Solder shall not be used primarily for obtaining mechanical strength. Electrical connections shall be mechanically secure and electrically continuous before and after soldering. MIL-HDBK-454, guideline 5 is a useful reference.

3.5.8 Degassing. When specified, choppers shall be degassed (see 3.1 and 6.2.2).

3.6 Seal.

3.6.1 Seal test I (applicable to sealed enclosures only (see 4.6.2.1)). There shall be no continuous visible stream of bubbles.

3.6.2 Seal test II (applicable to hermetically sealed enclosures only (see 4.6.2.2)). The leakage rate shall not exceed 1×10^{-8} atmospheric cubic centimeters per second of air (atm cc/s).

3.7 Electrical characteristics (see 4.6.3).

3.7.1 Contact resistance (see 4.6.3.1). Unless otherwise specified (see 3.1 and 6.2.2), the contact resistance shall not exceed 0.10 ohm.

3.7.2 Direct current (dc) coil resistance (see 4.6.3.2). The dc coil resistance shall be as specified (see 3.1 and 6.2.2).

3.7.3 Coil impedance (see 4.6.3.3). The coil impedance shall be as specified (see 3.1 and 6.2.2).

3.7.4 Capacitance (when specified) (see 3.1, 6.2.2, and 4.6.3.4). The capacitance shall be as specified.

3.7.5 Polarity (see 6.5, and 4.6.3.5). The polarity of the contacts shall be as specified (see 3.1 and 6.2.2).

3.7.6 Starting voltage (see 4.6.3.6). The choppers shall start immediately, but need not operate within the specified limits.

3.7.7 Waveform characteristics (see 4.6.3.7). The waveform characteristics shall be as specified in 3.7.7.1 to 3.7.7.5, inclusive. The chopper shall operate over the specified frequency and voltage range (see 3.1 and 6.2.2). The chopper output shall be a square wave with fundamental frequency equal to the frequency of the voltage applied to the coil.

3.7.7.1 Dwell time (see 4.6.3.7.1.1 and 6.5) (on time). The dwell time for choppers shall be as specified (see 3.1 and 6.2.2).

3.7.7.2 Dissymmetry (see 4.6.3.7.1.2 and 6.5). Unless otherwise specified (see 3.1 and 6.2.2), the differential between the dwell time of the positive half cycle and the dwell time of the negative half cycle shall not exceed 15 percent for single-pole, double-throw (SPDT) choppers with no special features. Dissymmetry for all other types of choppers shall be within specified limits (see 3.1 and 6.2.2).

3.7.7.3 Contact bounce (see 4.6.3.7.2 and 6.5). Unless otherwise specified (see 3.1 and 6.2.2), contact bounce shall not exceed 4 degrees during the initial and/or final 10 degrees of dwell, or a maximum of 8 degrees for any dwell period.

3.7.7.4 Transfer time (see 4.6.3.7.3 and 6.5) (when specified) (see 3.1 and 6.2.2). The transfer time shall be as specified.

3.7.7.5 Phase angle (see 4.6.3.7.4 and 6.5). The phase angle shall be as specified (see 3.1 and 6.2.2).

3.7.8 Noise level. Unless otherwise specified (see 3.1 and 6.2.2), the noise level shall not exceed 1 mV peak to peak or 300 μ V rms when choppers are tested as specified in 4.6.3.8.

3.8 Dielectric withstanding voltage (DWV) (see 4.6.4). There shall be no evidence of damage, arcing, breakdown, or leakage in excess of 100 μ A.

3.9 Insulation resistance (IR) (see 4.6.5). Unless otherwise specified (see 3.1), the IR between mutually insulated terminals and between terminals and case which do not normally form a conductive circuit, shall be at least 1,000 M Ω or greater.

3.10 Thermal shock and high and low temperature operation (when specified) (see 3.1) (see 4.6.6). The waveform characteristics, contact resistance (dynamic), starting voltage, IR, and DWV shall be as specified in 3.7.7, 3.7.1, 3.7.6, 3.9, and 3.8 respectively.

3.11 Salt spray (corrosion) (see 4.6.7). There shall be no corrosion of base material, nor shall oxidation of the plating be such that it would interfere with normal operation of the chopper. The contact resistance, dc coil resistance, and waveform characteristics (with nominal drive only) (see 6.5) shall be as specified in 3.7.1, 3.7.2, and 3.7.7, respectively.

3.12 Sand and dust (when specified) (see 3.1, 4.6.8, and 6.2.2). There shall be no evidence of mechanical or electrical damage. At the end of the test, the dielectric withstanding voltage, and waveform characteristics (with nominal drive only) shall be as specified in 3.8 and 3.7.7, respectively.

3.13 Vibration (see 4.6.9). There shall be no evidence of mechanical or electrical malfunction during or after the test. Following the test, the IR, DWV, contact resistance (dynamic), seal, coil impedance, noise level, starting voltage, and waveform characteristics (with nominal drive only) shall meet the requirements of 3.9, 3.8, 3.7.1, 3.6, 3.7.3, 3.7.8, 3.7.6, and 3.7.7, respectively.

3.14 Acceleration (when specified) (see 3.1, 4.6.10, and 6.2.2). The waveform characteristics (with nominal drive only) shall be as specified in 3.7.7.

3.15 Terminal strength (see 4.6.11). There shall be no evidence of loosening or breaking of the terminals, damage to the insulating base of the choppers, or detrimental effect on the seal. Bending of terminals shall not be construed as damage provided that sealing is not effected in the process and that plug-in terminals can be reformed in a manner to permit proper mating with the applicable socket. There shall be no damage which would adversely affect the normal operation of the choppers.

