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MILITARY SPECIFICATION

AMPLIFIER-INDICATOR GROUP, ALTITUDE-VERTICAL SPEED A/A24G-11

1. SCOPE

1.1 This specification establishes the requirements for one type of aircraft altitude vertical speed amplifier-indicator group, designated A/A24G-11.

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)
PPP-B-636	Box, Fiberboard

Military

MIL-P-116	Preservation, Methods of
MIL-C-675	Coating of Glass Optical Elements (Anti-Reflection)
MIL-C-5015	Connectors, Electrical, "AN" Type
MIL-E-5272	Environmental Testing, Aeronautical and Associated Equipment, General Specification for
MIL-E-5400	Electronic Equipment, Aircraft, General Specification for
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-M-26512	Maintainability Program Requirements for Aerospace Systems and Equipment
MIL-R-26667	Reliability and Longevity Requirements, Electronic Equipment, General Specification for
MIL-L-27160	Lighting, Instrument, Integral, White, General Specification for
MIL-C-38037	Computer, Central Air Data CPU-43/A
MIL-D-70327	Drawings, Engineering and Associated Lists

STANDARDS

Federal

FED-STD-595	Colors

Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U. S. Military Property
MIL-STD-143	Specifications and Standards Order of Precedence for the Selection of
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization of
MS17322	Meter, Time Totalizing Miniature, 400 Cycle, Digital
MS33558	Numerals and Letters, Aircraft Instrument Dial, Standard Form
MS33586	Metals, Definition of Dissimilar

(Copies of documents 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 publication. The following document forms 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.

Aeronautical Radio, Incorporated

Standard ARINC 545 Subsonic Air Data Computer System

(Copies of the ARINC document may be obtained from Aeronautical Radio, Incorporated, 1700 K Street, N. W., Washington 6, D. C.)

3. REQUIREMENTS

3.1 Preproduction. This specification makes provisions for preproduction testing.

3.2 Components. The amplifier-indicator group shall consist of

Indicator, Altitude-Vertical Speed AAK-15/A24G-11
Amplifier, Electronic Control ASK-11/A24G-11.

3.3 Selection of specifications and standards. Specifications and standards 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. If used within a hermetically sealed enclosure, fungicidal treatment shall not be required.

3.4.2 Metals. Metals shall be of the corrosion-resistant type or suitably treated to resist corrosion due to conditions likely to be encountered in storage or normal service.

3.4.2.1 Dissimilar metals. Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other. Dissimilar metals are defined in MS33586.

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

3.4.4 Protective treatment. Materials that are utilized within the hermetically sealed case of the indicator and amplifier shall be considered suitably protected against corrosion.

3.4.5 Toxic and corrosive fumes. The materials, as installed and under specified service conditions, shall not liberate gases or fumes which will result in such corrosion as to cause malfunction of equipment or discoloration of dials or indicia, nor shall toxic gases or fumes that are detrimental to performance of the aircraft or health of personnel be liberated under the service conditions specified herein.

3.5 Design and construction. The AAK-15/A24G-11 indicator and ASK-11/A24G-11 amplifier shall be designed and constructed in accordance with figures 1 through 7, and shall have maximum reliability consistent with the requirements and minimum weight specified herein.

*3.5.1 Power requirements. The amplifier-indicator group shall meet all applicable requirements of MIL-STD-704 and ARINC 545 and shall operate from the power defined therein. The power requirements shall be as follows and shall not exceed the indicated amounts:

A-C power
Operating limits: 102 to 124V
Standby voltage limits or emergency supply: 90 to 130V
Operating frequency limits: 380 to 420 cps
Standby frequency limits or emergency supply: 380 to 420 cps
Maximum operating volt-amperes: 63
Maximum warmup time: 1 minute if temperature has been at -35° C or higher and 3 minutes if temperature has been at -55° C.

3.5.2 Design life. The system shall be designed for a reliable life of at least 1,000 hours without servicing and a minimum operating life of at least 2,000 hours

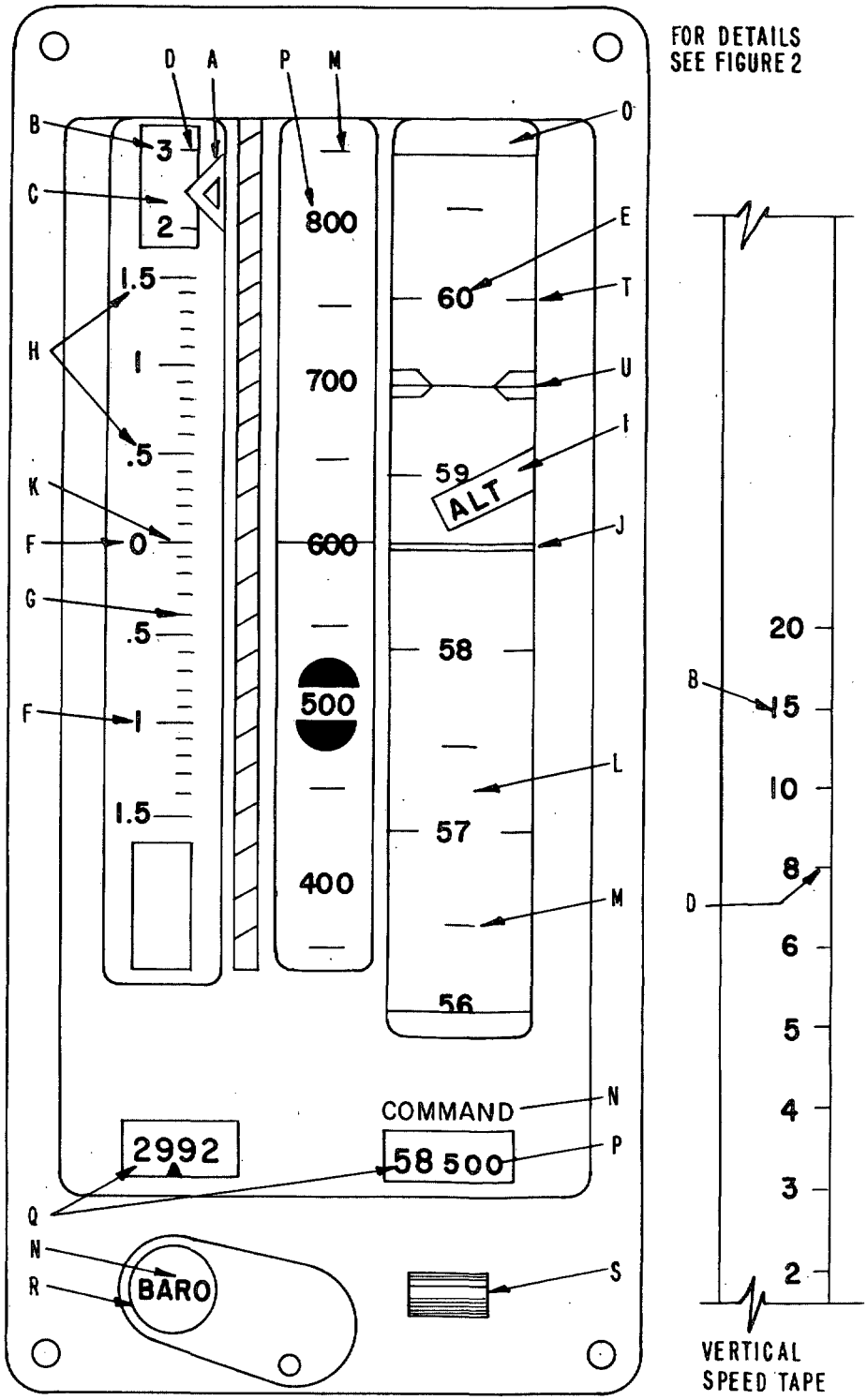


FIGURE 1.. Altitude - Vertical Speed

A	Triangular index moves under fixed reference. Vertical base is 3/8 long and chord is 7/32. Center, black with 1/16 white border
B	3/16 White numerals
C	Black durable dull
D	Black on black
E	7/32 High white numerals, except -1,000 shall be red
F	3/16 White numerals
G	3/32 White
H	1/8 High white numerals
I	Red 3/16 X 9/16 black letters
J	0.030 White
K	5/32 White
L	Black tape
M	White
N	1/8 White
O	Black
P	7/32 White numerals
Q	1/4 White numerals
R	Baro set knob 7/8 X 1/2 Dia, gray with black face
S	Spring centered switch - gray
T	3/16 White, except -1,000 shall be red
U	1/8 Total width white marker with 0.030 black centerline.

Stroke width of numerals and grads 1/16 to 1/8 of height

Width of numerals to be 3/5 of height
Letters and numerals shall conform to MS33558
All colors conform to FED-STD-595, except red

Black - Color No. 37038, White - Color No. 37875,
Gray - Color No. 36231, as applicable
Red - Red Fluorescent 116-1548 (Switzer Brothers, Cleveland, Ohio, or equal).

