MIL-R-50781
25 October 1972

MILITARY SPECIFICATION

RESOLVERS, ELECTRICAL, LINEAR: GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope.- This specification covers general requirements for electrical linear resolvers. These inductive devices convert a mechanical input (rotor position) into an electrical signal output which is a linear function of rotor position over a specified angular travel.

1.2 Classification.

1.2.1 Nomenclature.- All linear resolvers having the same nomenclature shall be mechanically and electrically interchangeable for all military applications. The nomenclature shall consist of the item name, i.e. Resolver, Electrical, Linear, followed by a type designation indicated by a combination of digits and letters. Illustrated below is the complete type designation for a linear resolver type 26V-11L14504A:

26V-	11	L	14	50	4	A
1.2.1.1	1.2.1.2	1.2.1.3	1.2.1.4	1.2.1.5	1.2.1.6	1.2.1.7

1.2.1.1 Voltage.- Linear resolvers designed to operate from a 115 volt supply, this space shall be left blank. Linear resolvers operating from a 26 volt supply shall be identified by "26V" preceding the type designation.

1.2.1.2 Size.- After the applicable voltage identification, the next two digits shall designate the maximum diameter in tenths of an inch. If the diameter is not exactly a whole number of tenths, the next higher tenth shall be used.

1.2.1.3 Function.- The letter "L" designates linear resolver.

1.2.1.4 Impedance of primary winding.- The impedance of the primary winding shall be the nominal primary impedance in hundreds of ohms. If the impedance is not exactly a whole number of hundreds, the next higher hundred shall be used.

1.2.1.5 Effective electrical travel.- The linear output function that is accomplished within the maximum effective electrical travel limits, by positive and negative angular rotor shaft displacement from linear resolver zero, shall be identified by a plus and minus value representing this angular displacement.

1.2.1.6 Energization frequency.- The energization frequency shall be identified as follows:

Energization frequency (Hz)	Code
400	4

1.2.1.7 Modification.- The upper case letter "A" following the frequency code shall indicate the original or basic design of a linear resolver. The first modification that affects the external mechanical dimensions or the electrical characteristics of the basic type shall be indicated by the upper case "B". Succeeding modifications are indicated by "C", "D", and so forth.

1.2.2 Military part number.- The military part number shall consist of the letter "M", the specification sheet number, and an assigned dash number (see 3.1) as illustrated:

M 50781/2-001

Military designator	specification sheet number	Dash number
M	50781/2	001

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Federal

QQ-A-250/4	Aluminum Alloy, Plate and Sheet, 2024
QQ-B-637	Brass, Naval: Rod, Wire, Shapes, Forgings, and Flat Products with Finished Edges (Bar, Flat Wire, and Strip)
QQ-S-764	Steel Bar, Corrosion Resisting, Free Machining

Military

MIL-W-583	Wire, Magnet, Electrical
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-S-12134	Synchros, Resolvers, and Servo Motors; Packaging of
MIL-W-16878/4	Wire, Electrical, Type E, 200°C and 260°C, 600 Volts (Insulated, High Temperature)

STANDARDS

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Interference Characteristics Requirements for Equipment
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of

(See Supplement 1 for list of applicable specification sheets.)

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

2.2 Other publications.- The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL BUREAU OF STANDARDS

Handbook H28 Screw-Thread Standards for Federal Services

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.)

AFBMA Standard ABEC-5

(Application for copies should be addressed to the Anti-Friction Bearing Manufacturers Association, Inc., 60 East 42nd Street, New York, N.Y. 10017.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Specification sheets.- The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets.

3.2 Qualification.- Linear resolvers 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 4.4 and 6.5).

3.3 First article.- When required by the procuring activity, linear resolvers shall conform to the requirements specified herein and shall have met the first article inspection specified in 4.5 prior to regular production on a contract (see 6.3).

3.4 Parts, materials, and processes.

3.4.1 Selection of parts and materials.- Whenever possible, parts and materials shall be selected from those specified herein. If a suitable material is not listed, a material shall be used which will permit the linear resolver to meet all the requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.4.2 Housing and rotor shaft.- Housing and rotor shaft material shall be corrosion resisting steel conforming to QQ-S-764, Type 416. The rotor shaft material shall have a hardness equivalent to Rockwell C20 to C32.

3.4.3 Collector rings.- Collector rings shall be of gold alloy material.

3.4.4 Ball bearings.- Ball bearings of the radial thrust type and conforming to AFBMA Standard, Grade ABEC-5 or better shall be used. Double shielding shall be employed. Balls, races, retainers, and shields shall be made of corrosion resisting steel.

3.4.5 Lubricants.- Lubricants used in linear resolvers shall be consistent with the requirements herein in regard to fungus and moisture resistance, corrosion, emission of toxic fumes while enabling the linear resolver to meet all the performance and environmental requirements of this specification.

3.4.6 Restricted material.- Flammable or explosive material, magnesium or magnesium alloys, material which can produce toxic or suffocating fumes, cotton, linen, cellulose nitrate, regenerated cellulose, wood (untreated), jute, leather, cork, organic fiberboard, paper and cardboard, hair or wool felts, plastic materials employing paper, cotton, linen or wood flours as a filler, materials composed of phenolic mercury or mercuric compounds shall not be used.

3.4.7 Fungus and moisture resistant materials.- Materials which are not nutrients for fungi and which are moisture resistant shall be used.

3.4.8 Plastics.- Plastics shall be in accordance with Requirement 11 of MIL-STD-454.

3.4.9 Dissimilar metals.- Dissimilar metals shall not be used in intimate contact with each other unless suitably protected against electrolytic corrosion. When it is necessary for any combination of dissimilar metals to be assembled a material compatible with each shall be interposed between them. For classification purposes metals are grouped as follows:

Group 1	Group 2	Group 3	Group 4
	Aluminum	Zinc	Copper and its alloys
Most anodic metals	Aluminum alloys	Cadmium	Nickel and its alloys
	Zinc	Steel	Chromium
	Cadmium	Lead	Corrosion-resistant steel
	Tin	Tin	Gold
	Corrosion-resistant steel	Corrosion-resistant steel	Silver (Cathodic)
			Most Cathodic metals

NOTES:

a. Contact between a member of any one group and another member of the same group shall be considered as being similar. Contact between a member of one group and a member of any other group shall be considered as being dissimilar except for zinc, tin and cadmium as listed in Groups 2 and 3, and corrosion-resistant steel as listed in Groups 2, 3, and 4.

b. All metals not listed in the above grouping shall be considered as being dissimilar not only to each other but also to any member of any group.

c. The above grouping shall not be construed as waiving requirements relating to the corrosion resistance treatment of parts and assemblies. Care shall be exercised in using aluminum alloys against each other or against differing materials.

d. Where reference is made in the above grouping to a certain member in a particular group the reference applies to the metal on the surface of the part such as zinc means zinc casting, zinc electro-plate, zinc hot dip or zinc metal spray.

e. If any corrosion is anticipated between different metals in contact, even though they are similar, the metals shall be assembled in such a manner that the smaller part is cathodic and protected and the larger anodic or corrodible.

f. Certain qualified standard or approved nonstandard parts and attaching hardware have tin or nickel-plate finish. These parts may be mounted on a chassis without additional protection from corrosion.

3.4.10 Electrolytic corrosion protection.- Where it is unavoidable that combinations of dissimilar metals be in contact the following methods or combinations of methods shall be employed unless electrical consideration preclude their use:

a. A material shall be interposed between the metals so as to reduce electrolytic potential differences, such as steel in contact with aluminum should be cadmium plated.

b. An inert material shall be interposed between dissimilar metals to act as an insulating barrier.

c. Corrosion inhibitors shall be applied to the faces of each of the dissimilar metals, such as nickel-plated brass screws in contact with aluminum shall be coated with zinc chromate paste.

d. The contact areas of each of the dissimilar metals shall be coated with an inorganic coating such as aluminum and steel surfaces in contact should be painted.

e. The requirements of 3.4.9e shall apply.

f. The amount of aeration reaching the dissimilar contact areas shall be restricted, such as steel bolts in contact with aluminum should have all contact surfaces sealed with zinc chromate primer or with a vinyl or equivalent film.

g. Any other systems of protection which are designed to alleviate electrolytic corrosion shall be subject to the approval of the procuring activity.

3.4.11 Threaded parts.- All screw threads used in the construction of linear resolvers shall be in accordance with the National Bureau of Standards Handbook H-28 - "Screw-Thread Standards for Federal Services." The number of threads and general dimensions shall be those specified for the American National Coarse-Thread series or the American National Fine-Thread series. Threads of the coarse-thread series are preferred, except where definite improvements in design or operating characteristics would be affected by use of fine-thread series.

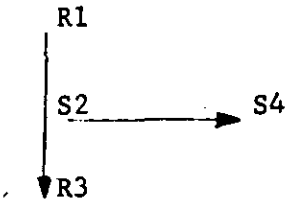
3.4.12 Soldering.- Soldering shall be in accordance with Requirement 5 of MIL-STD-454.

3.4.13 Magnet wire.- Magnet wire shall conform to MIL-W-583, class 130 or higher.

3.5 Design conventions.

3.5.1 Electrical angle.- The electrical angle is the angle θ which satisfies the magnitude and polarity relationship of the secondary voltage of an ideal linear resolver in the following equations. The instantaneous polarity and sense of rotation may be obtained from the arrow conventions indicating zero angular degrees in 3.5.1.1 and 3.5.1.2.

3.5.1.1 Electrical angle, rotor energized.-

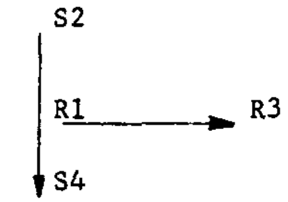


$$E(S2S4) = NE(R1R3)\,\frac{\theta}{b}$$

Where:

1. $-b \leq \theta \leq b$
2. b is the positive angle denoting the maximum effective electrical position as defined in 6.4.2.
3. N is the transformation ratio as defined in 6.4.6.

