

MIL-N-81497A(AS)
15 March 1970
 Superseding
 MIL-N-81497 (AS)
 1 May 1968

MILITARY SPECIFICATION
 NAVIGATION SET, INERTIAL
 AN/ASN-84

This specification has been approved by the Naval
 Air Systems Command, Department of the Navy

1. SCOPE

1.1 Scope - The equipment covered by this specification shall, by means of inertial instruments, provide aircraft azimuth, attitude, velocity and position outputs.

1.2 Classification - The Inertial Navigation Set (INS) covered by this specification shall consist of the following items:

<u>Item</u>	<u>Type Designation</u>	<u>Applicable Paragraph</u>
Control, Navigation	C -7561/ASN-84	3.5.1
Control, Gyroscope Assembly	C -7560/ASN-84	3.5.2
Indicator, Position	ID-1542/ASN-84	3.5.3
Gyroscope Assembly	CN-1231/ASN-84	3.5.4
Computer, Navigation	CP- 924/ASN-84	3.5.5
Power Supply	PP-4964/ASN-84	3.5.6
Rack, Electrical Equipment	MT-3947/ASN-84	3.5.7

1.3 Associated Equipment - The equipment shall operate with the associated equipment listed in 6.8.

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2. APPLICABLE DOCUMENTS

2.1. General - The following documents of the issue in effect on the date of invitation for bids form a part of the specification to the extent specified herein.

Specifications

Military

MIL-W-5088	Wiring, Aircraft, Installation of
MIL-E-5400	Electronic Equipment, Aircraft, General Specification For
MIL-T-5422	Testing, Environmental, Aircraft Electronic Equipment
MIL-I-6181	Interference Control Requirements, Aircraft Equipment
MIL-C-6781	Control Panel: Aircraft Equipment, Rack or Console Mounted
MIL-P-7788	Plate, Plastic, Lighting
MIL-M-7793	Meter, Time Totalizing
MIL-E-17555	Electronic And Electrical Equipment and Associated Repair Parts, Preparation for Delivery of
MIL-T-18303	Test Procedures: Preproduction and Inspection, for Aircraft Electronic Equipment, Format for
MIL-N-18307	Nomenclature and Nameplates for Aeronautical Electronic and Associated Equipment
MIL-T-19576	Transmitter, Remote Compass Thin Wing Type ML-1 (Unstabilized.)
MIL-S-20708	Synchros, 60 and 400 cycles, General Specification for

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2.1 (Continued)

Specifications

Naval Air Systems Command

AR-5

Microelectronic Devices Used in
Avionics Equipment, Procedures for
Selection and Approval of

Standards

Military

MSI7322

Meter, Time Totalizing, Miniature
Digital, 115 volt 400 cycle

MS91403

Cases, Large Size (For Use with
Electronic Equipment in Aircraft)

MIL-STD-454

Standard General Requirements for
Electronic Equipment

MIL-STD-704

Electric Power, Aircraft, Character-
istics and Utilization of

MIL-STD-781

Reliability Tests, Exponential
Distribution

MIL-STD-794

Parts and Equipment, Procedures for
Packaging and Packing ofFederal

FED-STD-595

Colors

Other

ARINC 407

Synchro Standard Manual,

ARINC 407-1

Aeronautical Radio, Inc.

Publications

Naval Air Systems Command

EI-554

Avionics Installation Instructions
for Navigation Set, Inertial, AN/ASN-842.1.1 Availability of Documents

- (1) When requesting specifications, standards, drawings and publications refer to both title and number. Copies of this specification and applicable specifications required by contractors in connection with specific procurement functions may be obtained upon application to the Commanding Officer, Naval Supply Depot, Code 105,5801 Tabor Avenue, Philadelphia, Pennsylvania.

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3. REQUIREMENTS

3.1 Preproduction - This specification makes provision for preproduction testing.

3.2 Parts and Materials - In the selection of parts and materials fulfillment of major design objectives shall be the prime consideration. In so doing the following shall govern:

- (1) Microelectronic technology shall be considered and microelectronic items shall conform to the requirements specified herein.
- (2) Other parts and materials requirements shall conform to MIL-E-5400.
- (3) Non-repairable subassemblies, as outlined in MIL-E-5400, shall be used when practicable. The general size of the subassembly and the amount of circuitry to be included therein shall be approved by the procuring activity. Non-repairable subassemblies must be reliable (See 6.4).
- (4) When previously produced models of this equipment did not use non-repairable subassemblies, the design shall not be changed to employ non-repairable subassemblies without the approval of the procuring activity.

3.2.1 Nonstandard Parts and Materials Approval - Approval for the use of non-standard parts and materials (including electron tubes, transistors, and diodes) other than micro-electronic devices shall be obtained as outlined in MIL-E-5400. Microelectronic devices shall be approved as outlined in AR-5.

3.2.2 Microelectronic Module Assemblies - When used, micro-electronic modular assemblies shall meet the requirements of AR-5.

3.2.3 Modules, Maintenance - The electronic portions of the equipment shall be divided into maintenance modules. Maintenance modules shall normally be considered repairable.

3.3 Design and Construction - The equipment shall conform with all the applicable requirements of MIL-E-5400 for design, construction, and workmanship, except as otherwise specified herein.

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3.3.1 Total Weight - The total weight of this equipment excluding cables, shall be a minimum consistent with good design and shall not exceed 85.0 pounds.

3.3.2 Reliability -

3.3.2.1 Operational Stability - The equipment shall be designed to operate with satisfactory performance, continuously or intermittently for a period of at least 500 operating hours or 6 months whichever occurs first, without the necessity for readjustment of any controls which are inaccessible to the operator during normal use.

3.3.2.2 Operating Life - The equipment shall have a total operating life of 25,000 hours with reasonable servicing and replacement of parts. Parts requiring scheduled replacement shall be specified by the contractor.

3.3.2.3 Reliability in Mean Time Between Failure (MTBF) - the equipment shall have 750 hours of mean (operating) time between failures when tested and accepted as outlined under the requirements of 4.4.3.

3.3.2.4 Time Totalizing Meter - The equipment shall contain time totalizing meters in accordance with MIL-M-7793. Meters shall have a range of 9999 hours, and shall be included in the following units:

<u>Unit</u>	<u>Type of Meter</u>
Gyroscope Assembly	MS17322
Computer, Navigation	MS17322
Power Supply	MS17322

3.3.3 Cabling and Connections

3.3.3.1 Cables and Connectors - The equipment shall provide for the use of cables and connectors in accordance with MIL-E-5400.

3.3.3.2 Interconnection Cabling - The equipment shall be capable of satisfactory operation using external wiring in accordance with the applicable requirements of MIL-W-5088. The external wiring shall be unshielded, except that a minimum number of the individual wires may be shielded when demonstrated as necessary to meet interference control requirements and provided the assembly of the cable to its plugs may be easily accomplished. External cables and that portion of the connectors attached to the cables shall not be supplied as part of the equipment.

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3.3.3.2.1 External Wiring - External wiring shall be in accordance with EI-554.

3.3.4 Control Panels - All rack or console mounted control panels shall conform to the applicable requirements of MIL-C-6781 Type I except as specified herein.

3.3.4.1 Control Panel Front Panels - All control panel front panel details shall conform to MIL-C-6781 (Type I), MIL-P-7788 (Class-1) except as specified herein. The configuration of all panels must be approved by the procuring activity prior to pre-production testing.

3.3.4.1.1 Panel Front; Control, Gyroscope Assembly - In accordance with Figure 1.

3.3.4.1.2 Panel, Front: Control, Navigation - In accordance with Figure 2.

3.3.4.1.3 Panel, Front: Indicator, Position - In accordance with Figure 3.

3.3.5 Interchangeability - The equipment shall meet the interchangeability requirements specified in MIL-E-5400.

3.3.6 Interference Control - The generation of radio interference by the equipment and the vulnerability of the equipment to radio interference shall be controlled within the limits of MIL-I-6181. Short duration interference levels shall be in accordance with 3.3.2 of MIL-I-6181.

3.3.7 Maintainability - The equipment shall meet the maintainability requirements specified herein.

3.3.7.1 In Flight Maintenance - In flight maintenance shall not be a requirement for the equipment. However, the equipment shall provide both visual and electrical failure indications in the event of malfunction.

3.3.7.2 Flight Line Maintenance - The equipment shall be designed to permit corrective maintenance to be performed within a mean time of 30 minutes (MIN) for 95 percent of all detected system failures. Corrective maintenance shall consist of fault isolation to an individual unit (LRU), unit replacement, and equipment checkout. The 30 MIN shall not include equipment warm-up and alignment time. LRU malfunction displays shall be provided on the Control, Gyroscope Assembly. Flight line maintenance shall be accomplished in a Self Test submode.

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3.3.7.2.1 Definition of Line Replaceable Units (LRU) - The LRU'S shall be defined as follows:

Gyroscope Assembly
 Computer, Navigation
 Power Supply
 Indicator, Position
 Control, Navigation
 Control, Gyroscope Assembly
 Battery

3.3.7.2.2 Flight Line, Maintenance - Additional Capability - The Power Supply and Computer, Navigation shall contain external test connectors which when coupled with standard test equipment can be used to identify and isolate malfunctioning modules or groups of modules while mounted in the aircraft. Access doors on the Power Supply and Computer, Navigation shall be provided to permit rapid removal and replacement of selected modules or groups of modules without the removal of the equipment from its mounted position. Where possible, the capability shall be provided for in-aircraft fault isolation to the module level of each unit, module replacement and equipment checkout within a maximum elapsed time of 90 MIN. The Power Supply shall, in addition, have exposed test points to facilitate unit checkout.

3.3.7.3 Removable Cam Compensator - The equipment shall be designed to permit removal and replacement of the magnetic heading cam compensator from the Control, Gyroscope Assembly when installed in the aircraft.

3.3.7.4 Control Panel Covers - All control panels shall have quick disconnect removable covers to facilitate unit repair.

3.3.7.5 Intermediate Maintenance - The equipment shall be such that shop repair actions can be accomplished to include module removal and repair to the component level.

3.3.8 Nomenclature and Nameplates - Nomenclature assignment and nameplate approval for equipment identification shall be in accordance with MIL-N-18307.

3.3.9 Standard Conditions - The following conditions shall be used to establish normal performance characteristics under standard conditions and for making laboratory bench tests.

Temperature:	Room ambient (25 ± 5 degrees Centigrade (DEG C))
Altitude:	Normal Ground
Vibrations	None
Humidity:	Room ambient up to 90 percent relative humidity

3.3.9 (Continued)

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Input Power Voltage: 115 \pm 1.0 volts (V); 400 \pm 5 hertz (Hz), 3 phase, Y connect

26^{+1.1}_{-1.4} V, 400 \pm 5 Hz, 1 phase
(Synchro excitation)

5 to 28V, 400 \pm 5 Hz, 1 phase
(variable) (Control Panel edge lighting voltage)

+27.5 \pm 0.5 V DC

+18 \pm 0.5 V DC (Advisory lamp excitation)

+27.5 \pm 0.5 V DC or +9 \pm 0.5 V DC
(Control, Navigation Advisory lamp excitation)

3.3.10 Service Conditions - The equipment shall operate satisfactory under any of the environmental service conditions or reasonable combination of these conditions as specified MIL-E-5400, Class 1, except as modified herein;

3.3.10.1 Vibration - The equipment shall operate satisfactorily when subjected to the vibration requirements of Curves I and II of MIL-E-5400. Maximum vibration for the Power Supply and Navigation Computer shall be 5G.

3.3.10.2 Temperature - The equipment shall operate satisfactorily when subjected to the continuous temperature requirements of MIL-E-5400 for Class 1 equipment except as specified herein. Degraded performance shall be permitted for ambient temperatures in excess of 46.1 DEG C. Minimum operating temperature for the Position Indicator shall be limited to -25 DEG C.

3.3.10.3 Cooling Air - Circulating cabin air with maximum temperature of +55 DEG C be available for cooling the equipment specified herein.

3.3.11 Alignment Time - The time required to warmup and align prior to operation shall not exceed the values tabulated below.

<u>Mode</u>	<u>Temperature Range (T)</u>	<u>Time</u>
Inertial -*Ground Align	T > -18 DEG C	20 MIN
Inertial -*Damping On (Inflight Align)	-54 DEG C < T \leq -18 DEG C	30 MIN
Slave	T \geq -54 DEG C	3.5 MIN
Free	T \geq -54 DEG C	3.5 MIN

*For latitudes below \pm 75 DEG

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3.3.12 Primary Input Power Requirements - The equipment shall meet all applicable requirements of MIL-STD-704 and shall give specified performance from the following power sources with characteristics as defined in MIL-STD-704 having limits as specified therein. The power required shall not exceed the specified amounts.

- (1) AC Power (three phase); 115\200V, 400 Hz, Category B, 660 voltamperes (VA) operating
- (2) AC power (three phase); 115/200V, 400 Hz, Category B, 1000 VA heater power (maximum), phase (load) balance shall be within 400 VA
- (3) AC Power (single phase); $26\frac{+1}{-1.4}$ V, 400 Hz, 27 volt amperes synchro power (maximum)
- (4) DC Power, 28 V, Category B; 2 amperes (maximum)
- (5) DC Power, 18 V, Category B, 1.2 ampere (maximum) advisory lamp excitation for Control, Gyroscope Assembly and Indicator, Position
- (6) AC Power, 5 to 28 V variable, (Single Phase) Category A, 400 Hz for control panel edge lighting; 25 VA (maximum)
- (7) DC Power, 28 V DC, Category B, 0.2 ampere (maximum) for press to test lamp excitation function
- (8) DC power, 28 V DC or 9 V DC (for annunciator and advisory lamps on the Control, Navigation), Category B, 0.2 ampere for 28 V DC, 0.1 ampere for 9 V-DC

3.3.12.1 Degraded Performance - The system shall be capable of operation under the influence of AC transients as defined in MIL-STD-704 for Category B equipment. It shall be capable of operation under the influence of DC voltage transients as defined on Figure 6 of MIL-STD-704. The equipment shall contain a battery which shall maintain operation of the equipment within the limits specified herein for periods of abnormal aircraft electrical system operation or power interruptions of up to 10 SEC in duration. Operation during this period shall be limited to those functions specified herein (see 3.4.1.3). For power interruptions, as defined by MIL-STD-704, in excess of 10 SEC, the equipment shall receive from external sources a power off signal which shall be used within the equipment to initiate an automatic shutoff procedure.

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3.3.13 Standby Provisions - The equipment shall provide for a standby position whereby rated voltage will be applied to the Gyroscope Assembly heaters, equipment synchro transmitters, and Power Supply 'battery trickle charge circuitry as in all other modes. Only during standby operation shall the Self Test Submode be operable.

3.4 Performance - Unless otherwise specified, values set forth to establish the requirements for satisfactory performance apply to performance under both standard and extreme service conditions (3.3.10). When reduced performance under the extreme service conditions is acceptable, tolerances or values setting forth acceptable variations from the performance under the standard conditions will be specified. The equipment described herein shall provide the specified accuracies of all areas of the earth, for flight durations up to 12 hours.

3.4.1 Operation - The INS shall be capable of the following.

3.4.1.1 General - The equipment shall operate as an inertial navigator providing present position in terms of geographic latitude and longitude, velocity, heading, and attitude data to external equipment and shall be capable of performing a self contained ground alignment function. With the availability of external Doppler radar, the equipment shall be capable of operating as a Doppler-damped inertial navigator with the capability of airborne (inflight) alignment operation. The INS shall additionally operate as an attitude a-rid heading reference providing either magnetic heading or grid heading information. An unstabilized magnetic heading mode shall be provided. Built in test circuitry and computer subroutines shall be included to determine equipment malfunction. The equipment shall contain provision for manual position fixes during operation and shall contain a magnetic deviation compensation function.

