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MILITARY SPECIFICATION

GYROSCOPE, DISPLACEMENT, ROLL AND PITCH, TYPE MD-1

1. SCOPE

1.1 This specification covers the requirements for one type of roll and pitch, displacement gyroscope, designated Type MD-1.

* 2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Federal

QQ-P-416	Plating, Cadmium (Electrodeposited)

Military

MIL-P-116	Preservation, Methods of
MIL-B-5087	Bonding, Electrical and Lighting Protection for Aerospace Systems
MIL-E-5400	Electronic Equipment, Airborne, General Specification for
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-I-6181	Interference Control Requirements, Aircraft Equipment
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series: General Specification for
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-G-25591	Gyroscope, Rate, Switching, Type MC-1
MIL-I-27193	Indicator, Attitude ARU-2B/A
MIL-I-27619	Indicator, Attitude Director
MIL-I-27623	Indicator, Attitude, Remote Standby, 2 Inch
MIL-I-27709	Indicator, Attitude ARU-14/A, Remote
MIL-I-27710	Indicator, Attitude Remote
MIL-I-38442	Indicator, Attitude Director ARU-24/A

STANDARDS

Military

MIL-STD-100	Engineering Drawing Practices
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of US Military Property
MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-781	Reliability Tests Exponential Distribution
MIL-STD-794	Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-810	Environmental Test Methods
MIL-STD-831	Test Reports, Preparation of
MIL-STD-889	Dissimilar Metals
MS3106	Connector, Plug, Electric, Straight
MS17322	Meter, Time Totalizing Miniature, Digital 115 Volt 400 Cycle
MS27150	Indicator, Attitude, Remote, Standby
MS27601	Fastener, Self-Locking, Case Mounting, Electronic Equipment (with Holding Clamp)
MS33678	Connector, Receptacle, Electric, Integral Mounting

(Copies of documents required by suppliers in connection with specific procurement functions shall be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Qualification. The gyroscopes 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 6.7).

3.2 Components. The gyroscope shall consist of a case, a vertically erected gyro and associated erection circuits, an elapsed time indicator, and a shock-mount base.

3.3 Standards and specifications. Standards and specifications for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-143.

3.4 Materials

3.4.1 Fungus-proof materials. Materials that are nutrients for fungi shall not be used where it is practical to avoid them. Where used and not hermetically sealed, they shall be treated with a fungicidal agent acceptable to the procuring activity. However, if they will be used in a hermetically sealed inclosure, fungicidal treatment will not be necessary.

3.4.2 Metals. Metals shall be of the corrosion-resistant type or suitably treated to resist corrosion due to fuels, salt spray, or atmospheric conditions likely to be met in storage or normal service.

3.4.2.1 Dissimilar metals. Dissimilar metals are defined in MIL-STD-889. Unless suitably protected against electrolytic corrosion by means of a protective coating or hermetic sealing, intimate contact of dissimilar metals shall be avoided.

3.4.3 Nonmagnetic materials. Nonmagnetic materials shall be used for all parts of the gyroscope, except where magnetic materials are essential.

3.4.4 Corrosive fumes. The materials, as used in the gyroscope and under the service conditions specified herein, shall not liberate deleterious fumes.

3.4.5 Protective treatment. When materials are used in the construction of the gyroscope that are subject to deterioration when exposed to climatic and environmental conditions likely to occur during service usage, they shall be protected against such deterioration in a manner that will in no way prevent compliance with the performance requirements of this specification. The use of any protective coating that will crack, chip, or scale with age or extremes of climatic and environmental conditions shall be avoided.

3.5 Design and construction. The gyroscope shall be designed and constructed in accordance with figure 1 and as specified herein. It shall be built to withstand the strains, jars, vibrations, and other conditions incident to shipment, storage, installation, and service.

3.5.1 Mean-time between failures (MTBF). The gyroscope shall be designed to provide a minimum acceptable MTBF of 800 hours at a 90 percent confidence level.

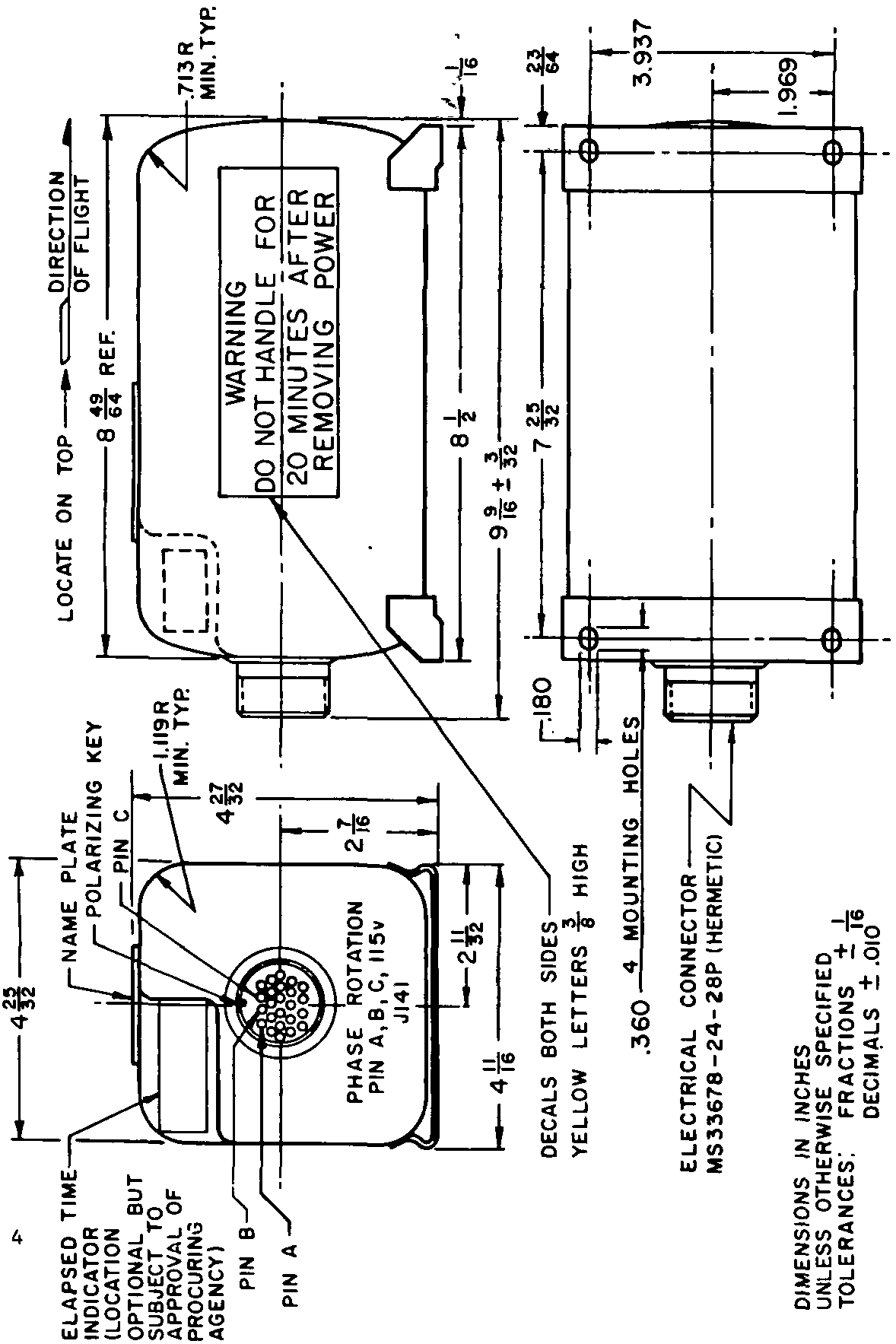

FIGURE 1. Gyroscope

3.5.2 Gimbals. The gyro shall be mounted in two gimbals and shall have two axes of freedom with a synchro and torque motor on each axis. The pitch axis shall be the pivot axis of the inner gimbal (gyro wheel housing) and shall be perpendicular to the roll axis which is the pivot axis of the outer gimbal. The roll axis shall be parallel to the longitudinal axis or long centerline of the case as shown on figure 1.

3.5.3 Gimbal freedom. The gyro shall have unlimited freedom in roll and a minimum of ±82° of freedom in pitch. Pitch stops shall be incorporated to produce a roll precession when the pitch freedom is exceeded. The pitch stops shall be so designed that no part of the instrument will be damaged by a loop at the rate of 90° per second and less than ± 3° error will result from loops of 10° ±1° per second. Errors induced by roll maneuvers at 400° per second shall not exceed 1°.

3.5.4 Drift. Unless otherwise specified, the gyroscope shall be so designed that the maximum free drift, noted after compensation for the earth's rotation, will be not greater than 0.25° per minute when operated over the entire temperature range specified herein, with the gyro spin axis vertical or tilted 20°.

3.5.5 Erection. The erection mechanism shall incorporate separate systems for pitch and bank. Erection shall be accomplished by electrolytic switches and torque motors on the gimbals. When the vertical is displaced in one axis, it shall not deviate more than 1.0° in the other axis while it is erecting. The erection system shall provide both initial and final erection and shall erect the gyro from any attitude to the vertical as determined by the vertical sensing electrolytic switches.

* 3.5.5.1 Initial erection. The initial erection of the vertical gyro shall be such that it will assume a position within 1° of vertical in pitch and bank within 1 minute or less after power is applied.

3.5.5.2 Final erection. The vertical gyro shall align its spin axis with the direction of gravity within ±1/4° in 2 minutes or less after the initial erection period.

