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MILITARY SPECIFICATION

COMPUTER, FLIGHT DIRECTOR CPU-65/A

This specification is approved for use by Code 99, Department of the Air Force, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 This specification covers the requirements for one type of universal flight director computer, designated CPU-65/A.

2. APPLICABLE DOCUMENTS

2.1 Issues of Documents. 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-601	Box, Wood, Cleated-Plywood
PPP-B-636	Box, Fiberboard

MILITARY

MIL-P-116	Preservation, Methods of
MIL-D-1000	Drawings, Engineering and Associated Lists
MIL-E-5400	Electronic Equipment, Aircraft, General Specification for

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: (Hq AFLC CASO/LODS, Federal Center, Battle Creek, MI 49016) by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MIL-C-5541	Chemical Films for Aluminum and Aluminum Alloys
MIL-S-6872	Soldering Process, General Specification for
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series, General Specification for
MIL-R-8323	Receiver, Radio R-540/ARN-14C
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-G-25597	Gyroscope, Displacement, Roll and Pitch, Type MD-1
MIL-C-26485	Control Assembly, Attitude Gyroscopic AF/A24G-1
MIL-H-26689	Horizontal Situation Indicator AQU-2/A (Indicator, Multiple, Air Navigation AQU-2/A)
MIL-I-27193	Indicator, Attitude ARU-2B/A
MIL-C-27205	Control Assembly, Attitude Gyroscopic A/A24G-5
MIL-R-27226	Receiving Set, Radio AN/ARN-67
MIL-I-27619	Indicator, Attitude ARU-11/A
MIL-H-27848	Horizontal Situation Indicator AQU-4/A

STANDARDS

MILITARY

MIL-STD-100	Engineering Drawing Practices
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-462	Electromagnetic Interference Characteristics, Measurement of
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 for Aerospace and Ground Equipment
MIL-STD-831	Test Reports, Preparation of
MIL-STD-889	Dissimilar Metals

DRAWINGS

AIR FORCE

64F 1866 Block Diagram - Computer CPU-65/A.

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

3. REQUIREMENTS

3.1 PREPRODUCTION. This specification makes provisions for preproduction testing.

3.2 SELECTION OF SPECIFICATIONS AND STANDARDS. Specifications and standards for necessary commodities and services not specified herein shall be in accordance with MIL-STD-143.

3.3 MATERIALS

3.3.1 FUNGUS-PROOF MATERIALS. Materials that are nutrients for fungi shall not be used where it is practicable 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.

3.3.2 NONMAGNETIC MATERIALS. Nonmagnetic materials shall be used for all parts except where magnetic materials are essential.

3.3.3 TOXIC AND CORROSIVE FUMES. The materials, as installed in the computer and under the service conditions specified herein, shall not liberate deleterious or corrosive fumes. This shall include any fungicidal agents that are used.

3.3.4 NONFERROUS MATERIALS. Nonferrous materials shall be used for all parts except where ferrous materials are essential.

3.3.4.1 Nonferrous materials contained within hermetically sealed inclosures shall be considered suitably protected against corrosion. Requirements specified for fungicidal and corrosion protective treatment and anodizing of aluminum alloy

parts shall not be applicable for parts within hermetically sealed inclosures. Steel parts within such inclosures shall be cadmium plated in accordance with QQ-P-416, type I, class C.

3.3.5 METALS. Metals shall be corrosion-resistant or suitably treated to resist corrosion from fuel, salt spray, or atmospheric conditions likely to be met in storage or normal service.

3.3.6 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 MIL-STD-889.

3.3.7 PROTECTIVE TREATMENT. When materials are used in the construction of the computer 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.

3.4 DESIGN AND CONSTRUCTION. The computer shall be designed to provide computed flight director signals to flight director indicators.

3.4.1 The computer shall be so designed and constructed that no parts will work loose in service. It shall be built to withstand the strains, jars, vibrations, and other conditions incident to shipping, storage, installation, and service.

3.4.2 RELIABILITY. The computer shall have a mean-time-between failures (MTBF) of 600 hours when tested in accordance with MIL-STD-781B, Test Plan II criteria.

3.4.3 MAINTAINABILITY. The computer shall be so designed that overhaul, including replacement of worn parts, adjustment, balance, and calibration may be accomplished by instrument and electronic repairmen provided with simplified tools and equipment, trained in the repair of electronic and similar equipment.

3.4.4 HERMETIC SEALING. The method of hermetic sealing and mounting of the components in the sealed chamber of the case shall be such that the case can be unsealed and the complete assembly of components removed as a unit, 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 case and seal (see 6.3.1) shall be designed to meet the pressure requirements specified herein.

3.4.4.1 FILLING MEDIUM. The filling medium shall be at least 90 percent pure, free of dust particles, and shall contain no 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 88 to 92 percent nitrogen and the remainder helium. The absolute pressure of the filling medium in the case shall be approximately 1 atmosphere. Where practicable, the 100 percent helium filling medium shall be utilized.

3.5 PERFORMANCE. The computer shall be capable of satisfactory operation when subjected to the following conditions:

a. Temperatures - operating temperatures ranging from -54° to +71°C and storage temperatures ranging from -65° to +98°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 feet)

d. Salt Fog - exposure to simulated salt sea atmosphere for 48 hours

e. Vibration - vibration with an applied double amplitude of 0.060 inch through the frequency range of 10 to 55 cps and 10g input from 55 to 500 cps

f. Fungus - fungus growth as encountered in tropical climate

g. Sand and Dust - sand and dust as encountered in desert areas

h. Rain - rainfall as encountered in any locale

i. Temperature Shock - alternate immersions in water maintained at 85° ± 4°C and 5° ± 4°C for a total of 8 cycles without leakage

j. Acceleration - acceleration forces of 20g without damage

k. Extreme voltage and frequency variation - applied voltages of 105V at 320 cps and 125V at 480 cps.

l. External pressure - external pressure of 26.5 psia with no power applied

3.5.1 ELECTROMAGNETIC INTERFERENCE. The computer shall comply with the requirements of MIL-STD-461A, Notice 3, for Class A1 equipment for test methods CE03, CE04, CS01, CS02, CS06, RE02, RS02, and RS03.

3.5.2 DIELECTRIC STRENGTH. There shall be no insulation breakdown when 500V dc is applied between isolated pins and between pins and the case for a period of 10 seconds.

3.5.3 LEAKAGE. The initial maximum leak rate at a pressure differential of approximately 1 atmosphere shall not permit a loss of more than 10 percent of the total filling medium after 1,000 hours.

3.6 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 numbers and changes thereto.

3.7 ELECTRONIC PARTS. Electronic parts and 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. Electronic tubes shall not be used.

3.7.1 OTHER COMPONENTS. All other components in the electronic system shall conform to applicable specifications, where existent.

3.8 MECHANICAL DESIGN. The computer shall be composed of one module for each flight mode listed in 3.10 plus any other components required to provide the operation specified herein. Functionally related modes of simple form may be combined in one module if approved by the procuring activity. Modern techniques of miniaturization and modular construction shall be exploited to the greatest extent possible without sacrificing ruggedness, reliability, and service life. Transistorized components shall be used throughout the computer.

3.9 CASE. The computer case shall be in accordance with figure 1 and shall be hermetically sealed except for external adjustments which shall be gasket sealed under a dust cover.

3.9.1 ADJUSTMENT PANEL. An adjustment panel shall be located on the front of the computer case as shown on figure 1. The potentiometer adjustments specified in table I and Drawing 64F1866 shall be located on this panel. Each potentiometer shall be properly numbered in accordance with table I. The test points shown on Drawing 64F1866 shall also be located on the adjustment panel to permit isolation of failures within the computer. The test points shall also provide for shorting out of various circuits in the computer for test purposes. Prior to fabrication, the design of the adjustment panel shall be approved by the procuring activity.

3.9.1.1 TEST POINTS. The test points shall be as follows:

a. TJ1 - Shorts out direct roll when connected to TJ6 to allow for measurement of roll rates.

b. TJ2 - Shorts out radio displacement when connected to TJ6 to allow for measurement of radio rates.

c. TJ3 - When shorted to TJ6, vertical pointer flag comes into view.

d. TJ4 - Shorts out course-zero and rates when connected to TJ6 to permit measurement of course gain. Also, shorts out roll rates for measurement of roll displacement.

e. TJ5 - Shorts out pitch-zero when connected to TJ6 to allow for measurement of direct pitch gain.

f. TJ6 - Signal Ground.

g. TJ7 - When shorted to TJ3, vertical pointer flag comes into view (reserved for systems where multiple logic is available for testing vertical pointer warning flag (circuit) - Manufacturers option)).

h. TJ8 - Spare.