3.5.1.2 Electrical angle, stator energized.-



$$E(R1R3) = NE(S2S4)\,\frac{\theta}{b}$$

Where:

1. $-b \leq \theta \leq b$
2. b is the positive angle denoting the maximum effective electrical position as defined in 6.4.2.
3. N is the transformation ratio as defined in 6.4.6.

3.6 Linear resolver zero.- Linear resolver zero is the position of the rotor shaft for which the electrical angle is zero. The electrical angle is zero when the position of the rotor with respect to the stator satisfies the applicable secondary voltage polarity relationship of 3.5.1 and minimum voltage is induced in the secondary winding. At this rotor position where minimum voltage occurs, the fundamental frequency component which is in time phase with the maximum value of secondary voltage is zero. The pertinent maximum value of inphase secondary voltage is obtained at the maximum positive effective electrical travel position when the rotor is turned in the positive direction (counterclockwise) from linear resolver zero. The pertinent maximum value of out of phase secondary voltage is obtained at the maximum negative effective electrical travel position when the rotor is turned in the negative direction (clockwise) from linear resolver zero.

3.6.1 Linear resolver zero, rotor energized.- Linear resolver zero, as defined in 3.5.1.1, occurs for rotor energized linear resolvers when windings R1R3 and S2S4 are at minimum coupling and is determined in accordance with Figure 1.

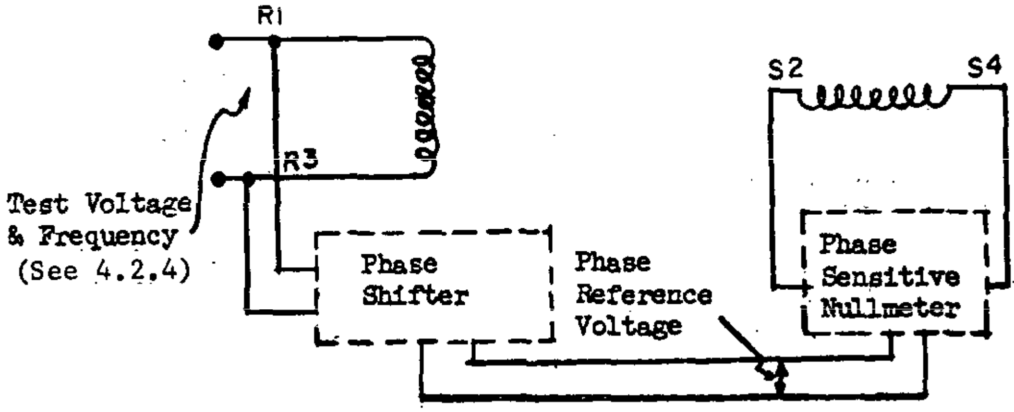


Figure 1. Linear resolver zero, rotor energized.

3.6.2 Linear resolver zero, stator energized.- Linear resolver zero, as defined in 3.5.1.2, occurs for stator energized linear resolvers when windings S2S4 and R1R3 are at minimum coupling and is determined in accordance with Figure 2.

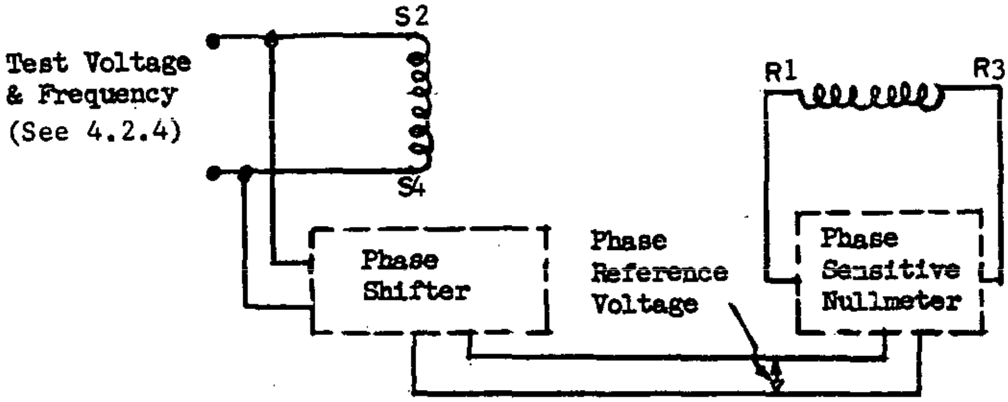


Figure 2. Linear resolver zero, stator energized.

3.7 Design and construction.

3.7.1 Terminal strength security.

3.7.1.1 Wire lead terminals.- Each wire lead terminal shall be 18 inches long minimum or as specified in the applicable specification sheet. Wire leads shall conform to MIL-W-16878/4. Each wire lead shall be capable, once only, of withstanding a minimum pulling force of 2 pounds applied in a manner that both the conductor strands and insulation will be subjected to the force. Each wire lead shall not separate from the housing nor show evidence of insulation or conductor strand damage.

3.7.1.2 Screw-thread terminal.- Each screw-thread terminal as specified in the applicable specification sheet shall be capable, once only, of withstanding a gradual minimum torque of 4.5 pound-inches and maintained for a period of 5 to 10 seconds without evidence of movement or damage to the terminal or surrounding materials. The torque shall be applied clockwise and then counterclockwise to the centerline of the terminal assembly.

3.7.1.3 Solder-pin terminal.- Each solder-pin terminal as specified in the applicable specification sheet shall be capable, once only, of withstanding a gradual 2 pound minimum pulling force and maintained for a period of 5 to 10 seconds without evidence of movement or damage to the terminal or surrounding materials. The force shall be applied in the direction of the terminal axes.

3.7.2 Termination identification.- Termination identification markings shall be molded permanently into the end cap. When screw-thread terminals are specified, the design of the end cap shall be such that the terminal block shall remain fixed when terminal screws are removed.

Table I - Termination Identification

Winding	Terminal Screw & Solder-Pin	Wire Lead Color-Code
STATOR S2S4	S2 S4	Yellow Blue
ROTOR R1R3	R1 R3	Red, White Tracer Black, White Tracer

3.7.3 Linear resolver zero marking.- The linear resolver housing shall be permanently marked with an index line or arrow adjacent to the rotor shaft to coincide with a permanent mark on the rotor shaft within 10° of exact linear resolver zero.

3.8 Performance.

3.8.1 Variation of brush contact resistance.- After having been rotated a maximum of three times in any direction, the rotor shaft shall be turned at a continuous travel equivalent to the cyclic rate of 1 rpm through the maximum effective electrical travel limits passing through zero. The brush contact resistance change (measured in terms of corresponding voltage) shall be permanently recorded. The allowable change in brush contact resistance between collector rings and brushes (between terminals R1R3) shall be not more than 1.0 ohm for linear resolvers whose measured rotor resistance is 200 ohms or less and 0.5 percent of measured rotor resistance is greater than 200 ohms. The linear resolver shall be energized from a source of constant current not to exceed 10 ma. Resistance variations of less than 25 milliseconds in duration shall be disregarded.

3.8.2 Radial and end play.- With a mechanical load on the rotor shaft as prescribed in the applicable specification sheet, the linear resolver shall meet the radial and end play specified limits therein.

3.8.3 Dielectric withstanding voltage.- The linear resolver shall be subjected to the test potentials between application points specified in accordance with Table II. The linear resolver shall display no evidence of insulation breakdown or of internal arcing nor shall winding leakage current exceed 1 milliampere peak. The leakage current limit shall not include the current drawn by the test equipment capacitance. Immediately after meeting this requirement, the linear resolver shall be subjected to the insulation resistance requirement of 3.8.4.

Table II. Dielectric Withstanding Voltages and Application Points

	Initial Acceptance Test Voltages, (50 or 60 Hz)	Subsequent Test Voltages, (50 or 60 Hz)
Maximum Rated Voltage, rms	Each Winding to Housing & Primary to Secondary Windings	Each Winding to Housing & Primary to Secondary Windings
Up to 50	242 to 250	194 to 200
51 to 100	485 to 500	388 to 400
101 to 200	870 to 900	720 to 740

3.8.4 Insulation resistance.- The linear resolver shall be measured for insulation resistance between those applications points specified in accordance with Table II. When tested at -55°C and at the standard test condition, the insulation resistance shall be at least 50 megohms, and at least 10 megohms when tested at 125°C. For linear resolvers with a maximum operating voltage greater than 50 volts rms 500 volts dc (300 volts dc during altitude requirement of 3.9.4) shall be applied to application points of Table II. For linear resolvers with a maximum operating voltage 50 volts rms or less, 100 volts dc shall be applied to application points of Table II.

3.8.5 Input voltage and frequency.- The linear resolver shall be designed to operate at the input voltage and frequency specified in the applicable specification sheet.

3.8.6 Current.- The primary current value shall be within the limits as specified in the applicable specification sheet when measured at linear resolver zero and the secondary winding open-circuited.

3.8.7 Power.- The primary power value shall be within the limits as specified in the applicable specification sheet when measured at linear resolver zero and the secondary winding open-circuited.

3.8.8 Voltage gradient (6.4.5).- The voltage gradient shall be within the limits as specified in the applicable specification sheet through the maximum effective electrical travel limits.

3.8.9 Friction torque.- The torque required to turn the rotor shall not exceed the values specified in the applicable specification sheet.

3.8.10 Phase shift.- The phase shift shall not exceed the value specified in the applicable specification sheet through the maximum effective electrical travel limits with the exception of plus or minus 5 degrees within the linear resolver zero position of 3.6.

3.8.11 Linearity error (6.4.3).- The output voltage shall be linear as expressed in varying degrees of percentage of linearity error as required for specified linearity error tolerance zones within the maximum effective electrical travel limits as specified in the applicable specification sheet.

3.8.12 Effective electrical travel (6.4.2).- The linear output function shall be accomplished within the maximum effective electrical travel limits as specified in the applicable specification sheet.