3.5.5.3 Normal erection rate. The rate of normal erection about the roll axis shall be nominally 1° per minute and shall fall between the limits plotted on figure 2 throughout all environments and roll attitudes of the gyroscope. Roll erection shall not be affected appreciably by displacement of the gyro from vertical about the pitch axis through ±80°. The rate of normal erection about the pitch axis shall be nominally 1° per minute and shall fall between the limits plotted on figure 2 throughout all environments and pitch attitudes of ±40° For greater pitch attitudes, the erection rate shall be held to a minimum but shall be not less than that shown on figure 2. Pitch erection shall not be affected appreciably by a ±85° displacement of the gyro in roll or less.

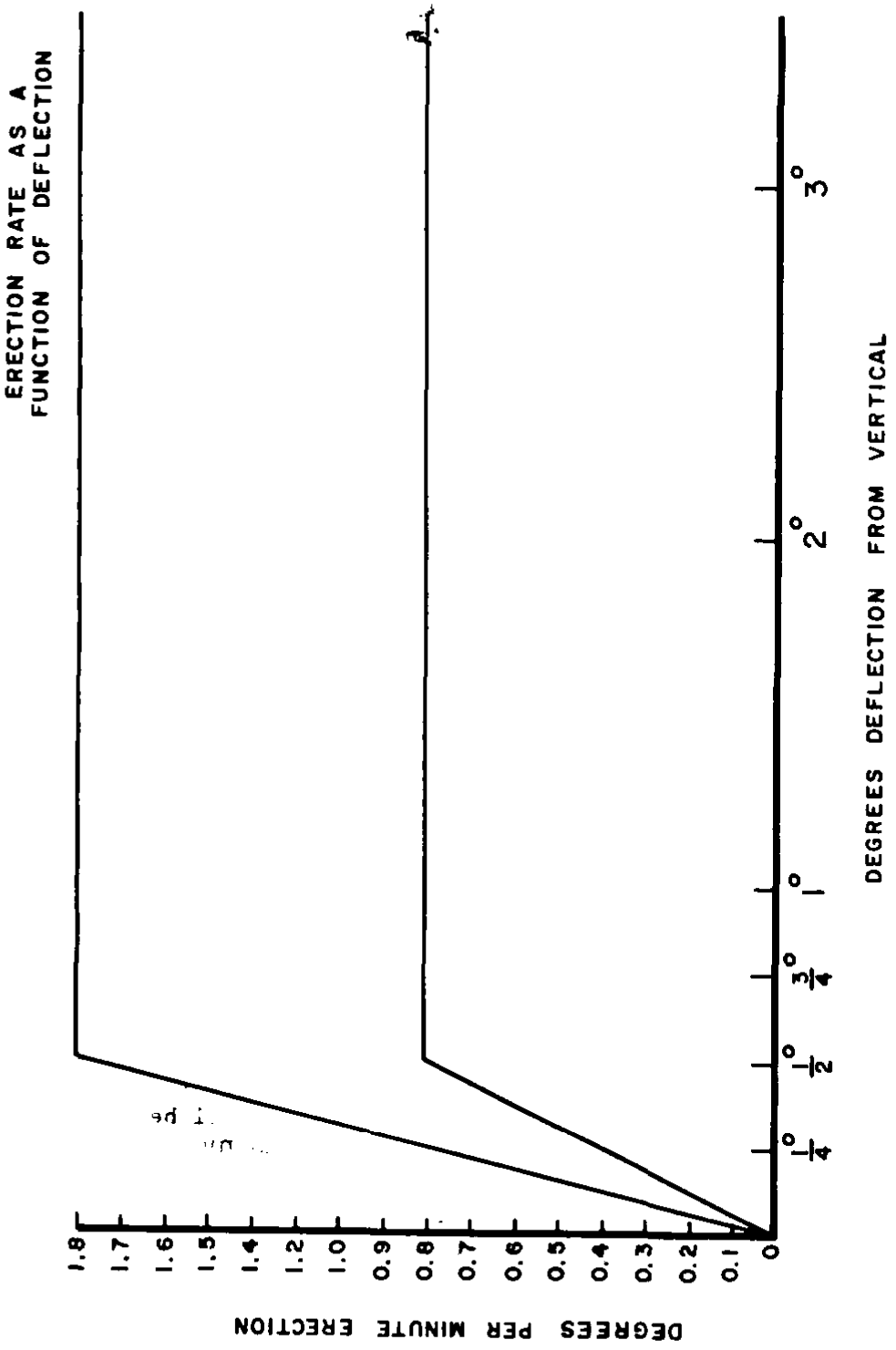

FIGURE 2. Limits

3.5.5.4 Fast erection. Means shall be provided for fast erection of the gyro to the apparent vertical of both axes of the gyro simultaneously. When the circuit is externally closed between pins N and C of the electrical connector, erection rate shall be not less than 15° per minute in either axis. In addition, the circuit between pins J and T shall be interrupted and shall remain interrupted as long as the circuit between pins N and C remains closed.

3.5.5.5 Roll and pitch erection cutout. The design shall be such that when pins L and B are connected externally, roll erection shall be cut out and when pins K and B are connected externally, pitch erection shall be cut out. The current drawn from pin B to each pin (L and K) shall not exceed 250 ma.

3.5.6 External torquing. The design of the gyroscope shall be such as to permit the gyro to be precessed off the vertical in both pitch and roll by externally connecting certain pins on the electrical connector. This external torquing shall be obtained when pin G is connected to pin C. The gyro shall then precess off the vertical so that the top of the gyro will be precessed forward and to the right when facing in the direction of line-of-flight at a rate of not less than 0.8° per minute. In addition, when pin N is connected to pin C, the precess rate shall be not less than 15° per minute. When pin K is connected to pin B, the gyro shall cease to precess forward and when pin L is connected to pin B, the gyro shall cease to precess to the right.

3.5.7 Power interruption. Means shall be provided in the gyroscope to prevent system recycling through initial erection when power has been removed. The gyroscope shall not recycle or develop errors greater than ±1° for 40 seconds when power is removed after 5 minutes of operation at normal voltage. Gimbal freedom shall be not less than ±82° in pitch and ±80° in roll with power removed.

3.5.8 Power failure warning. A 3-phase power warning circuit shall be incorporated in the gyroscope which shall operate a set of normally open contacts. Leads from this set of contacts shall be brought out of the case to pins J and T as shown in table I. When proper power is applied to the control, the contacts shall close the circuit between pins J and T after the initial erection cycle is completed. If at any time any phase of the 3-phase power to the control is broken, the contacts shall open breaking the circuit between pins J and T.

3.5.9 Pitch and roll synchro transmitter characteristics. The pitch and roll electrical output signals shall be of a standard synchro type. The pitch output shall be continuous through ±83°, and the roll output shall be continuous through 360°. Each synchro shall follow its respective gimbal movement at a 1 to 1 ratio and shall be capable of operating up to five control transformers, each with an impedance of 222 +j 470 ohms (Z_{so}).

TABLE I. Connectors

Pin (Synchro Leads)	Function
A	Power ground
B	115, 400 Hz
C	115, 400 Hz
D(X)	Roll transmitter synchro stator
E(Y)	
F(Z)	
R(X)	Pitch transmitter synchro stator
H(Y)	
P(Z)	
G	External torquing
J	Power off warning flag
T	Power excitation for power-off warning flag
K	Pitch erection cutout
L	Roll erection cutout
M(H)	Roll synchro excitation
S(C)	
U(H)	Pitch synchro excitation
V(C)	
N	Manual fast erection
X, Q, Y, Z, W	Spares

3.5.9.1 No-load characteristics. With no load, the electrical characteristics of each transmitter at room temperature shall be:

a. Line-to-line output voltage: 11.8 ±0.25V

b. Phase shift: Not to exceed 5.5°.

3.5.9.2 Loaded characteristics. When loaded with five loads, the electrical characteristics of each transmitter at room temperature shall be:

a. Line-to-line output voltage: Not less than 10.7V

b. Phase angle (measured between the exciting voltage of each transmitter rotor and the voltage across any pair of the three stator leads of each of the five control transmitters): Not to exceed 9°.

c. Nulls (measured up to five loads): Not to exceed 0.03V.