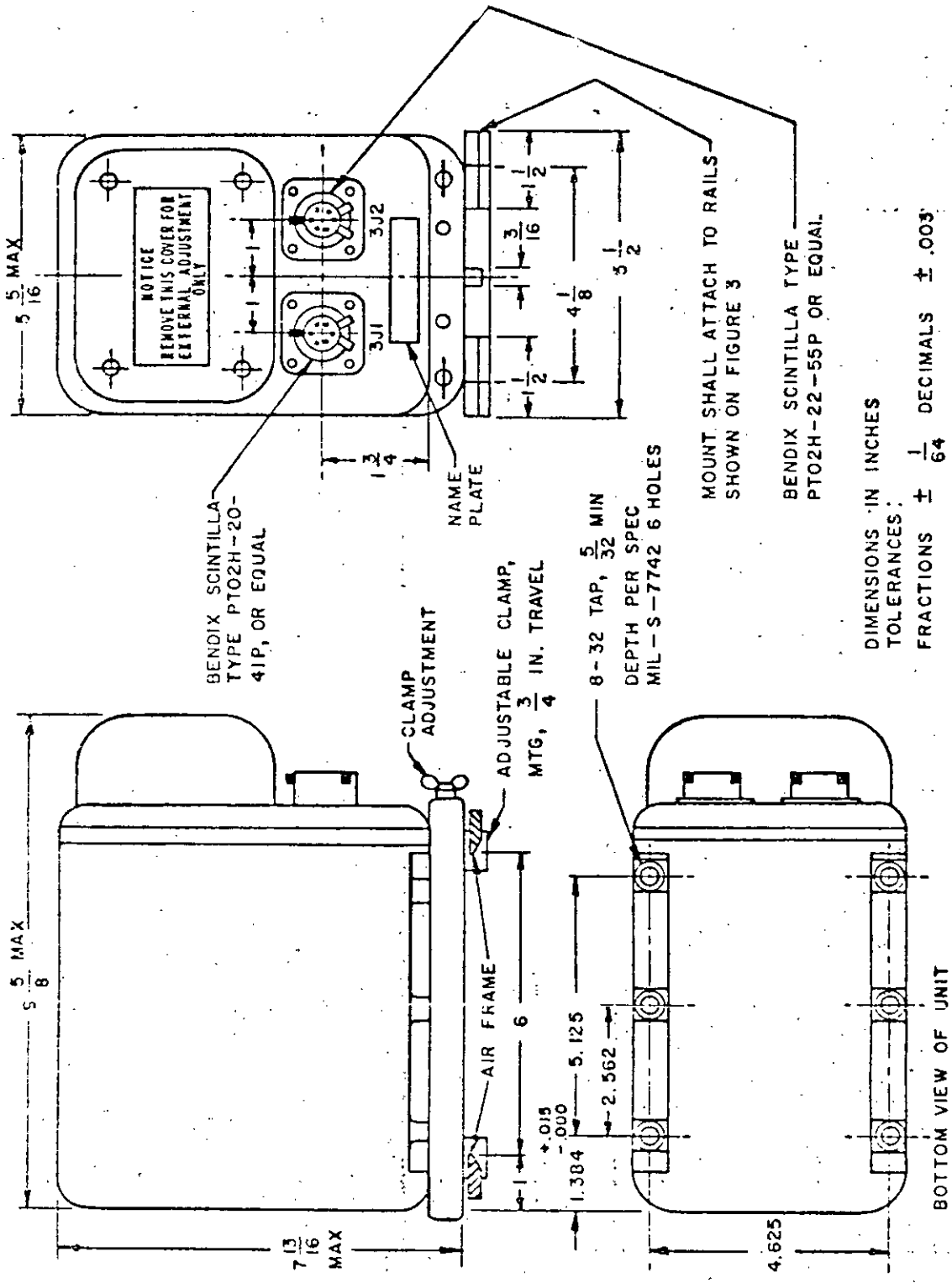


FIGURE 1. Computer, Flight Director CPU-65/A

TABLE I (See Notes)

POTENTIOMETERS LOCATED ON FRONT PANEL

POT NO.	CONTROL	MODE	MINIMUM RANGE	NOM SET	TOL AT 20° C	TEMP TOL	REMARKS	TOLERANCES FOR VOLTAGE AND FREQUENCY VARIATIONS			
								480 cps 125V	320 cps 105V	420 cps 125V	380 cps 105V
R_1	Approach V.P. Centering Trim	Approach	±0.25 ma	0	±0.02 ma	±0.06 ma		±0.03 ma	±0.03 ma	±0.03 ma	±0.03 ma
R_2	LP Pitch Zero	Approach	±0.06 ma	0	±0.03 ma		Pitch Input 3° (0.6V)	±0.12 ma	±0.09 ma	±0.09 ma	±0.075 ma
R_3	Altitude Error Gain	Altitude Hold	0.24 to 0.75 ma	0.485 ma	0.06 ma		Altitude Input 250 ft (2.48V)	±0.08 ma	±0.08 ma	±0.07 ma	±0.07 ma
R_4	Radio Track Course Cut	VOR	20° to 65° (7.7 to 20.2V)	45° (15.9V)	±3° (±0.8V)	±4°	Radio Input 1.0V	±5° (1.4V)	±5° (1.4V)	±5° (1.4V)	±5° (1.4V)
R_5	Vertical Centering	Heading	±0.25 ma	0	±0.02 ma			±0.03 ma	±0.03 ma	±0.03 ma	±0.03 ma
R_6	Horizontal Centering	Approach Altitude Hold	±0.25 ma	0	±0.02 ma	±0.06 ma		±0.03 ma	±0.03 ma	±0.03 ma	±0.03 ma
R_7	Heading Error Gain	Heading	0.05 to 1.1	0.28 ma	±0.06 ma	±0.12 ma	Heading Input 6.6 (2.58V)	±0.1 ma	±0.1 ma	±0.08 ma	±0.08 ma
R_8	Course Error Gain	Approach	0.025 to 0.55 ma	0.18 ma	±0.02 ma	±0.04 ma	Course Error Input 5° (1.95V)	±0.05 ma	±0.05 ma	±0.030 ma	±0.030 ma

TABLE I (CONT)

POTENTIOMETERS LOCATED ON FRONT PANEL

POT NO.	CONTROL	MODE	MINIMUM RANGE	NOM SET	TOL AT 20° C	TEMP TOL	REMARKS	TOLERANCES FOR VOLTAGE AND FREQUENCY VARIATIONS			
								480 cps 125V	320 cps 105V	420 cps 125V	380 cps 105V
R_9	ILS Course Cut Limit	ILS	20° to 50° (7.7 to 17.2V)	45° (15.9V)	±2°	±4°	Loc Input 1.0V	±5° (1.4V)	±5° (1.4V)	±5° (1.4V)	±5° (1.4V)
R_{10}	Radio Rate Gain	ILS	0.125 to 0.375 ma	0.325 ma	±0.03 ma	±0.06 ma	Loc Input 30 mv at 0.0159 cps	±0.06 ma	±0.06 ma	±0.04 ma	±0.04 ma
R_{11}	Bank Rate Gain	ILS	0.016 to 0.48 ma	0.32 ma	±0.05 ma	±0.1 ma	Bank Input 10° (2.0V) at 0.0159 cps	±0.07 ma	±0.07 ma	±0.06 ma	±0.06 ma
R_{12}	Course Rate Gain	ILS	0.125 to 0.375 ma	0.25 ma	±0.03 ma	±0.06 ma	Course Error Input 5° (1.95V) at 0.0159 cps	±0.04 ma	±0.04 ma	±0.03 ma	±0.03 ma
R_{13}	Beam Sensor Trip Level	ILS Approach	+10 to +50 mv and -10 to -50 mv	+15 mv and -15 mv	+1.5 mv -1.5 mv	±3 mv		±5 mv	±5 mv	±5 mv	±5 mv
R_{14}	Radio Track Bank Limit	VOR	20° to 50° (4.0 to 9.05V)	25° (5.0V)	±3° (.6V)		Course Error 90° (22.5V)	±5° (±0.95V)	±5° (±0.95V)	±5° (±0.95V)	±4° (0.8V)

TABLE I (CONT)

POTENTIOMETERS LOCATED ON FRONT PANEL

POT NO.	CONTROL	MODE	MINIMUM RANGE	NOM SET	TOL AT 20° C	TEMP TOL	REMARKS	TOLERANCES FOR VOLTAGE AND FREQUENCY VARIATIONS			
								480 cps 125V	320 cps 105V	420 cps 125V	380 cps 105V
R_{15}	Altitude Hold Pitch Limit	Altitude Hold	5° to 20° (1.0 to 4.0V)	12° (2.4V)	+2° (±0.4V)		Altitude Input (11.8V)	+3° (0.6V)	+2° (0.4V)	+2.5° (0.5V)	+2° (0.4V)
R_{16}	Approach Pitch Limit	Approach	5° to 20° (1.0 to 4.0V)	10° (2.0V)	+1° (±0.2V)	±1.5°	G.S. Input 1.0V	+1.5° (0.3V)	+1.5° (0.3V)	+1.5° (0.3V)	+1.5° (0.3V)
R_{17}	Data Link Bank Limit	Data Link	30° to 60° (5.9 to 10.2V)	60° (10.2V)	+4° (0.41V)	±5°	Heading Input 90° (22.5V)	+5° (±0.5V)	+5° (0.5V)	+5° (±0.5V)	+5° (±0.5V)
R_{18}	Manual Heading Bank Limit	Manual Heading	20° to 60° (+4 to 10.2V)	25° (5.0V)	+2° (0.4V)	±3°	Heading Input 90° (22.5V)	+3° (0.6V)	+3° (0.6V)	+3° (0.6V)	+3° (0.6V)
R_{19}	ILS Bank Limit	ILS	20° to 40° (4 to 7.6V)	25° (5.0V)	+2° (0.4V)	±3°	Course Error 90° (22.5V)	+5° (0.95V)	+3° (0.6V)	+5° (0.95V)	+3° (0.6V)
R_{20}	ILS APPR Bank Limit	ILS Approach	10° to 30° (2.0 to 5.9V)	15° (3.0V)	+1.0° (0.2V)	±1.5°	Course Error 90° (22.5V)	+2° (0.4V)	+2° (0.4V)	+2° (0.4V)	+2° (0.4V)