3.8.13 Residual (Null) voltage.- The fundamental and total residual (null) voltage shall not exceed the values as specified in the applicable specification sheet while being measured at the linear resolver zero position.

3.8.14 Impedance.- Rotor and stator winding impedances shall be within the limits as specified in the applicable specification sheet while being measured at the positive maximum effective electrical travel position.

3.8.15 Shift of linear resolver zero with frequency variation.- The change of position of linear resolver zero specified in 3.6 with frequency variation of plus and minus 10 percent shall be within the limits specified in the applicable specification sheet.

3.8.16 Electromagnetic interference.- The linear resolver shall not exceed the conducted and radiated limits of MIL-STD-461, requirements CE03 and RE02 of Equipment Class 11B while the primary winding is energized and the secondary winding is electrically loaded as applicable and the rotor shaft is rotated at a continuous travel equivalent to the cyclic rate of 60 ± 3 rpm through the maximum effective electrical travel limits passing through zero.

3.8.17 Temperature rise.- The temperature rise of the linear resolver shall not exceed the value specified in the applicable specification sheet.

3.9 Environmental.

3.9.1 Ambient temperature.- The linear resolver shall be capable of storage in ambient temperatures ranging from -62 to 100°C for a minimum of 24 hours.

3.9.1.1 Ambient low temperature.- The linear resolver shall be capable of operation in an ambient temperature of -55°C during which the linear resolver shall meet the requirements of Table III as listed therein.

3.9.1.2 Ambient high temperature.- The linear resolver shall be capable of operation in an ambient temperature of 125°C during which the linear resolver shall meet the requirements of Table III as listed therein.

3.9.2 Vibration.- The linear resolver shall be capable of withstanding harmonic vibrations of 0.06 inch double amplitude (maximum total excursion) or 15g (pK), whichever is less over the frequency range of 10 to 2000 Hz in each of three mutually perpendicular planes, one of which shall be that of the linear resolver's shaft axis for a period of four hours in each plane. The vibration cycle of 10 to 2000 Hz and return to 10 Hz, shall be traversed in 20 minutes. During the test, the linear resolver shall be energized and its shaft mechanically loaded and free to rotate. At the conclusion of testing, the linear resolver shall show no evidence of loose or damaged parts and shall then be subjected to and satisfactorily meet the requirements of Table III as listed therein.

3.9.3 Shock.

3.9.3.1 Low impact shock.- The linear resolver shall be capable of withstanding 30 impacts at an acceleration of 50g (pK) of 11 ± 1 millisecond time duration. The linear resolver shall be subjected to five blows in each direction along three mutually perpendicular axes, one of which shall be that of the linear resolver's shaft axis for a total of 30 blows while being energized and the shaft mechanically loaded and free to rotate. The shock may be produced by any method capable of generating a pulse of half sine wave form having an amplitude distortion at any point of less than 10 percent of the pulse peak amplitude. At the conclusion of testing, the linear resolver shall show no evidence of loose or damaged parts and shall then be subjected to and satisfactorily meet the requirements of Table III as listed therein.

3.9.3.2 High impact shock.- The linear resolver shall be capable of withstanding three shock blows from a weight of 400 lbs, falling vertically from heights of 1, 3, 5 feet respectively and three end (back) blows from a weight of 400 lbs. swinging on a radius of 5 feet and falling from a vertical height of 1, 3, 5 feet respectively while being energized and the shaft mechanically loaded and free to rotate. At the conclusion of testing, the linear resolver shall show no evidence of loose or damaged parts and shall then be subjected to and satisfactorily meet the requirements of Table III as listed therein.

3.9.4 Altitude.- The linear resolver shall be capable of operation from sea level to 100,000 feet in combination with any temperature from -55 to 125°C.

3.9.4.1 Altitude low temperature.- The linear resolver shall be subjected to a reduced chamber pressure of 8.27 Torr (approximately equivalent to an altitude of 100,000 feet) while in an ambient temperature environment of -55 ± 2°C. While still in this specified environment, the linear resolver shall be subjected to and satisfactorily meet the requirements of Table III as listed therein.

3.9.4.2 Altitude high temperature.- The linear resolver shall be subjected to a reduced chamber pressure of 8.27 Torr (approximately equivalent to an altitude of 100,000 feet) while in an ambient temperature environment of 125 ± 2°C. While still in this specified environment, the linear resolver shall be subjected to and satisfactorily meet the requirements of Table III as listed therein.

3.9.5 Endurance.- The energized linear resolver shall be subjected to a minimum of 2000 hours of continuous shaft rotation at a continuous travel equivalent to the cyclic rate of 60 ± 3 rpm through the maximum effective electrical travel limits passing through zero.

3.9.6 Moisture resistance.- The linear resolver shall be capable of operation or storage in an atmosphere of high relative humidity consisting of ten continuous 24 hour high humidity and temperature combination cycles as well as low temperature and vibration subcycles. After completion of the final 24 hour recovery period, the linear resolver shall be subjected to and satisfactorily meet the requirements of Table III as listed therein.

3.10 Identification marking.- Linear resolvers shall as a minimum be identified by marking conforming to Figure 3 and MIL-STD-130. Markings shall be applied by acid or electric etching, by permanent marking ink or by engraving. Irrespective of the method used, the marking shall be applied directly to the linear resolver housing, i.e. the use of a separate nameplate attached to the housing is not permitted. The markings shall be such as to withstand and to remain legible following the environmental requirements specified herein.

3.11 Workmanship.- The linear resolver including all parts and accessories shall be manufactured and finished in a thoroughly workmanlike manner. Particular attention shall be paid to neatness and thoroughness of soldering, wiring, marking, and plating. All dimensions and tolerances not specified shall be consistent with the best engineering practice. Where dimensions and tolerances affect the interchangeability, operation, or performance of the linear resolver they shall be held or limited accordingly. All material shall be sound, of uniform quality and condition, and free from seams, cracks, and other defects which may adversely affect the strength, endurance, or wear of the part. Any material hammered, filed, or treated in any other manner to conceal defects therein shall be subject to immediate rejection.

4. QUALITY ASSURANCE PROVISIONS

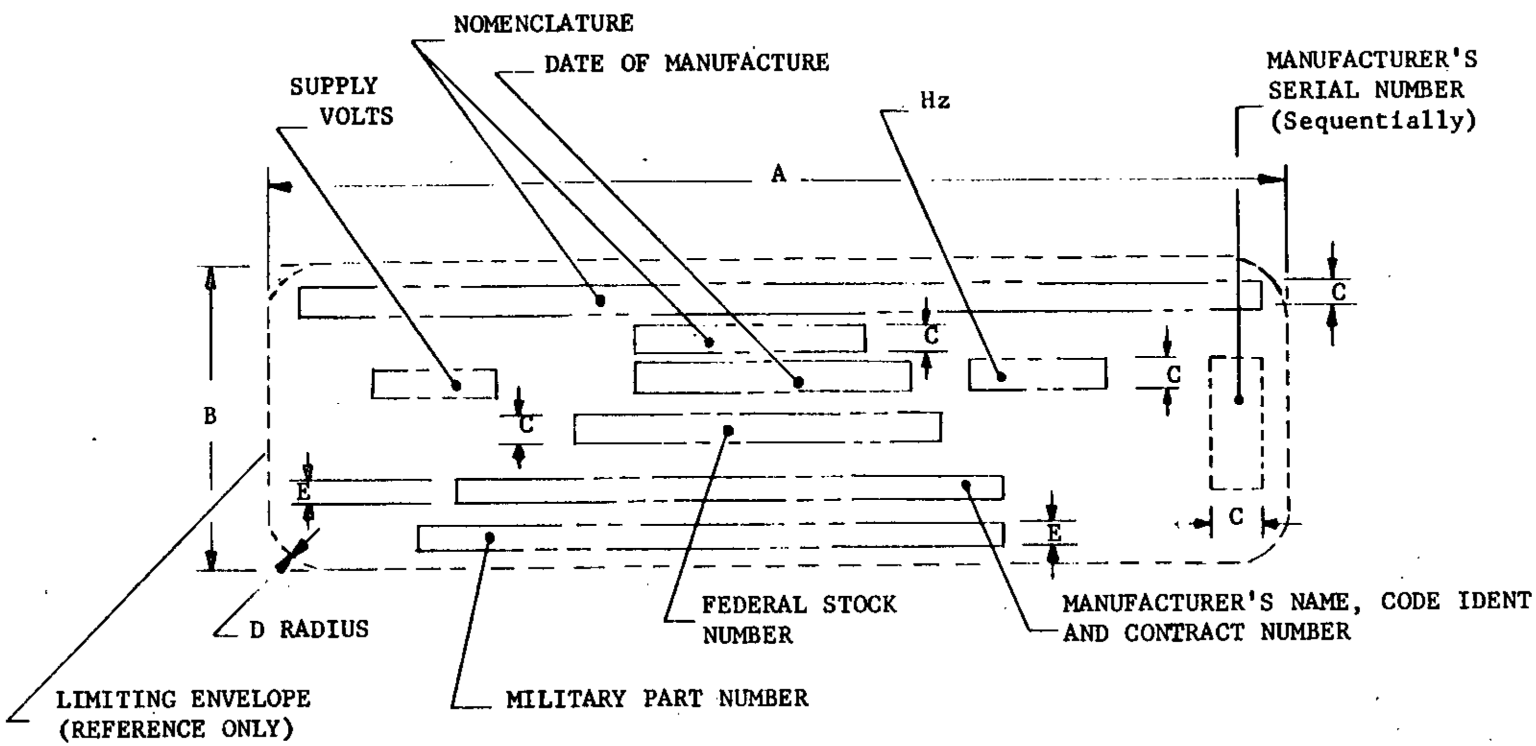
4.1 Responsibility for inspection.- Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any other facilities suitable 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 equipment and inspection facilities shall be of sufficient accuracy to permit adequate measuring equipment performance appropriate to the tolerances specified for requirements herein and the applicable specification sheet.