3.16 Moisture resistance (see 4.6.12). There shall be no evidence of excessive peeling, flaking, chipping, cracking, or grazing of the protective coating. Marking shall be legible at the completion of the test. Following the moisture resistance test and after the 24-hour drying period, contact resistance, IR, DWV, dc coil resistance, coil impedance, and waveform characteristics (with nominal drive only) shall be as specified in 3.7.1, 3.9, 3.8, 3.7.2, 3.7.3, and 3.7.7, respectively.

3.17 Barometric pressure (reduced) (when specified) (see 3.1, 6.2.2, and 4.6.13). The waveform characteristics (with nominal drive only) shall be as specified in 3.7.7.

3.18 Shock (see 4.6.14). There shall be no evidence of mechanical or electrical damage, nor shall the test impair the normal operation or cause any malfunction after the test. During the test, a transient increase in dissymmetry may occur. Following this test, waveform characteristics (with nominal drive only), starting voltage and DWV shall be as specified in 3.7.7, 3.7.6, and 3.8, respectively.

3.19 Life. Unless otherwise specified (see 3.1 and 6.2.2), choppers shall be tested in accordance with 4.6.15. Before, during, and after life test, the IR, DWV, static and dynamic contact resistance, waveform characteristics and noise level shall be as specified in 3.9, 3.8, 3.7.1, 3.7.7, 3.7.8, respectively.

3.20 Marking. Unless otherwise specified (see 3.1 and 6.2), choppers shall be marked in accordance with method I of MIL-STD-1285 and shall include as a minimum the following information:

- (a) PIN (see 1.2 and 3.1).
- (b) Date code.
- (c) Source code.
- (d) Lot symbol.
- (e) Coil rating (voltage, and frequency).

3.21 Interchangeability. All parts having the same PIN shall be directly and completely interchangeable with each other with respect to installation and performance to the extent specified in the associated specification sheet (see 3.1).

3.22 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.23 Workmanship. The choppers shall be fabricated 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 that will affect life, serviceability, and appearance.

4. VERIFICATION

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

- (a) First article inspection (see 4.3).
- (b) Inspection of choppers not covered by specification sheets (see 4.4).
- (c) Conformance inspection (see 4.5).

4.2 Inspection conditions. Unless otherwise specified herein, the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202 shall be considered for referee purposes only. All inspections may be performed at ambient conditions consistent with industry practice.

4.3 First article inspection. Inspection (see 3.2) shall be performed by the supplier after award of contract and prior to production or delivery at a facility acceptable to the Government. First article inspection shall be performed on sample units which have been produced with equipment and procedures normally used in production. First article approval is valid only on the contract or purchase order under which it is granted, unless extended by the Government to other contracts or purchase orders.

4.3.1 Sample size. Twelve choppers shall be subjected to first article inspection.

4.3.2 Inspection routine. The sample shall be subjected to the inspections in table II, in the order shown, except that groups II, III, and IV may be conducted concurrently. All sample units shall be subjected to the inspections of group I. The sample shall then be divided equally into three groups of four units each and subjected to the inspection for their particular group.

4.3.3 Failures. Failures in excess of those allowed in table II shall be cause for refusal to grant first article approval.

4.4 Inspection requirements for items not covered by specification sheets. Inspection requirements for items not covered by specification sheets shall be performed by the supplier, after award of contract, and prior to production, at a laboratory acceptable to the Government (see 6.2.2). The inspection shall be performed on sample units which have been produced with equipment and procedures normally used in production. Unless otherwise specified (see 6.2.2), the samples and inspection routine shall be as specified in 4.3.1, 4.3.2, and table II. Approval of inspection requirements and items not covered by specification sheets is valid only on the contract or purchase order under which approval is granted, unless extended by the Government to other contracts or purchase orders.

TABLE II. First article inspection.

Examination or Test	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of failures permitted
<u>Group I</u>				
Visual and mechanical inspection	3.1, 3.4, 3.5, 3.20, 3.21	4.6.1	12	1
Seal I	3.6.1	4.6.2.1		
Electrical characteristics	3.7	4.6.3		
Dielectric withstanding voltage	3.8	4.6.4		
Insulation resistance	3.9	4.6.5		
<u>Group II</u>				
Thermal shock and high and low temperature (when specified)	3.10	4.6.6	4	0
Salt spray (corrosion)	3.11	4.6.7		
Sand and dust (when specified)	3.12	4.6.8		
Vibration	3.13	4.6.9		
Acceleration (when specified)	3.14	4.6.10		
Terminal strength	3.15	4.6.11		
Seal II	3.6.2	4.6.2.2		
<u>Group III</u>				
Moisture resistance	3.16	4.6.12	4	0
Barometric pressure (reduced) (when specified)	3.17	4.6.13		
Shock	3.18	4.6.14		
Seal II	3.6.2	4.6.2.2		
<u>Group IV</u>				
Life	3.19	4.6.15	4	0
Seal II	3.6.2	4.6.2.2		

4.5 Conformance inspection. Conformance inspection shall consist of group A inspection.

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

4.5.1.1 Inspection lot. An inspection lot shall consist of all choppers covered by a single specification sheet, produced under essentially the same conditions, and offered for inspection at one time.

4.5.1.2 Production lot. A production lot shall consist of all choppers of the same PIN.

4.5.2. Group A inspection. Group A inspection shall consist of the examinations and tests specified in table III, and shall be made on the same set of sample units. Any of the tests specified in table III which are performed by the manufacturer as the final steps of his production process need not be repeated as a part of Group A inspection, provided that such tests and test conditions are clearly identical to, or more stringent than those specified in table III.

4.5.2.1 Sampling plan. A sample of parts shall be randomly selected in accordance with table IIIa. If one or more defects are found, the lot shall be rescreened and the defective parts removed. After screening and removal of defective parts, a new sample of parts shall be randomly selected in accordance with table IIIa. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

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

TABLE III. Group A inspection.