TABLE I (CONT)

POTENTIOMETER LOCATED ON FRONT PANEL

POT NO.	CONTROL	MODE	MINIMUM RANGE	NOM SET	TOL AT 20° C	TEMP TOL	REMARKS	TOLERANCES FOR VOLTAGE AND FREQUENCY VARIATIONS			
								480 cps 125V	320 cps 105V	420 cps 125V	380 cps 105V
R_{21}	Doppler Track Angle Error	Doppler	0.05 to 1.1 ma	0.36 ma	±0.04 ma		Doppler Track Angle Error Input 5° (1.95V)	±0.1 ma	±0.1 ma	±0.1 ma	±0.1 ma
R_{22}	ILS Appr Pitch Trim	ILS Approach	±15°	-3°	±0.5°		Nose Down				

NOTES: 1. Bank, altitude, and pitch voltage analogs based on 11.8V maximum output at 90°(270°).

2. Heading and course error and doppler track angle error voltage analogs based on 22.5V maximum output at 90°(270°).

3. Specifications in "ma" are requirements to drive each load.

4. Test equipment error is not considered in the establishment of these values.

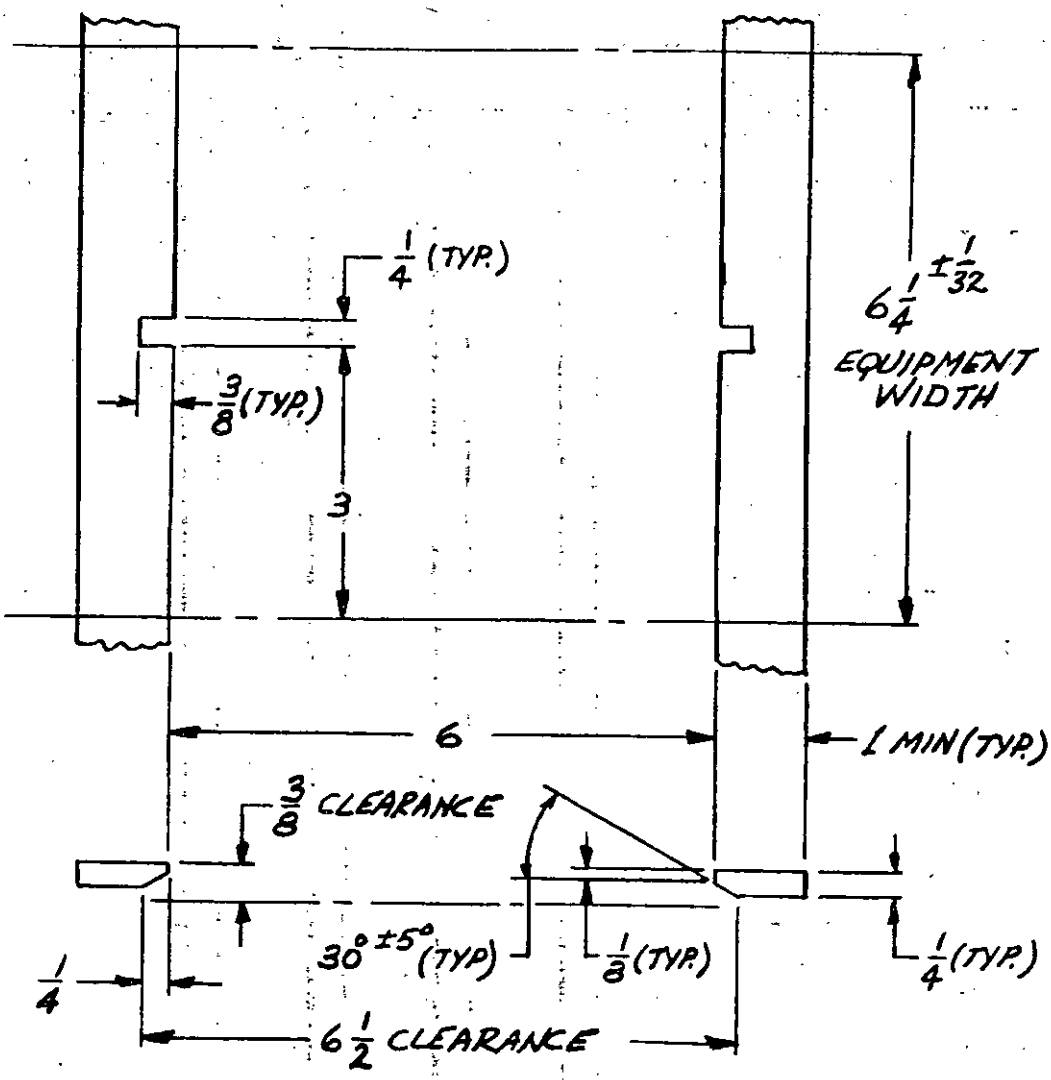
3.9.2 MOUNTING BASE. The computer shall incorporate a mounting base as shown on figure 1 for quick disconnect from the airframe. The mount shall be affixed to the computer case by means of screws and shall incorporate a thumb-screw adjustment so that it may be rigidly clamped to a mounting bracket. The mounting bracket shall be furnished by the airframe contractor and shall conform to figure 3. The quick-disconnect mount shall be such that it can be removed from the computer case and reversed in direction with respect to the case.

3.9.3 ELECTRICAL CONNECTORS. Two hermetically sealed connectors shall be affixed to the computer as shown on figure 1. The pin connections shall be in accordance with Drawing 64F1866 Connector 3J1 shall be a Bendix PT02H-20-41P, or equal, which mates with a PT06-20-41S, or equal. Connector 3J2 shall be a Bendix PT02H-22-55P, or equal, which mates with a PT06-22-55S, or equal.

3.10 FUNCTIONAL DESIGN. The computer shall supply proper signals to remote flight director indicators such as the ARU-11/A conforming to MIL-I-27619 and ARU-2B/A conforming to MIL-I-27193 attitude director indicators. The computer shall calculate the proper signals for display on the attitude director to enable the pilot to perform proper control action to intercept and maintain the desired course of flight path for the major modes of VOR, TACAN, doppler, data link, and ILS, and in the submodes of MANUAL HEADING and ALTITUDE HOLD. The submodes may be energized during any major mode operation. A NAV mode shall be provided in the computer for biasing all computed information out of view in the attitude director. The computer design shall be such that the final approach mode may be selected either externally by means of a 28V d-c signal or internally by means of a beam sensor when a jumper is provided between pins s and t of plug 3J1.

3.10.1 MODE RELAYS. Mode relays shall be incorporated into the circuitry in such manner as to provide the various modes of operation specified herein when the respective relay is energized by 28V dc and controlled by an external switch. Momentary interruption of the relay circuit shall not result in unsatisfactory signal output when power is reapplied. The beam sensor design shall trigger the final approach mode when the aircraft is on the glide-slope beam and the signal is within $\pm$15 mv of zero.

3.10.2 FLIGHT MODES. The computer shall provide the following modes of operations:



MOUNTING RAILS TO BE SUPPLIED BY AIRFRAME MANUFACTURE.

DIMENSIONS IN INCHES
UNLESS OTHERWISE SPECIFIED
TOLERANCE: FRACTIONS ± 1/64

FIGURE 2 MOUNTING RAILS

3.10.2.1 BASIC NAV MODE. During this operating mode, no external 28V relay excitation shall feed the computer. The following functions shall be displayed:

a. Vertical steering pointer - out of view to right

b. Horizontal steering pointer - out of view to bottom

c. Glideslope displacement bar - out of view to top

d. Vertical pointer warning flag - out of view

e. Glideslope warning flag - out of view

f. HSI warning flag - out of view.

3.10.2.2 MANUAL HEADING MODE. The flight director shall be placed in this mode when relay K-1 is excited with 28V dc from an external source. The following functions shall be displayed:

a. The vertical steering pointer shall receive a signal of heading error and bank angle. The correct zeroing action shall achieve the desired heading. The amount of required bank angle shall be limited. All sensitivities and limits shall be in accordance with tables I and II.

b. Vertical pointer warning flag - computer signal valid

c. All other pointers and flags shall be out of view as specified in 3.10.2.1 except when placed in view by excitation of a major mode.