DIMENSIONS IN INCHES

FIGURE 2. Nomenclature List

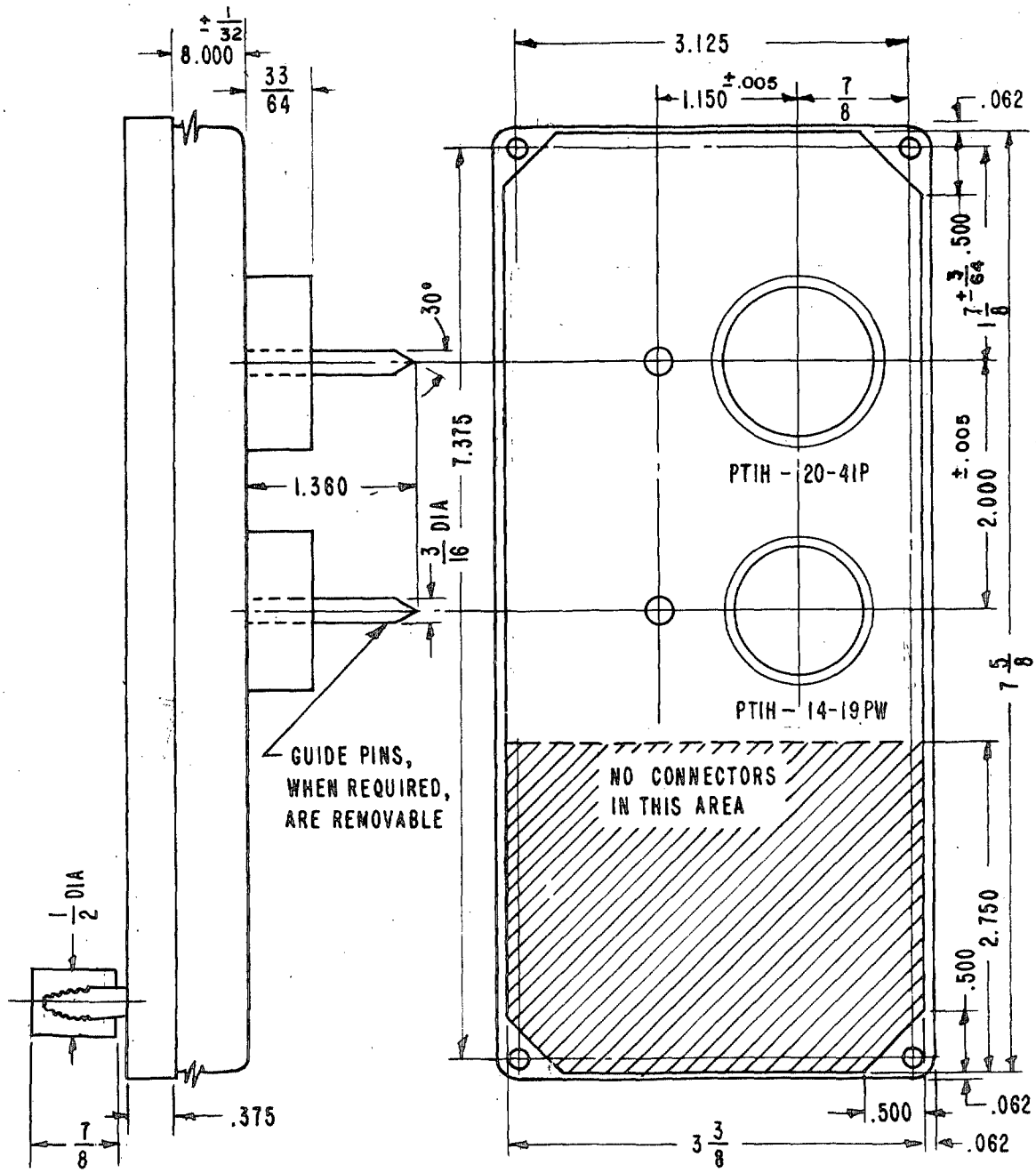


FIGURE 3. Case, Altitude Vertical Speed Rear & Side View

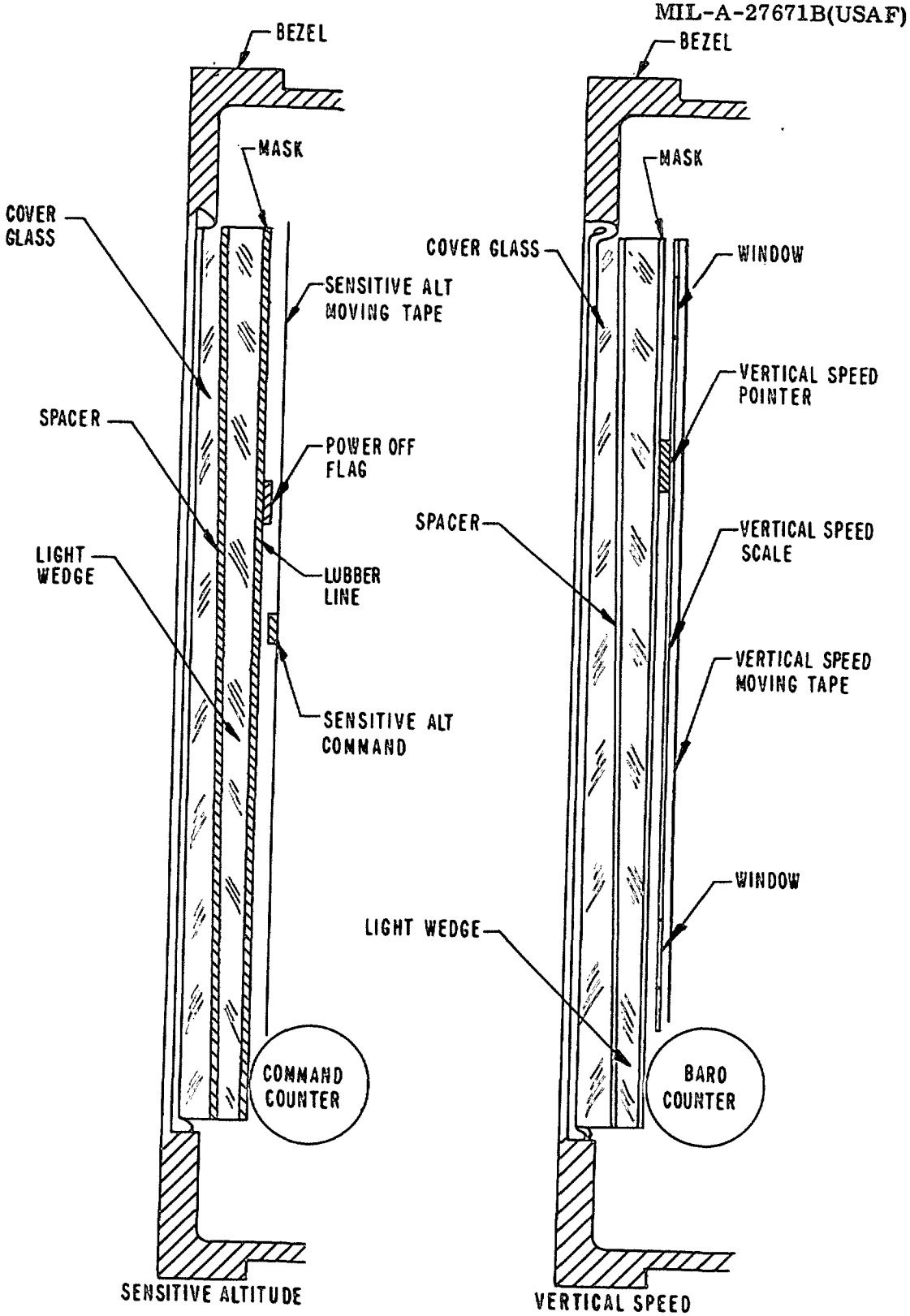


FIGURE 4. Sections Altitude Vertical Speed

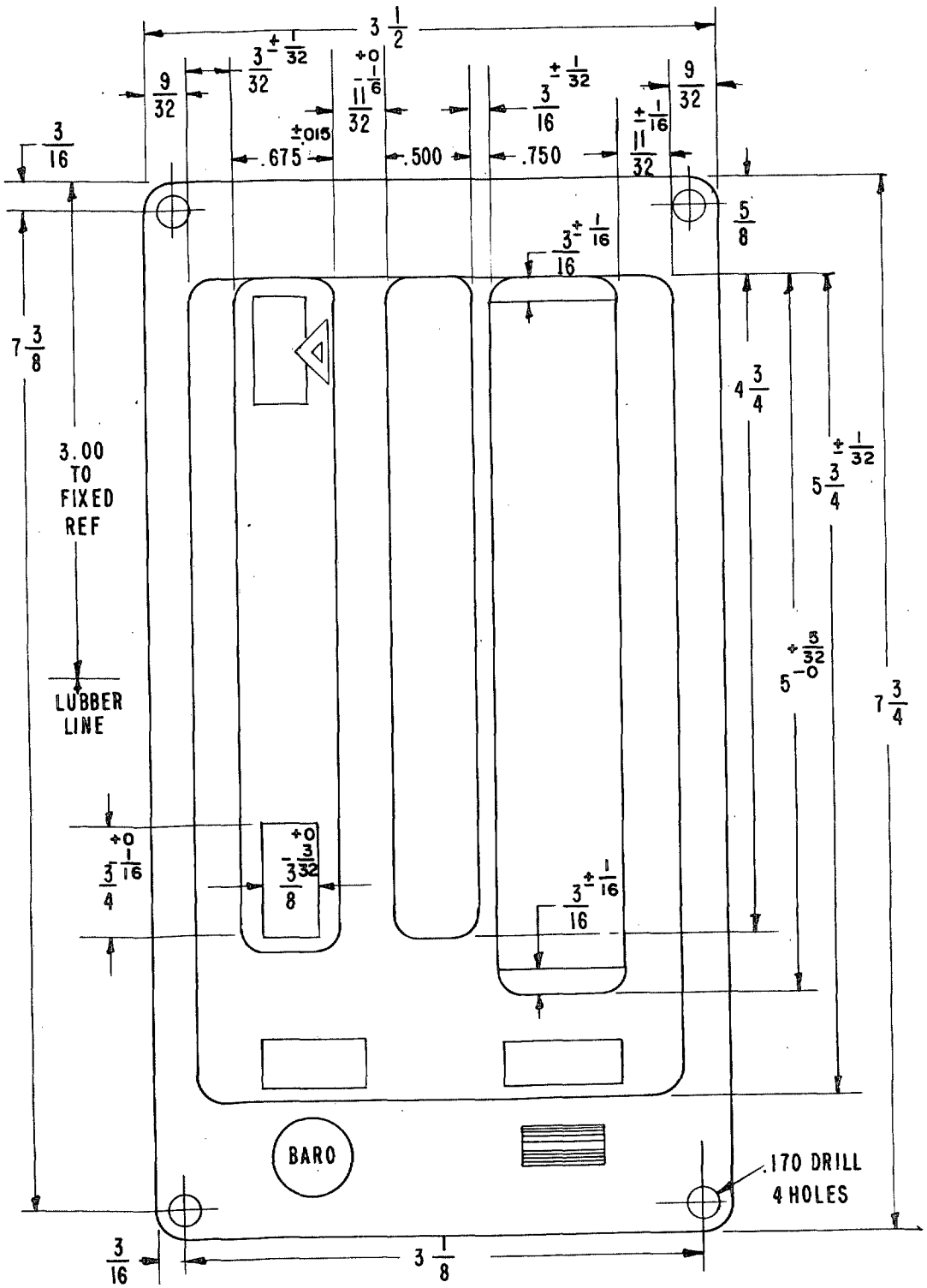
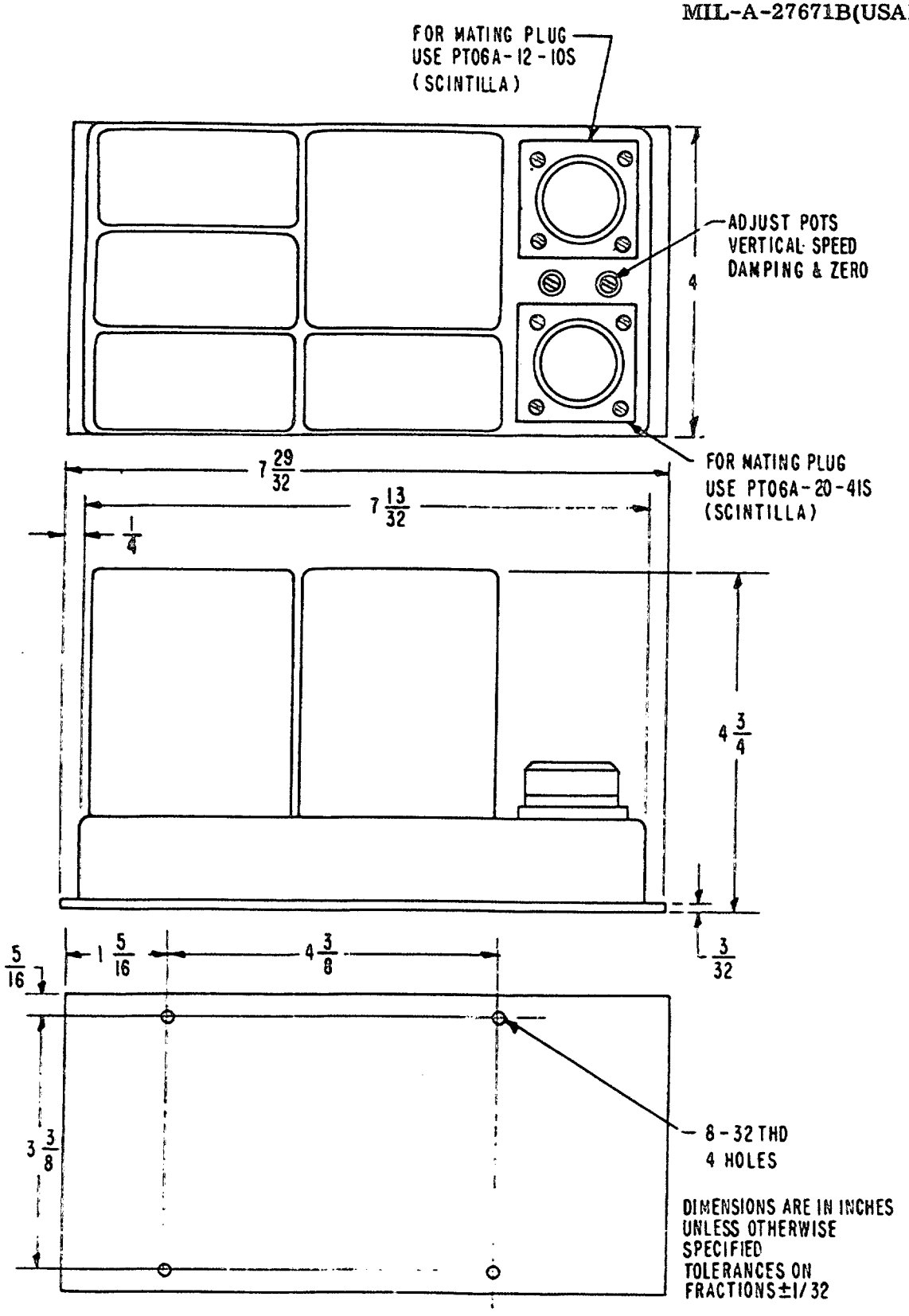


FIGURE 5. Bezel



* FIGURE 6. Outline, Amplifier, Altitude, Vertical Speed

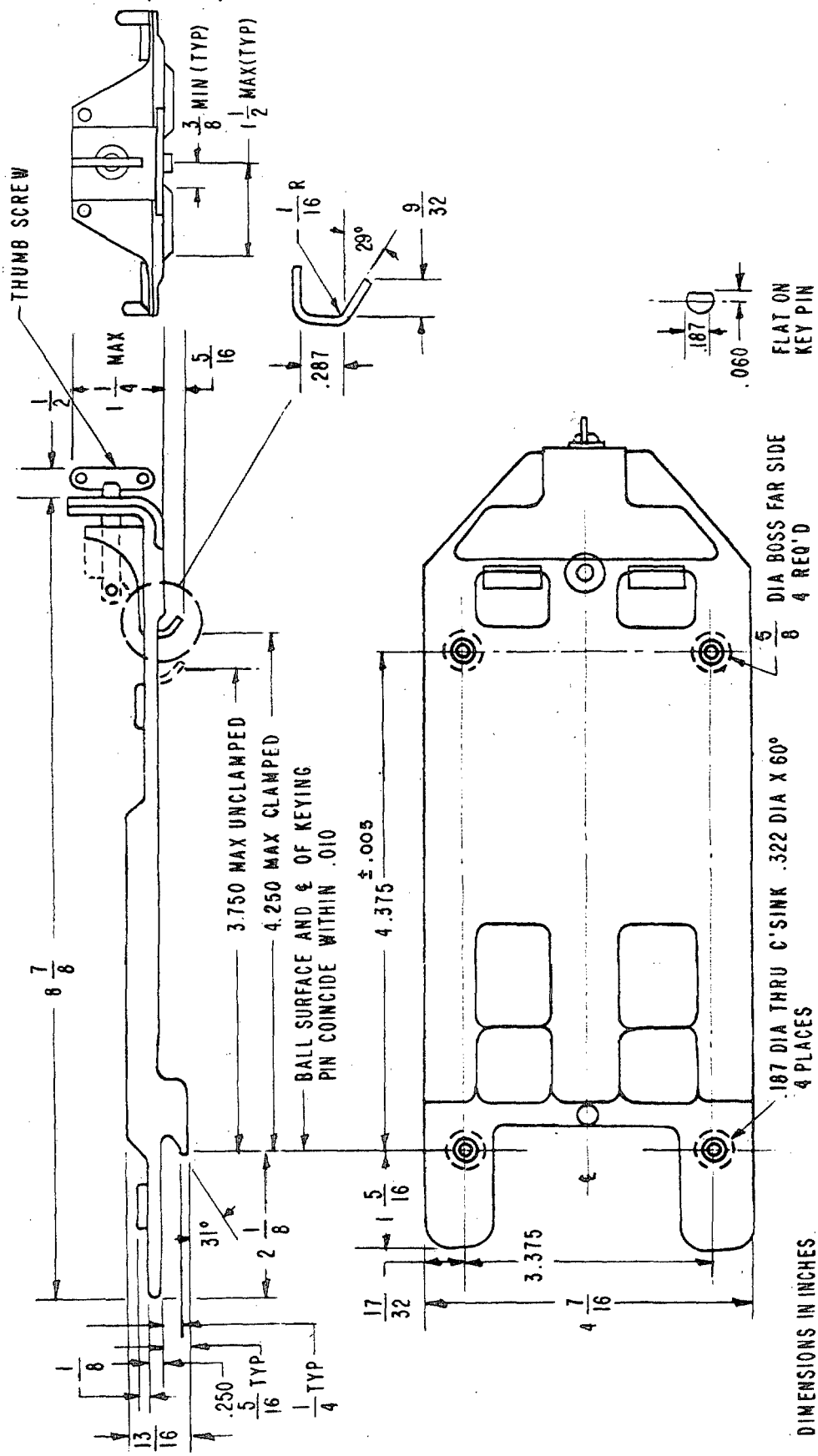


FIGURE 7. Mounting Base

with reasonable servicing and replacement of parts. The contractor shall prepare a list of parts requiring replacement within the minimum operating life of the equipment.