4.2 Test conditions.

4.2.1 Standard test conditions.- Unless otherwise specified herein, all measurements and tests shall be made in accordance with the general requirements section of MIL-STD-202.

4.2.2 Temperature, stabilized, non-operating.- The stabilized non-operating temperature is the temperature condition of an unenergized linear resolver while in an environment of any ambient temperature while shielded from stray air currents. This shall be determined by the periodic measurement of the dc resistance of the secondary winding and shall be deemed to have been attained when the resistance of that winding, measured at fifteen minute intervals, changes by less than one half percent from the preceding measurement.



LINEAR RESOLVER SIZE	A	B	C	D	E
05	1-1/2	5/8	1/16	1/8	1/16
08	2-1/4	5/8	1/16	1/8	1/16
11, 15	3	3/4	3/32	1/8	3/32

NOTES:
1. DIMENSIONS - Minimum, in inches.
2. LETTERING - Gothic or futura type capitals without serifs.
3. LEGEND shall be centrally located, horizontally and vertically.
4. Nomenclature, Military part number, voltage and frequency shall be as specified in the specification sheet.

Figure 3. Identification Marking

4.2.3 Temperature, stabilized, operating.- The stabilized operating temperature is the temperature condition of an energized linear resolver mounted on the standard test fixture after it has been energized in accordance with 4.2.4 for a period sufficient for the linear resolver to have attained a stable temperature. This shall be determined by the periodic measurement of dc resistance of the secondary winding and shall be deemed to have been attained when the resistance of that winding, measured at fifteen minute intervals changes by less than one half percent from the preceding measurement.

4.2.4 Test voltages and frequencies.- The amplitude and frequency of test voltages shall be within ± 1 percent of the rated or specified value. The total harmonic content of test voltages shall not exceed 1 percent of the amplitude of the voltage of fundamental frequency. In addition, at all corresponding ordinates, the divergence of the waveform of the test voltage from that of a pure sine wave of the same rms value shall not exceed 1 percent of the instantaneous value of the sine wave. The test voltage and frequency shall be as specified in the applicable specification sheet.

4.3 *Classification of inspections*.- The inspection requirements specified herein are classified as follows:

a. Qualification inspection.
b. First article inspection.
c. Quality conformance inspection.

4.4 Qualification inspection.- Qualification inspection shall be performed at a laboratory approved by the US Army Munitions Command (see 6.5).

4.4.1 Qualification sample.- A sample shall consist of four linear resolvers of the same type for which approval is requested as directed by the qualifying activity. The sample or samples submitted for qualification approval shall be representative of normal production.

4.4.2 Qualification inspection routine.- The sample will be subjected to the inspection in Table III in the order shown and the sample number identity.

4.4.3 Qualification sample failure.- Failure of any linear resolver in any test shall be cause for refusal to grant qualification approval.

4.4.4 Disposition of qualification sample.- Linear resolvers subjected to qualification inspection shall not be delivered on any contract.

4.4.5 Requalification.- In order to retain qualification approval, qualification inspection shall be performed every 24 months or as directed by the qualifying activity.

TABLE III - QUALIFICATION AND QUALITY CONFORMANCE INSPECTION

TEST NO.	REQ'T	TEST	TEST METHOD OR EXAMINATION	INSPECTION QUALIFICATION Sample Nos.	INSPECTION QUALITY CONFORMANCE
1	3.8.1	4.7.1	Variation of brush contact resistance	1, 2, 3, 4	x
2	3.1, 3.4 thru 3.4.13, 3.7.2, 3.10 & 3.11	4.7.2	Visual and mechanical examination	1, 2, 3, 4	x
3	3.8.2	4.7.3	Radial and end play	1, 2, 3, 4	x
4	3.8.9	4.7.4	Friction torque	1, 2, 3, 4	x
5	3.8.3	4.7.5	Dielectric withstanding voltage	1, 2, 3, 4	x
6	3.8.4	4.7.6	Insulation resistance	1, 2, 3, 4	x
7	3.8.6	4.7.7	Current	1, 2, 3, 4	x
8	3.8.7	4.7.8	Power	1, 2, 3, 4	x
9	3.7.3	4.7.9	Linear resolver zero marking	1, 2, 3, 4	x
10	3.8.12	4.7.10	Effective electrical travel	1, 2, 3, 4	x
11	3.8.8	4.7.11	Voltage gradient	1, 2, 3, 4	x
12	3.8.11	4.7.12	Linearity error	1, 2, 3, 4	x
13	3.8.10	4.7.13	Phase shift	1, 2, 3, 4	x
14	3.8.13	4.7.14	Residual (null) voltage	1, 2, 3, 4	x
15	3.8.14	4.7.15	Impedance	1, 2, 3, 4	x
16	3.8.15	4.7.16	Shift of linear resolver zero with freq. variation	1, 2, 3, 4	
17	3.8.17	4.7.17	Temperature rise	1, 2, 3, 4	
18	3.8.16	4.7.18	Electromagnetic interference	1, 2, 3, 4	
19	3.7.1	4.7.19	Security of terminals or wire leads	1, 2, 3, 4	
20	3.9.2	4.7.20	Vibration, followed by test nos. 1, 12, 14, 4, 3, 5 & 6	1, 2, 3, 4	
21	3.9.3.1	4.7.21.1	Shock, low impact, followed by test nos. 1, 12, 14, 4, 3, 5 & 6	1, 2, 3, 4	
22	3.9.1.1	4.7.22.1	Ambient low temperature, during which test nos. 1, 5, 6, 12, 14 & 4 shall be performed	1, 2	
23	3.9.1.2	4.7.22.2	Ambient high temperature, during which test nos. 1, 5, 6, 12, 14 & 4 shall be performed	1, 2	
24	3.9.6	4.7.23	Moisture resistance, followed by test nos. 1, 4, 12, 5 & 6	1, 2	
25	3.9.4.1	4.7.24.1	Altitude, low temperature, during which test nos. 1 & 6 shall be performed	3, 4	

TABLE III - QUALIFICATION AND QUALITY CONFORMANCE INSPECTION (Cont'd)

TEST NO.	REQ'T	TEST	TEST METHOD OR EXAMINATION	INSPECTION: QUALIFICATION Sample Nos.	INSPECTION: QUALITY CONFORMANCE
26	3.9.4.2	4.7.24.2	Altitude, high temperature, during which test nos. 1, 6 & 17 shall be performed	3, 4	
27	3.9.5	4.7.25	Endurance, following which test nos. 1, 12, 14, 5, 6, 4 & 3 shall be performed	3, 4	
28	3.9.3.2	4.7.21.2	Shock, high impact, followed by test nos. 1, 12, 14, 4 & 3	1, 2, 3, 4	

4.5 First article sample inspection.- When required by the procuring activity (see 6.2), sample linear resolvers taken from the first production lot of each contract shall be subjected to the provisions governing qualification inspection of 4.4, 4.4.1, 4.4.2, and 4.4.4.

4.5.1 First article sample failure.- Failure of any linear resolver in any test shall be cause for refusal to grant first article sample approval.

4.6 Quality conformance inspection.- The examinations and tests comprising quality conformance inspection are classified as specified in Table III and the applicable specification sheet.

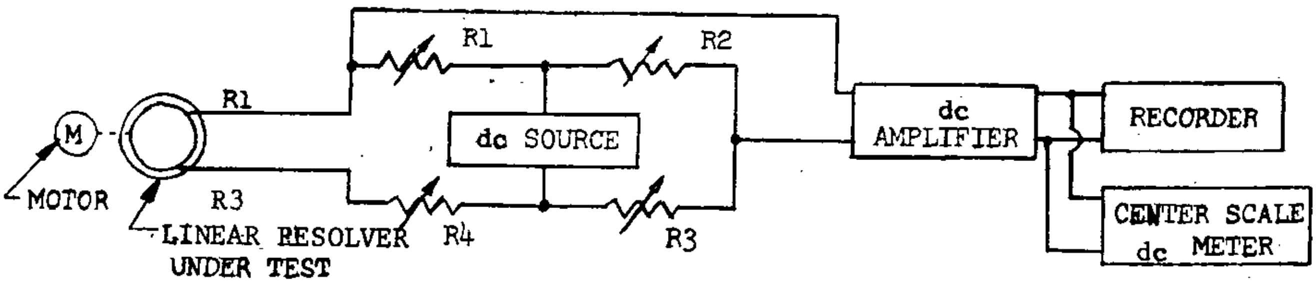
4.6.1 Quality conformance inspection sampling.- Statistical sampling and inspection shall be in accordance with MIL-STD-105, Table II-A, Single sampling plans for normal inspection. The acceptable quality level (AQL) shall be one percent defective for all tests combined.

4.6.2 Quality conformance inspection routine.- The minimum of inspection to be verified by the Government inspector shall be the applicable tests of Table III and the dimensional and visual requirements as indicated on the outline drawing in the applicable specification sheet.

4.6.3 Quality conformance sample failure.- In case of failure, the entire lot shall be rejected. The supplier shall withdraw the lot, correct the deficiencies or screen out the defective units by retest, as applicable and resubmit for inspection.

4.7 Test methods and examinations.

4.7.1 Variation of brush contact resistance test method.- The variation of brush contact resistance test method shall be measured by means of the basic bridge circuit of Figure 4 to meet the requirements of 3.8.1. Unless the applicable specification sheet specifies a lower current value, a maximum of 10 milliamps through the rotor winding shall be used. The bridge shall be balanced by R2 and R3 resistors with a suitable amplification factor set on the dc amplifier and the center scale dc meter. The sensitivity of both instruments shall be increased as the bridge is being balanced in order to produce a null. If drifting occurs, the rotor current shall be reduced until a steady null is achieved. The sensitivity of the recorder and amplifier should now be set at a level that will give a reference on the tape when the resistance of R4 is decreased and increased from the 0.5 ohm setting (0.0 to 1.0). After the reference marks have been established on the tape, the rotor shaft shall be driven by the one rpm motor at a continuous travel equivalent to the cyclic rate of one rpm through the maximum effective electrical travel limits passing through zero with the recorder chart feed set at 5mm per second. An instrument with a response time of 25 milliseconds or better shall be employed to obtain the variation of brush contact resistance.