3.4.1.2 Modes of Operation - The modes of operation shall be controlled by the Control, Navigation for safety of flight precautions. All modes selected at the Control, Navigation shall be displayed at the Control, Gyroscope Assembly. The modes shall be:

- (1) Inertial Mode
- (2) Slave Mode
- (3) Free Mode
- (4) Compass Mode
- (5) Standby Mode

3.4.1.2.1 Standby Mode - In the Standby Mode of operation rated aircraft voltage to the following shall be provided as in all other operational modes.

- (1) Gyroscope Assembly Heaters
- (2) Power Supply Battery Trickle Charge Circuitry
- (3) Synchro Transmitters

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3.4.1.2.1 (Continued)

Note

During the Standby Mode, and only during the Standby Mode, the Self Test Submode shall be initiated.

3.4.1.2.2 Inertial Mode - The Inertial Mode shall be the primary mode of operation of the equipment. In this mode the equipment shall operate as an unaided inertial navigator or as a Doppler velocity aided inertial navigator depending upon the submode of operation selected and the availability of external Doppler reference velocity. Acceleration data obtained from the Gyroscope Assembly shall be used to compute heading, velocity and present position to provide the earth referenced output signals as listed in Table I. The Inertial Mode shall have 3 submodes: Ground Alingment, Navigation, and Doppler Damping On.

3.4.1.2.3 Slave Mode - During this mode, the equipment shall operate as a pendulous attitude and heading system. Equipment heading shall be slaved to the external ML-1 magnetic heading after compensation for magnetic anomolies. The degree of synchronism of the equipment heading output shall be indicated on the Control, Navigation. Output functions provided in this mode appear in Table I. Earth's rate correction signals shall be supplied using the latitude control on the Control, Navigation to assist in maintaining attitude and heading performance. When external Doppler radar velocity is present, it shall also be utilized in the maintaining of the attitude and heading performance. Automatic erection cutoff techniques shall be employed to limit attitude degradation due to aircraft maneuvers. Self contained initial alignment processes shall be included to permit operation within 3.5 MIN after startup.

3.4.1.2.4 Free Mode - During this mode, the equipment shall operate as a pendulous attitude and heading system. Heading shall be settable to an initial datum using the Grid Slew control on the Control, Navigation. Earth's rate correction to the heading output shall be provided using the Latitude control on the Control, Navigation. When external Doppler radar velocity is present, it shall be utilized in the maintaining of the attitude performance. Automatic erection cutoff techniques shall be employed to limit attitude degradation due to aircraft maneuvers. Output functions shall be listed in Table I. Self contained initial alignment processes shall be included to permit operation within 3.5 MIN after startup.

3.4.1.2.5 Compass Mode - An unstabilized Magnetic Heading Mode shall be Provided in the event of either Gyroscope Assembly or Computer, Navigation failure. Magnetic heading-slaving rate shall be approximately 300 DEG/MIN. Table I delineates the output functions that shall be provided in the Compass Mode.

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3.4.1.2.6 Mode Changing - The equipment shall be designed to provide the following capabilities for changing modes of operation.

- (1) The equipment shall contain no manual provisions for shutting the equipment off.
- (2) The Self Test Submode shall only be operable in the Standby Mode.
- (3) The equipment shall be designed to inhibit inadvertent return to Standby Mode after operating in any of the other modes.
- (4) The equipment shall be capable of switching to any mode after operation in another mode without the loss of attitude data (except Compass and Standby).

3.4.1.2.7 Submodes - The equipment shall contain the submodes detailed herein. Submode selection shall be controlled at the Control, Gyroscope Assembly.

- (1) Ground Alignment Submode - The Ground Alignment Submode shall be provided for the Inertial Mode to automatically perform those operations necessary to align the accelerometer axes of the Gyroscope Assembly to the proper orientation with respect to local vertical and True North. Visual indications of the operation of this mode shall be made at both the Control, Navigation and the Control, Gyroscope Assembly. Upon completion of this operation the equipment shall maintain its ground alignment operation until the Navigate or Damping On Submode is selected. During the Ground Alignment Submode calculations of velocity and present position shall not be made.
- (2) Damping On Submode - The Damping On Submode shall be provided for equipment operation in the Inertial Mode and shall provide the following:
 - (a) Inflight Alignment - The equipment shall be capable of automatically performing those operations necessary to align the accelerometer axes of the Gyroscope Assembly to the proper orientation with respect to local vertical and True North during flight through the use of Doppler radar velocity input data in this submode.
 - (b) Doppler - Damped Inertial Navigation Operation - The equipment shall be capable of operating as a Doppler damped inertial navigator using a Doppler radar as a precision velocity reference. Output functions shall be the same as the Navigation Submode with the addition of a Damping On output signal.

3.4.1.2.7 (Continued)

Notes

- (1) This submode depends upon the availability of external Doppler radar signals which shall be used as a velocity reference.
 - (2) Equipment mechanization shall automatically determine if an inflight alignment or Doppler-damped inertial navigation operation shall be performed.
 - (3) Doppler-damped inertial navigation operation shall automatically succeed the inflight alignment operation.
 - (4) During Doppler-damped inertial navigation operation, a failure of the external Doppler radar shall " automatically result in the equipment switching to the unaided inertial navigation operation.
- (3) Navigation Submode - In the Navigation Submode of the Inertial Mode, the equipment shall compute aircraft present position, velocity, heading and attitude as described in 3.4.1.2.2.
 - (4) Self Test Submode - The Self Test Submode shall provide an automatic pre-flight test of critical portions of the equipment. This submode shall be designed to be operable only in the Standby Mode. During this Submode, the equipment shall be activated and shall automatically perform prescribed tests in a specified sequence. If the test is unsuccessful (failure) the equipment shall provide a visual display of the faulty component(s). The Self Test Submode design shall be such as to permit termination at any time to permit selection of the operational modes of Inertial, Slave, Free or Compass.

2.4.1.2.8 Position Fixing - The equipment shall be capable of performing a manual position fix operation in the Inertial Mode which shall be used to update computed present latitude and longitude. Operations shall be performed using the Indicator, Position and shall be as follows:

- (1) Freeze latitude and longitude displays on Indicator, Position (manual operation)
- (2) Allow manual insertion of new position coordinates.

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3.4.1.2.8 (Continued)

- (3) Compute accrued incremental distance in latitude and longitude from time of step (1).
- (4) Generate corrected present position data by adding new inserted coordinates plus accrued distances.

3.4.1.3 Operation During Power Interruptions - The equipment shall contain an internal, battery which shall permit the equipment to operate and perform within its specifications for aircraft power interruptions of up to 10 seconds in duration. Battery capability shall be in accordance with 3.5.6.5.

3.4.1.3.1 Operations - The following is a list of those functions that shall be maintained and operative during the interrupt period.

- (1) Battery in Use Indication - A visual indication of the power interruption condition and subsequent operation on the equipment battery shall be provided.
- (2) Alignment Operation - The alignment operation in the Inertial, Slave and Free Mode, except during the first 60 SEC of operation, shall continue uninfluenced by power interruptions. If the Power interruption occurs during these first 60 SEC, the equipment shall repeat those operations as required after the end of the power interrupt period. The equipment shall be maintained in an attitude-heading reference mode during inflight alignment when power interruptions occur.
- (3) System Failure Detection Circuitry - System failure detection circuitry shall be maintained operative during the power interruption period.
- (4) Slave and Free Mode - The Gyroscope Assembly shall be maintained as a stabilized inertial reference providing acceleration, heading and attitude references. Synchro output signals shall not be provided.
- (5) Inertial Mode - Navigate and Damp-On Submodes - The equipment shall continue to compute aircraft velocity components (V_{NS} and V_{EW}) and aircraft present position (latitude/longitude). In addition a digital output of last computed true heading shall be provided. In the Damp-On Submode, the equipment shall automatically revert to un-aided inertial navigation operation during power interruption periods.

3.4.1.3.2 Non-Operation - By virtue of the fact that the aircraft provides the excitation for the following, these functions/ outputs shall not be required during the power interrupt period but shall return to normal values and conditions after the reappearance of the aircraft power.

- (1) Synchro Transmitter Output (Energized by Aircraft 26V, 400 Hz)

Roll CX No. 1 True Heading CX

Roll CX No. 2 Magnetic Heading CX

Pitch CX No. 1 Magnetic Variation CX

Pitch CX No. 2 Grid Heading CX

Clutched Heading CX

- (2) Control Panel Edge Lighting

- (3) Control Panel Advisory Lamps - All advisory lamps need not be provided except the following on the Control, Gyroscope Assembly.

System Fail

Battery in Use

Align

Test Submode

- (4) Magnetic, True Heading and Magnetic Variation Servos - All heading servos need not be operative during power interruptions but shall automatically realign to their respective references upon the reappearance of aircraft power.

3.4.2 Accuracy.

3.4. 2.1 Present Latitude and Longitude - Present latitude and longitude readings shall be used to calculate radial position error. In the pure inertial mode the maximum radial error shall not exceed 5.4 nautical miles per hour of flight (1. 5 nautical miles per hour CEP).

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3.4. 2.2 Digital True Heading - Digital true heading output error shall not exceed 0.2 degrees initial error, plus 0.02 degrees per hour maximum long term drift error.

3.4.2.3 True Heading (Synchro) -

- (1) Inertial Mode - The true heading static output accuracy shall not deviate from the digital true heading output by more than ± 14 arc MIN. Dynamic accuracy of the true heading synchro output shall not exceed ± 17 arc MIN from the value of the digital true heading output.
- (2) Slave Mode - The true heading synchro output shall not exceed the accuracy of the magnetic heading output signal by more than ± 10 arc MIN with magnetic variation set to its proper value.

3.4.2.4 Stabilized Magnetic Heading (Synchro) - The magnetic heading output signal error excluding flux valve errors, but after deviation compensation, shall not exceed ± 30 arc MIN for static conditions.

3.4.2.5 Grid Heading (Synchro) - The drift error rate of the grid heading output shall not exceed 0.1 DEG/hour maximum with the Backup Latitude control on the Control, Navigation set to the local latitude.

3.4.2.6 Magnetic Variation (Synchro) - The magnetic variation output signal error shall not exceed ± 42 arc MIN (static condition).

3.4.2.7 Clutched Heading (Synchro) - The clutched heading output signal error for steady state conditions shall not exceed the digital true heading output by more than ± 30 arc MIN. Synchro return centering error and clutch engagement errors each shall not exceed ± 3 arc MIN.

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3.4.2.8 Roll and Pitch Attitude Accuracy (Synchro) - The initial alignment output errors for each pitch and roll output synchro shall not exceed the values listed in Table II.

3.4.3 System Interface - The equipment shall be compatible with the following inputs and outputs from associated equipment and operators.

3.4.3.1 Manual Inputs - The INS shall have the following manual inputs as specified in 3.5.

Mode Selection

Power Initiation

Grid Slew

Back-up Latitude Control

Magnetic Variation Control

Submode Selection

Self Test Initiation

Latitude and Longitude Insertion and Update

3.4.3.2 Electrical Inputs -

3.4.3.2.1 Doppler Interface - The equipment shall accept incremental Doppler velocity data inputs in pulse train format in accordance with the following characteristics.

(1) Along Heading Velocity (V_H) -

(a) Scale factor: 30 pulses per second (PPS)/knot

(b) Maximum Pulse Rate: 18,000 PPS at 600 knots

(c) This channel shall be one line representing positive velocity.

(2) Across Heading Velocity (V_D) -

(a) Scale Factor: 85 PPS/knot

(b) Maximum Pulse Rate: 17,000 PPS at 200 knots

(c) This channel shall be two lines, one representing a positive (rightward) and the other a negative velocity.

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3.4.3.2.1 (Continued)

(3) Pulse Train Characteristics/Interface Capabilities-

(a) Pulse Amplitude:

Logic 1: 0 \pm 0.5 VDCLogic 0: +4 \pm 1.0 VDC(b) Pulse Width: +5 $\begin{smallmatrix} +5 \\ -0 \end{smallmatrix}$. . . microseconds
(μ SEC)

(c) Minimum Spacing Between Pulses

Signal Line: 40 μ SECDual Line: 45 μ SEC between successive
positive and negative pulses.(d) Rise and Fall Time: 1 μ SEC maximum(4) Doppler Available Discrete -

(a) Logic

Doppler Good: Logic 1: 0 \pm 0.5 VDCDoppler Not Good: Logic 0: +4 \pm 1 VDC(5) Doppler Signal Input/Output Circuit Characteristics - In accordance with Figure 4.

3.4.3.2.2 Magnetic Azimuth Detector (ML-1) Interface - ML-1 signal electrical characteristics shall be in accordance with MIL-T-19576.

3.4.3.2.3 Altimeter Interface - The equipment shall accept parallel data from the Altimeter (type AAU21) under Computer, Navigation program control in accordance with the following requirements:

(1) Range - The altimeter output shall indicate an altitude range of -1000 to +38,000 feet.

(2) Code - Standard ICOA Altitude Telemetry code shall be used, A binary 1 shall be represented by a continuity, a binary 0 by an open circuit.

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3.4.3 .2.3 (Continued)

- (3) Resolution - The altimeter output is defined by altitude in 100 foot increments in 10 bit, 11 lead outputs (one common). Seven bits (D4, A1, A2, A4, B1, B2, B4) in a reflected Gray code are used to encode 500 foot increments from -1000 to +38,000 feet, the additional bits (C1, C2, C4) provide in conjunction with the 500 foot increments the encoding of 100 foot increments. The code represents the transition through zero feet altitude in the following manner:

Altimeter Code Designation

<u>Altitude (Feet)</u>	<u>D4</u>	<u>A1</u>	<u>A2</u>	<u>A4</u>	<u>B1</u>	<u>B2</u>	<u>B4</u>	<u>C1</u>	<u>C2</u>	<u>C4</u>
-100	0	0	0	0	0	1	1	0	1	1
- 50	(transition)									
0	0	0	0	0	0	1	1	0	1	0
+ 50	(transition)									
+100	0	0	0	0	0	1	1	1	1	0

- (4) Current Limitations - The maximum current drawn shall be 3.5 milliamperes (MA)\bit.
- (5) Voltage - The signal voltage placed on the altimeter is -15V applied to the common altimeter output lead. This signal shall be supplied by the equipment specified herein.
- (6) Altimeter Characteristics - The altimeter load equivalent circuit shall consist of the series circuit of a blocking diode (1V drop), 1000 ohm resistor plus encoder switch.
- (7) Input\Output Circuit Characteristics - In accordance with Figure 5.
- (8). Altimeter Operate Switch Discrete -
- (a) Logic:
- (i) Continuity (altimeter operative)
- (ii) Open Circuitry (inoperative)
- (b) Signal Characteristics:, See 3.4.3.2.3(4). through 3.4.3.2.3(7).

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3.4.3.2.3 (Continued)

- (9) Dual Equipment Interface - The interface between the equipment and the altimeter shall be designed to permit operation when either 1 or 2 identical ASN-84 equipments are connected in parallel to the altimeter.

-3.4.3.2.4 Power On Signal - The equipment shall receive an external Power On signal of aircraft DC ground potential and current rating of 0.5 ampere. Absence of this signal, open circuit condition, shall be supplied to shut off the equipment and shall be provided when aircraft power interruption exceeds 10 SEC in duration.

3.4.3.3 Displays - The INS shall have the following visual outputs as specified in 3.5.

Magnetic Synchronization Indicator

On Lamp

Align indicators

2 MIN to GO indicator

Test Mode Indicators

System Fail indicators

Mode indicators

LRU Fail indicators

Doppler Available indicator

Damping ON indicator

Battery in Use indicator

Present Latitude and Longitude

Present Position Insertion and Update indicators

3.4.3.4 Electrical Outputs -

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3.4.3.4.1 ~~Definition of Increasing Positive Angles and Functions~~ -
Definitions of increasing positive angles and functions shall be in accordance with ARINC 407-1 and shall be as follows:

(1) ~~Definition of Zero Reference Position~~ -

- (a) Roll: 180 DEG with respect to the horizon
- (b) Pitch: 180 DEG with respect to the horizon
- (c) Heading: 0 DEG with respect to North (magnetic or true).
- (d) Magnetic Variation: 0 DEG when magnetic heading equals true heading.