3.5.2.1 Lamps. Life requirements for lamps shall be in accordance with applicable specifications approved by the procuring activity. The lamps shall be replaced as required.

3.5.4 Maintainability. Ready access to the interior parts, terminals, and wiring of the amplifier and indicator shall be provided to permit adjustment, circuit checking, calibration, and removal and replacement of parts. If hermetic sealing is utilized, this requirement shall apply after removal of the sealed case. The maintainability requirements shall be in accordance with MIL-M-26512.

3.5.5 Mean-time-between-failures (MTBF). The equipment shall have a MTBF of at least 346 hours with a 90 percent confidence factor (see table in MIL-R-26667 entitled "Reliability Accept-Reject Criteria"). Failure is any condition that results in out-of-tolerance performance.

3.5.6 Compatibility and signal interchangeability. The AAK-15/A24G-11 indicator input requirements and ASK-11/A24G-11 amplifier input and output requirements shall be interchangeable and compatible with the input and output characteristics of the following:

a. CPU-43/A central air data computer in accordance with MIL-C-38037

b. AAK-15/A24G-11 indicator manufactured by any prior alternate source

c. ASK-11/A24G-11 amplifier manufactured by any prior alternate source.

3.5.7 Construction. The altitude-vertical speed display shall conform to figure 1. The design shall be reasonably simple to permit overhaul or repair without requiring numerous special tools and fixtures. The amplifier-indicator group shall be so constructed as to withstand normal strains, jars, vibrations, and other conditions incident to shipping, storage, installation, and service.

3.6 Performance. The indicator and amplifier shall be capable of meeting the requirements specified herein under the following conditions:

a. Vibration - In accordance with MIL-E-5272, procedures IV and V for the indicator and procedure XII for the amplifier

b. Acceleration - Procedure III of MIL-E-5272

c. Humidity - Relative humidity up to 100 percent

d. Fungus - Fungus growth as encountered in tropical climates

e. Temperatures - From -54° to +71° C

f. Sand and dust - Sand and dust particles as encountered in desert areas

g. Temperature-altitude - Operation under the various temperature-altitude conditions indicated on curves A, B, and C of figure 8

h. Shock - Procedure V of MIL-E-5272

i. Altitude - Pressures ranging from 31 to 2.118 inches Hg.

3.6.1 Dielectric strength. The indicator shall withstand applications of 250V 60 cps for 5 seconds under the conditions specified in 4.6.1.5.

3.6.2 Insulation breakdown and resistance. The amplifier shall withstand application of 500V for 5 seconds under the conditions specified in 4.6.2.4 and 4.6.2.5. The current leakage shall not exceed 4.5 ma and the insulation resistance shall be not less than 20 meg.

3.6.3 Radio interference. The radio interference requirements shall be in accordance with MIL-I-6181.

3.7 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The item identification and part number requirements of MIL-D-70327 shall govern the manufacturer's part numbers and changes thereto.

3.8 Indicator

3.8.1 Case. The indicator shall be in accordance with figures 1 through 5. The case shall be of nonferrous, low-density material and shall be finished in durable dull black, color No. 37038 of FED-STD-595. It shall provide a hermetically sealed enclosure for the internal mechanism and shall be of such design that the internal mechanism may be removed from the case, replaced, and the case resealed. This shall be accomplished without the use of special tools and fixtures unless they are approved by the procuring activity. The hermetic sealing shall be so accomplished that the seal will not be dependent upon materials that will be affected by the action of any atmosphere to which the indicator may be subjected.

3.8.1.1 Filling medium. The filling medium 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 filling medium shall be either 100 percent helium or a mixture of 90 percent nitrogen and 10 percent helium. The absolute pressure of the filling medium shall be approximately 1/2 to 1 atmosphere, as required. Where practicable, 100 percent helium shall be utilized.

3.8.2 Dial. The layout and dimensions of the dial shall be in accordance with figures 1 and 2.

3.8.3 Markings. All markings shall be so durable as to withstand usage encountered in service. The style and proportions of numerals and letters placed on the dial shall conform to figures 1 and 2.

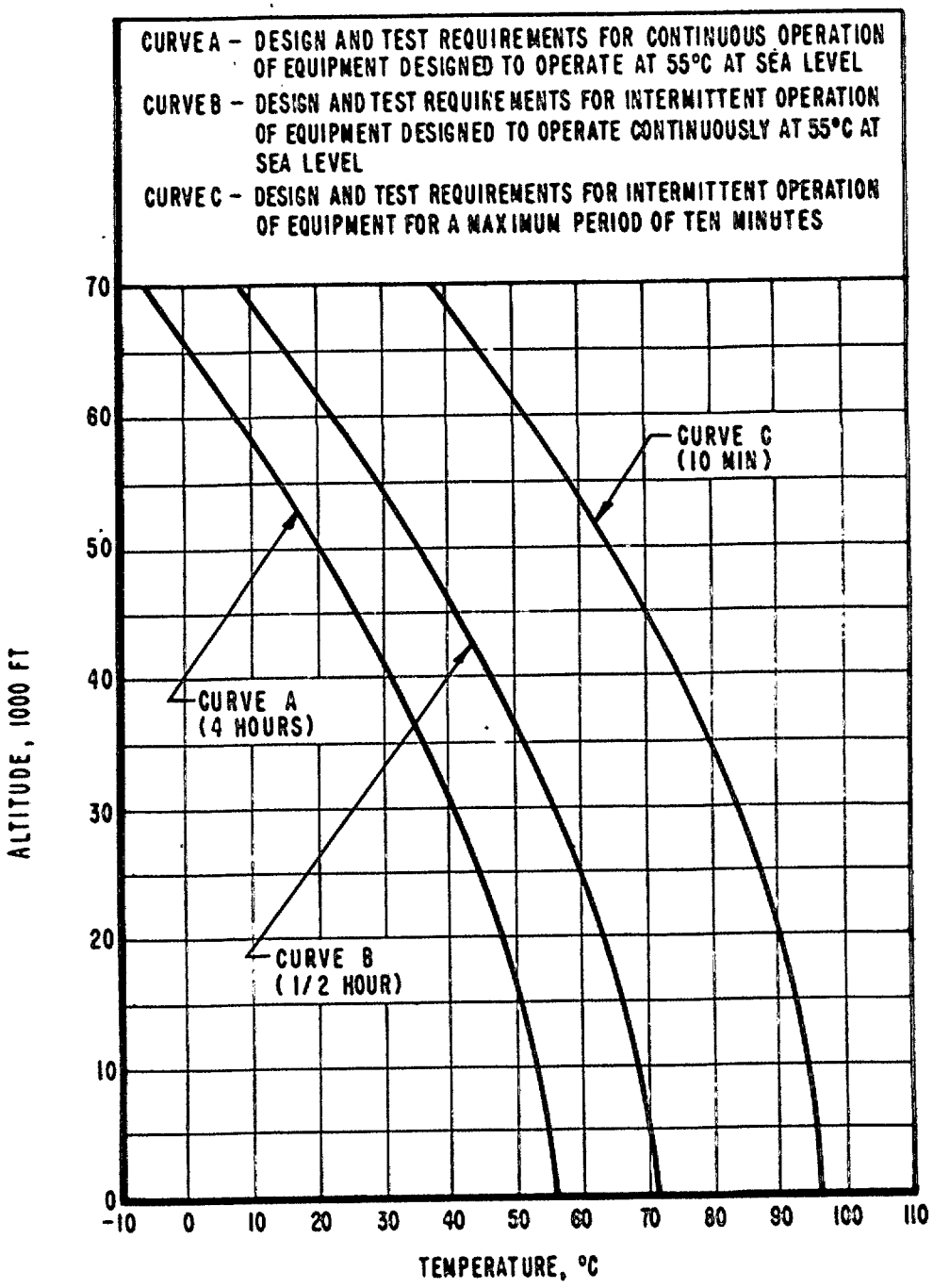


FIGURE 8. Altitude Vs Temperature

3.8.3.1 Numerals. Numerals shall distinctly indicate the graduation to which each applies. If practicable, each numeral shall be so placed that the center of mass of the numeral is on the line joining the appropriate graduations. There shall be no doubt as to which graduation the numeral applies. When several numerals are used in one group, the space between the numerals shall be approximately 1/62 inch.

3.8.4 Dial to lighting wedge distance. The distance from dial to lighting wedge shall be as small as practicable and shall not exceed 0.20 inch.

3.8.5 Lighting. The indicator shall be internally lighted in accordance with MIL-L-27160. Lighting acceptability shall be based on visual comparison with a prime standard indicator.

3.8.5.1 Prime standard. The prime standard lighting reference instrument shall be prepared as follows: A minimum of 20 areas covering the entire face of the indicator shall be measured for brightness level in foot-lamberts. The prime standard instrument and its recorded overall brightness measurements shall be approved by the procuring activity. The standard shall be checked periodically, at least every 100 hours of operation, to determine any change in brightness. Variations greater than ±20 percent in two or more areas shall require return of the standard for corrective action.

3.8.6 Integral lighting supply. A 400-cps voltage, variable from 0 to 5V rms, shall supply power for internal lighting for both normal and emergency operation. The frequency tolerances of the supply voltage shall be as specified in MIL-E-5400.

3.8.7 Reflective Surfaces. All reflecting glass surfaces shall be provided with a reflection reducing coating which meets the requirements of MIL-C-675, in addition to withstanding the environmental conditions specified herein, except that the following reflectance tolerances shall apply:

Angle of Incidence	Wave Length Millimicrons	Percent Reflectance
0°	450 to 675	0.6 Maximum
0°	425 to 700	0.5 Average
30°	450 to 625	1.0 Maximum
30°	425 to 700	0.5 Average.

3.8.8 Method presentation. The method of presenting command altitude shall be by means of translational motion of a symbol along a vertical scale, as well as indication on a counter. Sensitive altitude shall be presented by means of moving scales against fixed index marks. Vertical speed between 0 and 2,000 fpm ascent and descent shall be presented by a moving pointer against a fixed scale. Rates in excess of 2,000 fpm shall be presented by means of moving scales against a fixed index represented by the stalled pointer.

3.8.8.1 The indicator shall present the following information, derived from signal inputs in the form of synchro and rate generator signals from a central air data computer:

a. Aircraft altitude, range -1,000 to +60,000 feet

b. Vertical speed, range ±20,000 fpm.

3.8.8.2 Command information shall be manually set by the slew switch.

3.8.9 Barometric setting output. The barometric or zero setting system shall be mechanized as specified in 3.8.15 and the setting shall appear on a 4-digit counter and as the wiper position of a potentiometer having the following characteristics:

a. Resistance - 20K ohms ±5 percent

b. Power rating - 1.5w at 25° C

c. Rotation - 350° ±1°

d. Resolution - 1/800

e. Independent linearity - ±0.5 percent.

3.8.10 Aircraft altitude. The aircraft altitude moving tape scales shall be actuated by a servo mechanism with a dual speed transmitting synchro input. The input to the instrument control transformer synchro shall be linearly proportional to altitude over the range of -1,000 to +60,000 feet. Tape scale factor shall be 1 inch per 1,000 feet on the coarse scale and 1 inch per 100 feet on the vernier tape.

3.8.10.1 Aircraft altitude mechanization. The servo drive mechanism shall be designed to accurately position the moving scale at the center reference line. Provisions shall be made to prevent the moving scale from being driven beyond specified limits. Electrical zero of the followup synchro shall be at 29.92 inches Hg. Servo slew speed shall be not less than 60,000 fpm.

3.8.11 Command altitude. The command altitude symbol and associated counter shall be actuated by a mechanism driven by signals generated by the slew switch.

3.8.11.1 Command altitude mechanization. The drive mechanism shall be designed to convert the rotary motion of the motor into translational motion of the symbol. The mechanism shall be designed to accurately position the command marker with respect to the appropriate position on the aircraft altitude moving tape and command counter. When the command index is positioned to any value on the altitude scale, there shall be no apparent relative motion between command index and moving scale resulting from servoed motion of the moving scale in either direction. Motion of either element shall not result in interaction with the other. Provision shall be made to disengage the drive mechanism so that when the command altitude is beyond the visible range of the instrument dial on the moving tape scale, the index will assume a position at the scale extremity and remain visible at all times. The reading of the command altitude marker against the gross altitude tape (when the command value is within the visible range of the altitude scale) shall at all times read within 25 feet of the command value as read on the counter.

* 3.8.12 Counter. The command counter shall be of the continuous-rotation type for the counter wheel displaying only the least significant digit. Counter wheels that operate intermittently shall not be used.

3.8.13 Scale factor (altitude input functions). The scale factor of the followup synchros shall be as follows. Bendix synchros AY-500□F-42-A1, or equivalent, shall be used, set to electrical zero at 29.92 inches Hg.

72° per 1,000 feet on the fine synchro
2.667° per 1,000 feet on the course synchro

3.8.13.1 Range and scale factor - vertical speed. The vertical speed range and scale factor shall be as follows:

A-C tachometer output 0.250V per 1,000 fpm
50 fpm to 20,000 fpm ascent and descent
In phase ascent
180° ±10° out-of-phase descent.