M - Motor, 1 rev/m
R_1 - Resistor, decade, 1K
R_2, R_3 - Resistors, decade, 10K
R_4 - Resistor, decade, 10 ohm

NOTE: A current limiting resistor (1K), if required, would be connected in series with the dc source.

Figure 4. Variation of Brush Contact Resistance Test Circuit

4.7.2 Visual and mechanical examination.- The linear resolver shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements of 3.1, 3.4 thru 3.4.13, 3.7.2, 3.10 and 3.11.

4.7.3 Radial and end play test methods.

4.7.3.1 Radial play test method.- The linear resolver stator housing shall be rigidly mounted with the shaft horizontal. A dial indicator shall be rigidly mounted in a position to measure rotor shaft movement perpendicular to the rotor shaft axis in a horizontal plane. The measurement shall be made such that the activating button will contact the shaft within 1/8 inch of bearing face. A horizontal force or load as specified in the applicable specification sheet shall be applied within 1/4 inch of the end of the shaft and perpendicular to its axis. After noting the dial reading, the applied force shall be reversed and the new dial reading noted. The difference between the two readings shall not exceed the allowable radial play specified in accordance with 3.8.2.

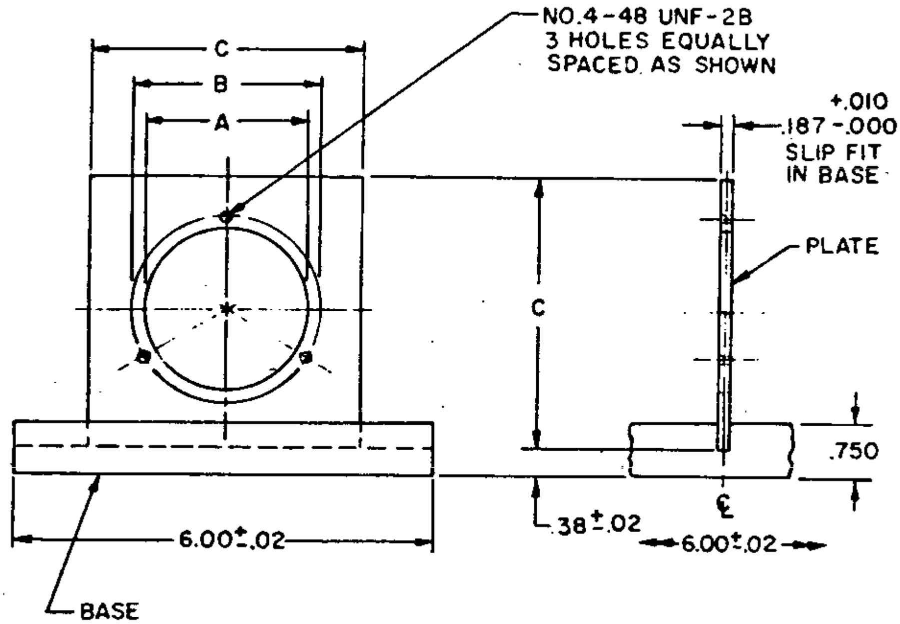


TABLE OF LETTERED DIMENSIONS			
SIZE	A	B REF ONLY	C
05	.376	.725	2.214
08	.501	1.020	2.439
11	.626	1.375	3.200
15	.875	1.688	4.300

NOTES:

1. Dimensions are in inches. Tolerance on lettered dimensions, + .010, -.000.

2. Material: Plate - aluminum alloy, QQ-A-250/4.
   Base - thermally insulating.

3. Finish: Plate - anodize per MIL-A-8625, type II, class 2 dyed black.

Figure 5. Standard Test Fixture for Linear Resolvers

4.7.3.2 End play test method.- The linear resolver stator housing shall be rigidly mounted with the shaft horizontal. A dial indicator shall be rigidly mounted in a position to measure rotor shaft movement along the axis of the shaft. A load or force of the value specified in the applicable specification sheet shall be applied axially to the shaft. The dial reading shall be noted, the applied force reversed and the new dial reading noted. The difference between the two readings shall not exceed the allowable end play specified in accordance with 3.8.2.

4.7.4 Friction torque test method.- With the applicable weight of Figure 6 attached to the dial of Figure 7 (corresponding to the developed torque specified in the applicable specification sheet) and with the dial mounted rigidly on the shaft and hanging free at the start of the test, the stator housing shall be rotated through a minimum of three revolutions in each direction equivalent to the cyclic rate between 4 and 6 rpm through the maximum effective electrical travel limits passing through zero. The linear resolver shall fail the test if the dial turns an equivalent of one revolution in accordance with the requirements of 3.8.9.

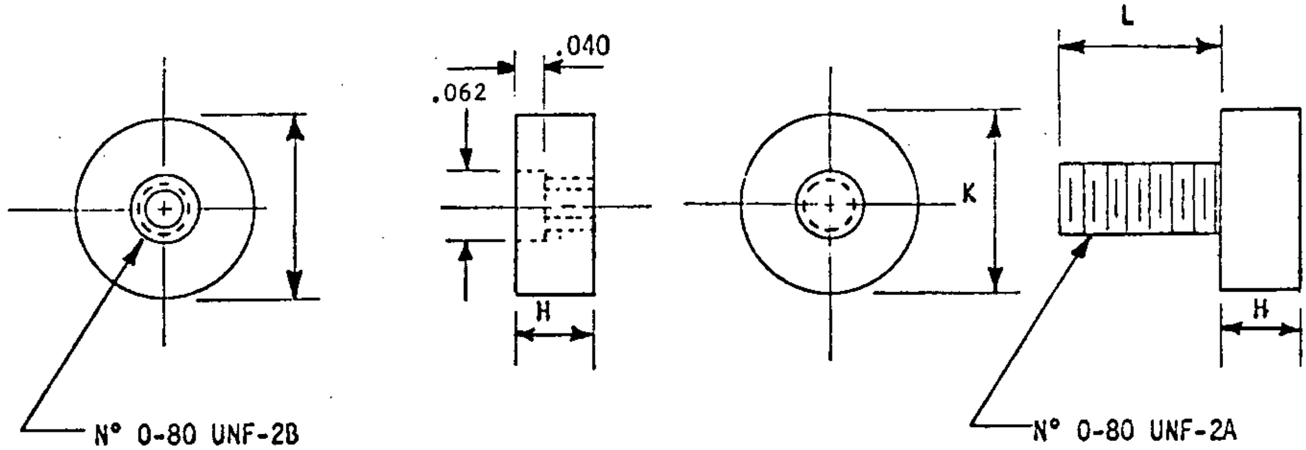
4.7.5 Dielectric withstanding voltage test method.- The test shall be performed in accordance with method 301 of MIL-STD-202 and the requirements of 3.8.3. The applicable test potential of Table II shall be applied between those points designated therein. The test potential shall be raised slowly (minimum time 3 seconds) from zero to the specified value in Table II. The peak value of the test potential throughout this test shall not exceed 1.5 times the specified rms test potential. The test equipment employed shall be such as to differentiate between winding leakage current and surge discharge current.

4.7.6 Insulation resistance test method.- Immediately after passing the dielectric withstanding voltage test, insulation resistance shall be measured in accordance with method 302 of MIL-STD-202 to determine conformance with the requirements of 3.8.4.

4.7.7 Current test method.- The linear resolver shall be brought to the stabilized operating temperature condition of 4.2.3 and the current drawn by the primary winding shall be measured at linear resolver zero with the secondary winding open-circuited. Current consumption shall be in accordance with the requirements of 3.8.6.

4.7.8 Power test method.- The linear resolver shall be brought to the stabilized operating temperature condition of 4.2.3 and the power consumed by the primary winding shall be measured at linear resolver zero with the secondary winding open-circuited. Power consumption shall be in accordance with the requirements of 3.8.7.

4.7.9 Linear resolver zero marking test method.- The linear resolver shall be appropriately connected as shown in either Figure 1 or 2 and the rotor turned until a minimum meter reading is obtained. The relative position of the linear resolver zero index marked on the housing and the index marked on the shaft shall be in accordance with the requirements of 3.7.3.

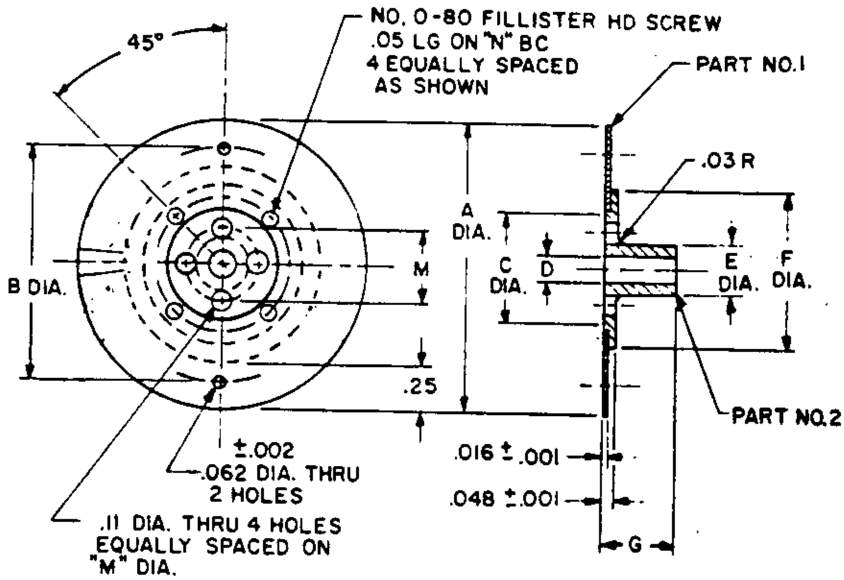


DEVELOPED TORQUE		DIMENSIONS OF MOUNTED DIAL WEIGHTS			WEIGHT ± 3%	MOUNTING RADIUS
		H	K	L		
oz-in	g.cm	in.	in.	in.	oz	in.
.02	1.44	.062	.262	.078	.033	.600
.03	2.16	.062	.325	.078	.050	.600
.04	2.88	.157	.242	.171	.067	.600
.05	3.60	.150	.267	.171	.083	.600
.06	4.32	.125	.324	.141	.100	.600
.07	5.04	.125	.346	.141	.117	.600
.08	5.76	.125	.373	.141	.133	.600
.09	6.48	.236	.288	.250	.150	.600
.10	7.2	.236	.300	.250	.166	.600

NOTES:

1. Tolerance on dimensions is ± .005 inches.
2. Material: Brass, QQ-B-637, composition 4.
3. The table contains examples of torque developed, other values may be obtained as required.