(2) ~~Definition of Positive Increasing Functions/Angles~~ -

- (a) Roll: Right side down (viewed from aft)
- (b) Pitch: Fore side up
- (c) Heading: Right turn
- (d) Magnetic Variation: Easterly direction
- (e) Velocity: Increasing North or East directions
- (f) Doppler Velocities:
 - Increasing velocity in Fore direction
 - Increasing rightward (viewed from aft) velocity.
- (g) Altitude: Increasing altitude above sea level.

(3) ~~Magnetic Variation~~ - Magnetic variation shall be defined by the following equation.

True Heading = Magnetic Heading + Magnetic Variation

3.4.3.4.2 Synchro Outputs - Equipment synchro output transmitters shall be in accordance with MIL-S-20708 and shall be electrically zeroed and phased in accordance with the requirements of ARINC 407 and ARINC 407-1 except as specified herein.

Note

All sychros, unless otherwise noted, shall be energized in parallel from the aircraft 26V, single phase, 400 Hz source.

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3. 4.3.4.3 Clutched Synchro Output -

- (1) Synchro - Kearfott CM09609005 or equivalent
- (2) Scale Factor - One DEG of synchro angle per 1 DEG of heading angle.
- (3) Clutch Rotational Bridge - ± 60 DEG; spring returned to 0 DEG after de-energization.
- (4) Function versus Operational Mode -

<u>Mode</u>	<u>Function</u>
Inertial	Clutched True Heading
Slave	Clutched Stabilized Magnetic Heading
Free	Clutched, Non-Slewable Grid Heading
Compass	Do Not Use

(5) Electrical Characteristics -

- (a) Clutch Excitation (externally provided) :
 Range: $+28 \begin{smallmatrix} +2.5 \\ -6.0 \end{smallmatrix}$ V DC
 Input Current: 0.22 ampere, maximum
- (b) Synchro Excitation (externally provided).
 Excitation: 26V, single phase, 400 Hz
 Input Current: 0.10 ampere, maximum
- (c) Output Characteristics
 Source Impedance (Z_{SS}): $14.2 + j3$ ohms (nominal)
 Electrical Scale Factor: 175 MV/DEG ± 10 percent
 Phase Shift Lead: 30 ± 3 DEG
 Null Voltage: 25 MV
- (d) Load: one 5000 ohm resistor across output connections Y, Z.
- (e) Electrical Zero: Represent zero heading angle at the time of clutch engagement.

3.4.3.4.4 Central Data Processor Interface - The equipment shall provide V_N/S and V_E/W in 14 bit serial and true heading in 15 bit serial data to an external Central Data Processor in accordance with the following requirements in the Navigate and Damp On submodes of the Inertial Mode. Velocity data ($V_N/S; V_E/W$) shall be ground speed referenced.

3.4.3.4.4 (Continued)

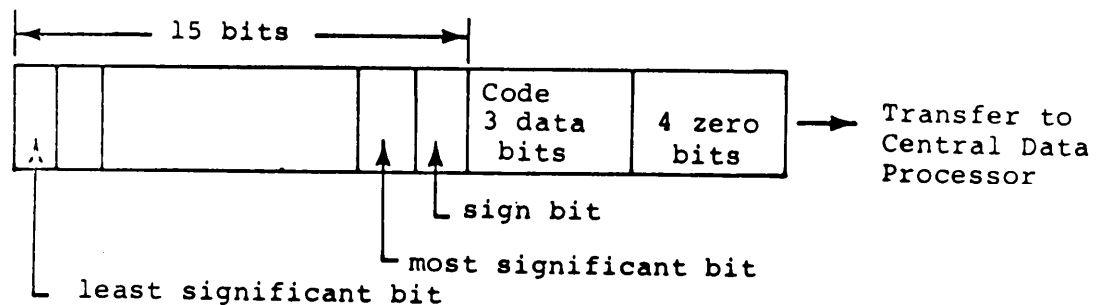
- (1) A fixed count of 22 shift clock pulses shall be generated by an external computer at a rate of 250 KHz.
- (2) Sampling of a particular data word shall take 100 μ SEC or less and shall not occur more often than once every 30 milliseconds (MS) in response to the external computer select signals, however, all three words can be called immediately after each other or dispersed throughout the 30 MS period.
- (3) All data shall be transmitted on one data line (twisted pair).
- (4) Three select gates shall be provided (one for each computer signal). The three select gates shall be initiated non-simultaneously. Each select gate will stay in the logic 1 state until the 22 bits have been clocked out. Upon completion of receipt of the output signal the select gate signal shall be removed.
- (5) The form of the transmitted words shall be: the first 4 bits are logic 0, the next 3 bits are identifier bits (001 for V_N , 010 for V_E and 100 for true heading) and the last 15 of the 22 pulses are data bits.
- (6) Data and control signals shall be logic 1: $0 \pm 0.5V$, and logic 0: $+4 \pm 1V$
- (7) Clock pulses of square wave shape and +4V amplitude shall be supplied by the external data processor within a time period of 2 to 8 μ SEC after the transmission of the enter signal by the equipment [3.4.3.4.4.(10)1.
- (8) Leading edge is defined as negative going slope from +4 to 0 V.
- (9) Each new data bit shall be available on the data shift line within 1 μ SEC after the leading edge of the clock pulse.

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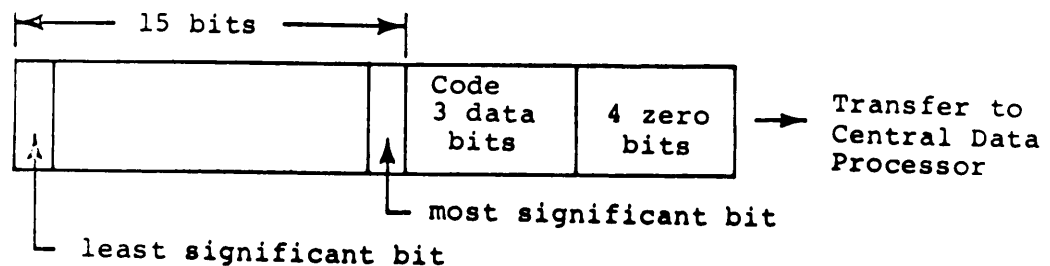
3.4.3.4.4 (Continued)

- (10) The enter signal from the equipment to the external computer must acknowledge acceptance of the select signal (go from logic 0 to logic 1) within 7 μ SEC after the leading edge of the select signal.
- (11) Enter signal must return to logic 0 (+4V) within 3 μ SEC after lagging edge of select signal.
- (12) All control lines shall be a two pin connection to a pair of twisted wires.
- (13) All interface characteristics shall be as shown in Figure 4.
- (14) The output serial data format shall be:

Velocity (VNS and VEW)



True Heading



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3.4.3.4.4 (Continued)

- (15) Velocity Sign Bit -
 - (a) 1 represents (-) negative velocity:
South or West
 - (b) 0 represents (+) positive velocity:
North or East
- (16) Most Significant Bit (MSB) Scaling -
 - (a) Velocity: = 540.10664 FT\SEC
 - (b) Heading: = 180 DEG
- (17) All negative numbers are in two's complement. Negative numbers represent South or West velocities.
- (18) Velocity Update Rate - 5 times/SEC
- (19) True Heading Update Rate - 20 times\SEC

3.4.3.4.5 Attitude/Unavailable Relay -

- (1) open contacts at the Control, Gyroscope Assembly due to:
 - System Failure
 - System in Alignment Process
 - System in Standby or Compass Mode
 - System is Off
 - Navigation Computer program has stopped
 - All other times, circuit is closed.
- (2) Maximum current rating: 1 ampere (resistive)at 28V DC
- (3) Contact closure not influenced by power interrupts of less than 10 SEC.

3.4.3.4.6 Inertial Mode Relay -

- (1) Closed contacts at Control, Gyroscope Assembly when INS is in the Inertial Mode. In all other modes, circuit is open.

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3.4.3.4.6 (Continued)

- (2) Current rating: 1 ampere (resistive) at 28 VDC.
- (3) During power interruptions, open circuit condition shall exist.

3.4.3.4.7 Doppler Dumping Relay -

- (1) Closed contacts at Control, Gyroscope Assembly whenever the equipment is utilizing Doppler radar velocity data for damping in the Damping On submode in the Inertial Mode.
- (2) Current rating: 1 ampere resistive at 28 VDC.
- (3) During power interruptions, open circuit condition shall exist.

3.4.3.4.8 Synchro Outputs - The equipment shall provide synchro output signals for the following functions:

Roll Attitude (2)

Pitch Attitude (2)

Magnetic Heading

True Heading

Magnetic Variation

Grid Heading

Note

The characteristics of the output synchro transmitters shall be in accordance with Table III.

3.4.3.4.9 ML-1 Excitation - Excitation for the ML-1 shall be provided by the equipment.

- (1) Excitation: 23.5V \pm 2* percent, single phase, 400 Hz, 1.5 VA.

*Based upon 26V, 400 Hz input to the equipment.

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3.5 Detailed Requirements.

3.5.1 Control, Navigation C7561\ASN-84 - The Control, Navigation unit shall meet the following requirements.

3.5.1.1 Function - The Control, Navigation shall contain all the controls and indicators which are necessary to permit the operator to have complete control over the modes of operation of the INS as described herein.

3.5.1.2 Form Factor - Form factor of the equipment shall conform to EI-554. Maximum envelope dimensions shall be 3.86 inches by 5.75 inches by 3 inches.

3.5.1.3 Weight - The weight of the Control, Navigation shall not exceed 1.55 pounds.

3.5.1.4 Contents of Unit - The Control, Navigation shall contain the following major subassemblies:

<u>Quantity</u>	<u>Nomenclature</u>
4	Backup Latitude Thumbwheel Switches
1	Backup Latitude Register Electronics
1	Mode Selector Switch
1	Grid Heading Slew Switch
1	Synchronization DC Meter
1	Push to Start Switch
1	Panel, Front
4	Indicator lamps (ON, SYSTEM FAIL, ALIGN, TEST)
3	Lamp Driver Electronic Circuits

3.5.1.5 Adjustment Controls - All adjustment controls shall be accessible from the front of the Control, Navigation. The following control functions shall be available on the front panel (see Figure 2).

3.5.1.5.1 Mode Selector Switch - The Mode Selector shall be a 5 position detented switch which shall be used to select the modes of operation (Standby, Inertial, Slave, Free, Compass) of the equipment. Switch design shall be such as to mechanically inhibit an inadvertent selection of Standby after operation in Inertial, Slave, Free or Compass modes.

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3.5.1.5.2 Power Pushbutton Switch - The Power pushbutton switch shall be used to start equipment operation in any of the Mode Selector positions listed in 3.5.1.5.1.

3.5.1.5.3 Latitude Backup Thumbwheel Switches - Latitude data shall be manually entered through four thumbwheel switches in the Slave and Free Modes. The latitude data shall consist of numeric data up to 90 DEG (in DEG, and tenth's of DEG) and alpha North or South (N or S) position.

3.5.1.5.4 Grid Slew Switch - A spring return, 5 position switch shall be provided for the slewing of the grid heading output to a desired datum in the Free Mode. Switch controls shall be for both clockwise and counterclockwise fast and slow slew operations. Spring return shall be to the zero center position.

3.5.1.6 Displays - The Control, Navigation shall have the following displays as shown in Figure 2.

3.5.1.6.1 MAG SYNC Indicator - The Magnetic Synchronization indicator shall be a dc microammeter which shall indicate the degree of synchronization of the equipment magnetic heading output during the Inertial, Slave and Compass Modes with the ML-1 input signal.

3.5.1.6.2 ON Lamp - An On lamp shall be provided to inform the operator that the equipment is operational and that the Power pushbutton has been operated.

3.5.1.6.3 SYSTEM FAIL Lamp - The System Fail lamp shall visually warn the operator that the equipment has failed. This shall be generated in the equipment's Computer, Navigation and shall be a 4V DC control signal.

3.5.1.6.4 ALIGN Lamp - A visual indication shall be provided to inform the operator that the equipment is in its alignment cycle during any of the operational modes described in 3.5.1.5.1. This signal shall be generated in the Computer, Navigation and shall be a 4V DC control signal.

3.5.1.6.5 TEST Lamp - A visual indication shall be provided to inform the operator that the equipment is in its Self Test submode. This signal shall be generated in the Computer, Navigation and shall be a 4V DC control signal.

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3.5.1.7 Electrical Connectors - Electrical connectors. shall be:

<u>Designation</u>	<u>Type</u>	<u>Function</u>
6J1	MS3114-H-22-55PZ	Cable to: Aircraft

3.5.1.8 Edge Lighting - Edge lighting shall be supplied to the Control, Navigation from external sources. Edge lighting shall be 5 to 28V, variable, 400 Hz, single phase.

3.5.1.9 Advisory Lamp Excitation - All advisory lamps shall be energized by a +28V DC or +9V DC aircraft power source.

3.5.1.10 Lamp Check Function - The Control, Navigation shall contain diode isolated circuitry to check all advisory lamps, when the equipment is operating, upon application of an external +28V DC test signal.

3.5.1.11 Color - The Control, Navigation including shell, front panel, and controls, shall be lusterless black No. 37038 of FED-STD-595.

3.5.1.12 Control, Navigation Mounting - The Control, Navigation, shall be a console mounted unit in accordance with the requirements of MIL-C-6781.

3.5.1.13 Control, Navigation Latitude Data Interface - Upon receipt of a 10 KHz serial clock signal from the Computer, Navigation, the Control, Navigation shall transfer a 13 bit serial binary data word dependent upon the setting of the back-up latitude thumbwheel switch positions. Each data word shall consist of three 4 bit characters and one 1 bit character. Bit position 13 shall identify North or South (N or S) position. A logic 1 in bit position 13 shall indicate a South setting. The data word shall present least significant bit first with the three 4 bit characters representing 10 arc MIN, DEG and 10 DEG intervals respectively in binary form.

3.5.2 Control, Gyroscope Assembly C7560\ASN-84 - The Control, Gyroscope Assembly unit shall meet the following requirements.

3.5.2.1 Function - The Control, Gyroscope Assembly shall contain the indicators necessary to inform the operator at all times of mode of operation, alignment status, ilure status and indication. The Control, Gyroscope Assembly shall also contain the Self Test Submode initiate control and the Submode control (for the Inertial Mode). The Control, Gyroscope Assembly shall be the INS heading computer providing analog signals of true heading, compensated magnetic heading, slewed grid heading, magnetic variation, and clutched heading. Built-in test circuitry (BITE) shall be incorporated into the Control, Gyroscope Assembly for the determination of unit malfunction. Manual insertion of magnetic variation for the generation of coarse true heading shall be provided.

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3.5.2.2 Form Factor - Form factor of the equipment shall conform to EI-554. Maximum envelope dimensions shall be 6.5 inches by 5.75 inches by 5.625 inches.

3.5.2.3 Weight - The weight of the Control, Gyroscope Assembly shall not exceed 7.50 pounds.

3.5.2.4 Contents of Unit - The Control, Gyroscope Assembly shall contain the following major subassemblies.

<u>Quantity</u>	<u>Nomenclature</u>
1	Magnetic Variation Counter and Control
1	Submode Selector Switch
1	Self Test Pushbutton Switch
7	Mode Indicator Lamps
5	LRU Failure Lamps
5	Status Lamps
1	800 Hertz Module
1	True Heading and Magnetic Heading Servo
1	Lamp Driver and Motor Logic Module
1	Relay Driver and Detection Module
1	Torquer Control
1	Magnetic Heading Pre-Amplifier
9	Relay Drivers
7	Lamp Drivers
1	Panel, Front

3.5.2.5 Adjustment Controls - All adjustments shall be accessible from the front of the Control, Gyroscope Assembly. The following control functions shall be available on the control panel. (see Figure 1).

3.5.2.5.1 Submode Selector Switch - A detented Submode Selector switch shall be provided which shall be used to select one of the following submodes of the Inertial Mode.