3.10.2.2.1 FIRE CONTROL MODE. The flight director shall contain provisions for increasing the sensitivity of the vertical pointer to 7/8-inch deflection for 12° roll. This shall be accomplished by connecting a shunt resistance external to the computer in parallel with the roll ciruitry as shown on Drawing 64F1866. The shunt resistance shall consist of a nominal 3K-ohm fixed resistor in series with a 10K-ohm potentiometer and a relay. When required, the shunt resistor and relay shall be the responsibility of the airframe manufacturer. Both input wires from the shunt shall be shielded and both wires shall be disconnected when not in the fire control mode. The heading error signal shall also be shorted out external from the computer when in this mode. Operation of this mode shall result when the external relay and relay K-1 are energized.

TABLE II (See Notes)

INTERNAL CONTROLS

CONTROL	MODE	MINIMUM RANGE	NOM SET	TOL AT 20° C	TEMP	REMARKS	TOLERANCES FOR VOLTAGE AND FREQUENCY VARIATIONS			
							480 cps 125V	320 cps 105V	420 cps 125V	380 cps 105V
Pitch Gain	Approach	0.5 to 0.72 ma	0.66 ma	±0.06 ma		Pitch Input 4° (0.8V)	±0.12 ma	±0.09 ma	±0.09 ma	±0.075 ma
Bank Gain	Heading	0.35 to 0.55 ma	0.50 ma	±0.06 ma		Bank Input 20° (4.0V)	±0.09 ma	±0.09 ma	±0.075ma	±0.075 ma
Course Zero	Approach	±0.05 ma	0	±0.04 ma	±0.05 ma	Course Error Input 10° (3.9V)	±0.07 ma	±0.07 ma	±0.07 ma	±0.07 ma
Localizer Radio Gain	ILS	0.3 to 0.37 ma	0.34 ma	±0.04 ma	±0.08 ma	Loc Input 60 mv	±0.06 ma	±0.06 ma	±0.05 ma	±0.05 ma
Glideslope Gain	Approach	0.4 to 0.48 ma	0.44 ma	±0.06 ma		G.S. Input 60 mv	±0.07 ma	±0.07 ma	±0.06 ma	±0.06 ma
Approach Radio Rate Gain	Approach	0.145 to 0.250 ma	0.22 ma	±0.02 ma		Loc Input 15 mv at 0.08 cps				
Approach Bank Rate Gain	Approach	0.2 to 0.24 ma	0.22 ma	±0.02 ma		Bank Input 20° (4.0V) at 0.08 cps				

TABLE II (CONT)

INTERNAL CONTROLS

CONTROL	MODE	MINIMUM RANGE	NOM SET	TOL AT 20° C	TEMP	REMARKS	TOLERANCES FOR VOLTAGE AND FREQUENCY VARIATIONS			
							480 cps 125V	320 cps 105V	420 cps 125V	380 cps 105V
Approach Course Rate Gain	Approach	0.25 to 0.32 ma	0.28 ma	±0.02 ma		Course Error Input 3° (1.17V) at 0.08 cps				
Time Constant	Approach	8 to 15 sec	13 sec	±2 sec			±2 sec	±2 sec	±2 sec	±2 sec

NOTES: 1. Bank, altitude, and pitch voltage analogs based on 11.8V maximum output at 90°(270°).

2. Heading and course error and doppler track angle error voltage analogs based on 22.5V maximum output at 90°(270°).

3. Specifications in "ma" are requirements to drive each load.

4. Test equipment error is not considered in the establishment of these values.

3.10.2.3 DATA LINK MODE. The flight director shall be placed in the data link mode when relay K-4 is excited. The pointers shall operate as follows:

a. The vertical steering pointer shall receive a signal of heading error and bank angle as in the manual heading mode. The bank angle limit required shall be as indicated in table I

b. Vertical pointer warning flag - computer signal valid

c. All other pointers and flags out of view as specified in 3.10.2.1.

3.10.2.4 RADIO TRACK MODE. The computer shall provide tracking of VOR, TACAN, or doppler courses. The amount of bank angle required shall be limited. All sensitivities and limits shall be in accordance with tables I, II, and III. A separate mode relay shall be provided for each navigational aid with the following excitation:

a. VOR - 28V dc on pin B of connector 3J2

b. TACAN - 28V dc on pin B of connector 3J2 and 28V dc on pin d of connector 3J2

c. Doppler - 28V dc on pin B of connector 3J2 and 28V dc on pin CC of connector 3J2 if a doppler set without a warning flag signal is used. If a warning flag signal is used, 28V dc on pins B and U of connector 3J2. The following functions shall be displayed in radio track mode:

(1) The vertical steering pointer shall receive a computed signal composed of radio deviation (VOR, TACAN, or doppler) plus course error and bank angle. When the deviation signal is high, the zeroing action called for shall result in a course-cut intercept angle, as specified in table I. The signal shall be such that the pointer will deflect in the direction in which control action must be taken and will center when the aircraft is flying on the desired track or on the programmed flight path to attain the desired track. Crosswind compensation shall be provided so that the track can be maintained.

(2) Vertical pointer warning flag - computer signal is valid

TABLE III (See Notes)

DEPENDENT GAINS

CONTROL	MODE	MINIMUM RANGE	NOMINAL SETTING	TOL AT 20° C	REMARKS
VOR Radio Rate Gain	VOR	0.15 to 0.43 ma	0.38 ma	±0.15 ma	VOR input 30 mv at 0.0159 cps. Set by the ILS radio rate gain control
TACAN Radio Rate Gain	TACAN	0.15 to 0.43 ma	0.38 ma	±0.15 ma	TACAN input 30 mv at 0.0159 cps. Set by the ILS radio rate gain control
Radio Track Bank Rate Gain	VOR	0.17 to 0.51 ma	0.34 ma	±0.13 ma	Bank input 20° (4.0V) at 0.0159 cps. Set by ILS bank rate gain control
Radio Track Course Rate Gain	VOR	0.27 to 0.81 ma	0.54 ma	±0.06 ma	Course input 20° (7.7V) at 0.0159 cps. Set by ILS course rate gain control
VOR Radio Gain	VOR	0.30 to 0.37 ma	0.34 ma	±0.07 ma	VOR input 60 mv. Set by loc radio gain control
TACAN Radio Gain	TACAN	0.30 to 0.37 ma	0.34 ma	±0.07 ma	TACAN input 60 mv. Set by loc radio gain control
Doppler Radio Gain	DOP	0.22 to 0.27 ma	0.25 ma	±0.03 ma	Doppler input 15 mv. Set by loc radio gain control
VOR and TACAN Course Error Gain	VOR/TAC	0.05 to 0.15 ma	0.10 ma		Course input 10 mv (3.9V). Set by ILS course rate gain control

NOTES: 1. Bank and pitch voltage analogs based on 11.8V maximum output at 90° (270°).

2. Headings and course error and doppler track angle error voltage analogs based on 22.5V maximum output at 90° (270°).

3. Specifications in "ma" are requirements to drive each load

4. Test equipment error is not considered in the establishment of these values.

(3) HSI warning flag - 28V dc on 3J2-CC-255 $^{+245}_{-0}$ ua (off scale voltage); 28V dc on 3J2-U - connected to AN/ASN-35 computer warning flag

(4) The remaining pointers and flags shall be out of view as specified in 3.10.2.1.

3.10.2.5 ALTITUDE HOLD. This mode shall provide ease in maintaining a desired altitude. The altitude hold mode shall be so designed that it may be selected optionally as a submode during any of the major modes in which the horizontal steering pointer is driven out of view. In the ILS mode, means shall be included for automatic override of altitude hold information at glideslope interception and glideslope beam flying thereafter without manual switching by the pilot. The following functions shall be displayed:

a. The horizontal steering pointer shall receive a signal of altitude error and pitch angle. The correct zeroing action shall cause the selected altitude to be maintained. The sensitivities and limits shall be as specified in tables I and II.

b. All other pointers and flags shall be out of view as specified in 3.10.2.1 except when placed in view by excitation of a major mode.

3.10.2.6 ILS MODE. The computer shall be established in this mode when 28V dc is on pin K of connector 3J1 and when the radio track function is deactivated in the computer as a function of ILS. The following information shall be displayed on each pointer and flag:

a. The vertical pointer steering signal shall mix localizer deviation, course error, and bank angle. When the localizer deviation is high, the zeroing action called for shall result in a course-cut intercept angle as specified in table I. The correct zeroing action shall result in an intercept of the localizer beam. Crosswind compensation shall be provided. Sensitivities and limits shall be as defined in tables I and II

b. Horizontal steering pointer - out of view at bottom

c. Glideslope displacement bar - directly connected to glideslope receiver

d. Glideslope warning flag - directly connected to glideslope receiver

e. Vertical pointer warning flag - affected by localizer radio signal and computer.