Figure 6. Weights for Friction Torque Test



Frame Size	DIAL DIMENSIONS								
	A --	B ±.002	C +.0004 -.0000	D +.0050 -.0000	E +.001 -.000	F --	G +.005 -.000	M* --	N --
05, 08 11, 15	1.50 1.50	1.20 1.20	.5625 .5625	.1250 .1875	.250 .250	.8125 .8125	.300 .300	.375 .375	.687 .687

*For mounting with standard drive washer

NOTES:

1. Dimensions are in inches. Unless otherwise specified, tolerances are ± .005 on decimals and ± 1° on angles.

2. Material: Aluminum alloy, QQ-A-250/4.

3. Finish: Anodize per MIL-A-8625, type III, class 2, dyed black.

Figure 7. Dial for Friction Torque Test

4.7.10 Effective electrical travel test method.- The linear resolver shall be mounted in an angular test stand capable of positioning the rotor to any angular position within ± 15 seconds of arc. The linear resolver shall then be brought to the stabilized operating temperature condition of 4.2.3 and energized in accordance with 4.2.4. The rotor shall then be set to the applicable linear resolver zero position of 3.6 after which the rotor shall be turned in a counterclockwise direction to the maximum positive effective electrical position and the inphase output voltage as well as the rotor angle at that point shall be recorded. The rotor shall then be set to the applicable linear resolver zero position of 3.6 after which the rotor shall be turned in a clockwise direction to the maximum negative effective electrical position and the out of phase output voltage as well as the rotor angle at that point shall be recorded. The effective electrical travel shall be in accordance with the requirements of 3.8.12.

4.7.11 Voltage gradient test method.- The linear resolver shall be mounted in an angular test stand capable of positioning the rotor to any angular position within ± 15 seconds of arc. The linear resolver shall be brought to the stabilized operating temperature condition of 4.2.3 and energized in accordance with 4.2.4. The rotor shall be set to the applicable linear resolver zero position of 3.6. Using the test circuit of Figure 8, the linear resolver's inphase output voltage shall be measured over the entire effective electrical travel (see 3.8.12). The voltage at the voltage data measurement points shall be taken at maximum effective electrical travel limits and at intervals not greater than 5 degrees in both ccw and cw direction from the applicable linear resolver zero position of 3.6. The linear resolver's inphase output voltage shall be compared with the calibrated inphase voltage of the voltage divider of Figure 8 for each measurement. The difference between the recorded inphase output voltage of the linear resolver as compared to the calibrated inphase voltage settings of the voltage divider shall be in accordance with the requirements of 3.8.8. The difference in readings is based on the applicable equation of 3.5.1 and the rotor shaft position.

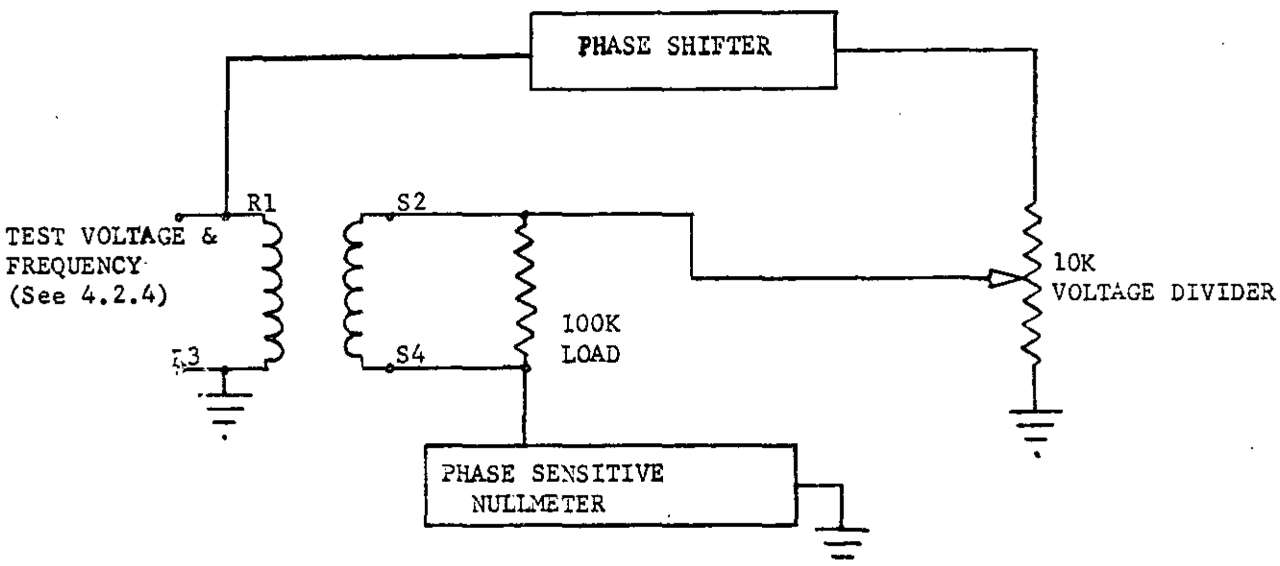


Figure 8. Voltage gradient and linearity test circuit.

4.7.12 Linearity error test method.- The linear resolver shall be mounted in an angular test stand capable of positioning the rotor to any angular position within ± 15 seconds of arc. The linear resolver shall be brought to the stabilized operating temperature condition of 4.2.3 and energized in accordance with 4.2.4. The rotor shall be set to the applicable linear resolver zero position of 3.6. Using the same test procedure of 4.7.11, the linear resolver's inphase output voltage shall be recorded from measurements obtained over the entire effective electrical travel (see 3.8.12). Measurements shall be taken at maximum limit points and at intervals not greater than 5 degrees in both ccw and cw direction from the applicable linear resolver zero position of 3.6. The resultant recorded inphase output voltage through zero shall be linear in accordance with varying degrees of specified percentage of linearity within required linearity tolerance zones as specified in accordance with the requirements of 3.8.11.

4.7.13 Phase shift test method.- The linear resolver shall be mounted in an angular test stand capable of positioning the rotor to any angular position within ± 15 seconds of arc. The linear resolver shall be brought to the stabilized operating temperature condition of 4.2.3 and energized in accordance with 4.2.4. The rotor shall be set to the applicable linear resolver zero position of 3.6 then turned to the maximum positive effective electrical travel position where the phase shift shall be measured. The rotor shall then be turned to the applicable linear resolver zero position of 3.6 and then to the maximum negative effective electrical travel position where the phase shift shall be measured. The phase shift shall be measured to an accuracy of ± 0.10 degrees with an instrument having an input impedance of not less than 500,000 ohms resistance shunted by a 30pF capacitance. The phase shift shall be in accordance with the requirements of 3.8.10.

4.7.14 Residual (null) voltage test method.- The linear resolver shall be brought to the stabilized operating temperature condition of 4.2.3 and energized in accordance with 4.2.4. The rotor shall then be set to the applicable linear resolver zero position of 3.6 and the linear resolver shall be measured for total and fundamental residual null voltage in accordance with either 4.7.14.1 or 4.7.14.2 to determine conformance with the requirements of 3.8.13. The voltage measuring instruments used shall indicate the value in terms of the rms value of an equivalent sine wave and shall have an input impedance not less than 500,000 ohms shunted by 30pF.

4.7.14.1 Frequency sensitive voltmeter method.- The frequency sensitive voltmeter to be used shall have a filter characteristic such that the output changes by not greater than ± 0.5 percent for a 1% change in frequency from the center frequency of the filter and by -97% (-30dB) for a one octave change from the center frequency of the filter. The linear resolver shall be calibrated to allow for the center frequency insertion loss of the filter. The rotor shall be turned to give a minimum reading on the frequency sensitive voltmeter. This is the fundamental component of the null voltage. The voltage read by a non-frequency-sensitive voltmeter at the same (undisturbed) rotor position is the total null voltage.

4.7.14.2 Phase sensitive voltmeter method.- The rotor shall be turned until the inphase component of the null voltage as indicated on the phase sensitive voltmeter is zero. The quadrature reading is the fundamental component of the null voltage. The voltage read by a non-phase-sensitive voltmeter is the total null voltage.

4.7.15 Impedance test method.- The linear resolver shall be mounted in the applicable test fixture of Figure 5 and shall be brought to the stabilized operating temperature condition of 4.2.3. The linear resolver shall then be energized in accordance with 4.2.4. The impedance measurement shall be determined at the positive maximum effective electrical travel position in accordance with the requirements of 3.8.14. Measurement shall be made by the wattmeter, ammeter, voltmeter method using instruments of sufficient accuracy, sensitivity and resolution, or by a method directly correlated and calibrated by this method.