3.5.2.5.1 (Continued)

Ground Alignment

Navigate

Damping On

3.5.2.5.2 Self Test Pushbutton Switch - The Self Test pushbutton switch provided shall be used to initiate the equipment's self test submode when the Mode Selector switch on the Control, Navigation is in the Standby Mode. Circuitry shall be included within the equipment to inhibit self test operation when the Control, Navigation Mode Selector is in a position other than Standby. The Self Test switch shall initiate circuitry and Computer, Navigation programs required to determine INS GO/NO-GO status and isolation of failure to malfunctioning LRU.

3.5.2.5.3 Magnetic Variation Counter and Control - The Magnetic Variation Counter provided shall be manually set by the Magnetic Variation knob. Information shall be numeric data with a range of 180 DEG from East 90 DEG through 0 DEG to West 90 DEG readable in increments of 0.1 DEG. The function of the magnetic variation counter in each of the operational modes is as follows:

<u>Mode</u>	<u>Function</u>
Standby	Not required
Inertial	Used for initial coarse true heading control of Gyroscope Assembly.
Slave	Generation of coarse true heading, True Heading = Manually Inserted Magnetic Variation plus Stabilized Magnetic Heading"
Free	Not required
Compass	Generation of coarse true heading, True Heading = Manually Inserted Magnetic Variation plus Unstabilized Magnetic Heading

3.5.2.5.4 Magnetic Deviation Compensator - The magnetic heading deviation compensator provided to compensate magnetic heading output signals for magnetic anomalies shall be accessible from the front of the Control, Gyroscope Assembly after removal of the front access plate. The Compensator/Control, Gyroscope Assembly design shall permit removal of the compensator from the unit and insertion of the compensator within a replacement unit to permit utilization without requiring readjustment. Characteristics of the compensator shall be as follows:

3.5.2.5.4 (Continued)

<u>Description</u>	<u>Criteria</u>
Maximum compensation	± 3.5 DEG
Maximum Limit in Compensation between Compensation Increments	± 0.75 DEG
Compensation Increments	24 point, 15 DEG increments

3.5.2.6 Displays - The Control, Gyroscope Assembly shall contain the following front panel displays as shown in Figure 1.

3.5.2.6.1 Mode Lamps - The Control, Gyroscope Assembly shall contain 7 mode indicator lamps to visually inform the operator of equipment operating mode.

- (1) INERTIAL Lamp - This 1 lamp shall indicate that the Inertial Mode of operation is selected at the Control, Navigation. The lamp shall be energized by an 18V DC signal from the Control, Navigation. In parallel with the excitation of this lamp shall be the inertial mode relay (see 3.4.3.4.6).
- (2) SLAVE Lamp - This lamp shall indicate that the Slave Mode of operation is selected at the Control, Navigation. The lamp shall be energized by an 18V DC signal from the Control, Navigation,
- (3) FREE Lamp - This lamp shall indicate that the Free Mode of operation is selected at the Control, Navigation. The lamp shall be energized by an 18V DC signal from the Control, Navigation.
- (4) COMP Lamp - This lamp shall indicate that the Compass Mode of operation is selected at the Control, Navigation. The lamp shall be energized by an 18V DC signal from the Control, Navigation.
- (5) TEST Lamp - This lamp shall indicate that the equipment is operating in the Self Test Sub-mode. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.

3.5.2.6.1 (Continued)

- (6) DAMP ON Lamp - This lamp shall indicate that the equipment is utilizing the external Doppler velocity data for damping in the Inertial Mode. In parallel with the excitation of this lamp shall be the damping on relay (see 3.4.3.4.7). The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.
- (7) STBY Lamp - This lamp shall indicate that the Standby mode of operation is selected at the Control, Navigation. The lamp shall be energized by an 18V DC signal from the Control, Navigation.

3.5.2.6.2 LRU Failure Lamps - The Control, Gyroscope Assembly shall contain 5 LRU Failure lamps to visually inform the operator of malfunctioning LRU'S in the Self Test Submode.

- (1) GYRO ASSY Lamp - The Gyroscope Assembly fail lamp shall indicate failure of this unit. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.
- (2) CMPTR Lamp - The Computer, Navigation fail lamp shall indicate failure of this unit. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.
- (3) CONT GYRO Lamp - The Control, Gyroscope Assembly fail lamp shall indicate failure of this unit. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.
- (4) POWER SUPPLY Lamp - The Power Supply fail lamp shall indicate the failure of this unit. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.
- (5) BTRY Lamp - The Battery fail lamp shall indicate failure of this unit. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.

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3.5.2.6.3 Status Lamps - The Control, Gyroscope Assembly shall contain 5 status lamps to visually indicate equipment status the operator.

- (1) SYSTEM FAIL Lamp - The System Fail lamp shall indicate INS failure. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.
- (2) ALIGN lamp - The Align lamp shall indicate the equipment is in its Alignment Submode for each of the operating modes of Inertial, Slave, Free and Compass. Extinguishment of the lamp shall be equivalent to the alignment complete function. The lamp shall be energized by a 4V control signal from the Computer, Navigation.
- (3) 2 MIN TO GO Lamp - The 2 Minutes To Go lamp shall indicate that the Alignment Submode will be completed in approximately 2 MIN of time. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.
- (4) BTRY IN USE Lamp - The Battery In Use lamp shall indicate when the equipment is operating on its internal battery. The lamp shall be energized by a 4V DC control signal from the Power Supply.
- (5) DOPP AVAIL Lamp - The Doppler Available lamp shall indicate that the equipment has received a Doppler available signal from the external Doppler radar. The lamp shall be energized by a 4V DC control signal from the Computer, Navigation.

3.5.2.7 True Heading and Magnetic Heading Servo Mechanism - The servo mechanism shall receive inertial heading information from the Computer, Navigation and unstabilized magnetic heading from the external ML-1 remote compass transmitter plus manual control signals of magnetic variation and grid slew to generate the analog output signals specified in 3.4.3.4.3 and 3.4.3.4.8. Magnetic deviation compensation specified in 3.5.2.5.4 shall be included.

3.5.2.8 Electrical Connectors - The electrical connectors shall be:

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3.5.2.8 (Continued)

<u>Designation</u>	<u>Type</u>	<u>Function</u>
3J1	MS3112-E-24-61PX	Cable to Aircraft
3J2	MS3112-E-24-61PY	Cable to Computer, Navigation.

3.5.2.9 Edge Lighting - Edge lighting shall be supplied to the Control, Gyroscope Assembly from external sources. Edge lighting shall be 5 to 28V, variable, 400 Hz, single phase.

3.5.2.10 Advisory Lamp Excitation - All advisory lamps shall be energized with +18 V DC, however, the TEST, SYSTEM FAIL< ALIGN and BTRY IN USE lamps shall be energized by a +28V DC non-power interrupt supply generated within the Power Supply Unit.

3.5.2.11 Lamp Check Function - The Control, Gyroscope Assembly shall contain diode isolated clrcultry, to check all advisory lamps when the equipment is operating upon application of an external +28V DC test signal.

3.5.2.12 Control, Gyroscope Assembly Color - The Control, Gyroscope Assembly iincluding shell, front panel and controls shall be lusterles gray No. 36231 as specified in FED-STD-595.

3.5.2.13 Control, Gyroscope Assembly Mounting - Mounting shall be in accordance with MIL-C-6181.

3.5.3 Indicator, Position ID-1542/ASN-84 - The Indicator, Position shall meet the followlng requirements.

3.5.3.1 Function - The Indicator, Position shall be used to display and manually update computer present position data for the INS. It shall also be used to insert auxiliary data into the Computer, Navigation, as required.

3.5.3.2 Form Factor - Form factor of the equipment shall conform to EI-554. Maximum envelope dimensions shall be 5.78 inches by 5.75 inches by 6.0 inches,

3.5.3.3 Weight - The weight of the Indicator, Position shall not exceed 4.85 pounds.

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3.5.3.4 Contents of Unit - The Indicator, Position shall contain the following major subassemblies

<u>Quantity</u>	<u>Nomenclature</u>
1	Longitude Driver Card
1	
1	Control and Register Logic Card
1	Pushbutton and Keyboard Logic Card
1	Panel, Front
1	Digital Indicator Assembly
4	Indicator Lamps
15	Pushbutton Switches

3.5.3.5 Adjustment Controls - All adjustments shall be accessible from the front of the Indicator, Position. The following control functions shall be available on the control panel (see Figure 3)

3.5.3.5.1 LAT SET Pushbutton and SET Advisory Lamp - The LAT SET pushbutton shall be used when it is desired to manually change the latitude display on the Indicator, Position. Illumination of the associated SET lamp shall indicate Computer, Navigation acceptance of the command from the LAT SET pushbutton. This operation shall not result in correction to the data in the Computer, Navigation but only an update of the displayed data.

3.5.3.5.2 LON SET Pushbutton and SET Advisory Lamp - The LON SET pushbutton shall be used to manually change the longitude display on the Indicator, Position. Illumination of the associated associated SET lamp shall indicate Computer, Navigation acceptance of the command from the LON SET pushbutton. This operation shall not result in correction to the data in the Computer, Navigation but only an update of the displayed data.

3.5.3.5.3 ENTER Pushbutton and ENT Advisory Lamp - The ENTER pushbutton switch shall be used to correct data (latitude and/or longitude) within the Computer, Navigation to the data displayed on the Indicator, Position latitude and longitude displays. Illumination of the associated ENTER advisory lamp shall indicate Computer, Navigation readiness to accept the correction command from the ENTER pushbutton switch.

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3.5.3.5.4 FIX/CANCEL Pushbutton and F/C Advisory Lamp - The FIX/CANCEL pushbutton switch shall be used to accomplish a manual delayed position fix within INS. Operation of the switch shall result in the freezing of the Indicator, Position latitude-longitude displays and the calculation of incremental position changes from the time of FIX start. The updating of the present position coordinates to the sum of the incremental distance plus newly inserted position coordinates at the time of FIX initiation shall be accomplished upon the use of the ENTER pushbutton. Depression of the FIX/CANCEL pushbutton a second time shall be used to cancel a started position update (fix) operation. The FIX/CANCEL advisory lamp shall indicate Computer, Navigation acceptance of the FIX command and that position fix operation is in process.

3.5.3. 5.5 CLEAR Pushbutton - The CLEAR pushbutton switch shall be used to clear the latitude or longitude displays and is operative after the LAT SET or LON SET switches are operated. This switch shall be used to erase displayed data so that new data may be inserted using the 10 digit keyboard.

3.5.3.5.6 Keyboard Pushbuttons - Latitude and Longitude data shall be manually inserted into the Computer, Navigation for computations and displays on the Indicator, Position through a keyboard consisting of 10 momentary pushbutton switches. The keyboard pushbuttons shall indicate numeric data from 0 to 9 and alpha data of N, S, E and W.

3.5.3.6 Latitude/Longitude Display - Latitude and longitude data shall be displayed using electromagnetic display devices. The latitude display shall consist of numeric data up to 90 DEG (in DEG, arc MIN, and tenths of arc MIN) and alpha North or South (N or S) direction. The longitude display shall consist of numeric data up to 180 DEG (in DEG, arc MIN, and tenth's of arc MIN) and alpha East or West (E or W) direction. The Indicator, Position shall be capable of receiving and displaying updated data from the Computer, Navigation at the rate of approximately once per 2 SEC. The Latitude/Longitude display need not be operative during the Slave, Free and Compass Modes of operation.

3.5.3.7 Indicator, Position and Computer, Navigation Interface - The Indicator, Position shall contain the circuitry necessary to receive display data from the Computer, Navigation and transmit data to the computer, Navigation with the following format.

3.5.3. 7.1 Latitude Data for Display - The Computer, Navigation shall supply 2 data words, each of 20 bit length comprising of four 5 bit characters in serial format with least significant bit first.

3.5.3.7.2 Longitude Data for Display - The Computer, Navigation shall supply 2 data words, each of 20 bit length comprising of four 5 bit characters in serial format with least significant bit first.

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3.5.3.7.3 Data to Computer, Navigation - Alpha-numeric data shall be transferred to the Computer, Navigation serially in one 20 bit data word which contains the punched in keyboard data.

3.5.3.8 Electrical Connectors - The electrical connector shall be:

<u>Designation</u>	<u>Type</u>	<u>Function</u>
5J1	MS3114-H-22-55PW	Cable to Aircraft

3.5.3.9 Edge Lighting - Edge lighting shall be supplied to the Indicator, Position from external sources. Edge lighting shall be 5 to 28V, variable, 400 Hz, single phase.

3.5.3.10 Advisory Lamp Excitation - All advisory lamps shall be energized with +18 V DC.

3.5.3.11 Lamp Check Functions - The Indicator, Position shall contain diode isolated circuitry to test all advisory lamps, when the equipment is operating upon application of an external +28V DC test signal.

3.5.3.12 Color - The Indicator, Position unit including case and front panel shall be lusterless gray No. 36231 as specified in FED-STD-595.

3.5.3.13 Indicator, Position Mounting - The Indicator, Position shall be a console mounted unit in accordance with the requirements of MIL-C-6781.

3.5.4 Gyroscope Assembly CN-1231/ASN-84 - The Gyroscope Assembly shall meet the following requirements.

3.5.4.1 Function - The Gyroscope Assembly shall furnish unambiguous signals of roll, pitch and azimuth, and signals from orthogonally mounted accelerometer axes. During alignment operation the Gyroscope Assembly shall provide a means for establishing a reference orientation with respect to true North and the local vertical. During the operational modes, orientation shall be maintained by means of the Gyroscope Assembly's own inertial properties and its gyro torquing capabilities. The Gyroscope Assembly shall have internal relays which shall make it capable of switching its mode of operation and built in test circuitry (BITE) which shall be used to determine unit malfunction.

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3.5.4.2 Form Factor - Form factor of the equipment shall conform to EI-554. Maximum envelope dimensions shall be 14.125 inches by 9.60 inches by 10.4 inches.

3.5.4.3 Weight - The weight of the Gyroscope Assembly shall not exceed 19.9 pounds.

3.5.4.4 Sealing - The Gyroscope Assembly inertial platform shall be hermetically sealed and filled with an inert gas.

3.5.4.5 Contents of Unit - The Gyroscope Assembly shall contain the following major subassemblies:

3.5.4.5.1 Inner Cluster, containing:

- (1) Two axis non-floated, 2 DEG-of-freedom gyros (2 required)
- (2) One two axis accelerometer including pre-amplifiers
- (3) Temperature sensor with resistor
- (4) Redundant axis capture electronics channel
- (5) Gyro torquer electronics (3 channels)
- (6) Gyro pickoff pre-amplifiers (4 required)
- (7) Accelerometer capture amplifiers (2 required)
- (8) Thermostats and heaters (as required)

3.5.4.5.2 Components mounted on the azimuth axis between the inner cluster and the pitch gimbal.

- (1) Azimuth gimbal DC torquer motor
- (2) Gyro signal coordinate resolver
- (3) Two speed resolver transmitter (8:1 ratio)
- (4) Slip rings

3.5.4.5.3 Components mounted on pitch axis between the pitch and roll gimbals.

- (1) Pitch gimbal DC torquer motor
- (2) Synchro transmitters (2 required)
- (3) Slip rings

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3.5.4.5.4 Components mounted on the roll axis between the roll gimbal and the fixed gimbal.

- (1) Roll gimbal DC torquer motor
- (2) Synchro transmitters (2 required)
- (3) Slip rings

3.5.4.5.5 Components mounted to the fixed gimbal.

- (1) Temperature Control electronics
- (2) Compensation and trim circuitry (as required)

3.5.4.5.6 Components mounted between the fixed gimbal and outer case.

- (1) Vibration isolators
- (2) Cables

3.5.4.5.7 Components Mounted on the Outer Case - Electronic Assembly containing:

- (1) Gimbal isolation loop circuits (3 required)
- (2) Gimbal caging loop circuits (3 required)
- (3) Gyro pulse torquing logic circuitry (3 channels)
- (4) Gyro wheel supply
- (5) 19.2 KHz clock
- (6) Accelerometer analog to pulse train converters (2 required)
- (7) Switching circuits and associated logic
- (8) DC power supply
- (9) Built in test equipment (BITE) circuitry
- (10) Elapsed time indicator
- (11) Vertical erection electronics (2 channels)

3.5.4.6 Interchangeability - Gyros and accelerometers shall be replaceable without major disassembly of the gimbal structure. The slip rings shall be united with the synchros or torquers or both to form an easily replaced assembly. The Gyroscope Assembly shall be such that it can be removed from its mount and replaced with another unit without making any alignment measurements.