3.10.2.7 ILS APPROACH. The computer shall be established in this mode when three conditions are satisfied, namely, when 28V dc is on pin K of 3J1 to K-2 (ILS) relay, when 28V dc is on pin s of 3J1 to K-3 (ILS approach) relay, and when the radio track function is deactivated in the computer as a function of ILS. Relay K-3 may be excited externally or by the internal beam sensor when jumped between two pins as shown on Drawing 64F1866. The ILS approach mode shall override the altitude hold mode. The functions displayed shall be as follows:

a. The vertical steering pointer shall mix localizer deviation and course error rate, radio rate, and bank rate through the crosswind filter and bank angle as shown on Drawing 64F1866. The bank angle limits and sensitivities shall be as defined in tables I and II

b. The horizontal steering pointer shall mix glideslope devaition and pitch as shown on Drawing 64F1866. Pitch limit and sensitivities shall be as defined in tables I and II

c. All other pointers and flags shall operate as in the ILS mode.

3.10.3 BEAM SENSOR. The computer shall contain an internal beam sensor to automatically switch from the ILS normal to the ILS approach mode when the glidepath is intercepted from above or below the beam. The beam sensor output shall be 28V dc and shall provide proper operation when a wire is jumpered between pins s and t of plug 3J1. A logic circuit shall be incorporated that will require the following conditions to be satisfied before switching. When these conditions are met, the beam sensor output will remain at pin t until either condition a or f is no longer met.

a. Computer in ILS - normal mode

b. Usable glideslope signal (glideslope flag-alarm signal tie-in)

c. Usable localizer signal (localizer flag-alarm signal)

d. Aircraft within ±2 dots deviation (±150 mv) of the center of the localizer beam

e. Switching shall occur only at a specified deviation from center of glideslope beam (see table I)

f. Radio receiver tuned to localizer frequency (28V dc output from VOR/LOC receiver).

3.10.3.1 HORIZONTAL STEERING POINTER OUT OF VIEW. After switching to the ILS approach mode, the horizontal steering pointer shall be in view or out of view in accordance with the following conditions. Under the horizontal-steering out-of-view conditions, the computer will continue to function in the ILS approach mode.

a. Glideslope and localizer flag signal - The horizontal steering pointer shall be biased out of view with no delay with an invalid flag signal and driven into view with no delay with a valid flag signal. An invalid flag signal is 180 mv or less and a valid flag signal is 255 mv or greater. These values are based on the operation of the ADI and correspond with operation of the flags in the actual aircraft

b. Glideslope deviation signal - The horizontal steering pointer will remain in view with increasing glideslope deviation signal up to 150 mv and will be out of view when the signal exceeds 190 mv. After the horizontal steering pointer goes out of view (due to glideslope deviation), reduction of the glideslope deviation signal to less than the value specified in table I will allow the horizontal steering pointer to return to view.

c. Localizer deviation signal - The horizontal steering pointer will remain in view with increasing localizer deviation signal up to 150 mv and will be out of view when the signal exceeds 190 mv. After the horizontal steering pointer goes out of view (due to localizer deviation), it shall return to view when the localizer deviation is reduced to 150 mv provided the glideslope deviation signal is less than the value specified in table I.

3.10.3.2 INCOMING RADIO SIGNALS. The incoming radio signals shall be sufficiently filtered within the computer to eliminate carrier noise interference and to provide proper switching when operating with the receivers specified in 3.11.3. Neither false nor nuisance switching shall occur.

3.11 INPUT SIGNALS. Input signals shall have the characteristics specified herein and loading shall be as follows:

3.11.1 ROLL AND PITCH ANGLE SIGNALS. Roll and pitch angle input signals shall be in the form of separate transmitter-synchro 3-wire stator outputs in accordance with the standard test transmitter specified in 3.11.4, with dial readings set at 180° for zero roll and pitch displacement. Increasing dial readings shall correspond to right roll and pitchup maneuvers. Decreasing dial readings shall correspond to opposite maneuvers. The load placed on these signals within the computer shall be equivalent to high impedance, balanced loads. The loads measured between any 2 lines of these inputs shall be at least 5K ohms. The computer shall operate satisfactorily with the MD-1 (MIL-G-25597), AF/A24G-1 (MIL-C-26485), or A/A24G-5 (MIL-C-27205) gyroscope.

3.11.2 HEADING AND COURSE ERROR SIGNALS. Heading and course error signals shall be in the form of separate synchro rotor outputs from the heading datum and course datum control transformers of the AQU-2/A and AQU-4/A horizontal situation indicators in accordance with MIL-H-26689 and MIL-H-27848, or equivalent. The output voltage shall be zero for zero heading error and zero course error. If the actual heading is to the left of the selected heading and course, voltage H prime to C shall be in phase with power excitation ground-to-phase. If the actual heading is to the right of the selected heading and course, voltage C to H prime shall be in phase with power excitation ground-to-phase. Loading of these input signals shall be 10,000 ohms, or greater. The datum control transformers shall be Clifton Precision CTC-8-A-4, or equal.

3.11.3 RADIO SIGNAL INPUTS. Computer loading of radio-deviation, flag, and displacement signals shall be 1,000 ±3 percent ohms each. The computer shall operate satisfactorily with input signals from the following equipment:

a. Glideslope receiver, Radio Receiving Set AN/ARN-18, or Receiving Set, Radio AN/ARN-67 (MIL-R-27226) and standard ARINC glideslope receivers

b. VOR/localizer receiver, Radio Receiving Set AN/ARN-14 (MIL-R-8323) and standard ARINC VOR receivers

c. Radio Set AN/ARN-21 plus Collins Radio Company 161B-1 TACAN coupler, or equal, Radio Set AN/ARN-65, or OSTER 9616-13 TACAN coupler, or equal

d. Standard ARINC doppler computer.

3.11.4 STANDARD SYNCHRO TEST TRANSMITTER. The standard calibrated synchro, with minimum and known errors, shall be an Eclipse-Pioneer type AY201-1, or equal, high-precision transmitting synchro. A 0° to 360° dial clamped to the rotor of the synchro shall be settable, rotatable, and readable through 360° of rotation to 6 minutes of arc. The following procedure shall be used to calibrate the test synchro:

3.11.4.1 With the rotor leads designated H and C and with one stator lead designated Z and connected to C, 26V shall be applied to H and C (C being grounded). The dial shall be positioned on 0° and clamped to the rotor when:

a. The voltage across H and Y is maximum

b. The voltage across the remaining two stator leads (X and Y) is minimum

c. The voltage across X and Z increases before it decreases for increasing heading indication of the dial. The voltage X to Z and Y to Z shall be in phase with the excitation voltage C to H when the dial reading is zero. For increasing heading indications of the dial, the voltage X to Y shall increase and be in phase with the excitation voltage C to H. The test transmitter shall be set at an index reference to zero and positive rotation reference XYZ.

3.11.5 ALTITUDE ERROR. The altitude error input signal shall be in the form of separate transmitter-synchro, 3-wire stator outputs in accordance with the standard test transmitter specified in 3.11.4. The remote altitude hold sensor shall be synchro driven from the altitude shaft through a clutch so that the

synchro will remain in the index reference position except when the altitude hold-energize lead is excited with 28V dc from the external mode selector switch. The output shall be 1.0 ±0.1V at 100 feet measured across 5,000 ohms. The range of the synchro shall be 0 to ±500 feet. The computer shall be fully compatible with ARINC standard altitude hold signals provided for flight director and autopilot operation.

3.12 OUTPUT SIGNALS. The computer output signals shall not be affected by those input signals that are not used in the particular mode of operation. To determine the affect of unused input signals not being used in the selected mode shall be set to their maximum value, the input signals used in the selected mode set to zero, and the output shall be measured. There shall be no signal outputs when the above conditions exist. The computer output signals shall have the following characteristics when loaded as specified.

3.12.1 VERTICAL AND HORIZONTAL POINTER SIGNALS. Each vertical and horizontal pointer output signal shall drive two meter movements. The signal shall be direct current with instantaneous polarity and magnitude, as required for the particular mode activated. No a-c ripple voltage of the on-scale signal (as read on a ballantine Model 300A voltmeter, or equivalent) shall be greater than 0.43 times the d-c output voltage or 150 mv, whichever is greater. The off-scale current shall be so filtered that the ripple voltage peak-to-peak shall not exceed 10 percent of the average d-c value. The attitude-director meter-movement loads applied to the output signals shall be driven out of view when supplied with 11.0, -1.0 and +2.5 ma. The resistance of each meter movement shall be 1,000 ±3 percent ohms. A deflection of 7/8 inch from the center position shall require 2.2 ±5 percent ma and shall be the normal full-scale command. The nominal output impedance for the vertical and horizontal steering signals shall be approximately 50 to 200 ohms.

3.12.2 FLAG OUTPUT SIGNALS. Each flag output signal shall be that required to operate 2 meter movement flags having the following characteristics. In those modes in which the flags are driven out of view, the computer shall supply a signal of 255, +245 and .0 ua. In the ILS and ILS approach modes, the glide-slope warning flag shall be connected directly to the glide-slope receiver. In the event of (1) a failure of the B+ voltage

to an amplifier, (2) an internal short of an amplifier, or (3) inadequacy of the radio deviation signal, the output power normally supplied to pull the vertical pointer warning flag out of view shall cease and allow the flag to appear. The vertical pointer warning flag shall be in view with a radio deviation signal input of 180 ua or less and shall be out of view with a radio signal input of 275 ua or more. This shall be applicable to all modes except the NAV and altitude hold modes. The resistance across each flag alarm circuit shall be two 1,000-ohm loads in parallel ±3 percent. Test points shall be brought out to the front panel to permit adequate testing of the flag circuits incorporated within the computer.