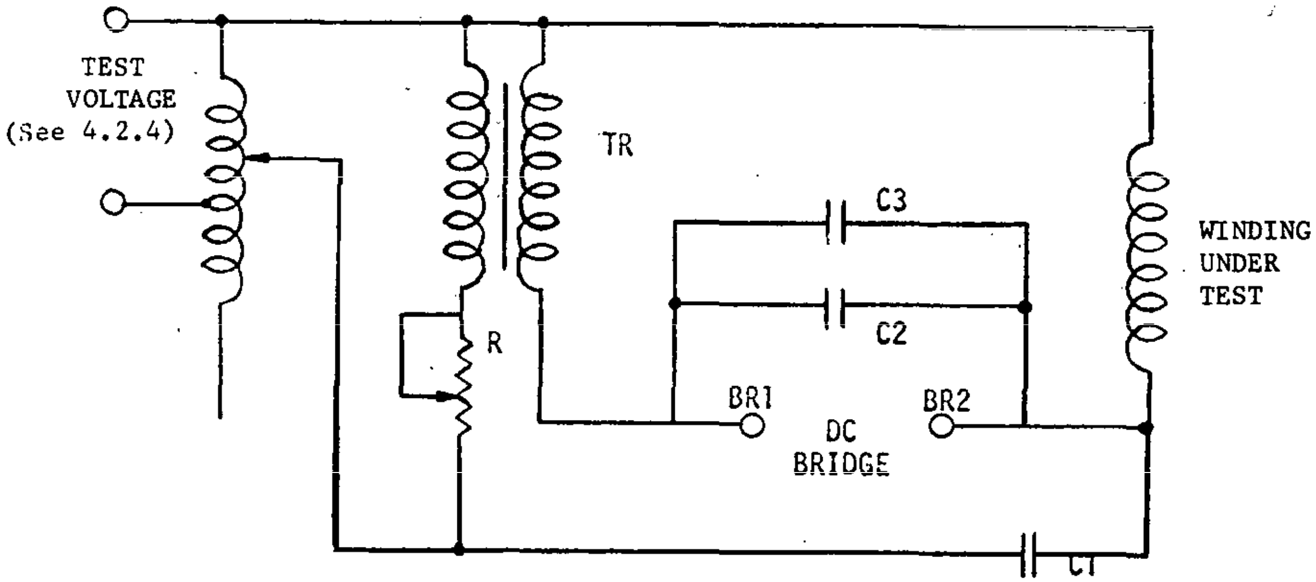
4.7.15.1 Z_{RO}, rotor winding, open-circuit impedance.- The open circuit impedance of the rotor winding shall be determined with the remaining stator winding open-circuited.

4.7.15.2 Z_{SO}, stator winding, open-circuit impedance.- The open circuit impedance of the stator winding shall be determined with the remaining rotor winding open-circuited.

4.7.15.3 Z_{RS}, rotor winding short-circuit impedance.- The rotor short circuit impedance shall be determined with the stator short-circuited. The energization voltage shall be of a magnitude necessary to induce a current within ± 3 percent of that obtained in the Z_{RO} measurement.

4.7.15.4 Z_{SS}, stator winding short-circuit impedance.- The stator short-circuit impedance shall be determined with the rotor short-circuited. The energization voltage shall be of a magnitude necessary to induce a current within ± 3 percent of that obtained in the Z_{SO} measurement.

4.7.16 Shift of linear resolver zero with variation of frequency test method.- The linear resolver shall be mounted in the applicable test fixture of Figure 5, brought to the stabilized operating temperature condition of 4.2.3 and energized in accordance with 4.2.4. The linear resolver shall then be set to the applicable linear resolver zero position of 3.6 and the specified operating frequency shall be first decreased by 10 percent and then increased by 10 percent. The shift in linear resolver zero shall be in accordance with the requirements of 3.8.15.



TR	1:1	TRANSFORMER RATED AT 250 VA.
R	250 ohms, 100 WATTS VARIABLE RESISTOR	
C1, C2, C3,	400 mfd, 115 V.A.C. CAPACITORS	

THE APPLIED AC TO THE CIRCUIT SHOULD BE ADJUSTED SO THAT THE FULL ENERGIZING VOLTAGE IS APPLIED TO THE WINDING. THE TRANSFORMER TR HAS ITS SECONDARY AND PRIMARY WINDINGS CONNECTED SO THAT THE AC VOLTAGE ACROSS THE BRIDGE IS LOW, (LESS THAN 1.5 VOLTS). SUITABLE ADJUSTMENTS CAN BE MADE WITH THE VARIABLE RESISTOR "R". THE BRIDGE IS THEN USED TO MEASURE THE KNOWN RESISTANCE OF THE TRANSFORMER TR SECONDARY PLUS THAT OF THE WINDING UNDER TEST.

FIGURE 9. CIRCUIT DIAGRAM FOR TEMPERATURE RISE TEST

4.7.17 Temperature rise test method.- The linear resolver shall be mounted in the applicable test fixture of Figure 5 and placed in a suitable enclosure of at least 3 cubic feet content per linear resolver and allowed to attain the ambient test temperature of 4.2.1. This shall be recorded as the initial ambient temperature of test enclosure. After the linear resolver has attained the stabilized nonoperating temperature condition of 4.2.2, the dc resistance of the secondary winding shall be measured and recorded. The primary winding shall be energized in accordance with 4.2.4 with the secondary winding unloaded. The dc resistance of the secondary winding shall again be measured and recorded when the linear resolver has attained the stabilized operating temperature condition of 4.2.3. The temperature rise shall be calculated from the following equation and shall be in accordance with the requirements of 3.8.17.

$$\text{Temperature rise, } ^{o}C = \frac{Rh-Rc}{Rc}(234.5+tc)$$

Where: Rh = Resistance of measured winding at stabilized operating temperature condition

Rc = Resistance of measured winding at stabilized non-operating temperature condition

tc = Initial ambient temperature of test enclosure

234.5 = Constant for non-alloy copper

Any method may be used for measuring the dc resistance of the designated winding however it shall not entail disconnection of that winding from the energizing supply while the measurements are taken. Figure 9 shows a suitable circuit for this purpose.

4.7.18 Electromagnetic interference test method.- The linear resolver shall be energized in accordance with 4.2.4. An electrical load equivalent to four times the secondary winding open-circuit impedance value specified in accordance with 3.8.14 shall be applied across the secondary winding. Measurements for conducted and radiated emission requirements as specified in 3.8.16 shall be in accordance with MIL-STD-462 while the rotor shaft is rotated at a continuous travel equivalent to the cyclic rate of 60 ± 3 rpm through the maximum effective electrical travel limits passing through zero.

4.7.19 Security of terminals or wire leads test method.

4.7.19.1 Wire lead terminals.- Each wire lead shall be tested by having a 2 pound weight attached to the extreme end. The weight shall be applied pulling straight away from the linear resolver, then the lead bent 90 degrees at the point of exit from the housing and while in this attitude the linear resolver rotated 360 degrees clockwise and 360 degrees counter-clockwise, once in each direction to determine conformance with the requirements of 3.7.1.1.

4.7.19.2 Screw thread terminals.- Each screw thread terminal shall be tested using 4.5 pound-inch torque in accordance with MIL-STD-202, method 211, test condition E and the requirements of 3.7.1.2.

4.7.19.3 Solder-pin terminals.- Each solder-pin terminal shall be tested using a gradual 2 pound minimum pulling force in accordance with MIL-STD-202, method 211, test condition A and the requirements of 3.7.1.3.

4.7.20 Vibration.

4.7.20.1 General and energization.- The linear resolver shall be tested in accordance with MIL-STD-202, method 204, test condition B and the requirements of 3.9.2 while the rotor is energized in accordance with 4.2.4. In the case of a stator energized linear resolver the energizing voltage of the rotor shall be determined accordingly by the voltage gradient as specified in 3.8.8.

4.7.20.2 Mounting and loading.- Utilizing its normal mounting surface, the linear resolver shall be secured to a test fixture by means of appropriate clamps and then the test fixture shall be rigidly mounted on the vibration equipment. The rotor shaft shall be free to rotate while mechanically loaded with a standard loading disc as depicted in Figure 10.

4.7.20.3 Post vibration.- Immediately after the test, the linear resolver shall be examined for loose or damaged parts and shall then be subjected to and shall meet the requirements as specified in 3.9.2 and as listed in Table III.

4.7.21 Shock.

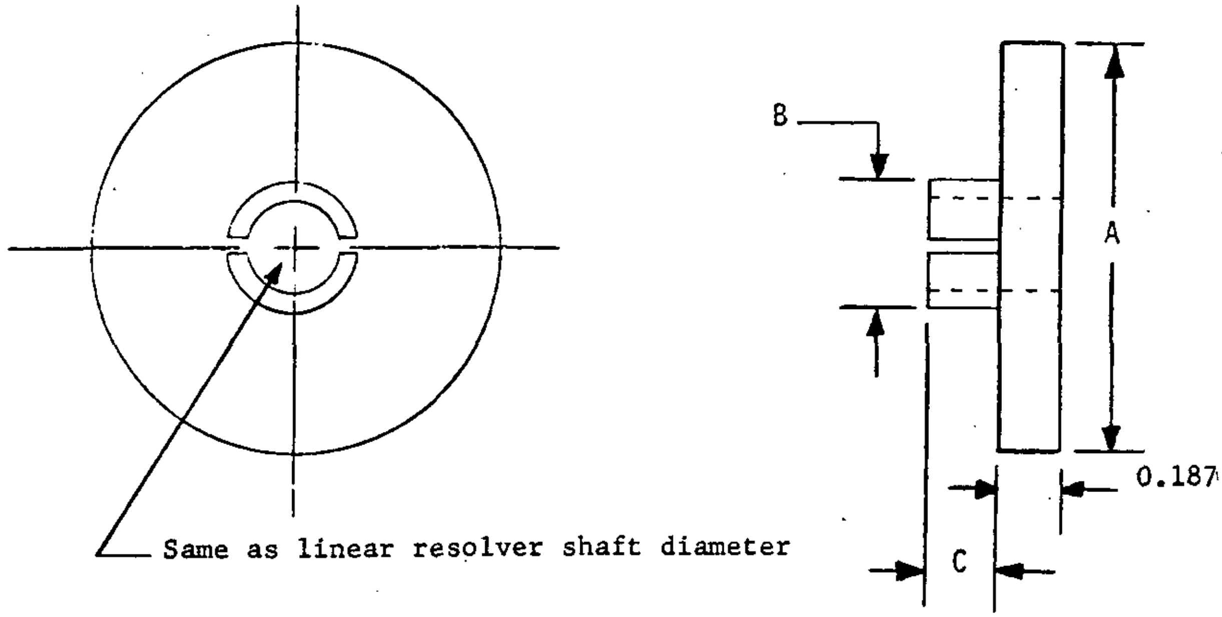
4.7.21.1 Low impact shock.