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3.5.4.7 Use of Trim Potentiometers - The use of trim potentiometers shall be held to a minimum to reduce weight and improve reliability. Use of the Computer, Navigation and Indicator, Position shall be made for the purpose of insertion of factory or depot calibration data. The Gyroscope Assembly shall provide an identification number as an output signal to the Computer, Navigation. Circuitry and computer program shall be used to verify that proper data is inserted into the Computer, Navigation.

3.5.4.8 Electrical Connectors - The electrical connectors shall be:

<u>Designation</u>	<u>Type</u>	<u>Function</u>
1J1	M81511/01E16-55P1	Cable to Aircraft
1J2	M81511/01E16-55P2	Cable to Aircraft
1J3	M81511/01E16-55P3	Cable to Power Supply

3.5.4.9 Cooling - The Gyroscope Assembly shall receive forced cooling air with flow rate of 15 cubic FT/MIN with temperature between -54 and +55 DEG C from the Rack, Electrical Equipment.

3.5.4.10 Color - The Gyroscope Assembly shall be lusterless gray No. 36231 as specified in FED-STD-595.

3.5.4.11 Gyroscope Assembly Environmental Limitations - The Gyroscope Assembly shall operate within accuracies consistent with the requirements of 3.4.2 for ambients between -54 and +46 DEG C. Degraded performance shall be permitted for ambient temperatures between +46 to +55 DEG C. Performance of 6 NM/HR shall be permitted for vibration inputs in excess of 2.5G for the frequency range of 30 to 70 Hz and 14 NM/HR for vibration inputs in excess of 5G for the frequency range of 200 to 500 Hz shall be permitted.

3.5.4.12 Gyroscope Assembly Mounting - Gyroscope Assembly mounting shall be mounted on to the Rack, Electrical Equipment as specified in EI-554.

3.5.4.13 Gyroscope Assembly Interface - Major Gyroscope Assembly interfaces shall be in accordance with the following requirements.

3.5.4.13.1 Control Signals - The Gyroscope Assembly shall receive all mode, submode and sequence control signals from the Computer, Navigation in the form of 4V DC control signals.

3.5.4.13.2 Incremental Velocity Signals - The Gyroscope Assembly shall provide incremental velocity signals, ΔV_x and ΔV_y in the form of separate plus and minus pulse trains for each velocity coordinate. Interface characteristics shall be in accordance with 3.5.5.12.3(1).

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3.5.4.13.3 Gyro Torquing Signals - The Gyroscope Assembly shall accept gyroscope torquing signals in the form of digital logic signals from the Computer, Navigation. Characteristics shall be in accordance with 3.5.5.12.7.

3.5.4.13.4 Azimuth Resolver Signal - The Gyroscope Assembly shall supply multi-speed azimuth data in the form of a dual speed resolver with 8:1 ratio between fine and coarse outputs. These signals shall be provided to the Computer, Navigation for computation of true heading and the Control, Gyroscope Assembly for initial coarse alignment of the Gyroscope Assemblies azimuth gimbal to North. Characteristics are in accordance with 3.5.5.12.1.

3.5.4.13.5 Attitude Synchro Signals - The Gyroscope Assembly shall provide 2 isolated synchro output signals on both of its roll and pitch gimbals. Synchro requirements shall be in accordance with Table IV.

3.5.5 Computer, Navigation CP-924/ASN-84 - The Computer, Navigation shall meet the following requirements:

3.5.5.1 Function - The Computer, Navigation shall be a general purpose digital computer and shall be programmed to solve the navigation equations for inertial navigation, Doppler damped inertial navigation, Slave and Free attitude heading reference modes. The Computer, Navigation shall contain the program and switching output discretes to permit both ground and inflight operation and shall provide the control signals to maintain the Gyroscope Assembly as the stabilized inertial reference. Digital output signals to external central data processors shall be provided, reference 3.4.3.4.4. The Computer, Navigation shall contain built in test circuitry and program subroutines which shall determine computer GO or NO-GO conditions.

3.5.5.2 Form Factor - Form factor of the equipment shall conform to EI-554. Maximum envelope dimensions shall be 17.03 inches by 5.17 inches by 8.4 inches.

3.5.5.3 Weight - The weight of the Computer, Navigation shall not exceed 21.65 pounds.

3.5.5.4 Contents of Unit - The Computer, Navigation shall contain the following major assemblies.

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3.5.5.4 (Continued)

<u>Quantity</u>	<u>Nomenclature</u>
1	Mother Board
3	Analog to Digital Converter Cards
2	Digital to Analog Converter Cards
1	Memory Module Assembly
3	Interface Assembly Card
5	Input/Output Logic Cards
5	Arithmetic and Control Logic Cards
1	Elapsed Time Indicator

3.5.5.5 Computer Memory Characteristics -

- (1) The Computer, Navigation shall contain a plug-in memory module assembly. The Memory Module shall consist of magnetic storage cores plus associated electronics, organized to provide Read/Restore and Clear/Write modes of operation.
- (2) The memory cores shall be organized into words of 10 bits each. Instruction orders consist of one to four 5 bit bytes. Data shall be contained on two 10 bit memory words.
- (3) The Computer, Navigation memory core stack shall consist of core fields of 512 - 10 bit words each. one field shall contain 256 - 20 bit addressable data words which may be read or stored during operation. Another field shall contain 256 - 20 bit constants. data words which shall only be addressed in Read/Restore Mode. The other fields shall contain program instructions which shall only be addressed in the Read/Restore Mode.
- (4) The computer memory shall operate at 4 μ SEC cycle time with a 1 μ SEC access time. When the memory is accessed, 10 bits are read out in parallel. The usage of these bits is dependent upon whether they represent an instruction or data.

3.5.5.5 (Continued)

- (5) Memory capacity shall be sufficient to perform the calculations, control functions and interface operation required for the performance of the INS as specified herein.

3.5.5.6 Number System - The Computer, Navigation Number system shall be: fixed point, binary whole number.

3.5.5.7 Modes of Operation -

3.5.5.7.1 Read/Restore Mode - Binary digit information read out of core locations during the read cycle of this mode shall be re-written in the same core during the restore cycle.

3.5.5.7.2 Clear/Write Mode - Binary digit information read out of the core locations during the clear cycle of this mode shall be replaced by new data bits in these core locations during the write cycle. Only the Scratch Pad memory shall be capable of clear/write operation, to enable updated digital information to be entered into storage.

3.5.5.8 Arithmetic and Control - The Computer, Navigation shall contain arithmetic and control logic of a general purpose design, capable of performing the following functions:

- (1) Capable of performing 22 basic orders including double precision operations.
- (2) Controlling and addressing the core memory
- (3) Performing arithmetic operations, using binary whole number, two's complement operands of up to 19 bits plus sign bit.
- (4) The capability for both program interrupt and idle time memory usage. Program interrupt may be either real time program interrupt or external equipment interrupt.

3.5.5.9 Arithmetic and Control Timing - The Computer, Navigation master oscillator shall provide a 4 MC clock rate. Binary digit counting shall be performed by a bit counter, which shall have a 10 bit capacity and a 1 MC (1 bit/ μ SEC) clockrate.

3.5.5.9.1 Addition Time - 20 μ SEC maximum

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3.5.5.9.2 Average Multiply Time - 200 μ SEC maximum

3.5.5.10 Program Control Instruction Format - The arithmetic and control logic shall execute the Computer, Navigation program using 5 bit byte instructions. Instructions shall be 1, 2, 3, or 4 bytes in length.

3.5.5.11 Input/Output (I/O)- The I/O section shall handle pulse train inputs and outputs, discretes inputs and outputs, serial and parallel inputs and output channels in addition to controlling analog to digital (A/D) and digital to analog (D/A) conversions. The Computer, Navigation I/O shall consist of, including A/D and D/A conversion, only solid state components. All inputs and outputs shall be conditioned in the I/O section of the computer for processing with the Computer, Navigation or transfer to other equipments with the exception of the serial output data to the external central data processor. Data to the central data processor shall be shifted directly out of Computer, Navigation Memory.

3.5.5.11.1 A/D and D/A Converters - The A/D and D/A converters shall be asynchronous peripheral devices using the 26V, 400 Hz, single phase excitation as reference.

- (1) Resolver A/D conversion shall be accomplished in two phases, octant conversion phase and angle magnitude phase. The conversion register shall have 13 bits of data. The first 3 bits shall contain octant information and the remaining 10 bits shall contain a linear representation of tan or cot. The A/D converter shall contain 3 analog data input channels plus 2 test channels.
- (2) D/A Conversion - The D/A conversion shall output analog signals in the form of 3 wire synchro signals from a 13 bit D/A register with output data continuously available. The converter shall accept 10 bits of tan or cot information and 3 bits of octant information for conversion.
- (3) Conversion Rates -
 - (a) The conversion rate of each channel shall occur within three cycles of the 400 Hz excitation reference. The conversion time following a computer command shall not exceed 10 MS per input channel.

3.5.5.12 Interface - The Computer, Navigation shall provide for the following input and output signals:

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3.5.5.12.1 Dual Speed Resolver Input -

<u>Characteristics</u>	<u>Value</u>
Output Voltage	5 to 7V, 400 Hz (RMS)
Source Impedance	80 ohms (minimum)
Resolver Phase Shift	{ 8X: 25 DEG } with reference { 1x: 65 DEG } to 26V, 400 Hz excitation
Speed Ratio	8:1

3.5.5.12.2 DC Analog Voltage Input -

<u>Characteristics</u>	<u>Value</u>
Output Voltage	0 to 6.5 VDC
Source Impedance	200 ohms

3.5.5.12.3 Incremental Data Input - The Computer, Navigation shall have the capability of handling the maximum input pulse rates and ensuring that no data is lost during transfers and clearing of buffers. Buffer capacity to be compatible with the maximum pulse rate and the clearing of buffers every real time interrupt of 5 MS.

(1) Incremental Velocity Data from Gyroscope Assembly -

Number of Channels: 2

Number of Lines per Channel: 2 (1 for positive,
and 1 for negative)

Maximum Pulse Rate: 10,000 pulses per second (PPS)

Scale Factor: 1000 PPS/G (nominal)

Pulse Train Characteristics: See 3.4.3.2.1(3).

(2) Doppler Incremental Distance Traveled - See
3.4.3.2.1.

3.5.5.12.4 Serial Input Line - Control, Navigation latitude data (see 3.5.1.13) and Indicator, Position manually inserted latitude and longitude data (see 3.5.3.7).

3.5.5.12.5 Altimeter Parallel Data Input - See 3.4.3.2.3.

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3.5.5.12.6 Central Data Processor Interface - See 3.4.3.4.4.

3.5.5.12.7 Gyro Torquing Outputs Signals (GYPTO) to Gyroscope Assembly - Three channels of incremental pulse information shall be supplied to the 3 GYPTO's in the Gyroscope Assembly. Each channel shall have two separate lines; a positive and a negative command output. The command pulse rate for each channel shall be a fixed frequency of approximately 200 PPS. The stability of the pulses shall be maintained to 10 parts per million with a minimum pulse width of 5 μ SEC. Turn off commands shall appear on the Z channel only and shall be used to turn off all channels. Turn off commands shall appear coincidentally on both Z lines in order that they may be distinguished from the turn on pulses. Turn off pulses shall be generated 4500 μ SEC after the occurrence of turn on signals. The period of each turn on pulse shall be 5000 μ SEC.

3.5.5.12.8 Indicator, Position Latitude and Longitude Display Signals - See 3.5.3.7.

3.5.5.12.9 Heading Analog Output - The computer shall provide one analog signal equivalent to a nominal 11.8V, 400 Hz synchro output with electrical phasing in accordance with ARINC 407 and 407-1. This output signal shall be capable of driving one 500 ohm (Zso) control transformer in the Control, Gyroscope Assembly.

3.5.5.12.10 Input Discretes - The Computer, Navigation shall have provision to accept 26 input discretes, detectable under program control.

3.5.5.12.11 Output Discretes - The Computer, Navigation shall have provision to set and reset 32 discrete outputs under program control.

3.5.5.13 protection Circuitry - The Computer, Navigation shall incorporate circuitry as necessary to prevent destruction of the memory contents as a result of power shutdown or input DC power failure. Upon shutdown the control logic shall ensure completion of commands necessary to ensure that the computer will be ready for an orderly restart when the DC voltages are again applied to the computer. DC power shall be provided to the computer for 0.1 MS after it receives a power turn off signal.

3.5.5.14 Computer Binary Logic Signal Levels -

Logic 1 level: $+5_{-2.5}^{+0.1}$ V DC

Logic 0 level: $0_{-0}^{+0.5}$ V DC

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3.5.5.15 Electrical Connectors - The Computer, Navigation shall have the following connectors:

<u>Designation</u>	<u>Type</u>	<u>Function</u>
4J1	MS3122-22E-55PX	Cable to: Power Supply
4J2	MS3122-24E-61SZ	Cable to: Aircraft
4J3	MS3122-24E-61SN	Cable to: Control, Gyroscope Assembly
4J4	MS3122-24E-61PW	Cable to: Aircraft
4J5	MS3122-24E-55SY	Cable to: Aircraft
4J6	M81511/01E16-55S2	Test Connector
4J7	M81511/01E16-55S1	Test Connector

3.5.5.16 Color - The Computer, Navigation shall be lusterless gray 36231 as specified in FED-STD-595.

3.5.5.17 Mounting - Computer, Navigation mounting shall be in accordance with MS91403.

3.5.6 Power Supply PP-4964/ASN-84 - The Power Supply shall meet the following requirements.

3.5.6.1 Function - The Power Supply shall generate the regulated DC voltages required by the INS. It shall include a battery capable of maintaining critical equipment operation, as defined in 3.4.1.3 during temporary loss of aircraft power. The Power Supply shall also distribute aircraft 400 Hz power as required. BITE shall be provided as part of the Power Supply unit to determine its GO or NO-GO status. The battery shall be considered as a separate LRU.

3.5.6.2 Form Factor - Form factor of the equipment shall conform to EI-554. Maximum envelope dimensions shall be 15 inches by 11.5 inches by 7.625 inches,

3.5.6.3 Weight - The weight of the Power Supply shall not exceed 23.6 pounds.

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3.5.6.4 Contents of Unit - The Power Supply shall contain the following major subassemblies.

<u>Quantity</u>	<u>Nomenclature</u>
1	Input 3 Phase, 400 Hz Transformer
1	Single Phase, 400 Hz Transformer
1	Battery
1	Battery Switch Circuit
1	Three Transformer Inverter Unit
1	± 15 V DC- A Post Regulator
1	± 15.4 V DC - B Post Regulator
1	± 15 V DC- C Post Regulator
1	± 5.6 V DC - A Post Regulator
1	+ 5.6 V DC - B Post Regulator
1	± 26 V DC Post Regulator
1	+ 28 V DC - A Post Regulator
1	+28 V DC Regulator
as required	RFI Filters
1	BITE Circuitry
20	Exposed Test Points
as required	Relay and Logic Circuitry
1	Battery Trickle Charge Circuitry

3.5.6.5 Battery Requirements - The Power Supply shall contain a nickel cadmium battery which shall be used to provide output power in the event of aircraft 400 Hz power interruption or abnormal power transient condition. The battery shall be capable of delivering maximum power of a 10 SEC period for a minimum of 12 cycles each of 10 SEC duration with a 12 hour interval. An interval between power interruptions defining a cycle, shall be 45 MIN. The battery shall accept a trickle charge from the Power Supply.