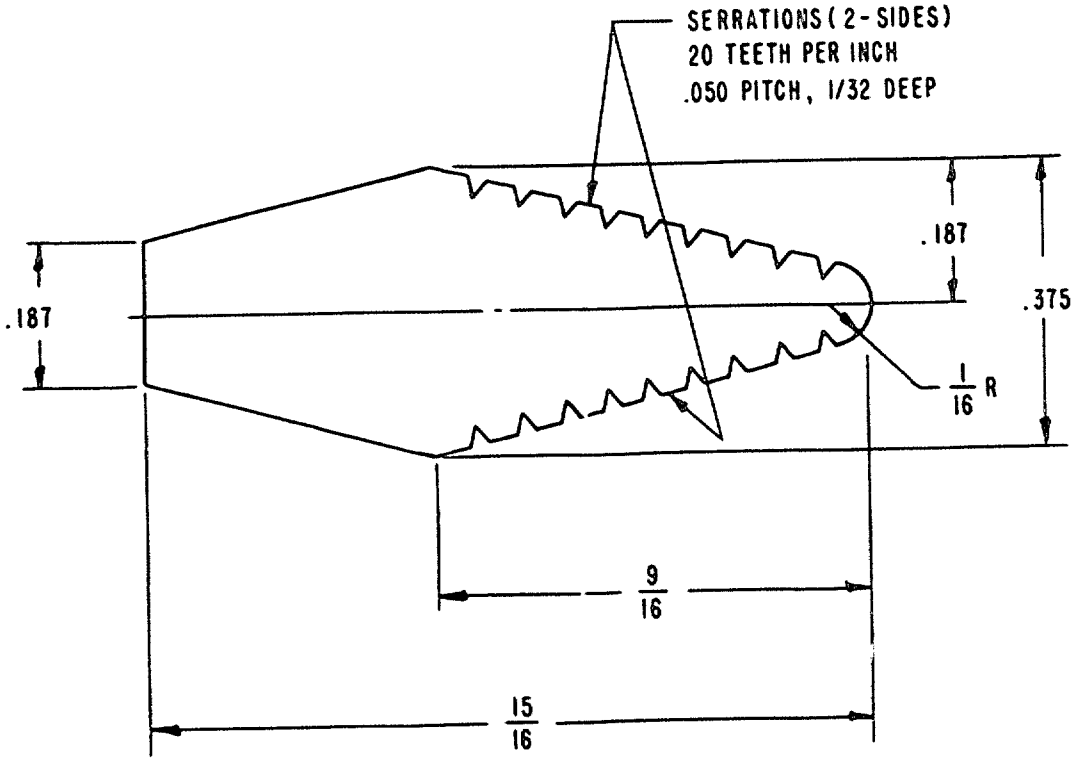
3.8.14 Slewing switch. A manually operated slewing switch as shown on figure 1 shall be provided to operate the command symbol and associated counter. The switch shall be spring centered. The slewing speed imparted to the command symbol shall be proportional to the amount the switch is displaced from center within the minimum and maximum speeds specified. Up-position of the switch shall drive the symbol toward increasing value of the function. A center lock position shall be provided on the slewing switch to position and retain the index on the center reference line. In this position, the counter shall continuously provide a digital indication of altitude. The slew switch shall incorporate a unit detent that will permit indexing of one unit on the associated counter. The slew switch dimensions shall be in accordance with figure 9.

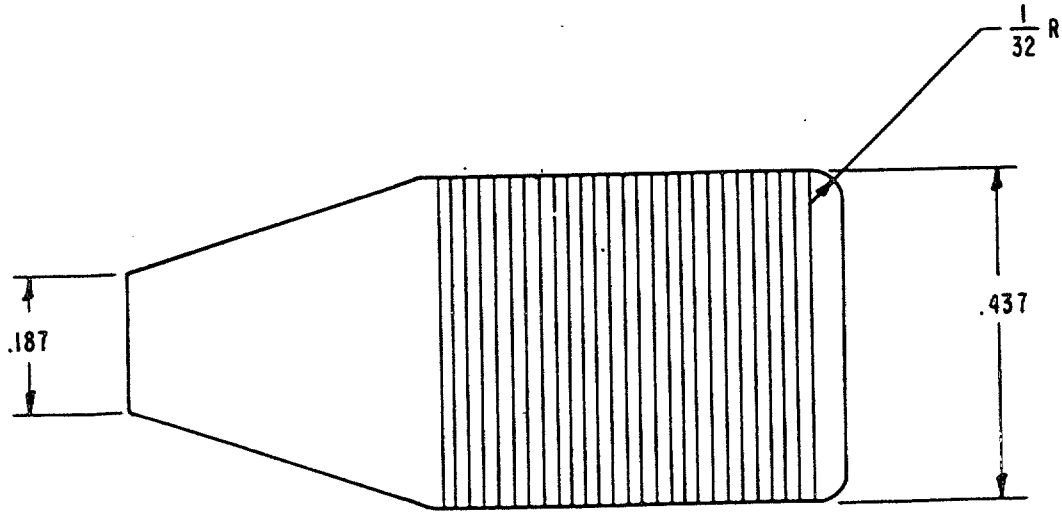
3.8.15 Zero setting system. A zero setting system, controlled by a setting knob, shall be provided that will permit the altimeter to be set a range of 31 to 28 (inclusive) inches Hg. A safety feature shall be provided on the pressure scale so that the scale cannot be read erroneously when the zero setting mechanism is moved beyond the range of 31 to 28 inches Hg. The pressure scale shall be 4-digit counter as shown on figure 1. Clockwise (cw) rotation of the knob shall drive the counter numerals toward increasing numerical values.

3.8.15.1 Adjustment of setting. The zero setting system shall be provided with a suitable means to adjust or correct the relative setting of the altitude and the zero setting system indications should this become necessary. The adjustment shall be accessible from the face of the altimeter when installed on the instrument board. Range of adjustment shall be ±200 feet. A protective covering shall be provided to prevent tampering with the adjustment.

3.8.16 Failure indicator. In the event of normal and emergency power failure, a spring-loaded, red dropout flag with black ALT lettering and having automatic reset when power is restored shall be provided. One flag shall be provided for the sensitive altitude scale. Location and configuration shall be as shown on figure 1.

3.8.17 Elapsed time indicator. A 10,000-hour, 4-digit type elapsed time indicator conforming to MS17322 shall be provided and so mounted in each indicator that the dial will be visible on the side or rear of the case.





DIMENSIONS IN INCHES

FIGURE 9. Slew Switch Knob

3.8.18 Decompression. The indicator shall be so designed and constructed as to withstand explosive decompression of surrounding atmosphere. Operation shall not be affected when a pressure differential of 16 inches Hg is applied instantaneously between the interior and exterior of the case.

3.8.19 Self-test circuit. A self-test circuit shall be provided in the indicator so that the altimeter tapes may be positioned at a preset value.

* 3.8.20 Monitoring circuit. A monitoring circuit shall be provided that will detect malfunctions in the indicator components and intercabling, including the transmitter synchro within the air data computer. A malfunction shall cause the altitude warning flag to appear. A calibration series voltage (stick off) shall be included in the monitor circuit to provide self-test capability. This series voltage, which is equivalent to the maximum trip level, shall cause the warning flag to appear when the excitation voltage is removed from the air data transmitter.

3.8.21 Indicator synchros. Indicator synchros shall be as follows, or their electrical equivalent:

Transmitting synchro (from CADC):	AY50▱-42-A1
All control transformer synchros:	AY300S-18-A1
All control differential synchros:	AY330S-15

3.8.22 External pressure. The indicator shall withstand an external pressure of 56 inches Hg absolute without failure of the hermetic seal or indicator glass and without such distortion of the case that would affect subsequent normal operation.

3.9 Amplifier. The amplifier shall be of the transistor or transistor-mag type. It shall be modular in construction with plug-in modules for the power supply, auxiliary circuits, and amplifier circuits. Envelope dimensions shall not exceed those specified on figure 6, excluding the shockmount. The mounting base for the amplifier shall be in accordance with figure 7.

3.9.1 Servo response. Response of the altitude servo shall be as follows:

Function	Bandwidth	Damping Ratio
Altitude	3 - 8	0.17 or greater

3.9.1.1 Response of vertical speed display. The vertical speed servo loop and associated display shall respond in an exponential manner to a vertical speed step function input of 2,000 fpm. The time constant of this response shall have a minimum range of from 2 to 6 seconds. Provisions shall be included on the amplifier to accomplish this adjustment. Bandwidth shall have a minimum range of 0.04 to 0.4 cps and damping shall be critical, or greater.

3.9.2 Feedback potentiometer. The followup potentiometer for vertical speed shall be a shaped function potentiometer tapped and shunted to give nonlinear response in accordance with nonlinear tape scale factor as follows:

a. From 0 to 2,000 fpm, 1,000 fpm = 1 inch

b. From 2,000 to 6,000 fpm, 1,000 fpm = 1/2 inch

c. From 6,000 to 10,000 fpm, 2,000 fpm = 1/2 inch.

d. From 10,000 to 20,000 fpm, 5,000 fpm = 1/2 inch.

3.9.3 Excitation. Unless otherwise specified, excitation for all remote transmitting synchros or potentiometers shall be furnished from the indicator amplifier.

3.9.4 Electron tubes. Electron tubes shall not be used.

3.10 Connectors. Electrical connectors used on the indicator and amplifier cases shall be of the hermetic-seal type and shall electrically conform to MIL-C-5015. Miniature connectors, Scintilla type, as specified herein, or the electrical equivalent shall be utilized. Keying provisions shall be made where necessary. Connector pin arrangements shall be as specified in table I.

TABLE I

Pin Connections For Altitude-Vertical Speed Indicator

Indicator-Amplifier Interconnections			
Connector PTO2A-20-41P PTO6A-20-41S Pin - Amplifier	Connector PTIH-20-41P PTO6A-20-41S Pin - Indicator	Function	Section
A	A	R G out	VERTICAL SPEED
R	R	R G out	
B	B	Amp out	
P	P	Capacitor	
S	S	Power Ground	
T	T	R G Exec	
C	C	Motor fixed ∅	
N	N	Pot Exc Hi /0°	
a	a	Pot Exc Lo /180°	
b	b	Pot Wiper	
U	U	Signal Ground	
D	D	IX CT H	ALTITUDE
M	M	27 X CT H + R G out	
Z	Z	Spare	
c	c	Spare	
V	V	Amp Out	
E	E	Capacitor	
L	L	Motor fixed ∅	
Y	Y	R G Exc	
W	W	Slew Switch Out	COMMAND ALTITUDE
F	F	Spare	
K	K	Amp Out	
J	J	Capacitor	
H	H	Motor fixed ∅	
G	G	R G Exc	
X	X	Chasis ground	

* TABLE I (CONT)

Pin Connections For Altitude-Vertical Speed Indicator

Indicator Inputs And Outputs			
Connector PT1H-14-19PW PT06A-14-19SW Pin - Indicator	Function		
M	Tach out Lo - Vertical Speed		
A	Lights - 5V		
B	Lights - 5V		
L N P	CT X CT Y CT Z	FINE	ALTITUDE
C K U	CT X CT Y CT Z	COARSE	
V	ADC Altitude Monitor		
R	Altitude Monitor - Flag Trip Level Voltage		
D	CT X - Altitude Monitor		
J	CT Z - Altitude Monitor		
T	Self Test (normally grounded - connect to 28V dc for self test)		
S	Baro Setting - Exc Hi		
E	Baro Setting - Exc Lo		
H	Baro Setting - Wiper		
G	Spare		
F	CT Y - Altitude Monitor		
Amplifier Inputs And Outputs			
Connector PT02A-12-10P PT06A-12-10S Pin - Amplifier	Function		
A	Spare		
H	Spare		
B	Tachometer Out Hi - Vertical Speed		
G	Signal Ground - Vertical Speed		
K	115V 400~ / 0° (H) (from AC Bus)		
J	AC Common (C)		
C	Spare		
F	Spare		
D	Spare		
E	Spare		

3.10.1 Extra contacts in receptacles. Extra contacts shall not be required unless necessary for conducting tests.

3.11 Electronic components. The electronic components shall be in accordance with MIL-E-5400.

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

3.13 Weight. The weight of the indicator shall be held to a minimum consistent with design requirements and shall not exceed 9 pounds 14 ounces. The weight of the amplifier shall not exceed 8 pounds including the mounting base.

3.14 Finishes and protective coatings

3.14.1 Plating. Plating shall not be required on normally lubricated parts such as gears, bearings, and shafts fabricated from brass, bronze, or corrosion-resistant steel.

3.14.2 Cadmium plated parts. Cadmium plated parts shall be in accordance with QQ-P-416 and of a type and class adequate to achieve the degree of protection required.

3.14.3 Aluminum alloy parts. Aluminum alloy parts shall be covered with an anodic film in accordance with MIL-A-8625, except that small holes, straight threads, and case inserts need not be anodized.

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

3.16 Government Loaned Equipment. When specified (see 6.2), one each of the following equipment will be loaned by the Government to the contractor upon his request:

a. CPU-43/A central air data computer in accordance with MIL-C-38037

b. AAK-15/A24G-11 indicator

c. ASK-11/A24G-11 amplifier.

3.17 Workmanship. The amplifier-indicator group, including all parts and accessories, shall be fabricated and finished in a thoroughly workmanlike manner. Particular attention shall be given to freedom from blemishes, defects, burrs, and sharp edges, accuracy of dimensions, radii of fillets, and marking of parts and assemblies, thoroughness of soldering, welding, brazing, painting, wiring and riveting, alignment of parts, and tightness of assembly screws and bolts.

3.17.1 Dimensions and tolerances. Dimensions and tolerances not specified shall be as close as is consistent with the best shop practices. Where dimensions and tolerances may affect the interchangeability, operation, or performance of the equipment, they shall be held or limited accordingly.

3.17.2 Gears. Gear assemblies shall be properly aligned and meshed, and shall be operable without interference, tight spots, or other irregularities. Where required for accurate adjustments, gear assemblies shall be free from backlash.

3.17.3 Cleaning. The equipment shall be thoroughly cleaned and loose, spattered, or excess solder, metal chips, resin flash that may crumble, and other foreign material removed after final assembly.