Inspection	Requirement paragraph	Method paragraph
Seal	3.6	4.6.2
Dielectric withstanding voltage	3.8	4.6.4.1
Electrical characteristics <u>1/</u>	3.7.1, 3.7.5, and 3.7.7	4.6.3.1.2, 4.6.3.5, and 4.6.3.7
Electrical characteristics <u>1/</u>	3.7.2, 3.7.3, and 3.7.4	4.6.3.2, 4.6.3.3, and 4.6.3.4
Insulation resistance	3.9	4.6.5
Visual and mechanical inspection	3.1., 3.4, 3.5, 3.20, and 3.21	4.6.1

1/ With nominal drive only.

TABLE IIIa. Group A inspection sampling plan.

Lot size	Sample size for tests in accordance with 3.6, 3.7.1, 3.7.5, 3.7.7, and 3.8	Sample size for tests in accordance with 3.7.2, 3.7.3, 3.7.4, 3.9 and visual and mechanical inspection
2 to 12	All	All
13 to 19	All	13
20 to 150	20	13
151 to 280	20	20
281 to 500	47	29
501 to 1,200	47	34
1201 to 3,200	53	42
3,201 and above	68	50

4.6 Methods of inspection.

4.6.1 Visual and mechanical inspection. Choppers shall be inspected to verify that the materials, design, construction, physical dimensions, marking, weight, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, 3.20, and 3.21).

4.6.2 Seal (see 3.6).

4.6.2.1 Seal test I (see 3.6.1). Choppers shall be tested as specified in method 112 of MIL-STD-202, test-condition letter B, except use water at room ambient temperature in lieu of silicone oil at a pressure of 1.5 inches of mercury. Care should be exercised to differentiate between actual leakage and bubbles caused by air dissolved in the liquid. Choppers that are sealed except for vent tube shall be immersed in water with 15 pounds per square inch of dry nitrogen applied to vent tube. Caution is to be exercised so that water does not enter vent tube.

4.6.2.2 Seal test II (see 3.6.2). Choppers shall be tested in accordance with method 112 of MIL-STD-202, test-condition letter C, procedure III or IV. Leakage-rate sensitivity shall be 1×10^{-8} atm cc/s.

4.6.3 Electrical characteristics.

4.6.3.1 Contact resistance (see 3.7.1).

4.6.3.1.1 Static contact resistance (or voltage drop (method I)). Choppers shall be tested in accordance with method 307 of MIL-STD-202. The following details and exception shall apply:

- (a) Method of connection: Between the measuring apparatus and the chopper terminals (for choppers with wire-lead terminals), this measurement shall be made $3/8 \pm 1/8$ inch from the emergence of the lead from the chopper. Voltage-sensing leads shall be connected in such a way as to exclude the resistance of the current-carrying leads.
- (b) Test current: Rated contact current.
- (c) Maximum open-circuit test voltage: The lower of rated contact voltage or 6.0 Vdc.
- (d) Points of measurements: All mated contacts in their closed position; the coil shall be energized with dc voltage which is 75 percent of rated ac coil voltage. The coil polarity shall be applied in both directions in order to transfer contacts.
- (e) Number of actuations prior to measurement: None
- (f) Number of test actuations: One for each contact pair (no contact voltage shall be applied during contact transfer).
- (g) Number of measurements per actuation: One in each closed contact position. In the event the measurement exceeds 0.10 ohm, the contact resistance shall be measured at the chopper terminations to determine if the excess is due to socket resistance. If so, the chopper shall be considered to have met the requirement.

4.6.3.1.2 Dynamic (method II). Contact resistance measurement shall be made with the chopper in the circuit of figure 1.

- (a) Connect the chopper as shown in figure 1. Energize the coil with nominal rated voltage and frequency.
- (b) In the contact circuit, set the oscillator frequency between 20 kHz and 30 kHz.
- (c) Set R_1 from 50,000 ohms to value required (see 3.1 and 6.2.2) for maximum contact current rating (S_1 closed).
- (d) Set R_2 for 3 ohms. Set the gain of pre-amp and scope to present an average vertical deflection of 8 centimeters.
- (e) Open S_1 , maintain a constant vertical deflection and adjust R_2 until the voltage drop (V) across the contact is $1/5$ to $1/10 R_2$ V drop.
- (f) The dynamic contact resistance is the calculated ratio of the contact V drop times the resistance R_2 (Note: Lead length must be deducted from results.).

4.6.3.2 DC coil resistance (see 3.7.2). The dc coil resistance of choppers shall be measured in accordance with method 303 of MIL-STD-202.

4.6.3.3 Coil impedance (see 3.7.3). The coil impedance of choppers shall be measured at +25°C with nominal coil voltage and frequency using the voltmeter-ammeter method or equivalent.

4.6.3.4 Capacitance (see 3.7.4). The contact capacitance of the choppers shall be measured in accordance with method 305 of MIL-STD-202. The following details and exception shall apply:

- (a) Test frequency: Nominal frequency as specified (see 3.1 and 6.2.2).
- (b) Points of measurement: Between switching contacts and coil, and between switching contacts and case.

4.6.3.5 Polarity (see 3.7.5). Apply dc voltage of predetermined polarity to specified drive coil terminals. Specified contact closure (see 3.1 and 6.2.2) shall occur. DC voltage applied to the coil shall be 75 percent of rated coil root-mean-square (rms) voltage.

4.6.3.6 Starting voltage (see 3.7.6). Each specimen shall be tested by the application of 120 percent of the rated coil voltage at nominal frequency across the coil for a minimum of 20 minutes. This voltage shall then be removed and within 1 minute, 80 percent of the rated coil voltage shall be applied. At the time the latter voltage is impressed across the coil and for 5 minutes thereafter, the output-waveform of the specimen under test shall be observed on an oscilloscope to determine immediate starting and continuous operation. The chopper shall not be jarred or vibrated during the test.