3.5.6.5.1 Transfer Operation - The Power Supply shall sense the 115 V, 400 Hz, 3 phase input power and shall automatically switch to battery power. Circuitry shall be provided to insure that the DC output voltages remain within the limits required.

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3.5.6.5.2 Transfer Criteria - Transfer to battery power shall be accomplished when input power is interrupted or during the abnormal transient limits as defined in MIL-STD-704 which would cause the output DC supplies to exceed the limits specified.

3.5.6.5.3 Battery Charging Requirements -

- (1) During normal equipment useage the battery shall be under trickle charge from the Power Supply. Trickle charge levels shall be nominally 80 milliamperes (MA). Charge current levels shall be automatically controlled as a function of ambient temperature.
- (2) Initial battery charging requirements shall be as follows:

<u>Current (maximum)</u>	<u>Duration</u>
500 MA	15 MIN
250 MA	30 MIN

- (3) Battery recharging shall be accomplished prior to utilization after the following storage periods.

<u>Storage Temperature</u>	<u>Storage Period</u>
25 DEG C	90 days
50 DEG C	30 days

3.5.6.6 Cable Monitor - The Power Supply shall provide a cable monitor circuit such that system operation is inhibited unless all system interconnection cables provided within the aircraft are properly connected to the INS.

3.5.6.7 Power ON - Power Supply operation shall require the presence of both a +28 VDC start signal from the Control, Navigation and an external power on DC ground signal.

3.5.6.8 Power OFF - Upon the removal of the external Power ON ground potential signal, defined as the Power OFF condition, the Power Supply shall issue a shutdown discrete to the Computer, Navigation and switch to internal battery power. After 200 μ SEC of battery operation the Power Supply shall automatically shutdown.

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3.5.6.9 Battery in Use - The Power Supply shall provide a battery in use signal simultaneously to the Computer, Navigation and the Control, Gyroscope Assembly during periods when the supply is operating on its internal battery.

3.5.6.10 Battery Test - Battery testing shall not be performed as part of the inflight fault warning operation but shall only be performed during the Self Test Submode upon the command of the Computer, Navigation.

3.5.6.11 Battery Environmental Limitations - Battery operation shall be limited to the temperature range of -20 to +55 DEG C. Maximum storage temperature shall be 71 DEG C.

3.5.6.12 Electrical Connectors - The Power Supply shall have the following electrical connectors.

<u>Designation</u>	<u>Type</u>	<u>Function</u>
2J1	MS3112E-22-55SZ	Cable to: Gyroscope Assembly
2J2	MS3112E-22-55SN	Cable to: Computer, Navigation
2J3	MS3112E-22-55SX	Cable to: Aircraft
2J4	MS3112-E-18-32SN	Aircraft Power Input
2J5	M81511/01E16-55S1	Test Connector

3.5.6.13 Color - The Power Supply shall be lusterless gray color 36231 as specified in FED-STD-595.

3.5.6.14 Mounting - Power Supply Mounting shall be in accordance with MS91403.

3.5.7 Rack , Electrical Equipment MT-3947\ASN-84 - The Rack, Electrical Equipment shall meet the following requirements.

3.5.7.1 Function - The Rack, Electrical Equipment shall provide the mechanical interface between the Gyroscope Assembly and the airframe. It shall provide the capability of not requiring an optical realignment of the Gyroscope Assembly after a removal and replacement in the aircraft.

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3.5.7.2 Form Factor - Form factor of the equipment shall conform to EI-554. Maximum envelope dimensions shall be 9.8 inches by 7.0 inches by 10.28 inches.

3.5.7.3 Weight - The weight of the Rack, Electrical Equipment shall not exceed 6.4 pounds.

3.5.7.4 Contents of Unit - The Rack, Electrical Equipment shall contain the following major subassemblies.

<u>Quantity</u>	<u>Nomenclature</u>
1	Support Machining
1	Fan Assembly

3.5.7.5 Adjustments - The minimum range of adjustment of the Rack in pitch and shall be ± 2 DEG. The minimum range of adjustment in azimuth shall be ± 1.5 DEG. Adjustments shall be made between the Rack and the airframe and not between the Gyroscope Assembly and the Rack.

3.5.7.5.1 Resolution - The adjustment resolution of the Rack, Electrical Equipment shall be within ± 30 arc SEC in pitch, roll and azimuth,

3.5.7.6 Gyroscope Assembly Alignment - The Rack, Electrical Equipment shall establish alignment of the Gyroscope Assembly with respect to its own mounting and setting axes to within ± 1 arc MIN.

3.5.7.7 Fan Subassembly - The fan subassembly including fan, plenum chamber, connector, capacitor and thermostat shall be a separately removable subassembly from the unit. The fan shall supply 15 cubic FT/MIN air flow to the Gyroscope Assembly. Thermostatic control shall be provided to inhibit air flow for ambients below -1 DEG C.

3.5.7.8 Electrical Connectors - The Rack, Electrical Equipment shall contain the following connector.

<u>Designation</u>	<u>Type</u>	<u>Function</u>
7J1	MS3122E-10-6P	Cable to: Power Supply

3.5.7.9 Color - The Rack, Electrical Equipment shall be lusterless gray 36231 as specified in FED-STD-595.

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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.

4.1.1 Classification of Tests - Items covered by this specification shall be subjected to the following tests to determine compliance with all applicable requirements.

- (1) Preproduction Tests
- (2) Initial Production Tests
- (3) Acceptance Tests
- (4) Life Tests

4.2 Preproduction Tests - Preproduction tests shall be made on an equipment representative of the production equipments to be supplied under the contract. Preproduction tests shall be accomplished under the responsibility of the contractor and shall be conducted in accordance with the approved test procedure of 4.6. The government inspector and the procuring representative may be designated to witness the tests when so desired. Contractors not having adequate facilities to conduct all required tests shall obtain the services of a commercial testing laboratory acceptable to the Government.

4.2.1 Preproduction Test Data - The contractor shall submit all data collected in conducting these tests to the procuring agency for review and approval.

4.2.2 Scope of Tests - Preproduction tests shall include all tests deemed necessary by the procuring activity to determine that the equipment meets all the requirements of this specification and the contract. Preproduction tests shall include environmental tests in accordance with the procedures of MIL-T-5422 and interference tests in accordance with MIL-I-6181.

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4.2.3 Preproduction Approval - Approval of the preproduction sample shall be by the procuring activity upon satisfactory completion of all test. Unless otherwise specified no production equipments shall be delivered prior to the approval of the preproduction sample. Prefabrication of production equipment prior to the approval of the preproduction sample is at the contractor's own risk; unless specified otherwise by the contract. The approved preproduction sample shall be retained by the contractor for his use in the fabrication and testing of equipment to be, submitted for acceptance. The preproduction sample shall not be considered as one of the equipments under the contract.

4.2.4 Production Equipments - Equipments supplied under the contract shall in all respects, including design, construction, workmanship, performance and quality, be equivalent to the approved preproduction sample. Each equipment shall be capable of successfully passing the same tests as imposed on the preproduction sample. Evidence of non-compliance with the above shall constitute cause for rejection and for equipment already accepted by the Government, it shall be the obligation of the contractor to make necessary corrections as approved by the procuring activity.

4.3 Initial Production Tests - When requested by the procuring activity one of the first ten production equipments shall be delivered to a designated Government laboratory for tests. This equipment shall be selected by the procuring activity after the equipment has successfully passed all individual tests. The preproduction sample shall not be selected for this test.

4.3.1 Scope of Tests - This equipment may be subjected to any and all tests the procuring activity deems necessary to assure that the production equipment is equivalent to the previously approved preproduction sample in design, construction, workmanship, performance, and quality and that it meets all applicable requirements.

4.3.2 Accessory Material - In addition to the complete equipment submitted for Initial Production Tests the contractor shall also submit such accessory material and data necessary to operate the equipment.

4.3.3 Initial Production Sample Approval - Approval of the Initial Production Sample shall be by the procuring activity upon satisfactory completion of all tests. Any design, material, or performance defect made evident during this test shall be corrected by the contractor to the satisfaction of the procuring activity. Failure of the Initial Production Sample to pass any of the tests shall be cause for deliveries of equipment under the contract to cease until proper corrective action is approved and accomplished. Corrective action also be accomplished on equipment previously accepted when requested by the procuring activity.

4.3.4 Reconditioning of Initial Production Test Sample - On completion of the initial production test the equipment shall be reworked by the contractor by replacing all worn or damaged items. After reworking, the contractor shall resubmit the equipment for acceptance.

4.4 Acceptance Tests - The contractor shall furnish all samples and shall be responsible for accomplishing the acceptance tests. All inspection and testing shall be witnessed by the procuring activity if desired. Contractors not having testing facilities satisfactory to the procuring activity shall engage the service of a commercial testing laboratory acceptable to the procuring activity. The contractor shall furnish test reports showing quantitative results for all acceptance tests. Such reports shall be signed by an authorized representative of the contractor or laboratory, as applicable. Acceptance or approval of material during the course of manufacture shall not be construed as a guarantee of the acceptance of the finished product. Acceptance tests shall consist of the following:

- (1) Individual Tests
- (2) Sampling Tests
- (3) Reliability Assurance Tests
- (4) Special Tests

4.4.1 Individual Tests - Each equipment submitted for acceptance shall be subjected to the individual tests. These tests shall be adequate to determine compliance with the requirements of material, workmanship, operational adequacy and reliability. As a minimum, each equipment accepted shall have passed the following tests:

- (1) Examination of Product
- (2) Operational Test
- (3) Manufacturing Run in Test

4.4.1.1 Examination of Product - Each equipment shall be examined carefully to determine that the material and workmanship requirements have been met.

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4.4.1.2 Operational Test - Each equipment shall be operated long enough to permit the equipment temperature to stabilize and to check sufficient characteristics and record adequate data to assure satisfactory equipment operation.

4.4.1.3 Manufacturing Run in Test - Each equipment shall be operated under the conditions specified herein for a period of 10 hours without failure. A failure shall be defined as anything which causes malfunctioning of the equipment. Only those adjustments will be permitted-- which can be made by using such controls and adjustments that are accessible to the operator during the normal use of equipment.

Altitude	Normal Ground
Temperature	Ambient room
Humidity	Ambient room
Vibration	Any selected frequency within the range of 20 to 30 CPS (excluding resonant points) and a minimum amplitude of ± 3 G's

The equipment shall be vibrated (without vibration isolators) for a period of 10 MIN prior to the beginning of the 10 hour period of operation. Where feasible, the equipment shall be operated during this vibration period for the purpose of detecting flaws and imperfect workmanship. Operation within the specified limits of satisfactory performance is not necessarily required during the vibration period. The direction of vibration should be vertical to the normal mounting plane for 5 MIN and lateral to the plane for 5 MIN. Where it is not feasible to vibrate the equipment in 2 directions the vertical direction shall be used. During the 10 hour period of operation following the 10 MIN vibration period, the equipment shall be mechanically cycled periodically through its various phases of operation. Should a failure occur, it should be repaired and the test started over, except that the 10 MIN vibration period need not be repeated when it is certain the failure was not a result of the vibration. Should repetitive failures occur, corrective action shall be taken to eliminate this defect from future equipment. A record shall be kept of all failures. The 10 hour period specified above may be composed of two 5 hour periods to conform with standard working hours.

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4.4.2 Sampling Tests - Equipments selected for sampling test shall first have passed the individual tests. Equipments shall be selected for sampling tests by the government inspector in accordance with the following: (Sampling tests shall not be conducted unless Reliability Assurance Tests of 4.4.3 are deleted by contractual action).

<u>Quantity of Equipments Offered for Acceptance</u>	<u>Quantity to be Selected for Sampling Tests</u>
First 10	0*
Next 50	1
Next 75	1
Next 100	1
	1 for each additional 200 or fraction thereof

*Note: If by contract action the Initial Production Test (4.3) is deleted, then a Sample Test shall be conducted on one equipment from the first 10 produced.

4.4.2.1 Scope of Tests - As a minimum, each equipment selected for sampling tests shall be subjected to the following tests:

- (1) Complete operational test at ambient room conditions making all necessary measurements to assure that all applicable specification requirements have been met.
- (2) Operational test at certain environmental conditions. The conditions may vary for each equipment tested and should be based on results of the preproduction, initial production, individual and special tests.
- (3) Manufacturing run in test specified in 4.4.1.3 except that the test duration shall be 120 hours with no restriction on the number of failures. However, each failure shall be analyzed as to cause and remedial action necessary to reduce the possibility of its recurrence in future equipment.

4.4.3 Reliability Assurance Tests - Reliability Assurance Tests shall be conducted using MIL-STD-781, Tests as required by both the Qualification Phase and the Sampling Phase shall be conducted.

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4.4.3.1 Qualification Phase - Prior to the acceptance of equipments under the contract or order, a minimum of 3 equipments shall be tested as outlined in MIL-STD-781, under the section entitled "Qualification Phase of Production Reliability Tests." The maximum number of equipments to be used shall be those listed in Table 5 of MIL-STD-781. For the Qualification Phase, Test Levels E and A1 shall be used. The Accept-Reject Criteria for Test Plan IV shall be used.

4.4.3.2 Reliability Production Acceptance (Sampling) Phase Tests - The equipment, throughout production, shall be tested as outlined in MIL-STD-781 (as modified herein) under the section entitled "Production Acceptance (Sampling) Phase of Production Reliability Tests." Test Level E shall be used.

4.4.3.2.1 All Equipment Test - Each equipment produced except those submitted for the Reliability Qualification Test, shall be tested for 50 hours. Prior to the 50 hour test on each equipment, a burn-in period may be used at the option of the contractor. If the burn-in period is to be used the details thereof must be included in the approved test procedures. To determine whether the MTBF is being met at any time during the contract the operating test hours and the failures thereon (not counting burn-in failures or burn-in operating time) shall be totaled and the results compared with the reject line of Test Plan II of MIL-STD-781. (Extend the line as necessary to accommodate the data.) These totals shall accumulate so that at any one time the experience from the beginning of the contract is included. At the conclusion of the month the test results shall be sent to the procuring activity and to the Naval Air Systems Command, Attention:Avionics Division. At any time that the current totals of test hours and test failures plotted on Test Plan II curves show a reject situation, the procuring activity shall be notified. The procuring activity reserves the right to stop the acceptance of equipment at any time that a reject situation exists pending a review of the contractor's efforts to improve the equipment, the equipment parts, the equipment workmanship, etc., so that the entire compilation will show other than a reject decision.

4.4.3.3 Test Details - The test details such as the length of the test cycle, the length of the heat portion of the cycle, the performance characteristics to be measured, special failure criteria, preventive maintenance to be allowed during the test, etc., shall be part of the test procedures to be submitted and approved by the procuring activity prior to the beginning of the Qualification Test Phase of the Reliability Assurance Tests.

4.4.4 Special Tests - Special tests shall be conducted on a quantity of equipments for the purpose of checking the effect of any design or material change on the performance of the equipment and to assure adequate quality control. The equipment selected for special tests may be selected from equipments previously subjected to the sampling of reliability assurance tests.

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4.4.4.1 Special Test Schedule - Selection of equipments for special tests shall be made as follows:

- (1)- On an early equipment after an engineering or material change.
- (2) Whenever failure reports or other information indicate additional tests are required. (This will be determined by the procuring activity) .

4.4.4.2 Scope of Tests - Special tests shall consist of such tests as approved by the procuring activity. Test procedures previously approved for the preproduction tests shall be used where applicable. When not applicable, the contractor shall prepare a test procedure and submit it to the procuring activity for approval prior to conducting the tests.

4.4.5 Equipment Failure - Should a failure occur during either the sampling, reliability assurance or special tests, the following action shall be taken:

- (1) Determine the cause of failure
- (2) Determine if the failure is an isolated case or design defect.
- (3) Submit to the procuring activity for approval, proposed corrective action intended to reduce the possibility of the same failure(s) occurring in future tests.
- (4) Where practical, include a test in the individual test to check all equipment for this requirement until reasonable assurance is obtained that the defect has been satisfactorily corrected.