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 commercial laboratory acceptable to 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 Classification of tests. Inspection and testing of the amplifier and indicator shall be classified as follows:

a. Preproduction tests

b. Acceptance tests.

4.3 Test conditions

4.3.1 Indicator

4.3.1.1 Standard atmospheric conditions. When the pressure and temperature are not specified, it is understood that the test will 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 temperature differing materially from the above values, proper allowance shall be made for the difference from the specified conditions.

4.3.1.2 Vibration. Unless otherwise specified, the indicator shall not be subjected to any form of vibration or tapping during the performance of any of the tests specified herein.

4.3.1.3 Attitude. Unless otherwise specified, the indicator shall be tested in the normal operating position.

4.3.1.4 Electrical power. Unless otherwise specified, the indicator shall be tested with 115V 400 cps ±2 percent, single-phase a-c power and 28V ±2 percent d-c power.

4.3.1.5 Standard test equipment. The indicator shall be tested with standard AY50/F-42 synchros (or equivalent) and precision potentiometers, resistance 10K ohms ±5 percent; 2.5w at 25° C, resolution 0.01 percent.

4.3.1.6 Test synchros. The synchro transmitters used to provide indicator input functions shall be accurate to within ±0.1° either by selection or calibration.

4.3.1.7 Test potentiometers. The potentiometers used to provide indicator input functions shall have a linearity of at least 0.005 percent.

4.3.1.8 Standard test amplifier. The standard test amplifier shall be a standard production amplifier which has successfully passed all individual tests.

*4.3.1.9 Electrical zero and rotation reference. The indicator synchros shall be so oriented electrically that the altitude function will be servoed to the following indication when a standard test transmitter is set at electrical zero and connected to the indicator and amplifier as follows:

Electrical Zero

Function	Indicator reading with transmitter set at EZ		Standard test transmitter pin connections		
	H	C	X	Y	Z
Altitude	0 feet, 26V	Cold	L/19PW	N/19PW	P/19PW

The pins of the amplifier connector shall be connected to the identically lettered pins of the indicator connector. The altitude coarse synchro shall be checked simultaneously with the fine synchro. After the function is servoed to the EZ point by the fine synchro, the coarse synchros shall be excited as shown on figure 10. The vacuum-tube voltmeter must indicate less than 0.150V. A c-w rotation of the standard test transmitter rotor (viewed from the shaft end) shall cause increasing function. A standard test transmitter is as follows: The rotor leads shall be arbitrarily labeled H_2 and C_2 and one stator lead arbitrarily labeled Z_2. The Z_2 lead shall be connected to C_2 and 26V 400 cps applied across H_2 - C_2. At electrical zero, a null voltage shall be measured across the two unlabeled stator leads (V_1). The voltage between H_2 and either of the unlabeled stator leads shall be approximately 15V (V_2). If this voltage is 15V (approximate), the synchro is 180° away from EZ (see figure 11). If c-w rotation (viewed from the shaft end) of the synchro rotor causes V_3 to increase (within 30° of EZ), V_3 is between X_2 and Z_2; if the voltage decreases, V_3 is between Y_2 and Z_2.

4.3.1.10 Potentiometer zero. Unless otherwise specified, the low end of the potentiometer shall correspond to the low end of the function.

4.3.2 Amplifier

4.3.2.1 Test equipment. The test equipment shall not load or affect the normal operation of the amplifier. The tolerances specified are acceptable limits of performance and are not to be confused with meter accuracies. The following instruments or their equivalents may be used:

a. Vacuum Tube Voltmeter Model 400C
Hewlett-Packard Co.
Palo Alto, California

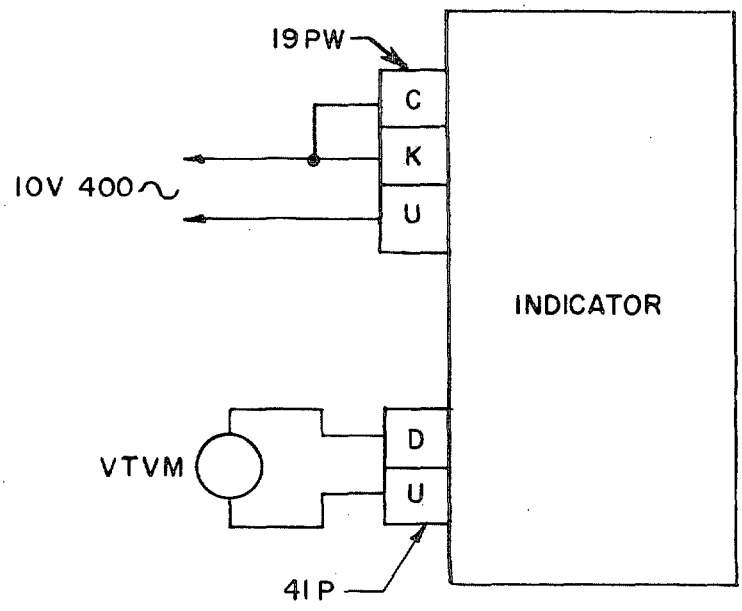
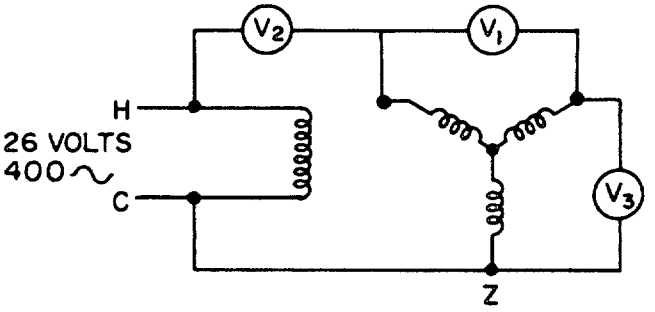


FIGURE 10. Altitude Coarse Synchro



V_1 — VACUUM TUBE VOLTMETER

V_2 — 1000 OHMS / VOLT VOLTMETER

V_3 — 1000 OHMS / VOLT VOLTMETER

FIGURE 11. Electrical Zero Circuit

b. Megger, James Biddle Co.
Philadelphia, Pennsylvania

c. Cathode-Ray Oscilloscope, Type 304A
Allen B. Dumont Labs, Inc.
Clifton, New Jersey

d. Voltohmmeter-Senior Volt Ohmyst WV-98A
Radio Corporation
Harrison, New Jersey

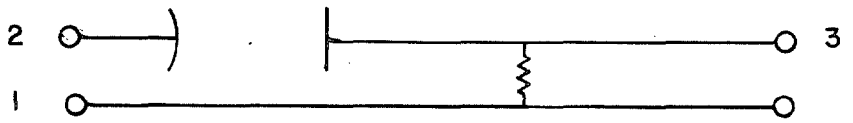
e. Phase Comparator, TES 113-4-A
Eclipse-Pioneer
Teterboro, New Jersey

4.3.2.2 Test position. Unless otherwise specified, the amplifier shall be tested in its normal operating position.

4.3.2.3 Power supply

4.3.2.3.1 AC. Where normal excitation is specified, it shall be 115 ±3V rms 400-cps single-phase source with a total harmonic distortion less than 5 percent and a frequency deviation less than 1 percent, and capable of supplying 150 va minimum.

4.3.2.3.2 Phase. A voltage specified as being "from pin X to pin Y" shall be measured using pin X as the reference or ground terminal. The direction of leading phase angle can be established by use of the following circuit:



In this circuit, the voltage from pin 1 to pin 3, V_{13}, leads the voltage from pin 1 to pin 2, V_{12}. All phase measurements shall be taken with respect to the a-c excitation measured from pin J to pin K on connector PT02A-12-10P.

4.3.2.4 A-C signal source. The 400-cps source shall have the following characteristics:

a. Output impedance - not to exceed 1,000 ohms

b. Voltage range - 0 to 1V continuously variable

c. Phase - 0° and 180° ±3° selectable

d. Distortion - less than 5 percent.

4.3.2.5 Load. The load (Z) specified herein shall be $155\angle 40°$ ohms ±1 percent, measured at 26V 400 cps.

4.4 Preproduction testing

4.4.1 Test samples. The test samples shall consist of three indicators and three amplifiers representative of the production equipment. Samples shall be identified with the manufacturer's part number and such other information as required by the procuring activity. The samples that were tested shall be submitted to the procuring activity.

4.4.2 Preproduction tests. The preproduction tests shall consist of all the tests specified under 4.6.

4.5 Acceptance tests. Acceptance tests shall consist of:

a. Individual tests

b. Sampling tests.

4.5.1 Individual tests. Each indicator and each amplifier shall be subjected to the following tests as described under 4.6.

4.5.1.1 Indicator

a. Examination of product

b. Functional check

c. Synchro correspondence

d. Case leakage

e. Dielectric

f. Lighting (visual comparison)

g. Scale error

h. Slew speed

i. Position error

j. Warning flag

k. Friction.

4.5.1.2 Amplifier

a. Examination of product

b. Leakage test

c. Functional check

d. Insulation breakdown

e. Insulation resistance

f. Voltage and current measurements

g. Power consumption

h. Signal channel measurements.

4.5.2 Sampling tests

4.5.2.1 Sampling plan A. One amplifier and one indicator shall be selected at random from each 100 or less produced on the contract or order and subjected to the following tests as described under 4.6.

4.5.2.1.1 Indicator

a. Individual tests
b. Scale error at -55°C
c. Scale error at 71°C
d. Vibration error
e. Frequency response
f. Sampling plan A of MIL-L-27160
g. Stray light.

4.5.2.1.2 Amplifier

a. Individual tests
b. Low temperature operation
c. High temperature operation
d. Vibration.

4.5.2.2 Sampling plan B. Unless otherwise specified, 3 indicators and 3 amplifiers shall be selected at random from the first 15 items on the contract or order and subjected to the following tests as described under 4.6.

4.5.2.2.1 Indicator

a. Sampling plan A tests
b. Magnetic property
c. Vibration failure
d. High altitude
e. Acceleration
f. Humidity
g. Fungus
h. Salt spray
i. Reliability
j. Sampling plan B tests of MIL-L-27160
k. Decompression
l. Compatibility and signal interchangeability tests
m. External pressure.

4.5.2.2.2 Amplifier

a. Sampling plan A tests
b. Temperature
c. Temperature-altitude
d. Shock
e. Acceleration
f. Humidity
g. Radio interference
h. Salt spray
i. Fungus
j. Magnetic property
k. Reliability
l. Vibration failure
m. Compatibility and signal interchangeability tests.

4.5.2.3 Rejection and retest. When one item selected from a production run fails to meet the specification, no items still on hand or later produced shall 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 and production reasons, individual tests may be continued pending the investigation of a sampling test failure. But final acceptance of items on hand or later produced shall not be made until it is determined that 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 items 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 Indicator tests

4.6.1.1 Examination of product. The indicator shall be inspected to determine compliance with the requirements specified herein with respect to materials, workmanship, and marking.

4.6.1.2 Functional check. Prior to final inspection and sealing of the indicator, a functional check shall be performed. The indicator functions shall be simultaneously cycled at the rate of 1 cycle per 2 minutes for 2 hours. A cycle shall consist of the excursion from minimum to maximum value and return to minimum value. The indicator shall meet the requirements of this specification after completion of the functional check.

4.6.1.3 Synchro correspondence. Any indicator section that has a dual-speed input shall have the synchros inspected to assure that the coarse synchro is set to satisfactorily correspond with its associated fine synchro. The coarse synchro shall be considered in satisfactory correspondence when the rotor output is less than 150 mv with the stator excited as in figure 10 for a fine synchro setting of precisely EZ. The 10V supply may be replaced by a precision synchro transmitter, set precisely at EZ.

4.6.1.4 Case leakage. The indicator shall be filled with a dust-free, 10-percent helium, 90-percent nitrogen mixture at a pressure of 1 atmosphere with a dew-point below -65°C and tested for case leakage following the final sealing. The leak rate shall not exceed 7.5 micron cubic foot per hour.

4.6.1.5 Dielectric strength. The application of 250V 60 cps for a 5-second interval between the following pins and the shell of the connector shall cause no evidence of voltage breakdown.

PT1H-20-41P	A, N, D, W
PT1H-14-19PW	D, S

4.6.1.6 Lighting (visual comparison). Indicator lighting shall be checked by comparison with a prime standard. The prime standard and the instrument under test shall be placed side by side and at eye level and both units connected to a common variable source (0-5V). The brightness of the two units shall be compared with 2.85 ±0.1V applied to both the standard and the unit under test. If the general brightness appears the same visually, the indicator under test shall be considered acceptable. If any area of the instrument under test appears visually to differ from the same area of the prime standard, it shall then be subjected to the lighting tests specified in MIL-L-27160 and sufficient data recorded to substantiate conformance to lighting requirements.

4.6.1.6.1 Color comparison. A color comparison shall be made by applying 4.5V to the prime standard and to the indicator being tested. The two indicators shall be compared and shall visually appear identical in color.

4.6.1.6.2 Stray light. The lighting system shall be so housed as to prevent the leakage of stray light and to shield all lamp filaments from direct view. Stray-light measurements shall be made as follows: A flat white reflecting surface of 85 ±5 percent reflectance shall be placed perpendicular to the front coverglass and parallel to the top edge of the mounting flage. Brightness readings shall be made looking down (perpendicular) on the reflecting surface and 1 inch in front of the coverglass. When the reflecting surface is positioned in the lower half of the display, the readings shall not exceed 1.5 foot-lamberts, and when positioned in the upper half shall not exceed 0.2 foot-lambert. Measurements shall be repeated looking upon the reflecting surface and in no case shall the readings exceed 0.2 foot-lambert. All measurements shall be made at 4.5 ±0.1V.