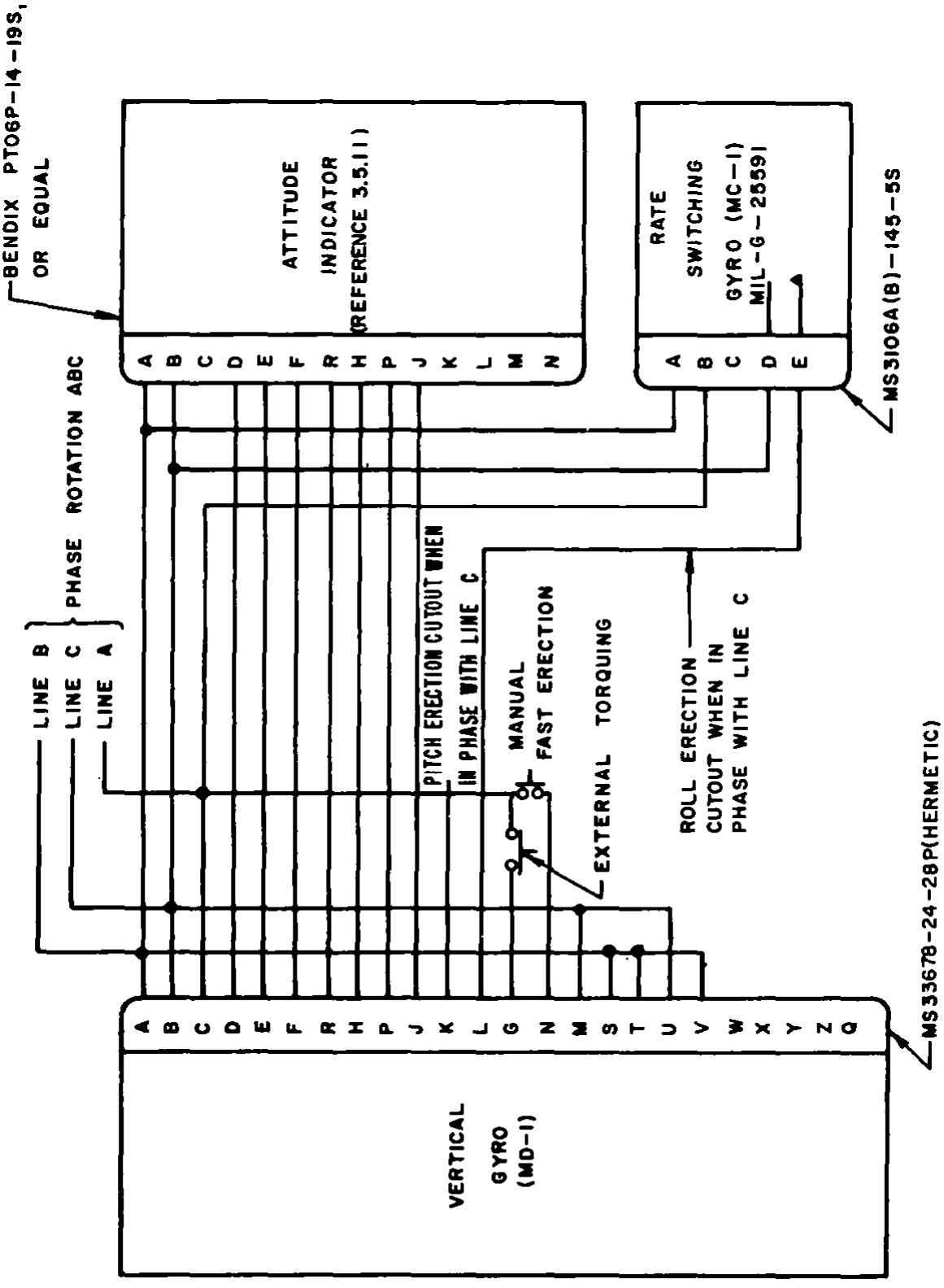

FIGURE 3. Schematic

3.5.10 Synchro zeroing and sensing. The synchros shall be zeroed and their lead pins shown in table I connected for the following procedure:

a. Connect pins S and V to the ground side of a single-phase 115V 400-Hz power source

b. Connect pins M and U to the hot side of the power source

c. Connect pins F and P to the common point of S-V. With the gyro gimbals at zero displacement about their axes, the voltage between pins D and E and between pins R and H shall each be at a null

d. With D and E connected, the voltage between this point and pin M shall be less than 115V (low null)

e. With pins R and H connected, the voltage between this junction and pin U shall be less than 115V (low null)

f. With pins D and E disconnected and the gyroscope displaced in right-bank about the roll axis with respect to the roll gimbal, the voltage between pin D and the common point of F-S shall increase before decreasing

g. With pins R and H disconnected and the gyroscope displaced in climb about the pitch axis with respect to the pitch gimbal, the voltage between pin R and the common point of P-V shall increase before decreasing.

3.5.11 External connections. The gyroscope shall be so designed that it will operate as specified herein under the following conditions:

a. When the external connections shown on figure 3 are made to the ARU-13/A indicator conforming to MIL-I-27710, the ARU-14/A indicator conforming to MIL-I-27709, or the MS27150 indicator conforming to MIL-I-27623

b. When the external connections shown on figure 3 are made by means of a banana-plug board by selecting the correct power, synchro, and warning flag pins for the ARU-2B/A indicator conforming to MIL-I-27193, the ARU-11/A indicator conforming to MIL-I-27619, or the ARU-24/A indicator conforming to MIL-I-38442.

3.5.12 Case. The gyroscope case shall be hermetically sealed and of such strength that 1 atmosphere of differential pressure will not cause binding of either the pitch or roll gimbals.

* 3.5.12.1 Filling medium. The filling medium shall be 95 percent helium and 5 percent carbon dioxide. The gases used shall be of at least 98 percent purity, free of dust particles, and shall contain not more than 0.006 milligram of water

vapor per liter (dewpoint -65 C) at the filling pressure. The absolute pressure of the filling medium in the case shall be 1 atmosphere.

3.6 Performance. The gyroscope shall be capable of withstanding the following conditions:

a. Temperatures - operation at temperatures ranging from -62° to +85°C and exposure to temperatures ranging from -62° to +100°C

b. Humidity - relative humidity up to 100 percent

c. Altitude - pressures ranging from 30 inches Hg down to 0.315 inch Hg (approximately 100,000-foot altitude)

d. Salt fog - exposure to salt sea atmosphere for a 50-hour period

e. Vibration - circular vibration when the gyroscope is tilted 45° to the horizontal plane through frequencies ranging from 10 to 50 Hz at amplitudes ranging from 0.009 to 0.060 inch

f. Fungus - fungus growth as encountered in tropical climates

g. Temperature shock - three temperature cycles, each cycle consisting of 4 hours at +85°C and within 5 minutes subjection to -40°C for 4 hours

h. Acceleration - an acceleration of 20g in each of 3 mutually perpendicular axes for a period of 1 minute without failure (gyro nonoperating)

i. Dielectric strength - 200V, 60-Hz ac applied between isolated pins and between pins (except those connecting the gyroscope erection switches) and the case.

3.6.1 Leak rate. The gyroscope shall be so sealed that the maximum leak rate will not permit more than 10 percent contamination or loss of the filling medium after 1,000 hours at a pressure differential equivalent to a 100,000-foot altitude.

3.6.2 Radio noise interference. The gyroscope shall meet the radio noise suppression requirements of MIL-I-6181.

* 3.6.3 Compatibility. Compatibility of the gyroscope with the UH-1, T-38, C-141, RF-4E, F-5, F-106, T-39, L-23, and C/KC-135 aircraft shall be demonstrated as specified in 4.6.28 to assure that no operational interface or installation conditions will adversely affect performance of the gyro. All inservice gyros shall be identical to the qualified item.

3.7 Part numbering of interchangeable parts. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The item identification and part number requirements of MIL-STD-100 shall govern the manufacturer's part number and changes thereto.

3.8 Electronic parts. Electronic parts and the application thereof shall be in accordance with MIL-E-5400. Parts that do not appear on approved lists shall not be used unless approved by the procuring activity.

3.8.1 Other components. All other components in the electronic system shall conform to applicable specifications where existent.

3.9 Electrical connector. An MS33678-24-28P hermetically sealed electrical connector shall be provided. The connector shall be affixed to the gyroscope as shown on figure 1 with pin connections as shown in table I. The keyway on the connector shall be located in the normal 0° position with respect to the pin insert. All electrical circuits shall be isolated from the case.

3.10 Power. Aircraft power supply shall be in accordance with MIL-STD-704, equipment category B; however, the gyroscope shall be operated from 3-phase, delta, 400-Hz 115V power. The phase sequence shall be ABC from pins C to A to B. The gyroscope shall function satisfactorily with variations in voltage and frequency from 103 to 127V and 320 to 480 Hz, respectively.

3.10.1 Power consumption. The power consumption of the gyroscope shall not exceed 30 va after 5 minutes of operation nor 55 va when fast erection is imposed at any time after 5 minutes of operation.

3.11 Time totalizating meter (TTM). An MS17322-8A TTM shall be provided to record the running time of the gyroscope. It shall be mounted externally on the gyroscope case and shall be located as shown on figure 1. The TTM shall be readable and removable without unsealing the gyroscope case. The connection on the gyroscope case shall be suitably protected from the elements.

3.12 Shockmount base. A shockmount base shall be provided on the gyroscope and shall be easily and quickly detachable. It shall be so designed that the dependent instrument will operate properly and indicate accurately when the complete gyroscope is subjected to vibrations and accelerations encountered in service use.

3.12.1 Vibration isolation. The shockmount shall be so designed that the complete assembly will meet the tests specified in 4.6.21, 4.6.25.6, and 4.6.26 when the gyroscope case is attached to the mount in such a manner that the cable end is on the fastener end of the mount.

* 3.12.2 Shockmount base design. The mounting base shall consist of a base plate for securing the gyroscope to the airframe and a component mounting plate supported from the base. The supports between the component mounting plate and the base plate shall be capable of sustaining the mounting plate when loaded with a component and shall be vibration absorbent to the extent specified herein. The snubbers shall not bottom at any attitude of the base plate. Isolation in the vertical plane shall comply with the isolation efficiency curves specified in 3.12.3.3. The component mounting plate and the base plate shall be electrically bonded in accordance with the electrical ground bonding requirements of MIL-B-5087. The mounting plate shall be provided with a self-locking fastener or quick-release mechanism in accordance with figure 4 for attaching and removing the component load.

3.12.2.1 Damping. Vibration dampers or shock snubbers shall be so designed that damping characteristics will not be changed due to wear.