4.6.3.7 Waveform characteristics (see 3.7.7). Waveform characteristics shall be tested as specified herein and 4.6.3.7.1 to 4.6.3.7.4 inclusive. The chopper waveform characteristics shall be measured by means of the circuit of figure 2 or one with equivalent accuracy. The dwell time, dissymmetry, contact bounce, transfer time, and phase angle shall be measured on an oscilloscope with a minimum diameter of 4 inches as shown in figure 3. Before taking any measurements, and with the chopper armature shorted to the electrical contacts, the value of R1 will be adjusted for a perfect circle on the oscilloscope. The value of R3 will be adjusted for the desired contact current level. The coil voltage and frequency shall be varied in the ranges indicated in table VI unless otherwise specified (see 3.1 and 6.2.2).

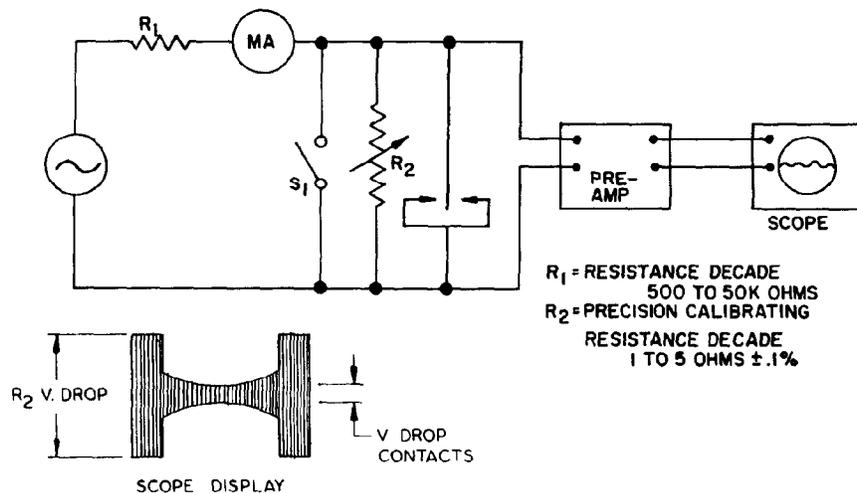
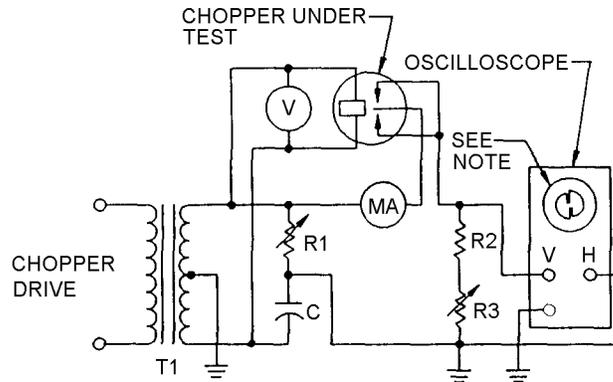


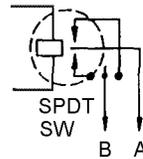
FIGURE 1. Circuit for measurement of dynamic contact resistance.

BBM CHOPPER CONNECTIONS



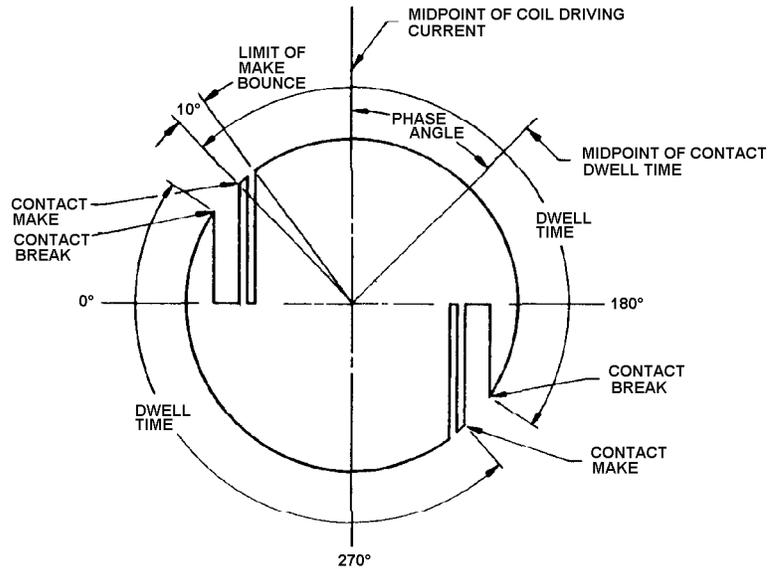
T1 = C.T. Power Transformer
 V = Voltmeter
 R1 = 0 to 50 K
 R2 = 820 OHMS
 R3 = 0 to 5 K
 C = .1 MFD

MBB CHOPPER CONNECTIONS



NOTE: Waveform display, (see figure 3) shall be a minimum of 4.00 (101.6 mm) inches in diameter.

FIGURE 2. Circuit for measurement of waveform characteristics.



Bounce or chatter may occur within the first 10° of dwell time (after make) or the last 10° of dwell time (before break). During this 10° period an aggregate of 4° maximum is allowed for either bounce or chatter breaks.

FIGURE 3. Waveform display.