4.6.1.7 Scale error

4.6.1.7.1 Sensitive altitude. The course synchro shall be set at the value specified in table II. The tape shall be brought into the specified reading using the fine

synchro only, being careful to approach from the right direction. The barometric counter shall be set at 29.92. The tape may be initially adjusted to zero altitude for dual synchro settings of zero altitude by use of the screwdriver slot located below the barometer set knob. With both synchros set at EZ, the barometer set knob set at 29.92, and the altitude tape adjusted to zero indication, the tape adjustment screw shall permit an adjustment range of ±200 ±30 feet.

TABLE II

Sensitive Altitude

Reading Altitude (Feet)	Transmitter Coarse (Deg)	Angle Fine (Deg)
0	0	0
1,000	2.67	72
2,000	5.33	144
4,000	10.67	288
5,000	13.333	0
10,000	26.67	0
20,000	53.33	0
30,000	80.00	0
40,000	106.67	0
50,000	133.33	0
60,000	160.0	0

4.6.1.7.1.1 Accuracy. Test readings shall be obtained for both function increasing and function decreasing. No reading shall be in excess of 0.72° on the fine synchro transmitter (10 feet). The gross and fine tape shall clearly indicate the correct altitude graduation.

4.6.1.7.1.2 Sensitivity. Rotation of the fine synchro transmitter ±0.36° (5-foot altitude) shall result in apparent motion of the sensitive altitude tape.

4.6.1.7.2 Disengagement test. With dual speed synchros, set in 0 altitude on the tape and 60,000 feet on the command counter. The marker shall position itself at the upper extremity of the window. With the dual synchro inputs, set in 60,000 feet. The tape shall so position the marker that some part of the marker is obscured by the lubber line. Set in 0 feet on the command counter. Set in 0 feet with dual synchro inputs. The tape shall so position the marker that some part of the marker is obscured by the lubber line.

4.6.1.7.3 Slew switch. The manually operated slew switch below the altitude window shall actuate the command marker and command counter as follows: The up-position of the switch shall increase command function, and the down position shall decrease function. The rate of slew shall be proportional to switch displacement.

4.6.1.7.4 Barometric correction operational check. With the sensitive altitude tape set at exactly 1,000 feet, the barometric correction mechanism shall be checked at the stations specified in table III for both increasing and decreasing functions.

TABLE III

Barometric Correction

Barometric Pressure	Altitude Feet
31.00	1,983
30.73	1,740
30.51	1,540
30.28	1,330
29.92	1,000
29.63	730
29.48	590
29.29	410
28.98	120
28.75	-100
28.50	-340
28.00	-824

4.6.1.7.4.1 Barometric pressure accuracy. No reading shall be in error in excess of 15 feet.

4.6.1.7.5 Scale error for sea-level pressure output potentiometer. The sea-level pressure potentiometer output voltage shall be directly proportional to the barometric pressure as read on the counter and as specified in table IV in both increasing and decreasing directions.

TABLE IV

Sea Level Pressure Potentiometer

Barometric Pressure	Voltage Output and Voltage Input
31.00	1.000
30.73	0.9100
30.51	0.8367
30.28	0.7600
29.92	0.6400
29.63	0.5433
29.48	0.4933
29.29	0.4300
28.98	0.3267
28.75	0.2500
28.50	0.1667
28.00	0

4.6.1.7.5.1 Accuracy. No reading shall be in error in excess of 0.015 inch Hg.

4.6.1.7.6 Altitude zero adjustment. Rotation of the zero set knob, located just below the barometric knob, from one extreme to the other shall result in a movement of ±200 ±30 feet on the sensitive altitude tape within the limits of -1,000 to +60,000 feet as read on the tape.

4.6.1.7.7 Scale error test for vertical speed. Vertical speed between 0 and 2,000 fpm ascent and descent shall be presented by the moving pointer against the fixed scale. Rates in excess of 2,000 fpm shall be presented by the moving tape as read against the stalled pointer. Tests shall be conducted at the points specified in table V.

TABLE V

Vertical Speed

Reading (fpm)	Tolerance (fpm)	Voltage Output Ratio Input	Tolerance
20,000	±500	1.000	0.0250
8,000	±190	0.400	0.0094
4,000	±100	0.200	0.0050
2,000	±100	0.100	0.0050
1,000	±75	0.050	0.0038
0	±75	0	0.0038
-1,000	±75	0.050	0.0038
-2,000	±100	0.100	0.0050
-4,000	±100	0.200	0.0050
-8,000	±190	0.400	0.0094
-20,000	±500	1.000	0.0250

4.6.1.8 Slew speed. Using a stop watch, the time for full excursion of the various presentations listed in table VI shall be recorded and shall not exceed that specified for either increasing or decreasing direction.

TABLE VI

Slew Speed

Function	Maximum Time In Seconds
Sensitive altitude tape, 0 to 60,000	60
Vertical Speed, -20,000 to +20,000 fpm	20
Command altitude, 0 to 60,000 (Max switch displacement - room test only)	60

4.6.1.9 Position error. With all servoes at null, in the normal operating position, the readings shall be recorded. These readings shall not vary with the indicator held in any other position.

4.6.1.10 Warning flag. When the indicator is connected to the test amplifier and the altitude tape satisfies the input information, the warning flag shall disappear from view.

4.6.1.10.1 Self test. Connecting pin T of connector PTIH-14-19PW to 28 ±5V dc by closing the self-test switch shall result in the altitude tapes being positioned at 50,000 ±50 feet (with barometric counter set to 29.92). The low side of the 28V dc shall be connected to the chassis ground. During the period in which the tapes are slewing to this point, the warning flag shall be in view provided the indicator was at least 150 feet from the self-test point at initiation of the test.

4.6.1.10.2 Monitoring. The monitoring circuit shall detect the following malfunctions which shall cause the warning flag to appear.

a. Inaccuracies in excess of 100 feet (monitor shall not trip for inaccuracies of less than 50 feet and shall not produce nuisance trips under the conditions specified in 3.9.1 and 4.6.1.2)

b. Fine or control transmitter stator or rotor failure due to actual component or intercabling failure

c. Loss of power to fine transmitter

d. Coarse or control transmitter stator failure due to actual component or intercabling failure

e. Slippage of the coarse tape resulting in a 100-foot altitude error

f. Removal of excitation power to the monitor transmitter.

Rotation of the monitoring test transmitter to angles equal to those listed in table II (fine transmitter) ±3.6° shall not cause the monitor flag to appear; rotation of the test transmitter to angles equal to those listed in table II (fine synchro) ±7.2° shall cause the monitor flag to appear. This test shall be performed at the 0-, 4,000-, 10,000-, and 40,000-foot test stations.

4.6.1.11 Friction test. The indicator shall be operated throughout its entire range and the motion of the tapes, command bars, and indices carefully observed. There shall be no evidence of tape stickage or erratic motion of the moving components.

4.6.1.12 Scale error at -55°C. The indicator shall be subjected to a temperature of -55° ±2°C for a period of 4 hours with no power applied. At the end of this period, after a 3-minute warmup and while still at the specified temperature, the indicator shall meet the requirements of 4.6.1.7.1, 4.6.1.7.1.1, 4.6.1.7.2, 4.6.1.7.7, 4.6.1.8, 4.6.1.10, 4.6.1.10.1, and 4.6.1.10.2. The permissible tolerances shall be increased by 75 percent.

4.6.1.13 Scale error at +71°C. The indicator shall be subjected to a temperature of 71° ±2°C for a period of 4 hours with no electrical power applied. At the end of this period and while still at the specified temperature, the indicator shall meet the requirements of 4.6.1.12 except that permissible tolerances shall be increased by 50 percent in lieu of 75 percent.

4.6.1.14 Vibration error. While operating, the indicator shall be subjected to a vibration test in accordance with procedure IV of MIL-E-5272 at amplitudes of

0.009 to 0.011 inch. Permissible tolerances during vibration shall not exceed the room temperature scale error tolerances specified in 4.6.1.7. Scale error shall be determined at not less than three test points for each servo.

4.6.1.15 Frequency response. Frequency response tests shall be performed for each servo system within the indicator. Figure 12 shows a typical circuit for obtaining the necessary data. The bandwidth and damping factor can be determined by plotting the ratio of 0-out to 0-in versus frequency (see figure 13). If a servo is less than critically damped, the damping ratio is related to the peak on the frequency response curve by an equation for $\delta < 1$, $-M_p = 1/2\,\delta\,\sqrt{1-\delta^2}$ where M_p is the magnitude of the peak and δ is the damping ratio.

4.6.1.16 Sampling plan A tests (lighting). The indicator shall be subjected to and shall meet the sampling plan A tests of MIL-L-27160.

4.6.1.17 Magnetic properties. The magnetic effect of the indicator shall be determined in terms of deflection of a free magnet approximately 1-1/2 inches long suspended in a magnetic field with a horizontal intensity of 0.18 ±0.01 oersted. It shall not cause the free magnet to deflect more than 5° when the indicator is held in various positions on an east-west line with its nearest part 12 inches from the center of the magnet. Tests shall be made with power applied to the indicator.

4.6.1.18 Vibration failure. While operating, the indicator shall be subjected to a vibration failure test in accordance with procedure V of MIL-E-5272.

4.6.1.19 Altitude. The indicator shall be subjected to a pressure of 2.118 inches Hg. At this pressure, all parts of the indicator shall be capable of operating through full scale. After return to sea-level pressure, the indicator shall be capable of meeting all performance requirements specified herein.

4.6.1.20 Acceleration. While operating, the indicator shall be subjected to an acceleration test in accordance with procedure III of MIL-E-5272, except the acceleration shall be 7g.

4.6.1.21 Humidity. The indicator, or a suitable hermetically sealed mockup that exactly duplicates the external portion of the indicator, shall be subjected to a humidity test in accordance with procedure I of MIL-E-5272 with relative humidity up to 100 percent.

4.6.1.22 Fungus. The indicator, or a hermetically sealed mockup that exactly duplicates the external portion of the indicator, shall be subjected to fungus growth (as encountered in tropical climates) in a mold chamber maintained at an internal temperature of 30°C and a relative humidity of 95 percent for a period of 28 days. At the end of this test, the parts shall be visibly examined. Deterioration or corrosion of any internal components which might prevent the indicator from meeting operational requirements during service life shall be considered failure.

4.6.1.23 Salt spray. The indicator, or a hermetically sealed mockup that exactly duplicates the external portion of the indicator, shall be subjected to a salt spray test in accordance with MIL-E-5272, procedure I.