4.5 Life Test - The contractor shall furnish all samples and shall be responsible for accomplishing the life test. The test shall be of 300-hours duration and shall be conducted on equipments that have passed the individual test. The life test shall be performed under the conditions specified in 4.5.1. The life test sample shall be selected by the government inspector in accordance with the following. (Equipments which have successfully passed the Initial Production Test, Sampling Tests, Reliability Tests, or Special Tests may be selected for life tests). When reliability tests are conducted; the life test may be omitted if, during the reliability tests, a quantity of equipments equal to, or more than, that listed below receive at least 300 hours each of test time.

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4.5 (Continued)

<u>Quantity of Equipments Offered for Acceptance</u>	<u>Quantity to be Selected for Life Test</u>
First 25	1
Next 175	1
Next 300	1
	1 for each additional 500 or fraction thereof.

4.5.1 Test Conditions - The life test shall be conducted under the following simulated service conditions.

Temperature	Normal Room
Altitude	Normal ground (0 to 5000 FT)
Humidity	Room ambient
AC Voltage	115 \pm 5V
DC Voltage	27.5 \pm 2.0V

4.5.2 Test Periods - The test may be run continuously or intermittently. Any period of operation shall be of sufficient duration to permit the equipment temperature to stabilize. Periodically, the equipment shall be turned on and off several times and put through its various phases of operation.

4.5.3 Performance Check - At approximately 24 hour intervals during the test, a limited performance check shall be made. The performance check proposed by the contractor shall be subjected to approval by the procuring activity.

4.5.4 Test Data - The contractor shall keep the daily record of the performance of the equipment, making particular note of any deficiencies or failures. In the event of part failures, the defective part shall be replaced and the operation resumed for the balance of the test period. A record shall be kept of all failures throughout the test including all tube failures. This record shall indicate the following:

- (1) Part type number
- (2) The circuit reference symbol number

4.5.4 (Continued)

- (3) The part function
- (4) Name of the manufacturer
- (5) Nature of the failure
- (6) The number of hours which the part operated prior to failure

4.5.4.1 Failure Report - In the event of a failure, the procuring activity shall be notified. A report shall be submitted to the procuring activity upon completion of the test. In this report the contractor shall propose suitable and adequate design or material corrections for all failures which occurred. The procuring activity will review such proposals and determine whether they are acceptable.

4.5.5 Reconditioning of Life Test Samples - An equipment which has been subjected to the life test shall be reconditioned as follows:

- (1) On completion of the life test, the equipment shall be reworked by the contractor by replacing all "wear" items. The "wear" items shall be determined by agreement between the contractor and the procuring activity.
- (2) After reworking, the contractor shall resubmit the equipment for acceptance.

4.6 Test Procedures - The procedures used for conducting preproduction tests, acceptance tests and life tests shall be prepared by the contractor and submitted to the procuring activity for review and approval. The right is reserved by the procuring activity or the government inspector to modify the tests or require any additional tests deemed necessary to determine compliance with the requirements of this specification or the contract. MIL-T-18303 shall be used as a guide for preparation of test procedures. When approved test procedures are available from previous contracts such procedures will be provided and may be used when their use is approved by the procuring activity. However, the right is reserved by the procuring activity to require modification of such procedures, including additional tests, when deemed necessary.

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4.7 Reconditioning of Tested Equipment - Equipment which has been subjected to acceptance and life tests may be reconditioned by the contractor by replacing all worn or damaged items. After reworking the contractor shall resubmit the equipment for acceptance.

4.8 Presubmission Testing - No item, part or complete equipment shall be submitted by the contractor until it has been previously tested and inspected by the contractor and found to comply, to the best of his knowledge and belief, with all applicable requirements.

4.9 Rejection and Retest - Equipment which has been rejected may be reworked or have parts replaced to correct the defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the defects found in the original shall be furnished the government inspector.

5. PREPARATION FOR DELIVERY

5.1 General - All major units and parts of the equipment shall be preserved, packaged, packed and marked for the level of shipment specified in the contract or order in accordance with MIL-E-17555 and MIL-STD-794. In the event the equipment is not covered in Specification MIL-E-17555, the method of preservation for Level A shall be determined in accordance with the selection chart in Appendix D of MIL-STD-794.

6. NOTES

6.1 Intended Use - The INS is intended for use in aircraft to provide continuous present position, velocity, attitude and heading information.

6.2 Ordering Data - Purchasers should exercise any desired options offered herein, and Procurement documents should specify the following:

- (1) Title, number, and date of this specification.
- (2) Selection of applicable levels of packaging and packing (see 5.1).

6.3 Precedence of Documents - When the requirements of the contract, this specification, or applicable subsidiary specifications are in conflict, the following precedence shall apply:

- (1) Contract - The contract shall have Precedence over any specification.
- (2) This Specification - This specification shall have precedence over all applicable subsidiary specifications. Any deviation from this specification, or from subsidiary specifications where applicable, shall be specifically approved in writing by the procuring activity.
- (3) Referenced Specifications - Any referenced specification shall have precedence over all applicable subsidiary specifications referenced therein. All referenced specifications shall apply to the extent specified.

6.4 Performance Objectives - Minimum size and weight, simplicity of operation, ease of maintenance, and an improvement in the performance and reliability of the specific functions beyond the requirements of this specification are objectives which shall be considered in the production of this equipment. Where it appears a substantial reduction in size and weight or improvement in simplicity of design, performance, ease of maintenance or reliability will result from the use of materials, parts and processes other than those specified in MIL-E-5400, it is desired their use be investigated. When investigation shows advantages can be realized, a request for approval shall be submitted to the procuring activity for consideration. Each request shall be accompanied by complete supporting information.

6.5 Non-Repairable Subassemblies - As a general rule non-repairable subassemblies should be encapsulated or hermetically sealed. The number of connections internal to the subassembly should be held to a minimum. Detail parts tolerances and ratings should be so selected that the life of the subassembly is greater than that of a similar repairable one, with few exceptions (such as high voltage power supplies) the non-repairable subassembly should evidence a mean-time-to-failure greater than 5,000 hours, and for many applications this figure must be nearer 50,000 hours.

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6.6 Type Designations - The parentheses (*) when used in the type designation, will be deleted or replaced by either a number or letter furnished by the procuring activity upon application by the contractor for assignment of nomenclature in accordance with 3.3.8. The complete type number shall be used on nameplates, shipping records and instruction books as applicable.

6.7 Revisions - In specification revisions and superseding amendments an asterisk "*" preceding a paragraph number denotes paragraphs in which changes have been made from the previous issue. This has been done as a convenience only and the government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the asterisk notations and relationship to the last previous issue.

6.8 Associated Equipment - The equipment shall operate with the following associated equipment with the interfaces specified herein.

<u>Unit</u>	<u>Type</u>
Remote Compass Transmitter	ML- 1
Data Analysis Programming Group	AN/AYA-8
Central Servo Repeater	AN-4923/A
Doppler Radar	AN/APN-187
Altimeter	WW-21/A
Flight Direction System	AN/AJN-15
Aircraft Power Sources	MIL-STD-704

6.9 Definitions -

6.9.1 CEP - CEP is defined as the circle of a radius which includes 50 percent of the points representing the position error indicated by a large number of navigation systems, where each system is used many times over courses in which bearings and distances have been randomly chosen. If the CEP of the system design has been specified as A nautical miles per hour, we can further infer that 39.35 percent of the positional error points will fall within a circle of radius 0.85A, that 86.47 percent of the positional error points will fall within a circle of radius 1.70A, and that 98.89 percent of the positional error points will fall within a circle of radius 2.55A, when a large number of systems are tested as specified above.

6.9.1 (Continued)

$$\text{CEP Rate} = 1.774 \sqrt{\frac{\sum_{i=1}^N \left(\frac{X_i}{t_i} \right)^2 + \left(\frac{Y_i}{t_i} \right)^2}{2N}}$$

Where X_i, Y_i = East-West and North-South position errors
 t_i = Δt from t_0 to the i^{th} fix
 t_0 = Time at which the navigation mode is initiated

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Table I

System Outputs vs Mode of Operation

Output Function	Inertial Mode	Slave Mode	Free Mode	Compass Mode
Present Latitude (Visual)	Yes	No	No	No
Present Longitude (Visual)	Yes	No	No	No
Digital Velocity (North-South)	Yes	No	No	No
Digital Velocity (East-West)	Yes	No	No	No
Roll Angle (Synchro)	Yes	Yes	Yes	No
Pitch Angle (Synchro)	Yes	Yes	Yes	No
True Heading (Digital)	Yes	No	No	No
True Heading (Synchro)	Yes	Yes Note 1	No	Yes Note 2
Magnetic Heading (Synchro)	Yes (Stabilized)	Yes (Stabilized)	No	Yes (Unstabilized)
Clutched Heading (Synchro)	Yes (True Heading)	Yes (Magnetic Heading)	Yes (Non Slewed Grid Heading)	No
Magnetic Variation (Synchro)	Yes	No	No	No
Attitude Unavailable (Electrical)	Yes	Yes	Yes	Yes
System Fail (Visual)	Yes	Yes	Yes	Yes
Mode Advisory (Electrical)	Yes	No	No	No
Mode Advisory (Visual)	Yes	Yes	Yes	Yes
Damping Decoupled Advisory (Electrical)	Yes	No	No	No
Damping Decoupled Advisory (Visual)	Yes	No	No	No
Sleable Grid Heading (Synchro)	No	No	Yes	No
Alignment Complete Advisory (Visual)	Yes	Yes	Yes	Yes

Notes

1. Stabilized magnetic heading plus handset magnetic variation.
2. Unstabilized magnetic heading plus handset magnetic variation.

Table II
Roll and Pitch Attitude Accuracy

Mode	Roll CX No. 1 Pitch CX No. 1		Roll CX No. 2 Pitch CX No. 2	
	$\theta < 45 \text{ DEG}$	$\theta > 45 \text{ DEG}$	$\theta < 45 \text{ DEG}$	$\theta > 45 \text{ DEG}$
Inertial	± 9	± 9	± 24	± 36
Slave	± 18	± 18	± 30	± 36
Free	± 18	± 18	± 30	± 36

Notes

1. All values in arc MIN
2. θ : Respective roll or pitch angle
3. Pitch angle maximum range shall be $\pm 80 \text{ DEG}$.