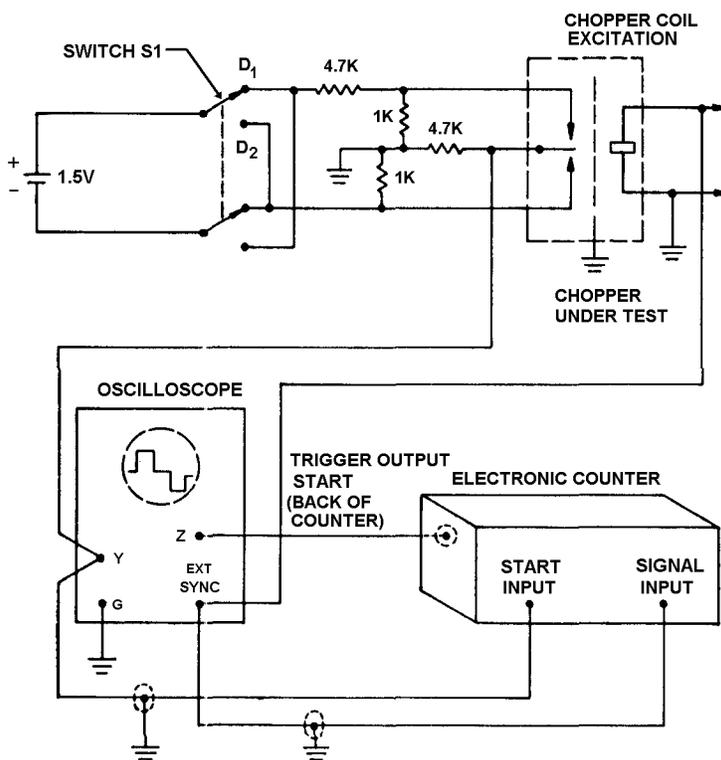


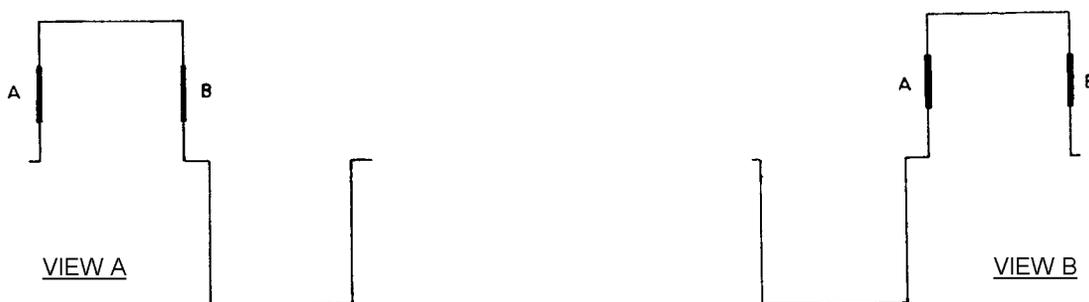
FIGURE 4. Alternate method of dwell and dissymmetry measurement.

TABLE VI. Coil voltage and frequency ranges.

Test Condition	Coil voltage (vrms) at 25°C ± 5°C			Coil frequency at 25°C ± 5°C		
	90%	100%	110%	90%	100%	110%
1	X			X		
2	X				X	
3	X					X
4		X		X		
5		X			X	
6		X				X
7			X	X		
8			X		X	
9			X			X

4.6.3.7.1 Alternate method for dwell time and dissymmetry.

4.6.3.7.1.1 Dwell time (see 3.7.7.1). The source of oscillator or coil excitation shall be as specified (see 3.1 and 6.2.2). The oscilloscope shall be set for internal sweep with horizontal and vertical amplitudes adjusted for an approximate pattern as shown in figure 4, using the specified coil voltage for the external trigger. The electronic counter function selector switch is set to "time interval" and the "start trigger level" is adjusted so that the marker appears approximately halfway on the rise slope (see point "A" in view A, figure 5). Then the "stop trigger level" is adjusted so that the marker appears approximately halfway on the decline slope (see point "B" in view B, figure 5). Read dwell time on counter in μs and convert to degrees. The dwell time displayed on the oscilloscope is the time of a particular dwell as sampled on the counter. Since at 400 Hz each μs represents 1/7 of a degree, successive samplings may not show the same number of μs on each sample due to the high accuracy of the measurement and the slight instability of the chopper. This phenomena does not always occur; however, when it is observed, it is not a sign of a faulty chopper. When this value varies as a dwell is sampled, the mean value should be taken as the dwell time. Example: If the maximum counter reading is 1,196 μs and minimum counter reading is 1,190 μs , the mean value of 1,193 μs at 400 Hz is the dwell time of the chopper and when converted from μs to degrees, equals 172 degrees.

FIGURE 5. Dwell and dissymmetry display.

4.6.3.7.1.2 Dissymmetry (see 3.7.7.2). Set switch S1 in figure 4 to D_1 position. Markers should appear at points "A" and "B" as shown in figure 5. If required, readjust markers as described in 4.6.3.7.1.1, read dwell on counter in μs , and convert to degrees. Switch S1 shall then be switched to the D_2 position. The difference in dwell readings is the dissymmetry of the chopper. Successive samplings may not show the same number of μs on each sample due to the high accuracy of the measurements and the slight instability of the chopper.

4.6.3.7.2 Contact bounce (see 3.7.7.3). Choppers shall be tested in accordance with the circuit shown in figure 2 and the waveform display of figure 3.

4.6.3.7.3 Transfer time (see 3.7.7.4). Choppers shall be tested in accordance with the circuit shown in figure 2 and the waveform display of figure 3.

4.6.3.7.4 Phase angle (see 3.7.7.5). Choppers shall be tested in accordance with the circuit shown in figure 2 and the waveform display of figure 3.

4.6.3.8 Noise level (see 3.7.8). With rated coil voltage and frequency applied to coil, test the chopper in the standard noise test circuit of figure 6, or a circuit of equivalent accuracy, with the load impedances required. The specified rms meter may be replaced with a peak-to-peak reading vacuum-tube voltmeter (VTVM), if desired. The output waveform of the system shall be monitored with an oscilloscope constantly to insure against the possibility of overdriving or clipping in the amplifier. Provisions shall be made to (1) calibrate the system, and (2) to measure the system noise level. The system noise level shall be subtracted in rms fashion from the output rms noise level to determine the actual rms noise level.