3.12.3 DISPLACEMENT POINTER. The displacement pointer output signal shall drive 2 meter movements requiring 500^{+500}_{-0} ua, each to be driven completely out of view. The sensitivity shall be 75 ua per dot with a total of 2 dots. The load of each meter movement shall be 1,000 ±3 percent ohms. In the ILS mode, the glideslope receiver shall provide the signal directly to the displacement pointer through the computer.

3.13 POWER. The computer shall operate from single-phase, 115V, 400-cps power supplied from an a-c aircraft electrical system in accordance with MIL-STD-704. In addition, the computer shall comply with the requirements of MIL-STD-704 for utilization equipment. The computer shall function satisfactorily with variations in voltage and frequency from 105 to 125V and 320 to 480 cps. An external 28V d-c source shall supply mode relay requirements. The a-c power consumption shall not exceed 16 va at rated voltage and frequency. The power factor shall be not less than 0.85. The d-c power consumption required for relay excitation shall not exceed the following values for each mode at rated voltage:

NAV	0w
Data link	2.3w
Manual heading	2.3w
Radio track	10.0w
Altitude hold	4.5w
ILS	8.5w
ILS approach	13.0w

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

3.15 WEIGHT. The weight of the computer, with the quick-disconnect mount attached, shall not exceed 12.0 pounds.

3.16 SOLDERING. Soldering shall be accomplished in accordance with MIL-S-6872.

3.17 SCREW THREADS. Unless otherwise specified, the threads of all machine screws shall conform to MIL-S-7742.

3.18 FINISHES AND PROTECTIVE COATINGS

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

3.18.1.1 Small holes and case inserts need not be anodized.

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

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

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

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

3.18.1.6 Parts inclosed in hermetically sealed containers need not be anodized or plated.

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

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

3.18.2 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 required degree of protection.

3.19 IDENTIFICATION OF PRODUCT. Equipment, assemblies, and parts shall be marked for identification in accordance with MIL-STD-130.

3.20 WORKMANSHIP. The computer, 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.

3.20.1 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 or bolt or threads.

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

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

3.20.4 CLEANING. Before insertion in the case, the computer shall be thoroughly cleaned of loose, spattered, or excess solder, metal chips, or other foreign material after assembly. Burrs and sharp edges as well as resin flash that might crumble shall be removed.

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. The inspection and testing of computers shall be classified as follows:

a. Preproduction tests

b. Acceptance tests.

4.3 TEST CONDITIONS

4.3.1 STANDARD ATMOSPHERIC CONDITIONS. Whenever 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 allowance shall be made for the difference from the specified condition.

4.3.2 ATTITUDE. Unless otherwise specified, the computer shall be tested in normal operating position.

4.3.3 SUPPLY VOLTAGE. Unless otherwise specified, all tests shall be conducted with 115 $\pm$5V ac single phase, 400 $\pm$10 cps.

4.3.4 CONNECTIONS. Whenever it is specified that the computer shall be properly connected, it shall be understood that the computer connector terminals shown on Drawing 64F1866 are connected to a test fixture that provides the required inputs, performs the mode relay excitation connections, and provides the required loads on the output as specified in section 3.

4.3.4.1 TEST FIXTURE INPUTS TO COMPUTER. Inputs from the test fixture to the computer shall simulate the radio signals required by the computer, the pitch and roll signals, the heading and course error signals, and the altitude error signals.

4.3.4.1.1 TEST FIXTURE LOADS ON COMPUTER. Shunt resistance in series with an external relay shall be provided for the fire-control-mode input. The cables shall be shielded.

4.3.4.1.2 Simulated radio deviation signals shall have manually variable magnitudes from 0 to ±1,000 mv at 0 frequency and 0 to ±100 mv at frequencies of 0.08 to 0.0159 cps where the signal varies sinusoidally. The radio flag signals shall be adjustable from 150 to 285 mv when connected to the computer.

4.3.4.1.3 Roll and pitch signals shall be provided from standard transmitters as specified in 3.11.4. Heading error and course error signals shall be from a control transformer as specified in 3.11.2. The test transmitters shall be manually settable to fixed displacements. The roll and course error signals shall provide 0.08 to 0.0159 cps oscillation when testing the rate circuits.

4.3.4.1.4 The altitude error signal shall be in accordance with 3.11.5.

4.3.4.2 TEST FIXTURE LOADS ON COMPUTER. Two 1,000-ohm loads ±3 percent, in parellel, shall be utilized on each output signal. For each output, the basic load shall be a meter movement in accordance with design criteria specified herein.

4.3.4.3 TEST FIXTURE MODE RELAY. The test fixture shall provide switching so that the various mode relays can be energized individually or in the combinations listed in section 3.

4.3.5 BURN-IN. Burn-in shall be in accordance with MIL-R-26667.

4.4 PREPRODUCTION TESTING

4.4.1 TEST SAMPLES. The test samples shall consist of three computers representative of the production equipment. The samples shall be identified with the manufacturer's part number and such other information as required by the procuring activity.

4.4.2 TEST REPORT. Three copies of a test report prepared in accordance with MIL-STD-831 shall be furnished to the procuring activity.

4.4.3 PREPRODUCTION TESTS. The preproduction tests shall consist of all tests specified under 4.6.

4.5 ACCEPTANCE TESTS. Acceptance tests shall consist of:

a. Individual tests

b. Sampling plans and tests.

4.5.1 INDIVIDUAL TESTS. Each computer shall be subjected to the following tests as described under 4.6:

a. Examination of product

b. Leakage

c. Signal adjustments

d. Basic Nav mode

e. Manual heading mode

f. Fire control mode

g. Data link mode

h. Radio track mode

(1) VOR

(2) TACAN

(3) Doppler

i. Altitude hold

j. ILS mode

k. ILS approach

l. Beam sensor

m. Early failure detection.

4.5.2 SAMPLING PLANS AND TESTS

4.5.2.1 SAMPLING PLAN A. Sample computers shall be selected at random in accordance with the following schedule and subjected to the tests listed below, as described under 4.6:

Production Quantity	No. of Sample Computers
1 to 10	1
11 to 100	2
101 to 200	1
Each additional 200	1 for each 200

a. Individual tests

b. Dielectric strength

c. Low temperature operation

d. High temperature operation

e. Extreme voltage and frequency variation

f. Vibration error

g. Power.

4.5.2.2 SAMPLING PLAN B. Unless otherwise specified, 3 computers shall be selected at random from the first 15 on the contract or order and subjected to the following tests as described under 4.6:

a. Sampling plan A tests

b. Electromagnetic interference

c. Vibration failure

d. High temperature exposure

e. High altitude - low temperature

f. Sand and dust

g. Rain

h. Fungus

i. Humidity

j. Salt fog

k. Thermal shock

l. Sealing thermal shock

m. Shock

n. Signal characteristics

o. Reliability

p. Acceleration

q. External pressure.

4.5.2.2.1 At the option of the procuring activity and with the exception of sampling plan A tests, tests may be divided into 3 groups, as follows, to be conducted on 3 sets of computers if a need exists to expedite tests. Each computer shall meet the requirements of sampling plan A tests after completing the group of specific tests to which submitted. At the option of the procuring activity, group II may be conducted on empty cases which have all external parts installed or attached as on a completed computer.

Group I	Group II	Group III
Electromagnetic interference	Humidity	Vibration failure
High temperature exposure	Fungus	Acceleration
Low temperature	Rain	Shock
Thermal shock	Salt fog	Reliability
Signal characteristics	Sand and dust	External Pressure
	Sealing thermal shock	

4.5.2.3 SAMPLING PLAN C. Unless otherwise specified, three computers shall be selected at random from the first 20 computers of each production quantity of 100 and subjected to the test specified in 4.6.21.2.

4.5.2.4 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.

4.5.2.4.1 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 EXAMINATION OF PRODUCT. The computer shall be inspected to determine compliance with the requirements herein with respect to materials, workmanship, marking, and design.

4.6.2 LEAKAGE. The computer shall be tested for leakage by means of a mass-spectrometer-type helium leak-detector. The initial maximum detected leak rate, at a pressure differential of one atmosphere, shall not permit more than 10 percent loss of the total filling medium after 1,000 hours.

4.6.3 SIGNAL ADJUSTMENTS. The computer shall be properly connected with all input signals initially set at zero signal or displacement. Each of the adjustments shall be checked for range and specified setting. The values shall be as specified in tables I, II, III, and IV. This test shall not be repeated under sampling plan A or B.

4.6.4 BASIC NAV MODE. The computer shall be properly connected with power applied and with all input signals initially set at zero signal or displacement. Operation of the computer shall be as specified in 3.10.2.1. The computer outputs shall not exceed the tolerances for each setting specified in tables I and II.