3.12.2.2 Safety wiring. Holes for safety wiring shall be provided for screwheads and thumbscrews which may loosen from the mounting base assembly due to vibration. The diameter of these holes shall be from 0.046 to 0.098 inch.

3.12.3 Cable and connector. With the gyroscope properly mounted, the mounting base shown on figure 4 shall meet the following requirements when used with a connector conforming to figure 3:

3.12.3.1 Loaded height. The height of the mounting base at maximum rated load shall be within the rating and tolerance shown on figure 4.

* 3.12.3.2 Resiliency. When the gyroscope case is mounted on the shockmount, the plane of the top plate shall be parallel to the plane of the bottom plate within 1°. This angle shall not exceed 2° when any side or end of the shockmount is displaced to its extreme. The gyroscope shall be deflected by depressing any side of the mount and then slowly releasing it. The mount shall return to the original plane to within ±1/2° of its original position with no vibration or motion applied to the assembly.

3.12.3.3 Transmissibility. When a dummy load is attached to the shockmount, the mount shall be capable of providing transmissibilities within the curves shown on figures 5, 6, and 7.

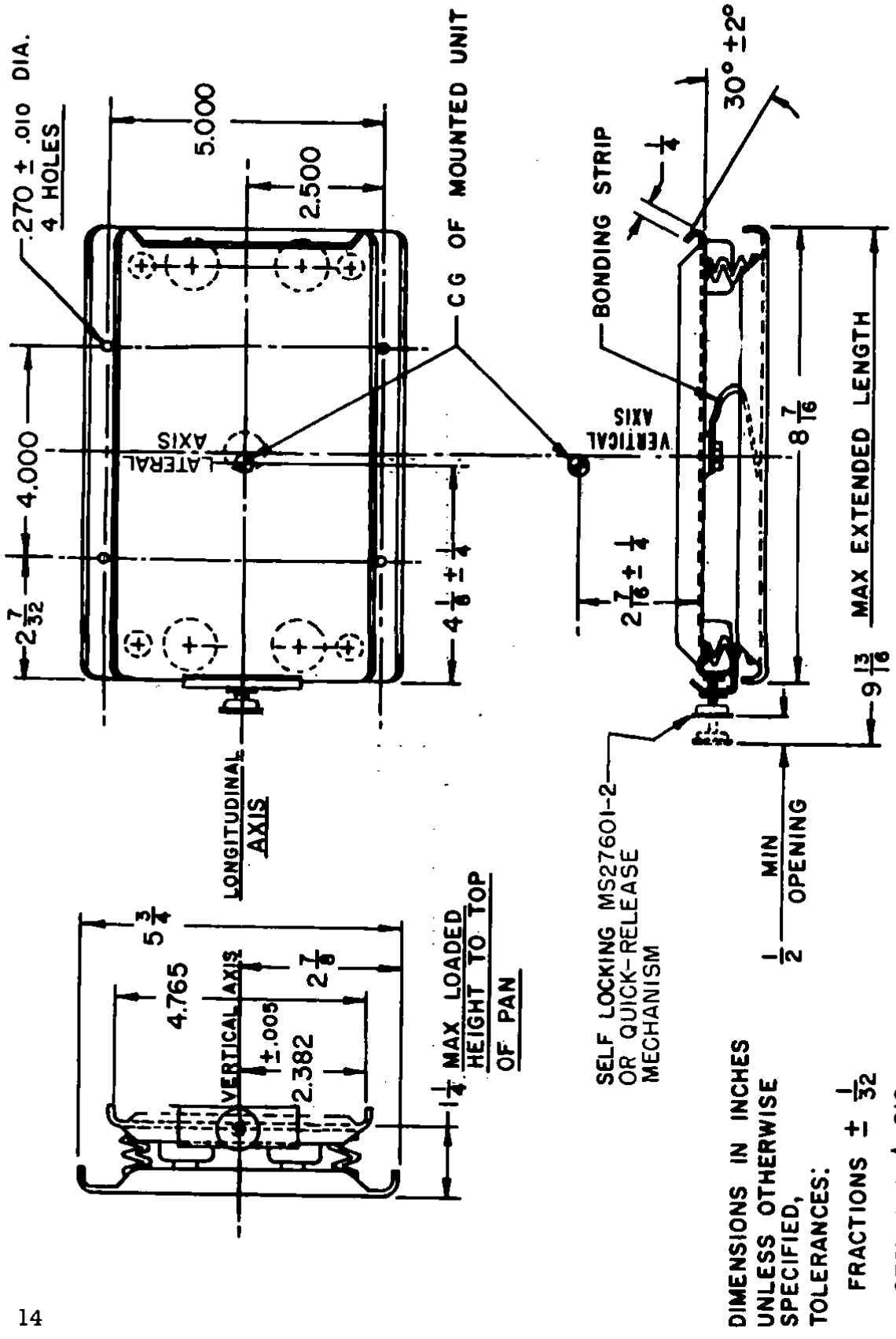

FIGURE 4. Shockmount

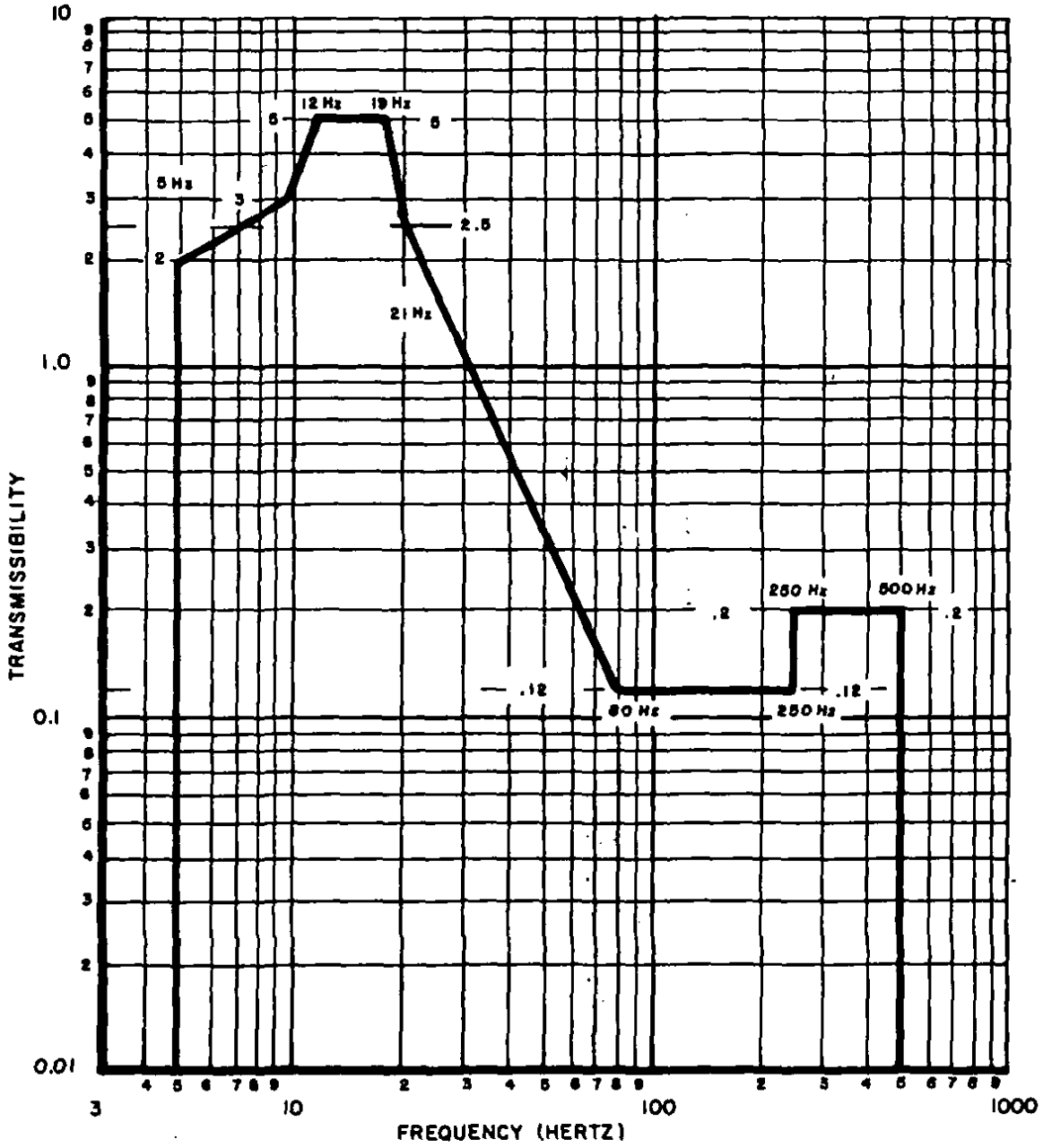

FIGURE 5. Maximum Allowable Transmissibility Along the Lateral Axis

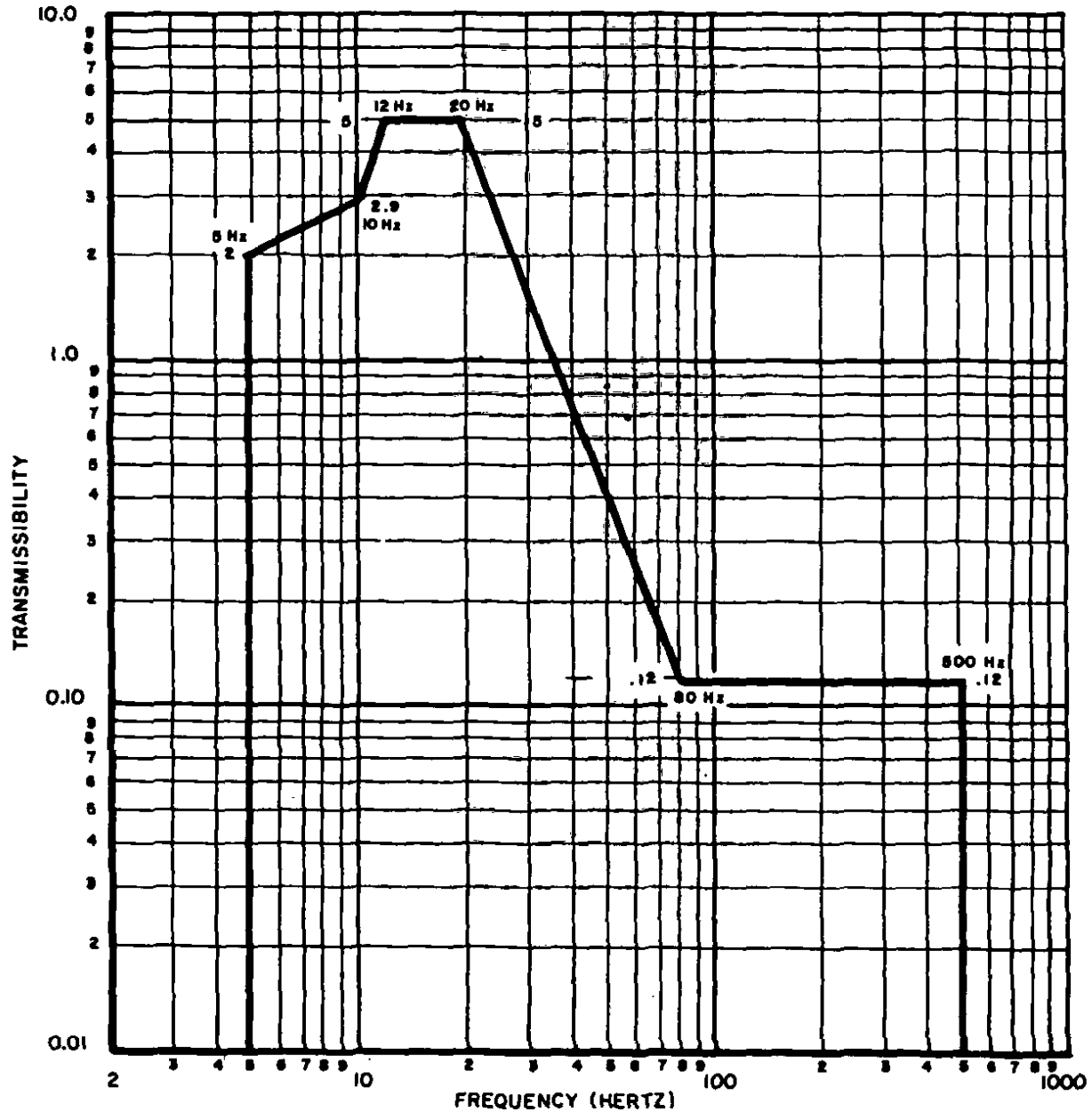

FIGURE 6. Maximum Allowable Transmissibility Along the Vertical Axis

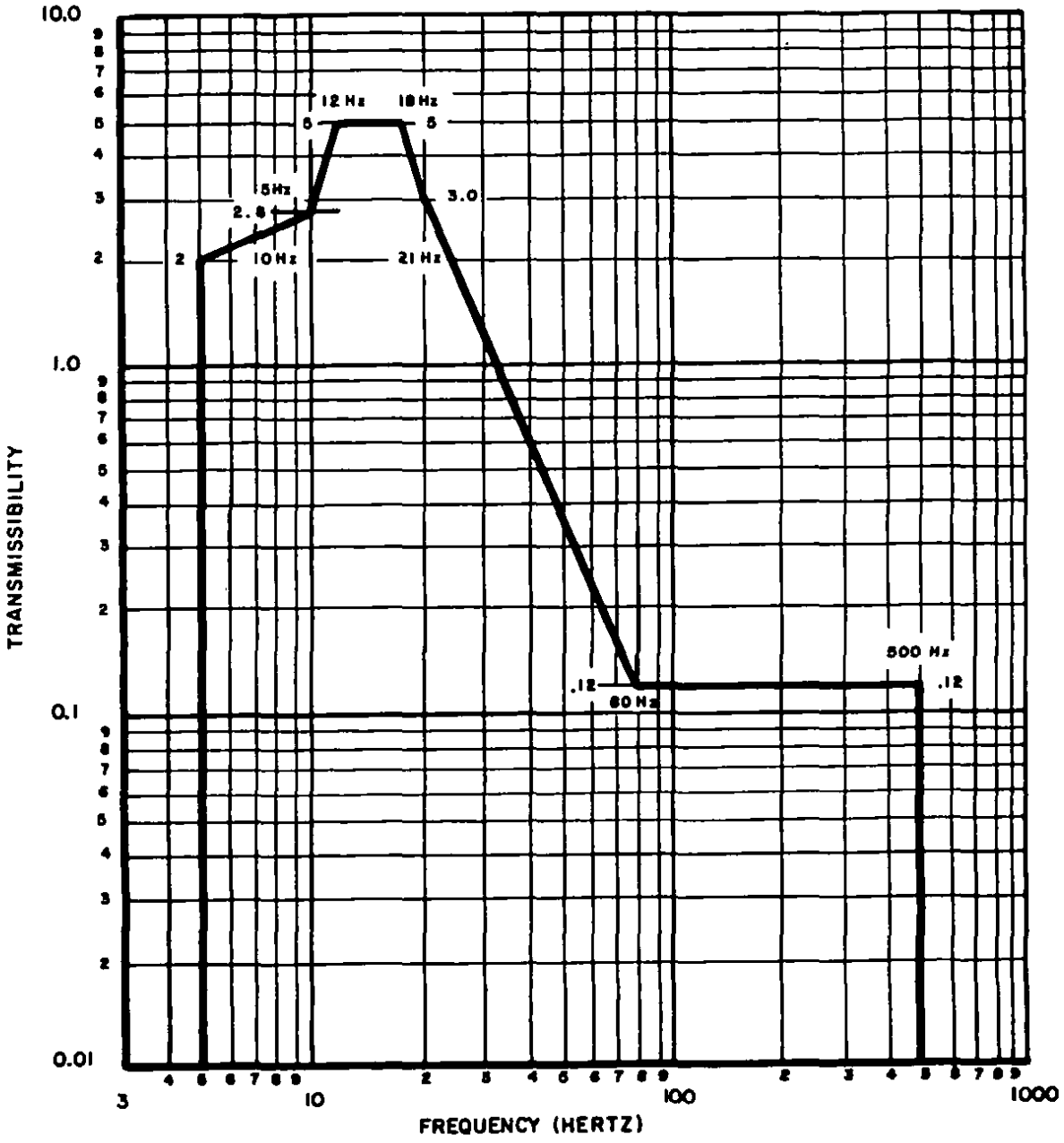

FIGURE 7. Maximum Allowable Transmissibility Along the Longitudinal Axis

3.12.3.4 Cross coupling. When loaded in accordance with 4.6.25.7 and subjected to the vibration input specified in 4.6.25.6, the mounting base shall not exhibit a rotation about the principle axes in excess of 1.5° peak to peak.