4.7.21.1.1 General and energization.- The linear resolver shall be tested in accordance with the requirements of 3.9.3.1 while the rotor is energized in accordance with 4.2.4. In the case of a stator energized linear resolver, the energizing voltage of the rotor shall be determined accordingly by the voltage gradient as specified in 3.8.8.

4.7.21.1.2 Mounting and loading.- Utilizing its normal mounting surfaces, the linear resolver shall be secured to a test fixture by means of appropriate clamps and then the test fixture shall be rigidly mounted to the elevator table. The rotor shaft shall be free to rotate while mechanically loaded with a standard loading disc as depicted in Figure 10.

4.7.21.1.3 Post low impact shock.- Immediately after the test, the linear resolver shall be examined for loose or damaged parts and shall then be subjected to and shall meet the requirements as specified in 3.9.3.1 and as listed in Table III.

4.7.21.2 High impact shock.



Frame Size	A	B	C
05, 08	1"	0.250	0.250
11, 15	2"	0.250	0.250

NOTES:

1. Dimensions are in inches. Tolerances on lettered dimensions, ± .010.

2. Material: Aluminum alloy, QQ-A-250/4

Figure 10. Standard disc for loading linear resolver shaft .

4.7.21.2.1 General and energization.- The linear resolver shall be tested in accordance with MIL-STD-202, Method 207, Figure 207-4 and the requirements of 3.9.3.2 while the rotor is energized in accordance with 4.2.4. In the case of a stator energized linear resolver, the energizing voltage of the rotor shall be determined accordingly by the voltage gradient as specified in 3.8.8.

4.7.21.2.2 Mounting and loading.- Utilizing its normal mounting surfaces, the linear resolver shall be secured to the standard mounting fixture depicted in Figure 207-4A. The rotor shaft shall be free to rotate while mechanically loaded with the appropriate dial as depicted in Figure 7.

4.7.21.2.3 Post high impact shock.- Immediately after the test, the linear resolver shall be examined for loose or damaged parts and shall then be subjected to and shall meet the requirements as specified in 3.9.3.2 and as listed in Table III.

4.7.22 Ambient temperature.- The temperature extremes of -62°C and 100°C as specified in 3.9.1, 4.7.22.1, and 4.7.22.2 are required to be accomplished but once per linear resolver. The linear resolver may be conditioned at the operational temperatures as often as necessary to perform the required tests. Upon completion of the ambient temperature tests, the linear resolver shall be removed from the test chamber and allowed to remain at the standard test conditions of 4.2.1 for a minimum of 4 hours before undergoing further testing.

4.7.22.1 Ambient low temperature.- The linear resolver shall be placed in a test chamber and mounted on a test fixture. The chamber temperature shall be lowered to and maintained at -62° ± 2°C for a minimum of 24 hours. The test chamber temperature shall then be raised to and controlled at -55° ± 2°C. The linear resolver shall be energized in accordance with 4.2.4 and having attained the stabilized operating temperature condition of 4.2.3, shall then meet the requirements as specified in 3.9.1.1 and as listed in Table III.

4.7.22.2 Ambient high temperature.- The linear resolver shall be placed in a test chamber and mounted on a test fixture. The chamber temperature shall be raised to and maintained at 100° ± 2°C for a minimum of 24 hours. The test chamber temperature shall then be raised to 125° ± 2°C. The linear resolver shall be energized in accordance with 4.2.4 and having attained the stabilized operating temperature condition of 4.2.3 shall then meet the requirements as specified in 3.9.1.2 and as listed in Table III.

4.7.23 Moisture resistance.

4.7.23.1 General.- The linear resolver shall be tested in accordance with MIL-STD-202, Method 106 and the requirements of 3.9.6. The linear resolver shall be placed in the test chamber with its rotor shaft in a horizontal position.

4.7.23.2 Energization.- During the test, half of the qualification sample (one linear resolver) shall be energized in accordance with 4.2.4 and the other half shall be unenergized. After completion of the final cycle, the entire sample (two linear resolvers) shall be maintained energized at standard test conditions (see 4.2.1) for 24 ± 4 hours.

4.7.23.3 Post moisture resistance.- Immediately after the final energization period, the linear resolver shall be subjected to and shall meet the requirements as specified in 3.9.6 and as listed in Table III.

4.7.24 Altitude.

4.7.24.1 Altitude low temperature.- The unenergized linear resolver shall be placed in a test chamber, the internal ambient temperature of which shall be reduced to and controlled at -55 ± 2°C and the linear resolver shall be allowed to attain the stabilized non-operating temperature condition of 4.2.2. The linear resolver shall then be energized so as to attain the stabilized operating temperature condition of 4.2.3. The pressure in the test chamber shall then be reduced to 8.27 Torr (approximately equivalent to an altitude of 100,000 feet). While still in this specified environment, the linear resolver shall be subjected to and shall meet the requirements as specified in 3.9.4.1 and as listed in Table III.

4.7.24.2 Altitude high temperature.- The unenergized linear resolver shall be placed in a test chamber, the internal ambient temperature of which shall be raised to and controlled at 125 ± 2°C and the linear resolver shall be allowed to attain the stabilized non-operating temperature condition of 4.2.2. The linear resolver shall then be energized so as to attain the stabilized operating temperature condition of 4.2.3. The pressure in the test chamber shall then be reduced to 8.27 Torr (approximately equivalent to an altitude of 100,000 feet). While still in this specified environment, the linear resolver shall be subjected to and shall meet the requirements as specified in 3.9.4.2 and as listed in Table III.

4.7.25 Endurance.

4.7.25.1 General and mounting.- The linear resolver shall be tested in accordance with the requirements of 3.9.5. The linear resolver shall be mounted on an appropriate test fixture capable of mechanically driving its rotor shaft a minimum of 2000 hours at a continuous travel equivalent to the cyclic rate of 60 ± 3 rpm through the maximum effective electrical travel limits passing through zero. The rotor shaft shall be turned mechanically in any manner which does not apply an axial load to the rotor. The 2000 hour time schedule shall be in accordance with Table IV.

4.7.25.2 Energization.- During the test, the rotor shall be energized in accordance with 4.2.4. In the case of a stator energized linear resolver, the energizing voltage of the rotor shall be determined accordingly by the voltage gradient as specified in 3.8.8.

4.7.25.3 Post endurance.- Immediately after the test the linear resolver shall be subjected to and shall meet the requirements as specified in 3.9.5 and as listed in Table III.

TABLE IV - Endurance Test, Time Schedule

Time (Hours) Min.	Temperature (°C)	Shaft Position
64	-25±5	horizontal
24	+125±5	up
24	+125±5	45° up
24	+125±5	45° down
24	+125±5	down
1840*	+ 23±5	horizontal

* 50% of the rotation to be CW; 50% of the rotation to be CCW

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall conform to MIL-S-12134. Minimum packaging and packing shall be at least level C unless otherwise specified (see 6.2).

6. NOTES

6.1 Intended use.- Linear resolvers covered by this specification are intended for use in military systems for fire control, radar, navigation, missiles, and instrumentation requiring the accurate transmission and reception of electromechanical signals concerning the angular position of one or more rotor shafts.

6.2 Ordering data.- Procurement documents should specify the following:

a. Title, number, and date of this specification.
b. Title, number, and date of the applicable specification sheet, the complete nomenclature, and the military part number (see 1.2.1, 1.2.2, and 3.1).
c. Whether first article inspection is required (see 3.3).
d. Levels of packaging and packing.

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.

6.4 Definitions.- For the purpose of this specification, the following definitions apply:

6.4.1 Direction of rotation.- The standard (positive) direction of rotation of the shaft is counterclockwise when the linear resolver is viewed from the shaft extension end.

6.4.2 Effective electrical travel.- The effective electrical travel is the linear output function of the linear resolver that is accomplished by means of shaft angle movement throughout the specified maximum effective electrical travel limits.

6.4.3 Linearity error.- Linearity error is the nonconformity of the function characteristic of the secondary voltage of fundamental frequency (established by means of the voltage gradient) at any angular rotor displacement, within the effective electrical travel limits. Linearity error is expressed as a percentage of nonconformance of the secondary voltage.

6.4.4 Voltage data measurement point.- A voltage data measurement point is a point of reference, fixing the relationship between a specified shaft angle position and the output voltage of the linear resolver. It is used to determine the voltage gradient (volts/degree) through the maximum effective electrical travel limits passing through zero.

6.4.5 Voltage gradient.- The voltage gradient is the output voltage expressed as a function of shaft angle (volts/degree) accomplished through the maximum effective electrical travel limits passing through zero.

6.4.6 Transformation ratio (N).- The transformation ratio (N) is the ratio of the fundamental frequency component of the open circuit secondary voltage, in relation to the angle θ in 3.5.1, to the primary energizing voltage.

6.5 Qualification.- With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is Frankford Arsenal, Philadelphia, Pa. 19137, ATTN: SMUFA-J4000 and information pertaining to qualification of products may be obtained from that activity.

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Navy - AS
Air Force - 80

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Navy - EC, SH
Air Force - 17, 11

User activities:
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Navy - MC, OS
Air Force - 19

Preparing activity:
Army - MU

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5. PROBLEM AREAS

a. *Paragraph Number and Wording:*

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional

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8. DATE OF SUBMISSION *(YYMMDD)*