4.6.5 MANUAL HEADING MODE. The computer shall be properly connected with power applied and all input signals initially set at zero signal or displacement. Operation of the computer shall be as specified in 3.10.2.2. The computer outputs shall not exceed the tolerances for each setting specified in tables I and II.

4.6.5.1 FIRE CONTROL MODE. The computer shall be properly connected with power applied and all inputs initially set at zero signal or displacment. No heading error signal shall be applied to the computer during this test. Operation of the computer shall be as specified in 3.10.2.2.1. The computer outputs shall not exceed the tolerances for each setting specified in tables I and II.

4.6.6 DATA LINK MODE. The computer shall be properly connected with power applied and all input signals initially set at zero signal or displacement. Operation of the computer shall be as specified in 3.10.2.3. The computer outputs shall not exceed the tolerances for each setting specified in tables I and II.

4.6.7 RADIO TRACK MODE. The computer shall be properly connected with power applied and all input signals initially set at zero signal or displacement. The three modes of VOR, TACAN, and doppler shall be individually tested under the conditions specified in 3.10.2.4. Computer outputs shall not exceed the tolerances for each setting specified in tables I and II.

4.6.8 ALTITUDE HOLD. The computer shall be properly connected with power applied and all input signals initially set at zero signal or displacement. Operation of the computer shall be as specified in 3.10.2.5. Computer outputs shall not exceed the tolerances for each setting specified in tables I and II.

4.6.9 ILS MODE. The computer shall be properly connected with power applied and all input signals initially set at zero signal or displacement. Operation of the computer shall be as specified in 3.10.2.6. Computer outputs shall not exceed the tolerances for each setting specified in tables I and II.

TABLE IV

POINTER AND FLAG INDICATIONS

MODE	SUBMODE	VERTICAL STEERING POINTER	HORIZONTAL STEERING POINTER	HSI WARNING FLAG	GLIDESLOPE WARNING FLAG	GLIDESLOPE DISPLACEMENT BAR	VERTICAL POINTER WARNING FLAG
Basic Nav	None	$11^{+2.5}_{-1.0}$ ma (Off Scale Supply)	$11^{+2.5}_{-1.0}$ ma (Off Scale Supply)				255^{+245}_{-0} ua (Off Scale Supply)
Manual Heading	None	Computed Signal					
	Altitude Hold		Computed Signal	255^{+245}_{-0} ua (Off Scale Supply)	255^{+245}_{-0} ua (Off Scale Supply)	500^{+500}_{-0} ua (Off Scale Supply)	255^{+245}_{-0} ua (When Computed Signal is Valid)
	Optional Fire Control	Computed Signal (Sensitive Bank Angle)	$11^{+2.5}_{-1.0}$ ma (Off Scale Supply)				
Data Link	None	Computed Signal					
	Manual Heading	Computed Signal Heading Bank Limit					
	Altitude Hold	Computed Signal	Computed Signal				

POINTER AND FLAG INDICATIONS

MODE	SUBMODE	VERTICAL STEERING POINTER	HORIZONTAL STEERING POINTER	HSI WARNING FLAG	GLIDESLOPE WARNING FLAG	GLIDESLOPE DISPLACEMENT BAR	VERTICAL POINTER WARNING FLAG
Radio Track VOR	None	Computed Signal	$11^{+2.5}_{-1.0}$ ma (Off Scale Supply)	Connected to VOR/Loc Receiver	255^{+245}_{-0} ua (Off Scale Supply)	500^{+500}_{-0} ua (Off Scale Supply)	255^{+245}_{-0} ua (When Computed Signal is Valid)
	Manual Heading	Computed Signal (Heading Mode)					
	Altitude Hold	Computed Signal (Radio Track VOR)	Computed Signal				
Radio Track TACAN	None	Computed Signal	$11^{+2.5}_{-1.0}$ ma (Off Scale Supply)	Connected to TACAN Receiver			
	Manual Heading	Computed Signal (Heading Mode)					
	Altitude Hold	Computed Signal (Radio Track TACAN)	Computed Signal				
Radio Track Doppler	None	Computed Signal	$11^{+2.5}_{-1.0}$ ma (Off Scale Supply	28V dc on 3J2-CC 255^{+245}_{-0} ua (Off Scale Voltage) 28V dc on 3J2-U Connected to AN/ASN-24(V) and AN/ASN-35 Computer Warning Flag			
	Manual Heading	Computed Signal (Heading Mode)					
	Altitude Hold	Computed Signal (Doppler Mode)	Computed Signal				

TABLE IV (CONT)

POINTER AND FLAG INDICATIONS

MODE	SUBMODE	VERTICAL STEERING POINTER	HORIZONTAL STEERING POINTER	HSI WARNING FLAG	GLIDESLOPE WARNING FLAG	GLIDESLOPE DISPLACEMENT BAR	VERTICAL POINTER WARNING FLAG
ILS	None	Computed Signal	$11^{+2.5}_{-1.0}$ ma (Off Scale Supply)	Connected to VOR/Loc Receiver	Connected to Glideslope Receiver	Connected to Glideslope Receiver	255^{+245}_{-0} ua (When Computed Signal is Valid)
	Manual Heading	Computed Signal (Heading Mode)					
	Altitude Hold	Computed Signal (ILS Mode)					
ILS APPROACH	None	Computed Signal	Computed Signal				

4.6.10 ILS APPROACH. The computer shall be properly connected with power applied and all input signals initially set at zero signal or displacement. Operation of the computer shall be as specified in 3.10.2.7. Computer outputs shall not exceed the tolerances for each setting specified in tables I and II.

4.6.10.1 BEAM SENSOR. The computer shall be properly connected with power applied. To simulate tuning of the VOR/Loc radio to a localizer frequency, 28V dc shall be supplied to pin 3J2-n. The computer shall operate as specified in 3.10.3.

4.6.11 EARLY FAILURE DETECTION. This test shall not be repeated under sampling plans A and B. The computer shall be properly connected with power applied and operated for a minimum of 10 hours. All components of the computer shall be energized and operated throughout the test. No failures shall occur. At the completion of this test, the vertical-pointer warningflag circuitry shall be tested and shall meet the requirements of 3.12.2.

4.6.12 DIELECTRIC STRENGTH. A potential of 500V dc 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.

4.6.13 ENVIRONMENTAL STABILITY. After completion of the following tests (4.6.13.1 through 4.6.13.4.1), the computer shall be subjected to and shall meet the individual tests.

4.6.13.1 LOW TEMPERATURE OPERATION. The computer shall be properly connected, with no power applied, and subjected to a temperature of -54° $+2^{\circ}$ C for a period of 4 hours. At the end of this period and while still at the low temperature, power shall be applied. The computer shall meet all of the individual tests, except sealing. Immediately following removal from the temperature chamber, the computer shall be subjected to the sealing test.

4.6.13.2 HIGH TEMPERATURE OPERATION. The computer shall be properly connected, with no power applied, placed in a chamber, and maintained at a temperature of 71° $+2^{\circ}$ C for a period of 4 hours. While still at the high temperature, power shall be applied and the computer shall meet all individual tests, except sealing. The temperature shall be increased to 98° C for a

period of 10 minutes with the computer operating. The computer shall meet the requirements of 3.10.2.4 and immediately following removal from the chamber shall meet the test specified in 4.6.2.

4.6.13.3 EXTREME VOLTAGE AND FREQUENCY VARIATION. The computer shall be properly connected and, with input power applied, shall meet the individual tests at all combinations of 105V 380 cps and 125V 420 cps. With input power applied, the computer shall then meet the individual tests at all combinations of 105V 320 cps and 125V 480 cps, except that the tolerances shall be within those specified in tables I and II for extreme voltage and frequency variations.

4.6.13.4 VIBRATION ERROR. The computer shall be properly connected with power applied and subjected to vibration error tests consisting of a frequency survey with vibration applied to the longitudinal, lateral, and vertical axes of the computer. The computer shall be subjected to vibration with a constant applied double amplitude of 0.060 inch through the frequency range of 10 to 55 cps and 10g input from 55 to 500 cps in each of the 3 mutually perpendicular axes. This test may be conducted with vibration applied in a circular motion in a plane 45° to the horizontal plane of the computer. Duration of vibration shall be 1 minute in each axis for 1 complete cycle of frequency range or 1 minute with vibration applied in a circular motion for 1 complete frequency range.

4.6.13.4.1 SIGNAL CONTINUITY. During vibration, there shall be no transients or discontinuity in output for any mode of operation.

4.6.14 POWER CONSUMPTION. The computer shall be properly connected with power applied. The a-c and d-c power consumption for each mode shall not exceed the values specified in 3.13.

4.6.15 ELECTROMAGNETIC INTERFERENCE. The computer shall be tested in accordance with MIL-STD-462, Notice 2, Test Methods CE03, CE04, CS01, CS02, CS06, RE02, RS02, and RS03 to demonstrate compliance with the requirements of paragraph 3.5.1 of this equipment specification.