* 3.12.4 Attaching method. The shockmount shall incorporate a means of rigidly clamping the feet of the gyroscope case in place. One end of the shockmount shall hold the case firmly by the feet when it is placed on the mount and slid along its axis toward that end for a distance not greater than 5/8 inch. The other end of the mount shall permit the quick release of the gyroscope case by means of an MS27601-2 self-locking fastener or a thumbscrew quick-release mechanism on the mount. Normally, the cable end of the gyroscope case shall be on the fastener end of the mount; however, the design of the mount shall be such that the gyroscope case may be mounted in reverse and locked by the above means without interference of or modification to any part of the assembly.

3.13 Shockmount. The dimensions of the shockmount shall be as shown on figure 4. It need not be of this design, but the dimensions shown shall be adhered to.

3.14 Soldering. Soldering shall be accomplished in accordance with MIL-STD-454, requirement 5.

3.15 Weight. The weight of the gyroscope, including shockmount, shall not exceed 9-1/2 pounds.

3.16 Screw threads. Unless otherwise specified, the threads of all machine screws shall conform to MIL-S-7742.

3.17 Finishes and protective coatings

3.17.1 Aluminum alloy parts. Aluminum alloy parts shall be covered with an anodic film conforming to MIL-A-8625, except as follows:

3.17.1.1 Small holes and case inserts need not be anodized.

3.17.1.2 Aluminum alloys which do not anodize satisfactorily shall be coated with a chemical film in accordance with MIL-C-5541.

3.17.1.3 Where the primary purpose of the treatment is to afford a suitable paint base, chemical treatments in accordance with MIL-C-5541 may be used in lieu of anodizing.

3.17.1.4 Castings containing nonaluminum alloy integral inserts may be treated with a chemical film in accordance with MIL-C-5541 in lieu of anodizing.

3.17.1.5 When abrasion resistance is a factor, chemical films in accordance with MIL-C-5541 shall not be used in lieu of anodizing.