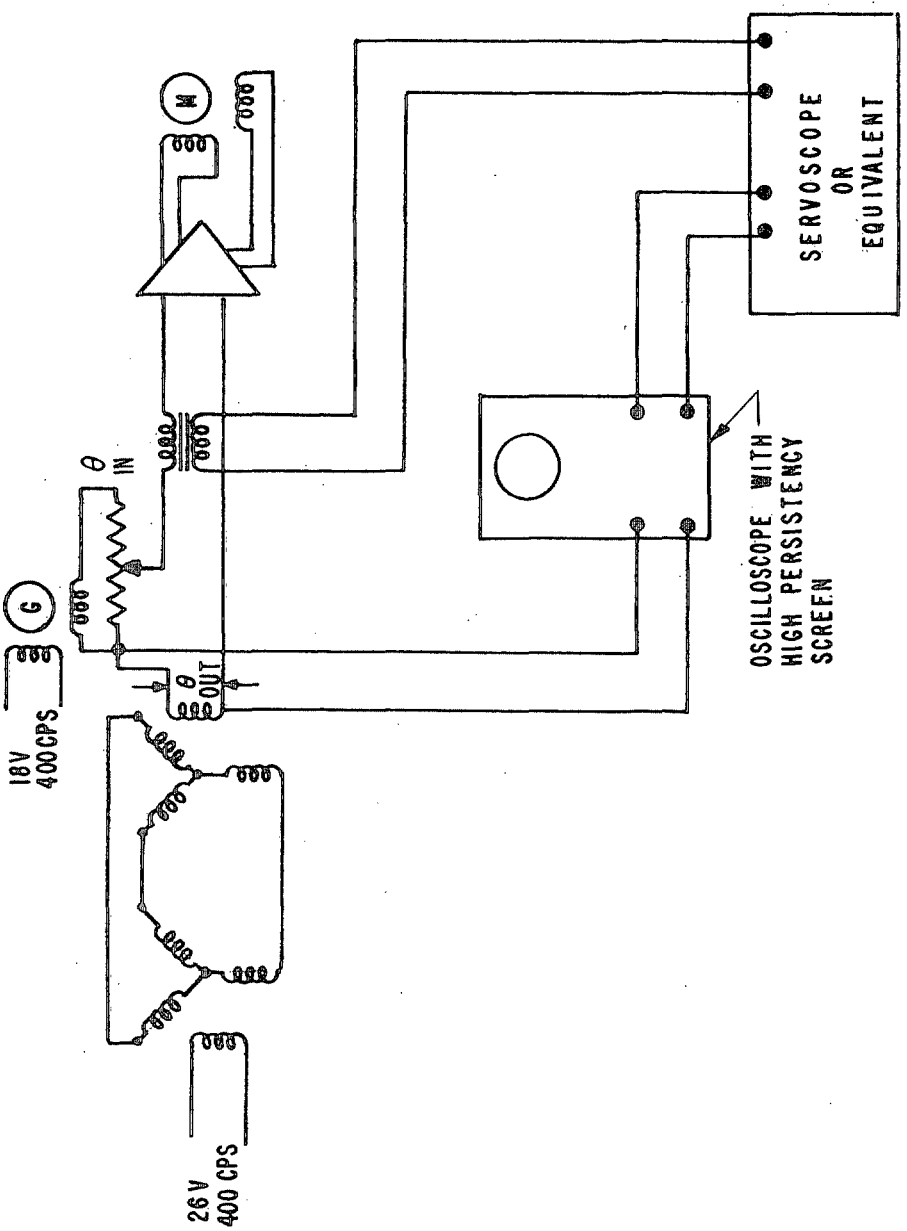


FIGURE 12. Response Test Circuit

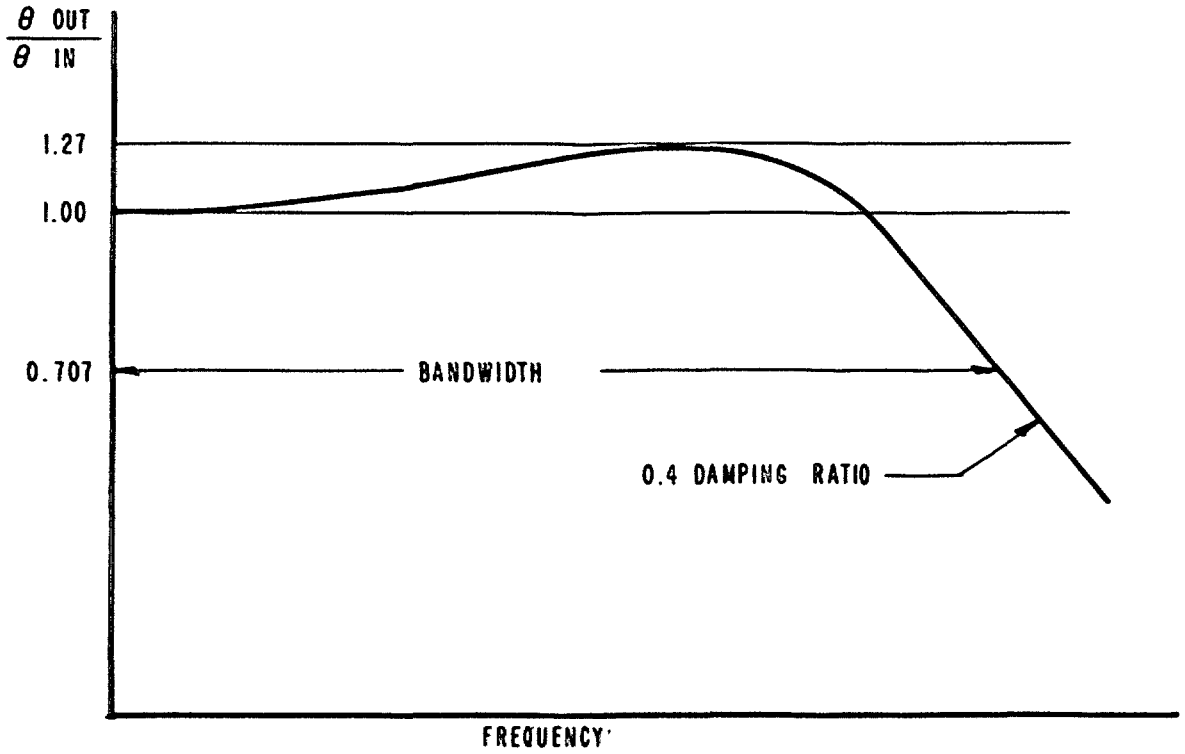


FIGURE 13. Band Width And Damping Curve

4.6.1.24 Reliability. A minimum of three indicators shall be subjected to the following reliability test. The maximum allowable failures for the test time specified shall be in accordance with table VI.

TABLE VI

Maximum Allowable Failures	Total Test Time (3 Units)
2	2,076
3	2,352
4	2,629
5	2,941

Each indicator shall be tested a minimum of 693 hours of actual electrical operation with a cycling time for each indicator function of 6 to 7 minutes per cycle with a minimum of 6,000 cycles per function. A cycle shall consist of the excursion from minimum value of the function to maximum and return to minimum. The test shall begin when rated power is applied to the unit. After 4 hours of rated power on, the power shall be turned off for a period of 2 hours. This procedure of power-on, power-off operation shall be repeated until the test has been completed. Only the power-on portion of the test shall be utilized in calculating the total test time specified in table VI. After each 50 hours of electrical operation, the system shall be subjected to a scale error test of at least three test stations per function. Room tolerances shall apply throughout. The indicator shall be tested at room temperature for approximately 64 percent of the test time, at -10°C for approximately 14 percent of the test time, and at 50°C for approximately 22 percent of the test time as shown in table VII. During the fifth cycle period, the indicator shall be vibrated in accordance with procedure IV of MIL-E-5272, at an amplitude of 0.009 to 0.011 inch and a frequency of 35 cps. The transition from the fourth to the fifth cycling period shall be completed in the shortest possible time to allow the vibration test to be conducted during the temperature change from -10° to +25°C. In case of malfunction of any kind, the malfunction shall be recorded and the test interrupted while repairs are being made. The test shall then be continued from the point of interruption. Failure to meet the scale error test shall be considered a malfunction. Upon completion of this test, the indicator shall again be tested for scale error, and the allowable tolerances increased by 50 percent. If recalibration is required to pass the scale error test, an additional malfunction shall be charged. The test may be interrupted for normal weekend shutdowns. All tests listed under 4.6 may be included as part of this test. Satisfactory completion of the reliability test (the maximum failures shall not exceed those specified in table VI) will demonstrate with a 90 percent confidence level that an MTBF of at least 346 hours has been achieved (MIL-R-26667, table entitled "Reliability Accept-Reject Criteria (Method 2)".

4.6.1.25 Sampling plan B (lighting). The indicator shall be subjected to and shall meet the sampling plan B tests of MIL-L-27160.

4.6.1.26 Decompression test. The indicator shall be placed in a cabinet in which the pressure is maintained at the same pressure as inside the hermetically sealed case. The pressure within the cabinet shall be released in such a manner that a

TABLE VII

Reliability Test Table

Cycling Period	Number of Hours	Ambient Temp (°C)
1	50	25
2	50	50
3	100	25
4	50	-10
5	50	25
6	50	50
7	100	25
8	50	-10
9	100	25
10	50	50
11	50	25

pressure differential of 16 inches Hg is instantaneously applied between the interior and the exterior of the case. Operation of the indicator shall not be affected by the sudden decrease in pressure.

* 4.6.1.27 External pressure. The indicator shall be subjected to a pressurization test by applying an absolute pressure of 56 inches Hg (approximately 26 inches Hg above atmospheric pressure) for a period of 15 minutes. Normal subsequent operation shall not be affected by this test and no failure of the cover glass, hermetic seal, or case shall occur.

4.6.2 Amplifier tests

4.6.2.1 Examination of product. The amplifier shall be inspected to determine compliance with the requirements specified herein with respect to materials, workmanship, and marking. Attention shall be given to neatness of wire bundling and wrapping and the routing of wire bundles to eliminate mechanical and electrical interference.

4.6.2.2 Leakage test. Each amplifier module shall be tested for leakage by means of a mass spectrometer. The leakage rate shall not exceed 0.1 micron cubic foot per hour at a pressure differential of 1 atmosphere. Each module shall be marked to indicate that it has been subjected to and has met this test.

4.6.2.3 Functional check. The amplifier shall be excited and all channels shall be used to simultaneously cycle indicator functions at the rate of 1 cycle per 2 minutes for 2 hours. A cycle shall consist of the excursion from minimum value of the indicator function to maximum and return to minimum.

4.6.2.4 Insulation breakdown test. This is a destructive test and shall not be done repeatedly. The test shall be performed with the equipment de-energized, no system connections to the amplifier, and with all grounds disconnected from the chassis. The application of the following specified sine wave rms voltage at a commercial

frequency for a period of 5 seconds between each terminal (designated below) and the case shall not cause an insulation breakdown. The leakage current shall not exceed 4.5 ma.

Test Voltage	Connector	Pin
500	10P	K
500	10P	B
300	41P	S

4.6.2.5 Insulation resistance. This test shall be performed with the equipment de-energized, no system connections to the amplifier, and with all grounds disconnected from the chassis. A voltage of 500V dc shall be applied for 5 seconds between the case and the following test points. The resistances obtained (using a megohm resistance bridge or megger) shall be recorded. In no case shall the resistance be less than 20 meg. Upon completion of this test, the chassis ground lugs shall be replaced.

PT02A-20-41P - Pin S
PT02A-12-10P - Pins K, J

4.6.2.6 Voltage and current measurements. Apply 115V 400 cps from pins J to K of PT02A-12-10P. This voltage shall be designated as the reference voltage and hereafter shall be referred to as such.

* 4.6.2.6.1 A-C test. Before performing the following, the a-c voltages and their corresponding phase angles with respect to the reference voltage shall be measured at each of the following pins:

Pin Designation PT02A-20-41P	RMS Voltage	Phase
X to T	18 ±2V	0° ±5°
X to C	18 ±2V	0° ±5°
X to L	26 ±2 percent	0° ±5°
X to Y	9 ±2 percent	0° ±5°
X to H	26 ±2 percent	0° ±5°
X to G	9 ±2 percent	0° ±5°

After a 15 minute warmup period, the ratio of the voltages from pins J to K of PT02A-12-10P and pins a to N of PT02A-20-41P shall be as follows:

$$\frac{V_{aN}}{V_{JK}} = \frac{20}{115} \pm 1 \text{ percent} = 0.1739 \pm 0.0017$$

The phase of V_{aN} shall be 0° ±18' with respect to V_{JK}.

4.6.2.7 Warning flag test. With 115V applied to the altimeter and the altitude value satisfied by the tape, the flag shall be hidden from view.

4.6.2.8 Power consumption. With the amplifier excited with an applied voltage of 115V 400 cps and all loads connected, the power consumption shall be no greater than 63 va as measured from the 400-cps line.

4.6.2.9 Signal channel measurements. The amplifier shall consist of three separate signal channels (altitude, vertical speed, and manual altitude). Each channel shall be tested separately with signal voltages as specified on its respective figure. The loads shall be connected as shown on figures 14, 15, and 16.

4.6.2.9.1 Vertical speed (see figure 14)

4.6.2.9.1.1 Null output. With the input shorted and POT adjusted for null, the total rms voltage across the load shall not exceed 900 mv.

*4.6.2.9.1.2 Gain. With an input signal of 5.7 mv ac (0° and 180°), the output shall be 5 ±1.5V.

*4.6.2.9.1.3 Phase shift. For an input signal of 5.7 mv at an angle of 0°, the output voltage shall lead the reference voltage by an angle of 90° ±15°. For an input signal of 5.7 mv at an angle of 180°, the output voltage shall lead the reference by an angle of 270° ±15°.

4.6.2.9.1.4 Saturation. The output shall be not less than 13V when the input signal is 100 mv of either phase.

4.6.2.9.2 Manual altitude (see figure 15)

4.6.2.9.2.1 Null (a-c input). With the a-c input shorted, the total rms voltage across the load shall not exceed 900 mv.

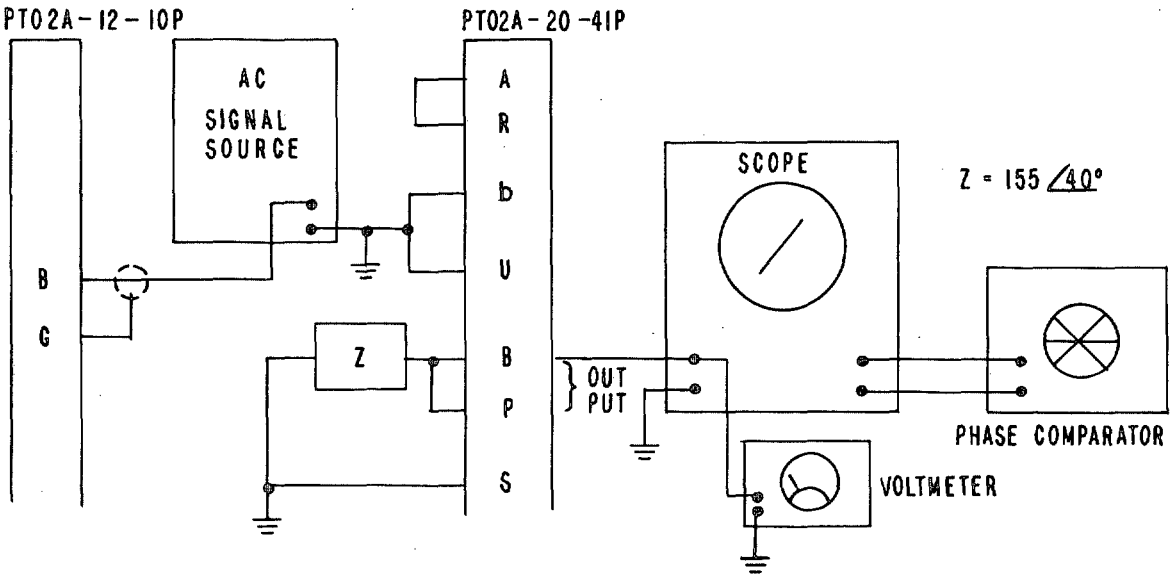
4.6.2.9.2.2 Gain (a-c input). With an a-c input signal of 10 mv (0° and 180°), the output shall be 5 ±1.5V.

4.6.2.9.2.3 Phase shift (a-c input). For an input signal of 10 mv at an angle of 0°, the output shall lead the reference voltage by 90° ±15°. For an input signal of 10 mv at an angle of 180°, the output voltage shall lead the reference voltage by 270° ±15°.

4.6.2.9.2.4 Saturation (a-c input). The output shall be not less than 13V when the input signal is 200 mv of either phase.