4.6.4 Dielectric withstanding voltage (DWV) (see 3.8).

4.6.4.1 At sea level. Choppers shall be tested in accordance with method 301 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Magnitude of test voltage: Unless otherwise specified (see 3.1 and 6.2.2), 200 V rms 60 Hz or 280 Vdc, except across open contacts 2 times rated contact voltage shall be applied.
- (b) Points of application:
 - (1) Between switching circuit and coil.
 - (2) Between switching circuit and case or frame.
 - (3) Between coil and case or frame.
- (c) Maximum leakage current: 100 μ A.
- (d) Examination after test: Choppers shall be visually examined for evidence of arcing, flashover, insulation breakdown, and damage.

4.6.4.2 At reduced barometric pressure. When applicable, choppers shall be tested in accordance with methods 105 and 301 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Test condition letter of method 105: C.
- (b) Magnitude of test voltage: Unless otherwise specified (see 3.1 and 6.2.2), 150 V rms, 60 Hz.
- (c) Points of application: As specified in 4.6.4.1b.
- (d) Maximum leakage current: As specified in 4.6.4.1c.
- (e) Examination after test: As specified in 4.6.4.1d.

4.6.5 Insulation resistance (IR) (see 3.9). Choppers shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

- (a) Test condition letter: A.
- (b) Points of measurement: Measurements shall be made between mutually insulated terminals, and between terminals and case.

4.6.6 Thermal shock and high and low temperature operation (see 3.10) (when specified) (see 3.1). Choppers shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:

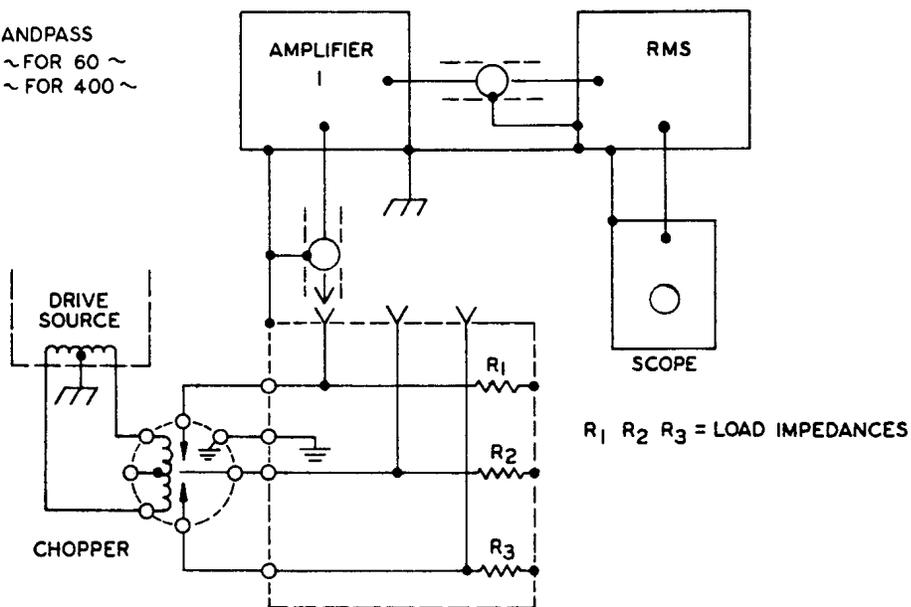
- (a) Test condition letter: A or B, as applicable, in accordance with the specified chopper temperature range.
- (b) Measurements: During the fifth cycle, at the completion of steps 1 and 3 and while maintaining the specified temperatures, contact resistance and waveform characteristics shall be measured as specified in 4.6.3.1.2 and 4.6.3.7. After return to room temperature after thermal shock, contact resistance, starting voltage, IR and DWV shall be measured as specified in 4.6.3.1.2, 4.6.3.6, 4.6.5 and 4.6.4, respectively.

4.6.7 Salt spray (corrosion)(see 3.11). Choppers shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

- (a) Test condition letter: B.
- (b) Measurements after exposure: Salt deposits shall be removed by a gentle wash. The choppers shall then be air blasted and permitted to dry 24 hours at 40°C. After the drying period, choppers shall be visually examined for evidence of excessive corrosion and oxidation. Contact resistance, dc coil resistance and waveform characteristics (with nominal drive only) shall be measured as specified in 4.6.3.1.1, 4.6.3.2, and 4.6.3.7, respectively.

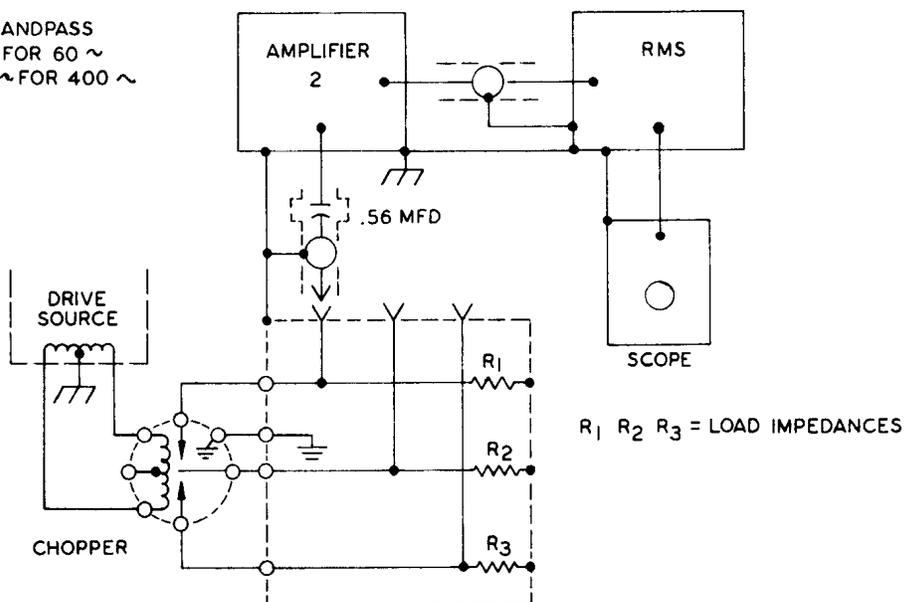
4.6.8 Sand and dust (see 3.12). Choppers shall be tested in accordance with method 110, test condition letter B, of MIL-STD-202. At the end of the test period, DWV and waveform characteristics (with nominal drive only) shall be measured as specified in 4.6.4 and 4.6.3.7, respectively.