3.17.1.6 Parts enclosed in a hermetically sealed container need not be anodized or plated.

3.17.1.7 When the part is plated with tin over a copper flash, the part need not be anodized.

3.17.1.8 When necessary for electrical bonding, parts need not be anodized.

3.17.2 Steel parts. Where practicable, steel parts shall be cadmium plated in accordance with QQ-P-416, type II or III, as applicable, and of a class that is adequate to achieve the degree of protection required.

3.18 Identification of product. Equipment, assemblies, and parts shall be marked for identification in accordance with MIL-STD-130.

3.18.1 The direction-of-flight arrow and cautionary markings shall be legibly and permanently marked on the case.

3.19 Workmanship. The gyroscope, including all parts and accessories, shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness and thoroughness of soldering, brazing, painting, riveting, machine-screw assemblies, and freedom of parts from burrs and sharp edges.

3.19.1 Dimensions and tolerances. Dimensions and tolerances not specified shall be consistent with the best industry practices. Where dimensions and tolerances may affect the interchangeability, operation, or performance of the gyroscope, they shall be held or limited accordingly.

3.19.2 Screw assemblies. Assembly screws and bolts shall be tight. The word tight means that the screw or bolt cannot be appreciably tightened further without damage or injury to the screw, bolt, or threads.

3.19.3 Riveting. Riveting operations shall be carefully performed to insure that the rivets are tight and satisfactorily headed.

3.19.4 Gears. Gear assemblies shall be properly aligned and meshed and shall operate without interference, tight spots, loose spots, or other irreguarities. Where required for accuracy adjustment, gear assemblies shall be free from backlash.

3.19.5 Cleaning. The gyroscope shall be thoroughly cleaned and loose, spattered, or excess solder, metal chips or other foreign material removed after final assembly. Burrs and sharp edges as well as resin flash which might crumble shall be removed.

4. QUALITY ASSURANCE PROVISIONS

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

4.2 Classifications of tests. The inspection and testing of gyroscopes shall be classified as follows:

a. Qualification tests

b. Quality conformance tests.

4.3 Test conditions

4.3.1 Standard atmospheric conditions. When the pressure and temperature existing at the time of the test are not specified definitely, it is understood that the test is to be made at atmospheric pressure (approximately 29.92 inches Hg) and at room temperature (approximately 25° C). When tests are made with atmospheric pressure or room temperature differing materially from the above values, proper allowances shall be made for the difference from the specified condition.

4.3.2 Attitude. Unless otherwise specified, the gyroscope shall be tested in its normal operating position, and all tests shall be conducted with the gyroscope mounted on the shockmount specified in 3.12.2.

4.3.3 Power input. Unless otherwise specified, the gyroscope shall be tested with 115V 3-phase 400-Hz power input (nominal). The phase sequence shall be A to B to C.

4.3.4 Master indicator. Unless otherwise specified, the gyroscope shall be connected to an indicator having an input impedance, as near as practicable, equivalent to the ARU-14/A indicator in accordance with MIL-I-27709.

4.4 Qualfication testing

4.4.1 Test samples. The qualification test samples shall consist of five gyroscopes representative of the production equipment. The humidity, fungus, and salt fog tests may be conducted on five hermetically sealed cases containing only the filling medium. The samples shall be identified with the manufacturer's own part number and any additional information required by the procuring activity. Upon completion of qualification testing, the contractor shall deliver the test samples to the qualifying activity.

4.4.2 Test report. After the contractor completes the qualification tests, he shall prepare a test report in accordance with MIL-STD-831 and furnish three complete copies of the report to the procuring activity.

4.4.3 Qualification tests. The qualification tests shall consist of all the tests specified under 4.6.

4.5 Quality conformance tests. Quality conformance tests shall consist of:

a. Individual tests

b. Sampling tests.

* 4.5.1 Individual tests. Each gyroscope shall be subjected to the following tests as described under 4.6. The gyroscope shall not be shockmounted for these tests except for the shockmount assembly test (o).

a. Examination of product

b. Infant mortality aging

c. Initial erection

d. Final erection

e. Power consumption

f. External torquing

g. Erection rate

h. Roll and pitch erection cutout

i. Manual fast erection

j. Drift

k. Loop test

l. Roll test

m. Power interruption

n. Gimbal freedom

o. Shockmount assembly test

p. Power-off warning circuit

q. Leak rate.

4.5.2 Sampling tests

4.5.2.1 Sampling plan A (see 6.2). One gyroscope selected at random from each 100 or less produced on the contract or order shall be subjected to and shall pass the following tests as described under 4.6:

a. Individual tests

b. Low voltage operation

c. Low temperature operation

d. High temperature operation

e. Dielectric strength

f. Vibration error

g. Gimbal clearance

h. Synchro zeroing and sensing.

4.5.2.2 Sampling plan B (see 6.2). Unless otherwise specified, 5 gyroscopes selected at random from the first 30 items on the contract or order shall be subjected to and shall pass the following tests, in the sequence listed, as described under 4.6:

a. Sampling plan A tests

b. Radio noise interference

c. Environmental tests

d. Acceleration

e. Synchro transmitter characteristics.

4.5.2.3 Rejection and retest. When one gyroscope selected from a production run fails to meet the specification, gyroscopes still on hand or later produced shall not be accepted until the extent and cause of failure are determined. After corrections have been made, all necessary tests shall be repeated.

4.5.2.3.1 Individual tests may continue. For operational reasons, individual tests may be continued pending the investigation of a sampling test failure. But final acceptance of gyroscopes on hand or later produced shall not be made until it is determined that the items meet all the requirements of the specification.

4.5.3 Defects in items already accepted. The investigation of a test failure could indicate that defects may exist in gyroscopes already accepted. If so, the contractor shall fully advise the procuring activity of all defects likely to be found and methods of correcting them.

4.6 Test methods

* 4.6.1 Examination of product. The gyroscope shall be inspected to determine compliance with the requirements specified herein with respect to material, workmanship, marking, weight, and the dimensions shown on figures 1 and 4. The weight and dimension values shall be recorded once for each gyroscope in test.

* 4.6.2 Infant mortality aging. The gyroscope shall be operated for 24 hours on a scorsby-type mechanism having a 15° movement at 5 to 7 oscillations per minute. In the event of failure of any component or an out-of-tolerance condition of the gyroscope, the unit shall be unsealed and opened. The failed component shall be replaced or the out-of-tolerance condition shall be corrected. The unit shall then be resealed. This test need not be repeated on the resealed gyroscope except the unit shall be operated as above for the remaining length of time necessary to complete the 24-hour aging period. If additional failures or out-of-tolerance conditions occur during the aging period, they shall be corrected as specified herein. At the conclusion of this test, the gyroscope shall be subjected to the remaining individual tests.

* 4.6.3 Initial erection. The gyroscope shall be leveled to within ±6 minutes. The spin axis of the gyroscope under test shall be at any random position. Power shall be applied to the gyroscope. The gyro shall erect to within ±1° in pitch and bank by the end of the initial erection time delay period. The time-delay period shall not exceed 60 seconds as determined by a connection between pins J and T for power-off warning flag excitation. This test may be conducted with the gyro mounted on a low-angle (not to exceed 2° total movement) roll, pitch, and yaw mechanism operated at a speed of 5 to 7 oscillations per minute or with the gyroscope vibrated at 0.004 to 0.006 inch total amplitude at 10 to 12 Hz.

4.6.4 Final erection. The gyro shall be allowed to erect for 2 minutes after the initial erection test. The spin axis of the gyro shall erect to within ±1/4° of the vertical in pitch and bank within the 2-minute period. The gyro shall then be rotated rapidly 180° in azimuth. As a result, neither the pitch nor the bank axis indications shall change more than 1/2° from their indications prior to the 180° rotation. This test may be conducted with the gyro mounted on a low-angle (not to exceed 2° total movement) roll, pitch, and yaw mechanism operated at a speed of 5 to 7 oscillations per minute or with the gyroscope vibrated at 0.004 to 0.006 inch total amplitude at 10 to 12 Hz.

4.6.5 Power consumption. After 5 minutes of operation, the power consumption shall not exceed 30 va and power consumption during fast erection shall not exceed 55 va.

4.6.6 External torquing. The gyroscope shall be mounted on a low-angle (1° total movement) roll, pitch, and yaw mechanism and power shall be applied. Pin G of the electrical connector shall be connected to pin C. The top of the gyro shall precess forward and to the right (when facing in the direction of the line-of-flight arrow) at a rate of not less than 0.8° per minute. Pin L shall be connected to pin B and the top of the gyro shall cease to precess to the right. Pin K shall be connected to pin B and the top of the gyro shall cease to process forward. Pin K and pin L shall be connected to pin B both individually as well as simultaneously. The connection from pins L and K to pin B shall be removed and pin N shall be connected to pin C. The top of the gyro shall precess forward and to the right as specified herein but at a rate of not less than 15° per minute. Connecting pins K and L to pin B shall cause precession to cease as specified. During this test, the synchro outputs from the gyroscope shall give a direct indication of gyro position at all times.

4.6.6.1 Erection rate. The gyroscope shall be deflected 10° in right bank and the time required for the instrument to erect from 10° to 5° recorded. The computed erection rate shall be between 0.8° and 1.8° per minute. The same test shall be conducted for left bank and dive and climb and the same limits shall apply. The gyro shall not be deviated by more than 1.0° in the undeflected axis while it is erecting. This test shall be conducted with the gyro mounted on a low-angle (1° total movement) roll, pitch, and yaw mechanism.