4.6.16 ENVIRONMENTAL. The computer shall be subjected to the following tests, conducted in accordance with MIL-STD-810 and as specified.

4.6.16.1 HIGH TEMPERATURE EXPOSURE. This test shall be conducted in accordance with method 501. The period of exposure shall be 24 hours. The computer shall be properly connected, with no power applied during exposure. At the end of the 24-hour period and while still at the high temperature, power shall be applied for 1 hour. The computer shall meet the individual tests specified herein. The computer shall operate without sticking or erratic performance during this test.

4.6.16.2 TEMPERATURE-ALTITUDE. The high altitude-low temperature test shall be conducted in accordance with method 504 for class 2 equipment, except that the altitude shall be 100,000 feet. The computer shall be connected with no power applied. At the end of the 72-hour period, pressure in the chamber shall be reduced to the equivalent of 100,000 +500 feet, and power applied. The computer shall operate immediately and its operation shall be observed for 1 hour. There shall be no evidence of erratic performance. All mode relays and rate circuits shall be tested. Pressure in the test chamber shall be increased to atmospheric and, after the computer has returned to room temperature, it shall meet all individual tests.

4.6.16.3 SAND AND DUST. The sand and dust test shall be conducted in accordance with method 510. Upon completion of this test, the computer shall be examined to determine that no sand or dust has entered the adjustment dust cover. The computer shall then meet the individual tests.

4.6.16.4 HUMIDITY. The computer shall be subjected to a humidity test in accordance with method 507 after which it shall meet the individual tests. There shall be no evidence of corrosion or rust which will affect subsequent operation.

4.6.16.5 FUNGUS. The fungus test shall be conducted in accordance with method 508, proceure I. Upon completion of this test, the computer shall meet the individual tests. There shall be no deterioration nor shall any part of the computer support fungus growth.

4.6.16.6 RAIN. The rain test shall be conducted in accordance with method 506 in its normal operating position. The computer shall then meet the individual tests.

4.6.16.7 SALT FOG. The computer shall be subjected to a salt fog test in accordance with method 509. At the end of the 48-hour period, the computer shall be subjected to and shall meet the individual tests.

4.6.16.8 VIBRATION FAILURE. The computer shall be properly connected with power applied and subjected to a vibration test in accordance with method 514, 1B1C. At the end of this test, the computer shall be subjected to and shall meet the individual tests. The computer shall then be subjected to a vibration of 0.4 inch double amplitude or 1.0g (whichever is less) within the frequency range of 1 cps to 10 cps for a period of 15 minutes. There shall be no transients or discontinuity in outputs for any mode of operation. No damage to the computer shall occur as a result of this test.

4.6.17 ACCELERATION. The computer, not operating, shall be mounted on a centrifuge in its normal operating position and subjected to an acceleration of 20g for a period of 1 minute in each axis, first along the vertical axis and then along each of two axes that are perpendicular to the vertical axis and to each other. At the end of this acceleration, the computer shall meet the individual tests. No damage to the computer shall result from this test.

4.6.18 TEMPERATURE SHOCK. The computer shall be subjected to a temperature shock test in accordance with method 503. After the computer has returned to room temperature, connectors and seals shall be examined. There shall be no evidence of cracked terminals or leaks in the seals. The computer shall then meet the individual tests.

4.6.19 SEALING TEMPERATURE SHOCK. The computer shall be immersed alternately in tap water maintained at 85° ±4° C and 5° ±4°C for a total of 8 cycles. The length of time for each bath immersion shall be 30 minutes and no more than 5 seconds shall elapse between bath immersions. The forward 1/2 inch of the front adjsutment panel need not be submerged. No damage shall result to the hermetic seal as a result of this test. Following the immersions; the computer shall be tested for leaks by means of a mass-spectrometer-type helium leak detector. The initial maximum detected leak rate, at a pressure differential of 1 atmosphere, shall not permit more than 10 percent loss of the total filling medium after 1,000 hours.

4.6.19.1 EXTERNAL PRESSURE. With no power applied, the computer shall be cycled 6 times from atmospheric pressure to 26.5 psia. At the completion of this test, the computer shall pass all the individual tests.

4.6.20 SHOCK. The computer shall be subjected to a shock test in accordance with method 516, procedure I. The equipment shall not be damaged or subsequently fail as a result of this test.

4.6.21 RELIABILITY.

4.6.21.1 Three (3) computers shall be subjected to a reliability demonstration test in accordance with MIL-STD-781B, Test Plan II, which shall demonstrate a computer minimum acceptable MTBF of 600 hours. The test environment shall be in accordance with MIL-STD-781B, Test Level E. Each mode covered in paragraph 3.10.2.1 through 3.10.2.7 shall be switched at 1 hour intervals during the ON time of this test. All inputs shall be applied to the computer at their maximum value during the test. The output loads shall be 500 ohms.

4.6.21.2 An acceptance reliability test shall be conducted to demonstrate a computer minimum acceptable MTBF of 600 hours. Acceptance shall be based on MIL-STD-781B, Test Plan XXVII and the test environment of Test Level E. Eachmmode covered in 3.10.2.1 through 3.10.2.7 shall be switched at 1 hour intervals during the ON time of this test. All inputs shall be applied to the computer at their maximum value during test. The outputs shall be 500 ohms.

4.6.22 SIGNAL CHARACTERISTICS

4.6.22.1 Vertical and horizontal output signal characteristics shall be tested to determine that the requirements of 3.12 and 3.12.1 are fulfilled.

4.6.22.2 Computer loading of input signals shall be tested. Input impedance for attitude signals, heading and course error signals, and radio signals shall be as specified in 3.11.

4.7 PACKAGING INSPECTION

4.7.1 QUALITY CONFORMANCE. The inspection of the preservation-packaging and interior package marking shall be in accordance with group A and B quality conformance inspection requirements, section 4 of MIL-P-116. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of applicable container specification and the marking requirements of MIL-STD-129.

4.7.2 FIRST ARTICLE. When the unit container is capable of serving as the shipping container First Article Inspection, and rough handling tests as outlined in section 4 of MIL-P-116, shall be accomplished followed by a functional test of the unit to insure freedom from operational malfunction.

5. PACKAGING

5.1 PRESERVATION-PACKAGING. Preservation-packaging shall be level A, B, or C as specified by the procuring activity.

5.1.1 LEVEL A.

5.1.1.1 CLEANING. Unit shall be cleaned in accordance with process C-1 of MIL-P-116.

5.1.1.2 DRYING. Immediately after cleaning, the unit shall be dried following any one or combination of the drying procedures of MIL-P-116. The drying procedures employed shall not be injurious to the unit.

5.1.1.3 PRESERVATION APPLICATION. Not required.

5.1.1.4 UNIT PACKAGING. Unless otherwise specified by the procuring activity, each unit shall be packaged in quantity unit packs of one each in accordance with Method IAB of MIL-P-116. Overbox each completed pack in a PPP-B-636 Fiberboard, weather-resistant class box. Cushioning material between bag and container shall be of a type, density and thickness that will protect the unit from impact shock damage when tested as specified in paragraph 4.7.2 of this specification.

5.1.2 LEVEL B. Each unit shall be packaged as indicated for Level A except that a specification PPP-B-636 class domestic box shall be used as the unit container.

5.1.3 LEVEL C. Units shall be cleaned, dried, and individually packaged in a manner that will afford adequate protection against corrosion, deterioration and physical damage during shipment from supply source to the first receiving activity.

5.2 PACKING. Packing shall be level A, B, or C as specified (see 6.2).

5.2.1 LEVEL A. Units packaged as specified in 5.1 shall be packed in shipping containers conforming to specification PPP-B-636 weather-resistant. Closure and reinforcing requirements shall be in accordance with the appendix of PPP-B-636. For the Army, specification PPP-B-601 plywood box, shall be used for the shipping container.

5.2.2 LEVEL B. Units packaged as specified in 5.1 shall be packed in shipping containers conforming to specification PPP-B-636, class domestic. Closure and reinforcing requirements shall be in accordance with the appendix of PPP-B-636. For the Army, the shipping containers shall conform to specification PPP-B-636 class weather resistant.

5.2.3 LEVEL C. Packaged units shall be packed in shipping containers in a manner that will afford adequate protection against damage during direct domestic shipment from the supply source to the first receiving activity. These packs shall conform to applicable carrier rules and regulations.

5.3 MARKING. In addition to any special marking required by the contract or order, each unit package and shipping container shall be marked in accordance with MIL-STD-129. The nomenclature shall be as follows: Computer, Flight Director CPU-65/A.

6. NOTES

6.1 INTENDED USE. The CPU-65/A computer covered by this specification is intended for universal use in all types of military fixed-wing aircraft, such as cargo, bomber, and high-performance fighters, to provide computed flight director signals to flight director indicators.

6.2 ORDERING DATA. Procurement documents should specify the following:

a. Title, number, and date of this specification

b. When sampling plan B and C tests will not be conducted

c. Selection of applicable levels of packaging and packing

d. Reinspection date markings.

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.

Custodian:
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Preparing Activity:
Air Force - 99

Project Number:
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