PREAMP BANDPASS
 20-1500~ FOR 60 ~
 80-1500~ FOR 400 ~



CIRCUIT "A" FOR IMPEDANCES
 UP TO 10 K Ω

PREAMP BANDPASS
 8-1000~ FOR 60 ~
 80-1000~ FOR 400 ~



CIRCUIT "B" FOR IMPEDANCES ABOVE 10 K Ω

FIGURE 6 Standard noise test circuits.

MIL-DTL-83729B

4.6.9 Vibration (see 3.13). Choppers shall be tested in accordance with 4.6.9.1, 4.6.9.2, or 4.6.9.3, as applicable (see 3.1 and 6.2.2). Nominal drive only applicable for waveform tests.

4.6.9.1 Vibration I (10-55Hz). Choppers shall be tested in accordance with method 201 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Tests and measurements prior to vibration: Dynamic contact resistance as specified in 4.6.3.1.2.
- (b) Mounting method: Rigidly mounted by normal mounting means on the vibration test apparatus.
- (c) Tests and measurements during vibration (when applicable, see 3.1 and 6.2.2): Waveform characteristics shall be continuously monitored during vibration.
- (d) Following vibration, IR, dynamic contact resistance, starting voltage, waveform characteristics, DWV, noise level, coil impedance and seal shall be measured as specified in 4.6.5, 4.6.3.1.2, 4.6.3.6, 4.6.3.7, 4.6.4.1, 4.6.3.8, 4.6.3.3, and 4.6.2, respectively.
- (e) Energize chopper coil with nominal drive during half of the vibration test time in each of the three mutually perpendicular planes.

4.6.9.2 Vibration II (10-500 Hz). Choppers shall be tested in accordance with method 204 of MIL-STD 202. The following details and exceptions shall apply:

- (a) Mounting method: As specified in 4.6.9.1b.
- (b) Test condition letter: A.
- (c) Tests and measurements during and after test: As specified in 4.6.9.1c and 4.6.9.1d.

4.6.9.3 Vibration III (10-2,000 Hz). Choppers shall be tested in accordance with method 204 of MIL-STD-202. The following details shall apply:

- (a) Method of mounting: As specified in 4.6.9.1b.
- (b) Test condition letter: B.
- (c) Tests and measurements during and after test: As specified in 4.6.9.1c and 4.6.9.1d.

4.6.10 Acceleration (see 3.14). The choppers shall be tested in accordance with method 212 of MIL-STD-202. The following details shall apply:

- (a) Mounting method: Rigidly mounted on the centrifuge.
- (b) Test condition letter: C.
- (c) Value of acceleration: As specified (see 3.1 and 6.2.2).
- (d) Measurements: During the test, the waveform characteristics (with nominal drive only) shall be measured as specified in 4.6.3.7.

4.6.11 Terminal strength (see 3.15). Unless otherwise specified herein, three terminals of each discrete design, size, and configuration shall be tested; however, if there be less than three of such design, size, and configuration, they shall be tested. The choppers shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Wire leads: Bend test for wire leads shall be in accordance with test condition C. For PC board wire leads, bend test is not applicable. Pull test for wire leads shall be in accordance with test condition A with the applicable pull (pounds) shown in table VII.
- (b) Solder lug, pin and plug-in terminals: Choppers shall be subjected to the applicable pull force specified in table VII in accordance with test condition A. Bend test of solder lug, pin and plug-in terminals shall be performed by applying the applicable force (see table VII) to the outer 20 percent of terminal length and at right angles to the terminal axis. Maintain load for 15 to 30 seconds.

TABLE VII. Pull and bend test.

Terminal diameter (inches)	Pull pounds, test condition A					Bend test - test condition C *Test condition C (modified)				
	Wire leads	Solder lug	Pin	Plug in	Wire Leads PC board	Wire leads	Solder lug	Pin	Plug in	Wire leads PC board
<.023	2±0.2	2±0.2	2±0.2	2±0.2	2±0.2	1.0	*1.0	*1.0	*1.0	1.0
.023-.035	3±0.3	3±0.3	3±0.3	3±0.3	3±0.3	1.0	*1.0	*1.0	*1.0	1.0
.035-.047	5±0.5	5±0.5	5±0.5	5±0.5	5±0.5	2.5	*2.5	*2.5	*2.5	2.5

4.6.12 Moisture resistance (see 3.16). Choppers shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Mounting: On a corrosion-resistant metal panel, by normal mounting means.
- (b) Polarization: A polarizing voltage of 100 V dc shall be applied between all terminals tied together, and the metal panel. The negative polarity shall be applied to the case. Steps 7a and 7b are not applicable.
- (c) Final measurements: Upon completion of step 6 of the final cycle, the IR shall be measured as specified in 4.6.5. After a 24-hour drying period at a relative humidity of 50 ±5 percent, choppers shall be examined for evidence of excessive peeling, flaking, chipping, or crazing of the protective coating, and dynamic contact resistance, IR, DWV, dc coil resistance, coil impedance, and waveform characteristics (with nominal drive only) shall be measured as specified in 4.6.3.1.2, 4.6.5, 4.6.4, 4.6.3.2, 4.6.3.3, and 4.6.3.7, respectively.