4.6.7 Roll and pitch erection cutout. The gyroscope shall be deflected 10° in bank and 10° in pitch. Pin B shall be connected to pins K and L and there shall be no evidence of erection in either the pitch or the roll axis, respectively. The current drawn from pin B to pin K and from pin B to pin L shall not exceed 250 ma.

4.6.8 Manual fast erection. With the gyro deflected as specified in 4.6.7, pin C shall be connected to pin N. The gyro shall start to erect immediately at a rate of at least 15° per minute. The circuit between pins J and T shall be interrupted as long as the manual fast erection circuit is closed.

4.6.9 Drift. The gyroscope shall be mounted on a roll, pitch, and yaw mechanism with the connector end of the gyroscope pointed to the geographic west. The spin axis shall be deflected between 20° and 30° from the vertical in an easterly direction and the erection disconnected. The roll, pitch, and yaw mechanism shall be operated at a speed of 5 to 7 oscillations per minute and a total movement of 2-1/2°. With proper correction for the earth's rotation, the computed drift rate in either axis shall not exceed 15° per hour. The test shall be repeated immediately without power interruption with the connector end of the gyro case pointed to the south, east, and north. The same tolerances shall apply. If the drift in one heading exceeds the limit by not more than 1° in 5 minutes, the gyro may be retested in that heading and accepted if the first repeat test is within limits. Drift readings shall be recorded after a minimum period of 5 minutes on each heading. For sampling plan A, three drift readings shall be recorded in each of the four headings. If 1 of the 12 drift readings exceeds the limit by not more than 1° in 5 minutes, the gyro may be retested once in that heading for three additional drift readings and accepted if all three readings are within limits.

4.6.10 Loop test. The gyroscope shall be mounted on a fixture permitting rotation about the pitch (lateral) axis. The gyroscope shall be rotated one complete revolution (loop) at a rate of 10° $\pm 1°$ per second, and returned to the normal position. The error in either pitch or bank shall not exceed $\pm 3°$.

4.6.11 Roll test. The gyroscope shall be mounted on a fixture permitting rotation about the roll (longitudinal) axis. The gyroscope shall be rotated 5 complete revolutions (rolls) at a rate of 400° $\pm 10°$ per second. The error induced in either pitch or bank shall not exceed $\pm 1°$.

4.6.12 Gimbal freedom. With power applied to the gyroscope, the gyroscope shall be moved $+360°$ in bank and $+82°$ in pitch. There shall be no indication of gimbal sticking or binding in either axis.

4.6.13 Power interruption. The gyroscope shall be properly connected. After 5 minutes of operation, the power shall be removed and the gyroscope moved through angles of +60° in pitch and +75° in roll and returned to level. Power shall be applied 40 seconds after removal. The pitch and bank axes shall indicate level within +1° and there shall be no recycling of the initial erection. The circuit between pins J and T shall immediately close.

4.6.14 Shockmount assembly test. The gyroscope, including shockmount base, shall be attached to a level surface. The gyroscope shall be level to within ±1°. The gyroscope case shall be deflected by separately depressing each side and each end of the shockmount until the shockmount bottoms; the case shall then be released slowly. The shockmount shall return the gyroscope case to within +1/2° of its initial attitude after each deflection with no vibration or other motion applied to the assembly.

4.6.15 Power-off warning circuit. The gyroscope shall be properly connected and power shall be applied. After the gyro has reached full speed, the external connection to pin A shall be removed and the circuit between pins J and T shall open immediately. Pins A shall be connected and the circuit between pins J and T shall close. This procedure shall be repeated with pin B and then pin C. The results shall be the same as with pin A.

4.6.16 Leak rate. The sealed case shall be tested for leaks by means of a mass-spectrometer type helium leak detector. The leak rate shall not be sufficient to cause more than 10 percent loss or contamination of the filling medium after 1,000 hours at approximately 1 atmosphere differential pressure.

4.6.17 Low voltage operation. Power shall be applied to the gyroscope and the voltage and frequency reduced to 103V and 320 Hz respectively. The gyroscope shall then meet the following tests: Drift, gimbal freedom, and power-off warning circuit.

4.6.18 Low temperature operation. The gyroscope shall be placed in a chamber at a temperature of -54° +2° C for a period of 4 hours. At the end of this period and while the gyroscope is at the reduced temperature, the initial erection, final erection, erection rate, drift, synchro transmitter characteristics, gimbal freedom, and power-off warning circuit tests shall be repeated except as follows:

4.6.18.1 The initial erection time shall not exceed 1-1/2 minutes after power applied.

4.6.18.2 Power shall be applied for 10 minutes before conducting the final erection test.

4.6.18.3 The erection rate limits shall be 0.8° to 1.8° per minute with a 3° maximum deviation on the undeflected axis.

4.6.18.4 The no-load output shall be 11.8 +0.4V and the no-load phase shift shall not exceed 5.5° . The line-to-line output voltage when loaded with 5 loads as specified in 3.5.9.2 shall be not less than 10.7V. The phase shift with five loads shall not exceed 9° .

4.6.19 High temperature operation. The gyroscope shall be properly connected and placed in a chamber at a temperature of 85° +2° C for 4 hours. After the soak period, power to the gyro shall be terminated and the gyro rotor permitted to run down to zero rpm. The high temperature shall be maintained during rotor run down and during subsequent tests. After rotor run down, the gyroscope shall be subjected to and shall meet the initial erection, drift, and synchro transmitter characteristics tests except that conditions for the synchro transmitter characteristics test shall be as follows:

4.6.19.1 The no-load output shall be 11.8 +0.4V and the no-load phase shift shall not exceed 8° . When loaded with five loads as specified in 3.5.9.2, the line-to-line output voltage shall be not less than 10.6V. The phase shift with the five loads shall not exceed 11.5° .

4.6.20 Dielectric strength. A potential of 200V, 60 Hz ac shall be applied between isolated pins and between pins and the case for a period of 10 seconds. There shall be no breakdown of insulation. No dielectric tests shall be made in circuits connected with the vertical gyro erection switches.

4.6.21 Vibration error. The vibration error test shall consist of a frequency survey with vibration applied to longitudinal, lateral, and vertical axes of the gyroscope. The gyroscope shall be mounted with the shockmount and shall be subjected to vibration with a constant applied double amplitude of 0.060 inch through the frequency range of 10 to 55 to 10 Hz within 1 minute in each of the 3 mutually perpendicular axes. This test may be conducted with vibration applied in a circular motion for one complete frequency range.

4.6.21.1 Signal continuity. There shall be no transients or discontinuity in the pitch and roll synchro outputs during vibration.

4.6.21.1.1 Synchro transmitter characteristics. After vibration, the electrical characteristics of the transmitting synchros will be measured with suitable test equipment. The characteristics shall be within the tolerances specified in 3.5.9.

4.6.21.2 Variation. After the 1-minute vibration, the pitch and roll axes shall not be more than 3/4° from their original position before vibration.

4.6.22 Gimbal clearance. After passing the gimbal freedom test, the gyroscope shall be subjected to a differential pressure test. The pressure applied outside the case shall be 1 atmosphere greater than the pressure inside the case. The pressure differential shall be maintained for 15 minutes. At the conclusion of this test, the gyroscope shall again be subjected to the gimbal freedom test.

4.6.23 Synchro zeroing and sensing. The gyroscope synchros shall be tested to determine compliance with 3.5.10 and shall meet the requirements specified therein.

4.6.24 Radio noise interference. The radio noise interference test shall be conducted in accordance with MIL-I-6181.

4.6.25 Environmental tests. The gyroscope shall be subjected to the following environmental tests conducted in accordance with the applicable methods of MIL-STD-810 and as specified:

4.6.25.1 High temperature exposure. The gyroscope shall be properly connected and subjected to a high temperature exposure test in accordance with method 501, procedure I, except that the exposure period shall be 20 hours and no power shall be applied. At the end of the 20-hour period and while at the high temperature, the gyroscope shall be subjected to the initial erection, final erection, drift, gimbal freedom, and power-off warning circuit tests. The temperature shall be raised to 100° +2° C within 15 minutes and maintained for 2 hours and 50 minutes. The gyroscope shall then be subjected to the gimbal freedom test.

4.6.25.2 Temperature-altitude. The gyroscope shall be subjected to a temperature-altitude test in accordance with method 500, procedure II, except that for step 2, the chamber internal pressure shall be reduced to -62° C for 48 hours. In step 3, the chamber internal pressure shall be equivalent to 100,000 +500 feet. With power applied and with the temperature and pressure as specified herein, the initial erection and gimbal freedom tests shall be conducted. The time required for initial erection shall not exceed 5 minutes, and there shall be no binding or sticking of the gimbals at any indication. After the gyroscope has returned to room temperature and pressure, it shall meet all individual tests.

* 4.6.25.3 Humidity. The humidity test shall be conducted in accordance with method 507, procedure I except in steps 2 and 3, the humidity shall be 100 percent. The gyroscope shall then meet the leak rate test. There shall be no evidence of corrosion or rust.

4.6.25.4 Fungus. The fungus test shall be conducted in accordance with method 508, procedure I. The gyroscope shall then meet the leak rate test. There shall be no deterioration nor shall any part of the gyroscope support fungus growth.

4.6.25.5 Salt fog. The salt fog test shall be conducted in accordance with method 509, procedure I. The gyroscope shall then meet the leak-rate test.

* 4.6.25.6 Vibration failure. The gyroscope shall be subjected to a vibration failure test in accordance with method 514, equipment category (a), with vibration isolators, except the vibration test curve shall be as follows:

Frequency (Hz)	Double Amplitude (Inch)	Acceleration (g)
5-14	0.10	---
14-23	---	±1.0
23-74	0.036	---
74-500	---	±10.0

At the completion of this test, the gyroscope shall be subjected to and shall meet the individual tests. No damage or irregular operation shall result.