4.6.2.9.3 Altitude (see figure 16)

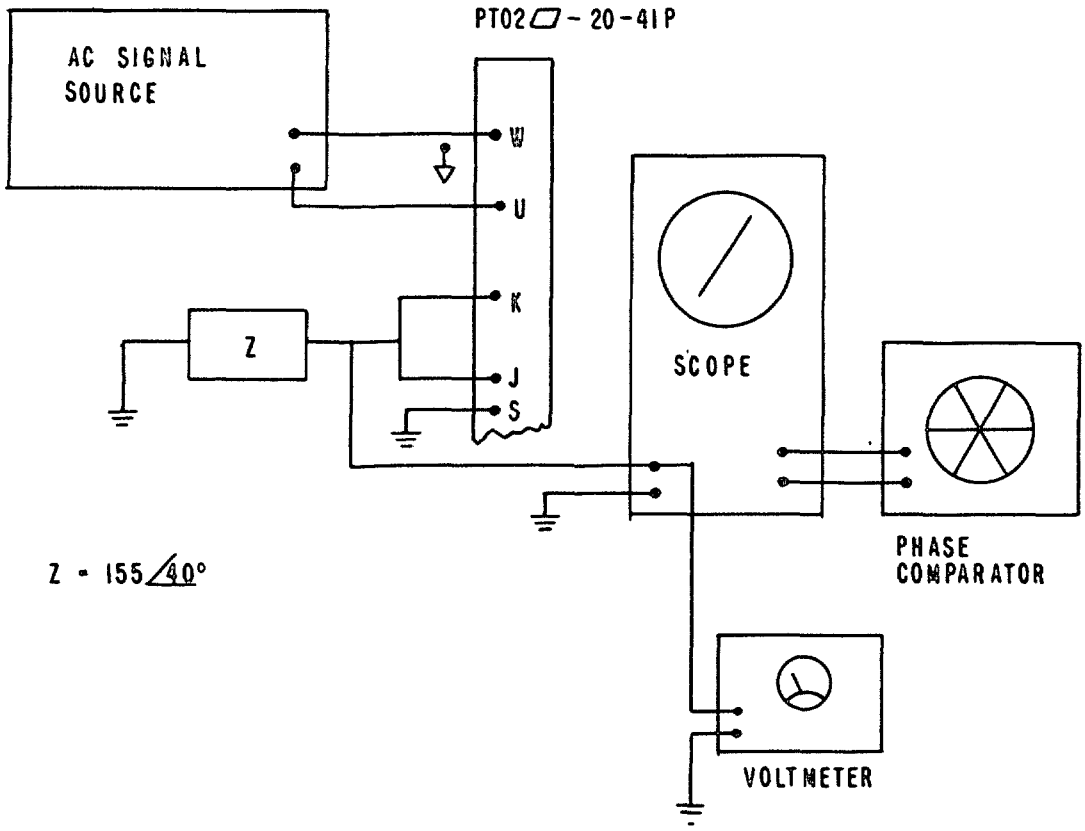
4.6.2.9.3.1 Null. With the fine input shorted, the total rms voltage across the load shall not exceed 900 mv.



WARNING: REMOVE JUMPER ON OUTPUT CIRCUIT WHEN LOAD IS REMOVED

NOTE: SHORT INPUTS OF AMPLIFIER NOT UNDER TEST, AND KEEP THE LOADS ON THE OTHER AMPLIFIER OUTPUTS IN ACCORDANCE WITH FIGURE 13

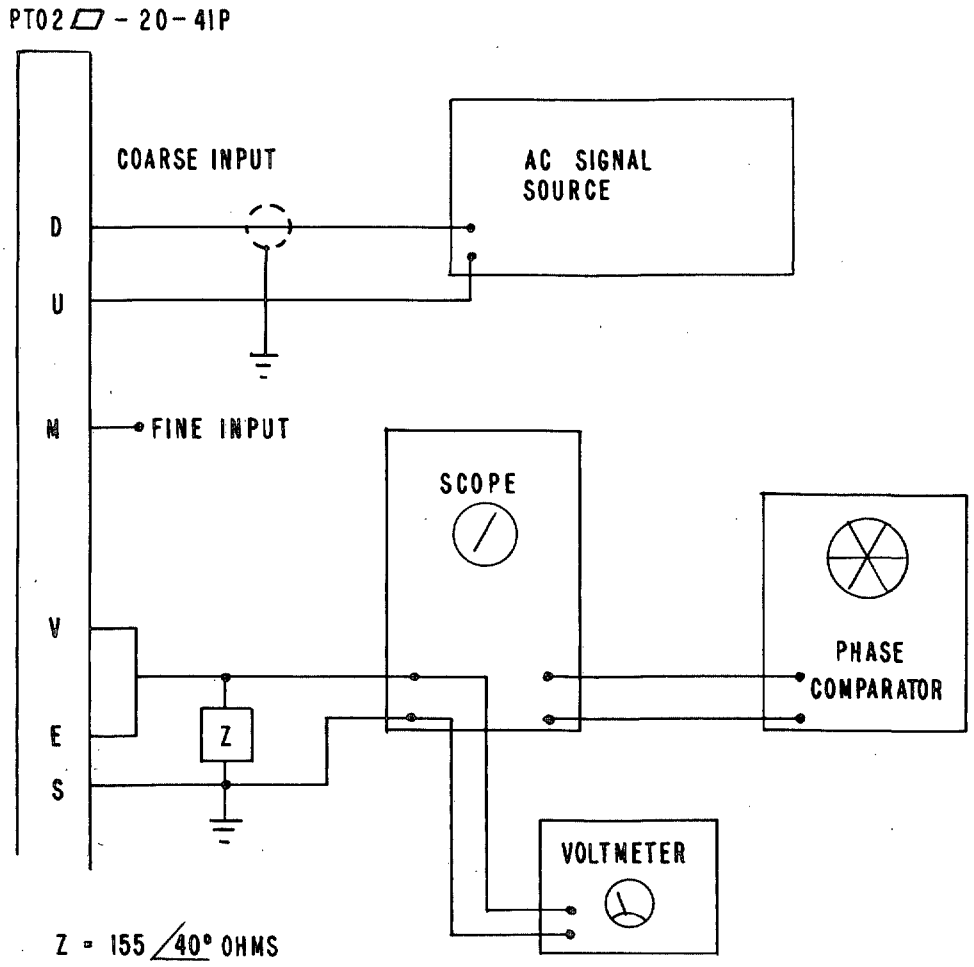
FIGURE 14. Vertical Speed - Null, Gain, And Phase Shift



WARNING: REMOVE JUMPER ON OUTPUT CIRCUITS WHEN LOAD IS REMOVED

NOTE: SHORT INPUTS OF AMPLIFIERS NOT UNDER TEST, AND KEEP THE LOADS ON THE OTHER AMPLIFIERS OUTPUTS

FIGURE 15. Command Altitude (Manual Mode)



WARNING: REMOVE JUMPER ON OUTPUT CIRCUITS WHEN LOADS ARE REMOVED

NOTE: SHORT INPUTS OF AMPLIFIERS NOT UNDER TEST AND KEEP THE LOADS ON OTHER AMPLIFIERS

FIGURE 16. Attitude Servo-Null Gain And Phase Shift

4.6.2.9.3.2 Gain. The gain of the amplifier with the signal applied to the coarse and fine input terminals shall be as follows:

a. Fine input - With 12 mv (0° and 180° phase) applied to the fine input terminal, the output shall be 5 ±1.5V.

b. Coarse input - Short fine input for this test only. With 150 mv (0° and 180° phase) applied to the coarse input terminal, the output shall not exceed 1.5V. With 1.0V (0° and 180° phase) applied to the coarse input terminal, the output shall be 5V minimum.

4.6.2.9.3.3 Phase shift. For an input signal of 12 mv applied to fine input terminals at an angle of 0°, the output shall lead the excitation voltage by 90° ±15°. For an input signal of 12 mv at an angle of 180°, the output shall lead the excitation voltage by 270° ±15°.

4.6.2.9.3.4 Saturation. The output shall be not less than 13V when the fine input is 200 mv of either phase.

4.6.2.10 Low temperature operation. The amplifier shall be subjected to a temperature of -55°C for a period of 4 hours. After exposure, with the ambient temperature maintained at -55°C and following a 3-minute warmup period with power applied, the amplifier shall meet the requirements of 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4, except that the following tolerances shall apply:

Null: 1.5V maximum
Gain: AC, 5 ±2V
Phase Shift: 90° ±30° and 270° ±30°
Saturation: 13V minimum.

4.6.2.11 High temperature operation. The amplifier shall be subjected to a temperature of 71°C for a period of 4 hours. After exposure and with the temperature maintained at 71°C, the item shall meet the requirements of 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4, except that the following tolerances shall apply:

Null: 1.5V maximum with a-c input shorted and
2V maximum with d-c input shorted
Gain: AC, 5 ±2V
Phase Shift: 90° ±30° and 270° ±30°
Saturation: 13V minimum.

4.6.2.12 Vibration. With the amplifier operating, this test shall be performed without shockmounts and in accordance with MIL-E-5272, cycling portion only of procedure XII, curve B. The unit shall suffer no physical damage as a result of this test. Each channel of the amplifier shall be tested and shall meet the requirements of 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4.

4.6.2.13 Extreme temperature exposure. After alternate exposure to temperatures of -55° and +71°C for a period of 25 hours each and a delay of 3 hours at room temperature, the amplifier shall meet the tests specified in 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4.

4.6.2.14 Temperature-altitude test. The temperature-altitude test shall be conducted in accordance with the conditions specified on figure 8. At any combination of temperature-altitude as specified on figure 8, curves A, B, and C, the amplifier shall meet the tests specified in 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4, except that the following tolerances shall apply:

Null: 1.5V maximum with a-c input shorted and
2V with d-c input shorted
Gain: AC, 5 ±2V
Phase Shift: 90° ±30° and 270° ±30°
Saturation: 13V minimum.

4.6.2.15 Shock. The amplifier shall be subjected to a shock test as specified in MIL-E-5272, procedure V, after which it shall meet the tests specified in 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4. The amplifier shall suffer no mechanical failures due to the applied shocks.

4.6.2.16 Acceleration. The amplifier shall be subjected to an acceleration of 10g in accordance with MIL-E-5272, procedure III. During this test, each channel of the unit shall meet the tests specified in 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4.

4.6.2.17 Humidity. The amplifier shall be subjected to a humidity test as specified in MIL-E-5272, procedure I. At the completion of this test, each channel of the unit shall meet the tests specified in 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4.

4.6.2.18 Salt spray. The amplifier shall be subjected to the salt spray test of MIL-E-5272, procedure I. At the completion of the test, the unit shall meet the tests specified in 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4.

4.6.2.19 Fungus resistance test. The amplifier shall be subjected to a fungus resistance test in accordance with procedure I of MIL-E-5272. At the completion of the test, the amplifier shall meet the tests specified in 4.6.2.6, 4.6.2.8, and 4.6.2.9.1 through 4.6.2.9.3.4.

4.6.2.20 Magnetic property. The amplifier shall be magnetically shielded. When held in any position so that the nearest portion of the amplifier is a distance of 12 inches from the pivot of the card of an aircraft magnetic compass in a horizontal magnetic field having a strength of 0.18 oersted, the amplifier shall not cause a change in reading of the compass card exceeding 5°.

4.6.2.21 Reliability. The amplifier shall be subjected to a reliability test in conjunction with the indicator as specified in 4.6.1.24.

4.6.2.22 Radio interference. The amplifier shall be subjected to a radio interference test in accordance with MIL-I-6181, except that the upper frequency noise requirements shall be 1,000 megacycles per second. The conducted noise requirements shall not apply to the frequency range nor to those conductors that interconnect components.

4.6.3 Compatibility and signal interchangeability tests. Compatibility and signal interchangeability tests (see 6.2), as required to demonstrate compliance with 3.5.6, shall be conducted in accordance with the applicable document for the equipment specified herein.

4.6.4 Maintainability verification. Maintainability verification shall be in accordance with MIL-M-26512, appendix A, paragraph entitled "Maintenance Task Test and Demonstration". All tasks shall be effectively simulated.

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

*

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging

5.1.1 Level A. Each amplifier-indicator group shall be preserved and packaged in accordance with MIL-P-116, method III. Electrical receptacles and connectors shall be equipped with waterproof plugs or caps and gaskets.

5.1.2 Level C. Amplifier-indicator groups shall be provided sufficient protection against corrosion, deterioration, and physical damage to assure safe delivery, without degradation of the item reliability, from the supply source to the first receiving activity for immediate use.

5.2 Packing

5.2.1 Level A. Units packaged as specified in 5.1.1 shall be packed in exterior weather-resistant shipping containers conforming to PPP-B-636. Insofar as practicable, exterior containers shall be of uniform shape and size and of minimum weight and cube consistent with the protection required. The gross weight shall not exceed approximately 200 pounds.

5.2.2 Level B. Units packaged as specified in 5.1.1 shall be packed in domestic-type exterior containers conforming to PPP-B-636.

5.2.3 Level C. Units requiring overpacking for acceptance by the carrier shall be packed in exterior-type shipping containers in a manner that will insure safe transportation at the lowest rate to the point of delivery. Containers shall meet consolidated freight classification rules or regulations of other common carriers as applicable to the mode of transportation.

5.3 Marking. Interior and exterior containers shall be marked in accordance with MIL-STD-129. The nomenclature shall be as follows:

Amplifier-Indicator Group, Altitude-Vertical Speed A/A24G-11

6. NOTES

6.1 Intended use. The A/A24G-11 amplifier-indicator group covered by this specification is intended for use in cargo, trainer, and transport aircraft.

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

a. Title, number, and date of this specification

b. Whether procurement covers the indicator or amplifier, or both

c. When guide pins are required (see figure 3)

d. When equipment listed in 3.16 will be made available for loan to the contractor

e. When sampling plan B tests will not be conducted

f. Procedure for conducting compatibility and signal interchangeability tests.

6.3 The outside margins of this specification have been marked to indicate where changes from the previous issue have been made. This has been 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 as written irrespective of the marginal notations and relationship to the last previous issue.

Custodian:
Air Force - 11

Preparing activity:
Air Force - 11

Review activity:
Air Force - 11, 67

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(see indicated on reverse hereof)*.

SPECIFICATION

ORGANIZATION *(Of submitter)*

CITY AND STATE

CONTRACT NO.

QUANTITY OF ITEMS PROCURED

DOLLAR AMOUNT
$

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)*

DATE

DD FORM 1 APR 63 1426 REPLACES NAVSHIPS FORM 4863, WHICH IS OBSOLETE

C-8279