4.6.13 Barometric pressure (reduced) (see 3.17). Choppers shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply

- (a) Mounting method: Choppers shall be rigidly mounted by a normal mounting means.
- (b) Test condition letter: C.
- (c) Tests during subjection to reduced pressure: The choppers shall be operated for 2 hours at the maximum operating temperature. Within the final 15 minutes of the test, the waveform characteristics (with nominal drive only) shall be measured as specified in 4.6.3.7.

4.6.14 Shock (see 3.18).

- (a) Mounting method: Choppers shall be rigidly mounted by normal mounting means.
- (b) Test condition letter: As specified (see 3.1 and 6.2.2).
- (c) Electrical load conditions: The coil shall be energized, and choppers contacts shall be monitored with an oscilloscope to insure dwell time are continuous.
- (d) Test and measurements: After each direction of impact shock, measurements of waveform characteristics (with nominal drive only) and starting voltage shall be made as specified in 4.6.3.7 and 4.6.3.6. At the completion of the test, DWV shall be tested as specified in 4.6.4.1.

4.6.14.2 High impact shock (when specified, see 3.1 and 6.2.2). Choppers shall be tested in accordance with method 207 of MIL-STD-202. The following details shall apply:

- (a) Mounting method: Same as 4.6.14.1a.
- (b) Electrical load conditions: Same as 4.6.14.1c except continuous dwell time not required.
- (c) Tests and measurements: Same as 4.6.14.1d.

4.6.15 Life (see 3.19). Unless otherwise specified (see 3.1 and 6.2.2), life tests shall be of 2,000 hours duration. The coil shall be energized with nominal voltage and frequency. The temperature throughout the life tests shall be $+25 \pm 5^\circ \text{C}$. No current or voltage shall be applied to the contacts during life tests.

- (a) At the start of life tests and at 100, 500, 1,000, 1,500 and 2,000 hours, insulation resistance, dielectric withstanding voltage, static and dynamic contact resistance, waveform characteristics and noise level shall be measured as specified in 4.6.5, 4.6.4, 4.6.3.1.1, 4.6.3.1.2, 4.6.3.7, and 4.6.3.8, respectively. The coil shall be energized with nominal voltage and frequency for all measurements. All measurements shall be made at $+25 \pm 5^\circ \text{C}$ before, during, and at the end of life tests.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. Electromechanical choppers are used in power supplies and special applications that require conversion of a direct current voltage to a modified square wave of the same frequency and phase relationship to a driving sine or square wave of alternating current.

6.2 Acquisition requirements. Acquisition documents must specify the following:

6.2.1 Choppers covered by specification sheets.

- (a) Title, number, and date of the specification.
- (b) Title, number, and date of the applicable specification sheet and the complete part number (see 1.2).
- (c) Packaging requirements (see 5.1).
- (d) Special or additional identification marking requirements (see 3.20).

6.2.2 Choppers not covered by specification sheets.

- (a) Title, number, and date of this specification.
- (b) Information pertaining to inspection (see 3.3 and 4.6):
 - (1) The laboratory at which the inspection is to be performed (see 4.6).
 - (2) Submission of samples and data (see 4.6).
- (c) Applicable interface and construction requirements (see 3.5 through 3.5.8 inclusive).
- (d) Applicable electrical characteristics (see 3.7.1 to 3.7.8, inclusive).
- (e) Whether sand and dust, acceleration, barometric pressure (reduced) are applicable (see 3.12, 3.14, and 3.17).
- (f) Applicable vibration test.
- (g) Packaging requirements (see 5.1).
- (h) Special or additional identification marking requirements (see 3.20).

6.3 First article inspection. Information pertaining to first article inspection of products covered by this specification should be obtained from the procuring activity for the specific contracts involved (see 3.2).

6.4 Intermetallic contact. The finishing of metallic areas to be placed in intimate contact before 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.

6.5 Subject term (key word) listing.

BBM - Break-before-make.

Chatter - A discontinuity of contact closure during dwell time (exclusive of bounce time) for periods exceeding 10 μ s.

Chopper - An electromechanical device for the production of modified square waves, of the same frequency as, and bearing a definite phase relationship to a driving sine wave.

Common time - In a MBB chopper, the angle in degrees that the contacts are all mutually closed.

Contact bounce - Intermittent opening of contacts after the initial closing due to contact impact.

Dissymmetry - The differential between the dwell time of the positive half cycle and the dwell time of the negative half cycle.

Drive (also called coil voltage) - In a chopper, the power supplied to a coil to cause action, usually measured in terms of voltage and frequency.

Dwell time - The time in degrees during which a contact is closed, or time in ms, either referred to a driving sine wave.

Hermetic seal - Hermetic seal is metal-to-metal, ceramic-to metal, or glass-to-metal only.

MBB - Make-before-break.

Off-time - The time in degrees of a driving sine wave, in a BBM chopper, during which neither contact of an opposing pair is closed.

Phase angle - Of a chopper, the angle in degrees between a driving sine wave and the midpoint of the dwell time (the angle between the 90 degree point of the sine wave and the square wave center).

Polarity - The closing of specified contacts, as a result of application of DC voltage of predetermined polarity to specified coil terminals. (DC voltage to be 75 percent of rated coil RMS voltage).

Transfer time - Transfer time is the elapsed time between end of one dwell period to initial contact closure of next successive dwell period.

6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - CR
Navy - EC
Air Force - 11
DLA-CC

Preparing activity:
DLA - CC

(Project 5945-1152)

Review activities:
Army - AR, AT, AV, CR4, MI
Navy - AS, MC, OS
Air Force - 19, 99