4.6.25.7 Shockmount vibration. A cable connector in accordance with 3.9 and figure 3 shall be attached to a dummy load representative of the gyroscope. The dummy load shall be attached to the shockmount and the resulting assembly shall be subjected to and shall meet the following tests. The shockmount used for this test need not be used for other tests specified herein.

* 4.6.25.7.1 The assembly shall be subjected to and shall pass the test specified in 4.6.25.6 except it need not meet the individual tests. The resonant frequency shall be a minimum of 6 Hz and the shockmount shall meet the transmissibility requirements of 3.12.3.3 and figures 5, 6, and 7.

4.6.25.7.2 At the conclusion of the test specified in 4.6.25.7.1, the parallelism of the bottom surface of the mount with respect to the top surface of the mount shall be determined. The difference shall not exceed 1° .

4.6.25.7.3 With the dummy load attached to the shockmount, all four corners of the shockmount shall be depressed and then released. The shockmount shall return to its original angular position to within 0.0087 inch per inch (±1/2°) of original deflection.

4.6.25.7.4 The transmissibility curves for the three principle axes of the shockmount shall be plotted and the points of maximum cross coupling about the axes shall be determined. The transmissibility characteristics shall meet the requirements of 3.12.3.3 and the principle axes cross coupling shall meet the requirements of 3.12.3.4.

*4.6.25.8 Shock. With a dummy load or rejected Type MD-1 gyroscope mounted on the shockmount, the assembly shall be subjected to a shock test in accordance with method 516, figure 516.1-1, procedures I and III for flight vehicle equipment. The 20g shock shall not cause the shockmount to bottom out.

* 4.6.25.9 Temperature shock. The gyroscope shall be subjected to a temperature shock test in accordance with method 503. After the gyroscope has returned to room temperature, the connector and seals shall be examined. There shall be no evidence of cracked terminals or leaks at the seals. The gyroscope shall then be subjected to the drift, power-off warning circuit, and leak rate tests.

4.6.26 Acceleration. The gyroscope, nonoperating, shall be mounted on a centrifuge in its normal position and subjected to 20g, first along its vertical axis and then along each of two axes that are perpendicular to the vertical axis and to each other. The acceleration time period shall be 1 minute in each axis. The gyroscope shall then be subjected to and shall meet the individual tests. No damage to the gyroscope shall result from this test.

* 4.6.27 Reliability. The five gyroscopes specified in 4.4.1 shall be subjected to a reliability test. Each gyroscope shall be properly connected and operated for a period of 1,700 hours (total of 8,500 hours) on a 15° total movement roll, pitch, and yaw mechanism having 5 to 7 oscillations per minute. Not more than six failures will be permitted for an accept decision which will demonstrate a minimum acceptable MTBF of at least 800 hours at a 90 percent confidence level based on the Chi-squared distribution. The qualifying activity reserves the right to perform the 1,700-hour test without interruption. At the conclusion of the 1,700-hour test (on each gyroscope), the gyroscope shall meet the individual tests. All out-of-tolerance conditions shall be considered as failures. Test records, test reports, and the failure summary analyses shall be in accordance with MIL-STD-781.

4.6.28 Compatibility (see 6.6). Prototype installation and flight compatibility tests shall consist of the following: Initial erection, final erection, erection rate, manual fast erection, power interruption, and power-off warning circuit. As many of these tests as possible shall be conducted on the ground prior to aircraft takeoff. The rest of the tests shall be conducted in the air during straight and level flight and during coordinated turns.

* 4.7 Inspection of the preservation, packaging, packing, and marking for shipment and storage. The inspection of the preservation, packaging, packing, and marking shall be in accordance with the requirements of section 5, or the documents specified therein.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging (see 6.2)

5.1.1 Level A. Gyroscopes shall be preserved in accordance with method III of MIL-P-116 and packaged in accordance with MIL-STD-794. Electrical connectors shall be equipped with water-vaporproof caps and gaskets.

5.1.2 Level C. The gyroscope shall be packaged in a manner that will afford protection against deterioration and damage so that serviceability is assured at the point of destination.

5.2 Packing (see 6.2)

5.2.1 Level A. Gyroscopes preserved and packaged as specified in 5.1.1 shall be packed in accordance with level A of MIL-STD-794.

5.2.2 Level B. Gyroscopes preserved and packaged as specified in 5.1.1 shall be packed in accordance with level B of MIL-STD-794.

5.2.3 Level C. Gyroscopes preserved and packaged as specified in 5.1.1 shall be packed in accordance with level C of MIL-STD-794.

5.3 Marking for shipment. The gyroscope shall be marked for shipment in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. The Type MD-1 gyroscope covered by this specification is intended for use in aircraft to provide pitch and roll signals for indication or tie-in to other equipment. This gyroscope has provisions for turn error compensation to be controlled by a remote rate gyro switching mechanism.

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

a. Title, number, and date of this specification

b. That sampling plan A tests will be completed within 30 days after the sample unit is manufactured and that sampling plan B tests will be completed within 120 days after the five sample units are manufactured (see 4.5.2.1 and 4.5.2.2)

c. When sampling plan B tests will not be conducted (see 4.5.2.2)

d. Levels of preservation and packaging and packing required (see 5.1 and 5.2).

6.3 Definition

6.3.1 Hermetic seal. A hermetic seal is defined as a perfectly closed and airtight seal made between vitric or metallic, or both, materials. A hermetic seal is not intended to include seals accomplished by gaskets.

6.4 Inspection records. Inspection records of the examination and tests will be kept complete and will be available to Government representatives upon request.

6.5 Installation. Installation of the Type MD-1 gyroscope will be governed by figure 8.

6.6 Compatibility. The prototype installation and compatibility tests will be performed by the Air Force with technical support and assistance of the contractor. Changes or modifications resulting from these tests will be accomplished by the contractor on all production gyros at no extra cost to the Government. Any gyro delivered prior to completion of satisfactory flight tests will be reworked and updated as necessary at no additional cost to the Government. If the changes are class I, requalification of the units will be necessary.

6.7 Qualification. With respect to products requiring qualification, awards will be made only for such products which are, at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Aeronautical Systems Division, Attn: ASD/ENFIF, Wright-Patterson Air Force Base, Ohio 45433, and information pertaining to qualification of products may be obtained from that activity.

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

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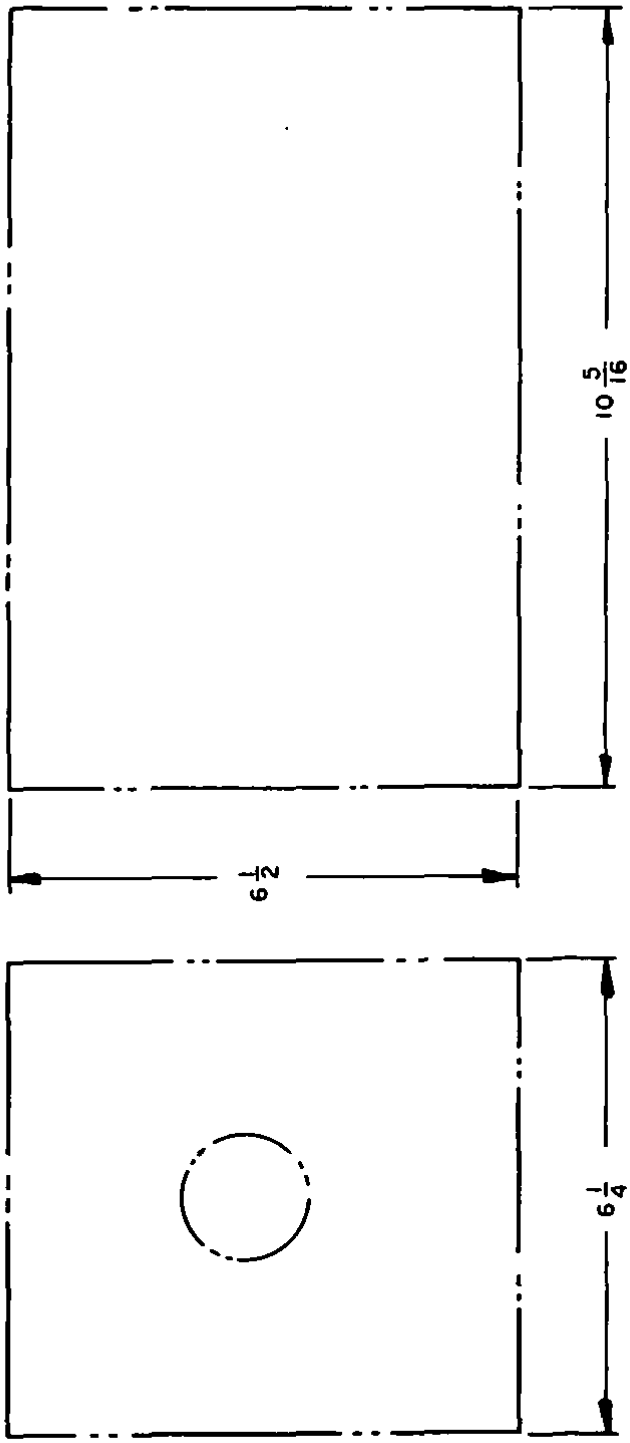

FIGURE 8. Installation Clearance Outline

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