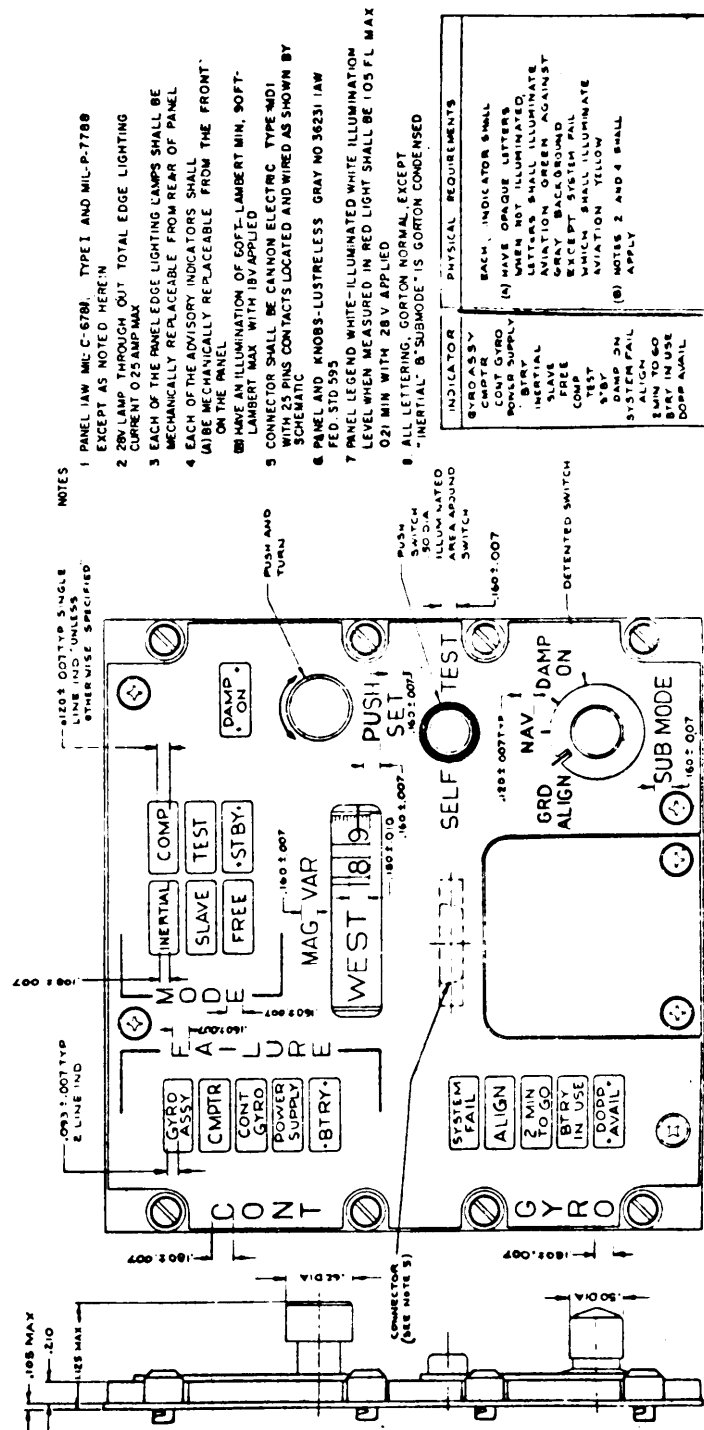
Table III

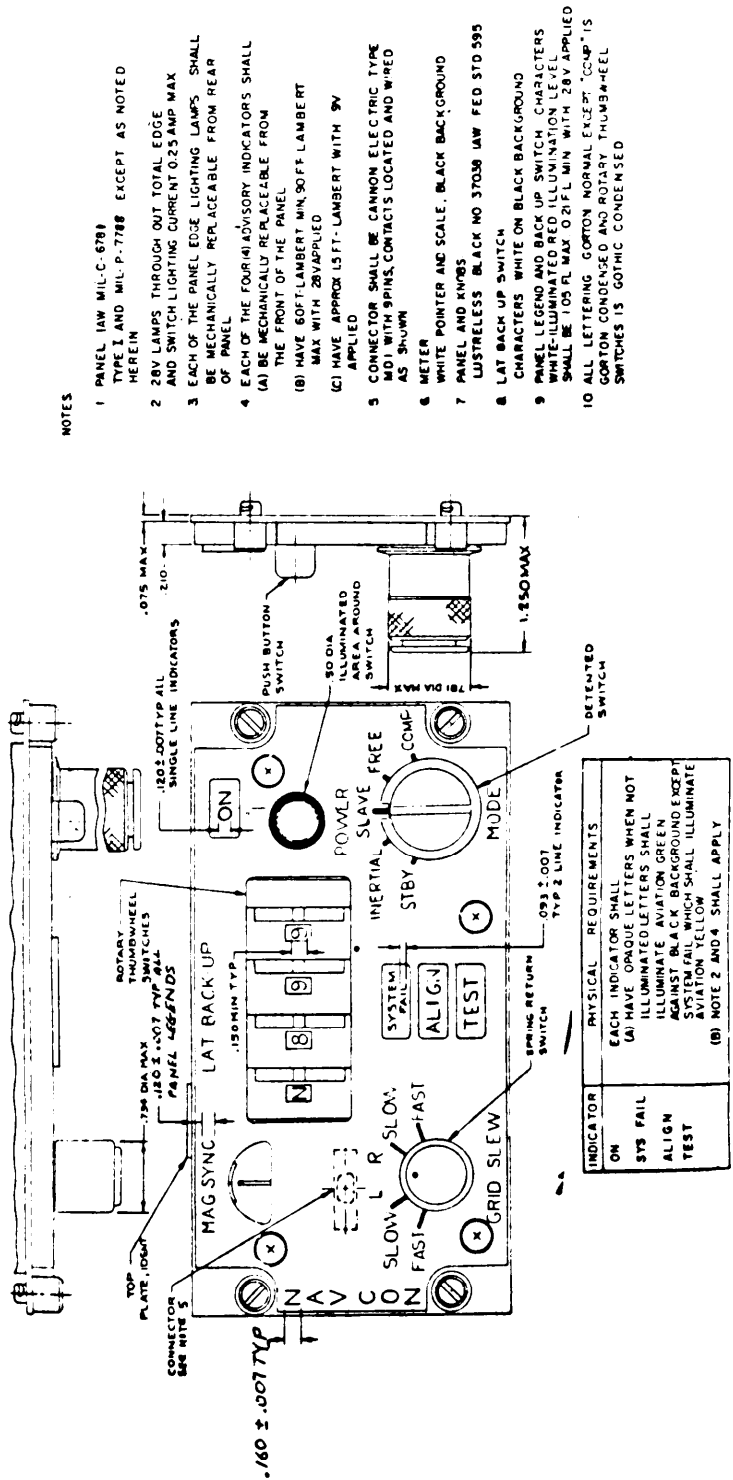
Synchro Output Characteristics

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Synchro Characteristic (or equivalent)	Roll CX 1	Roll CX 2	Pitch CX 1	Pitch CX 2	Magnetic Heading CX	Inertial Heading CX	Magnetic Variation CX	Magnetic Heading Plus Magnetic Variation CX
1. Synchro Type (or equivalent)	CZ0666006-1	CZ06210046	CZ0666006-1	CZ06210043	CM41014034	CM41014034	CM41014034	CM41014034
2. Load	2-500 ohm CT's (Z _{SO})	2-500 ohm CT's (Z _{SO})	2-500 ohm CT's (Z _{SO})	2-500 ohm CT's (Z _{SO})	4-500 ohm CT's (Z _{SO})	4-500 ohm CT's (Z _{SO})	1-500 ohm CT (Z _{SO})	4-500 ohm CT's (Z _{SO})
3. Synchro Source Impedance (Z _{SS} Nominal)	66.5 + j15.1 ohms	160 + j34 ohms	66.5 + j15.1 ohms	161 + j34.5 ohms	14.2 + j3 ohms	14.2 + j3 ohms	14.2 + j3 ohms	14.2 + j3 ohms
4. Transformation Ratio (Nominal)	0.404 V/V (L) 0.454 V/V (U)	0.396 V/V (L) 0.528 V/V (U)	0.404 V/V (L) 0.454 V/V (U)	0.404 V/V (L) 0.528 V/V (U)	0.319 V/V (L) 0.454 V/V (U)	0.319 V/V (L) 0.454 V/V (U)	0.422 V/V (L) 0.454 V/V (U)	0.319 V/V (L) 0.454 V/V (U)
5. Electrical Scale Factor (Nominal)	183 MV/DEG (L) 206 MV/DEG (U)	179 MV/DEG (L) 240 MV/DEG (U)	183 MV/DEG (L) 206 MV/DEG (U)	183 MV/DEG (L) 240 MV/DEG (U)	145 MV/DEG (L) 206 MV/DEG (U)	145 MV/DEG (L) 206 MV/DEG (U)	191 MV/DEG (L) 206 MV/DEG (U)	145 MV/DEG (L) 206 MV/DEG (U)
6. Phase Shift (Lead)	20 DEG (L) 8 DEG (U)	50 DEG (L) 18 DEG (U)	20 DEG (L) 8 DEG (U)	50 DEG (L) 18 DEG (U)	35 DEG (L) 8.5 DEG (U)	35 DEG (L) 8.5 DEG (U)	18 DEG (L) 8.5 DEG (U)	35 DEG (L) 8.5 DEG (U)
7. Output Voltage (Nominal)	10.5 (L) 11.8 (U)	10.3 (L) 13.7 (U)	10.5 (L) 11.8 (U)	10.5 (L) 13.7 (U)	8.3 (L) 11.8 (U)	8.3 (L) 11.8 (U)	10.95 (L) 11.8 (U)	8.3 (L) 11.8 (U)
8. Electrical Zero	180 DEG Roll Angle	180 DEG Roll Angle	180 DEG Roll Angle	180 DEG Pitch Angle	Zero Mag Hdg Angle	Zero True Hdg Angle	Zero Mag. Var Angle	Zero : Mag Var plus Mag Hdg
9. Synchro Connections Unit	Gyro Assy	Gyro Assy	Gyro Assy	Gyro Assy	Gyro Assy Control	Gyro Assy Control	Gyro Assy Control	Gyro Assy Control
Connector X } Y } PINS Z }	J2 49 50 51	J2 40 41 42	J2 43 44 45	J2 46 47 48	J1 T S U	J1 L K M	J1 z y PP	J1 L K M
10. Output Function verses Mode								
Inertial								
Slave	Roll Angle	Roll Angle	Pitch Angle	Pitch Angle	Stab Mag Hdg	True Hdg	Mag Var	Not Provided
Free					Stab Mag Hdg			
Compass	Do Not Use	Do Not Use	Do Not Use	Do Not Use	Grid Hdg. (slewable) Un-Stab Mag. Hdg	Not Provided	Do Not USE	Stab, Mag. Hdg. and Manual Mag. Var. Grid Hdg. and Manual Mag. Var. (Do Not Use) Un-Stab Mag. Hdg. and Manual Mag. Var.

Note: Loaded Characteristics (L)
Unloaded Characteristics (U)





NOTES

- 1 PANEL IAW MIL-C-6789 TYPE I AND MIL-P-7788 EXCEPT AS NOTED HEREIN
- 2 28V LAMPS THROUGH OUT TOTAL EDGE AND SWITCH LIGHTING CURRENT 0.25 AMP MAX
- 3 EACH OF THE PANEL EDGE LIGHTING LAMPS SHALL BE MECHANICALLY REPLACEABLE FROM REAR OF PANEL
- 4 EACH OF THE FOUR ADVISORY INDICATORS SHALL (A) BE MECHANICALLY REPLACEABLE FROM THE FRONT OF THE PANEL (B) HAVE 60 FT LAMBERT MIN, 90 FT LAMBERT MAX WITH 28V APPLIED (C) HAVE APPROX 15 FT LAMBERT WITH 28V APPLIED
- 5 CONNECTOR SHALL BE CANNON ELECTRIC TYPE MD1 WITH 9 PINS, CONTACTS LOCATED AND WIRED AS SHOWN
- 6 METER WHITE POINTER AND SCALE, BLACK BACKGROUND
- 7 PANEL AND KNOBS LUSTRELESS BLACK NO 37038 IAW FED STD 595
- 8 LAT BACK UP SWITCH CHARACTERS WHITE ON BLACK BACKGROUND
- 9 PANEL LEGEND AND BACK UP SWITCH CHARACTERS WHITE-ILLUMINATED RED ILLUMINATION LEVEL SHALL BE 105 FL MAX 0.2 FL MIN WITH 28V APPLIED
- 10 ALL LETTERING GORTON NORMAL EXCEPT "COM" IS GORTON CONDENSED AND ROTARY THUMBWHEEL SWITCHES IS GORTIC CONDENSED

FIGURE 2
PANEL, FRONT
CONTROL, NAVIGATION

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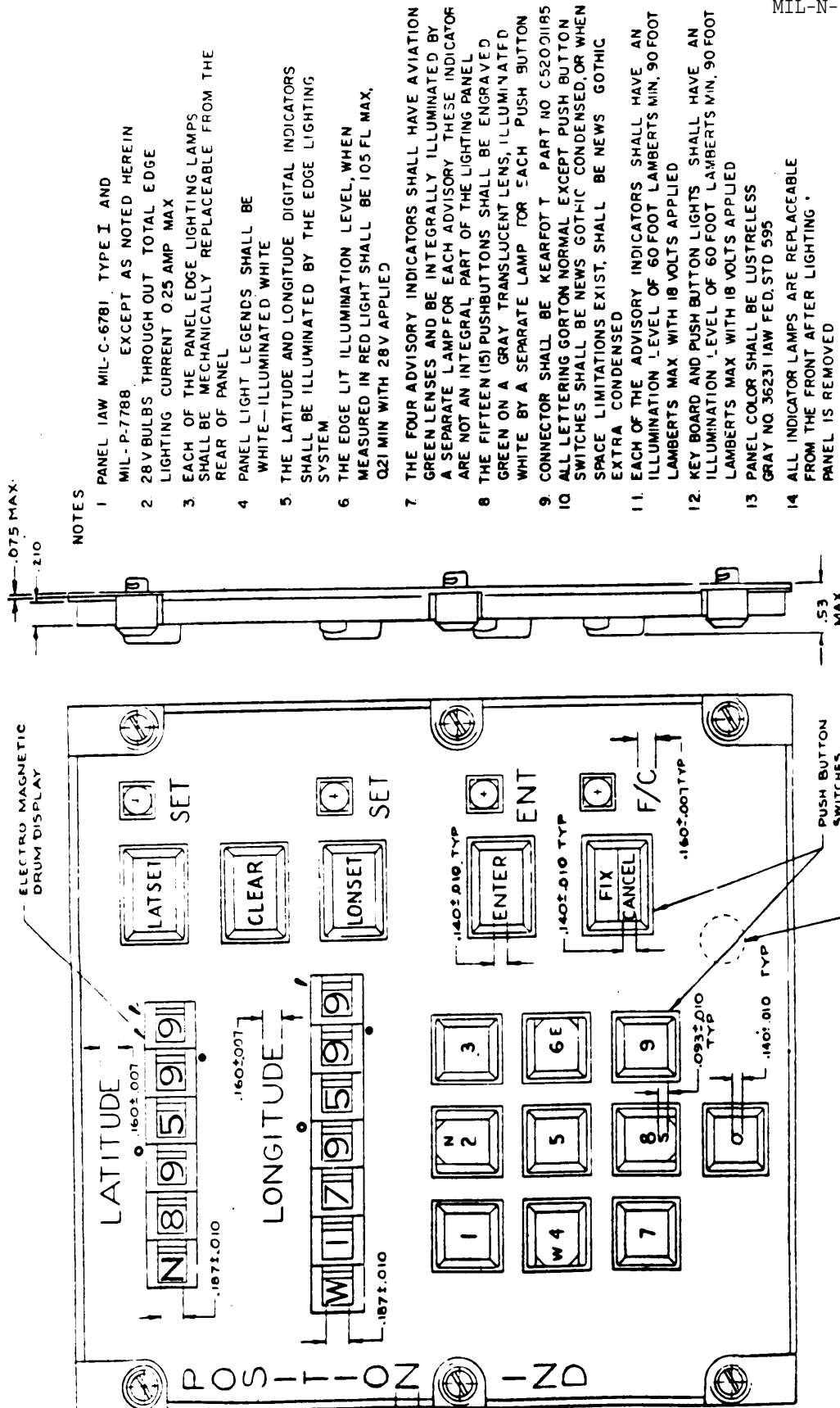
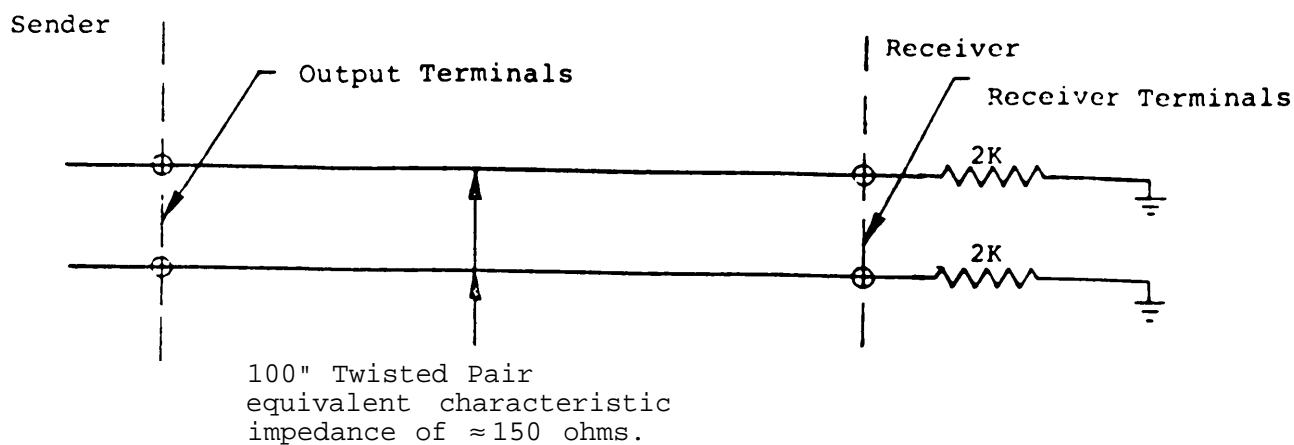


FIGURE 3

NOTES

- 1 PANEL IAW MIL-C-6781, TYPE I AND MIL-P-7788, EXCEPT AS NOTED HEREIN
- 2 28V BULBS THROUGH OUT TOTAL EDGE LIGHTING CURRENT 0.25 AMP MAX
- 3 EACH OF THE PANEL EDGE LIGHTING LAMPS SHALL BE MECHANICALLY REPLACEABLE FROM THE REAR OF PANEL
- 4 PANEL LIGHT LEGENDS SHALL BE WHITE-ILLUMINATED WHITE
- 5 THE LATITUDE AND LONGITUDE DIGITAL INDICATORS SHALL BE ILLUMINATED BY THE EDGE LIGHTING SYSTEM
- 6 THE EDGE LIT ILLUMINATION LEVEL, WHEN MEASURED IN RED LIGHT SHALL BE 105 FL MAX, 0.21 MIN WITH 28V APPLIED
- 7 THE FOUR ADVISORY INDICATORS SHALL HAVE AVIATION GREEN LENSES AND BE INTEGRALLY ILLUMINATED BY A SEPARATE LAMP FOR EACH ADVISORY THESE INDICATOR ARE NOT AN INTEGRAL PART OF THE LIGHTING PANEL
- 8 THE FIFTEEN (15) PUSHBUTTONS SHALL BE ENGRAVED GREEN ON A GRAY TRANSLUCENT LENS, ILLUMINATED WHITE BY A SEPARATE LAMP FOR EACH PUSH BUTTON
- 9 CONNECTOR SHALL BE KEARFOOT T PART NO C5203185
- 10 ALL LETTERING GORTON NORMAL EXCEPT PUSH BUTTON SWITCHES SHALL BE NEWS GOTHIC CONDENSED, OR WHEN SPACE LIMITATIONS EXIST, SHALL BE NEWS GOTHIC EXTRA CONDENSED
- 11 EACH OF THE ADVISORY INDICATORS SHALL HAVE AN ILLUMINATION LEVEL OF 60 FOOT LAMBERTS MIN, 90 FOOT LAMBERTS MAX WITH 18 VOLTS APPLIED
- 12 KEY BOARD AND PUSH BUTTON LIGHTS SHALL HAVE AN ILLUMINATION LEVEL OF 60 FOOT LAMBERTS MIN, 90 FOOT LAMBERTS MAX WITH 18 VOLTS APPLIED
- 13 PANEL COLOR SHALL BE LUSTRELESS GRAY NO 36231 IAW FED. STD 595
- 14 ALL INDICATOR LAMPS ARE REPLACEABLE FROM THE FRONT AFTER LIGHTING. PANEL IS REMOVED



With the above configuration the following performance will be maintained.

- (1) Voltage levels at output terminals will be:
 logic 1: $0 \pm 0.5V$
 logic 0: $+4 \pm 1V$
- (2) Threshold level of receiver, distinguishing the logic 1 from the logic 0 is $+1.5 \pm 0.5V$ at the receiver terminals.
- (3) The circuit will be capable of $\pm 5V$ common mode noise rejection.
- (4) Rise and fall times as measured from the 10 to 90 percent of full amplitude at the output terminals will not be greater than $1 \mu SEC$.
- (5) The maximum steady state current drawn from a line by the receiver will not exceed 3 MA.

Figure 4

Input/Output Circuit Characteristics
 (INS//Doppler and INS//Data Processing System)

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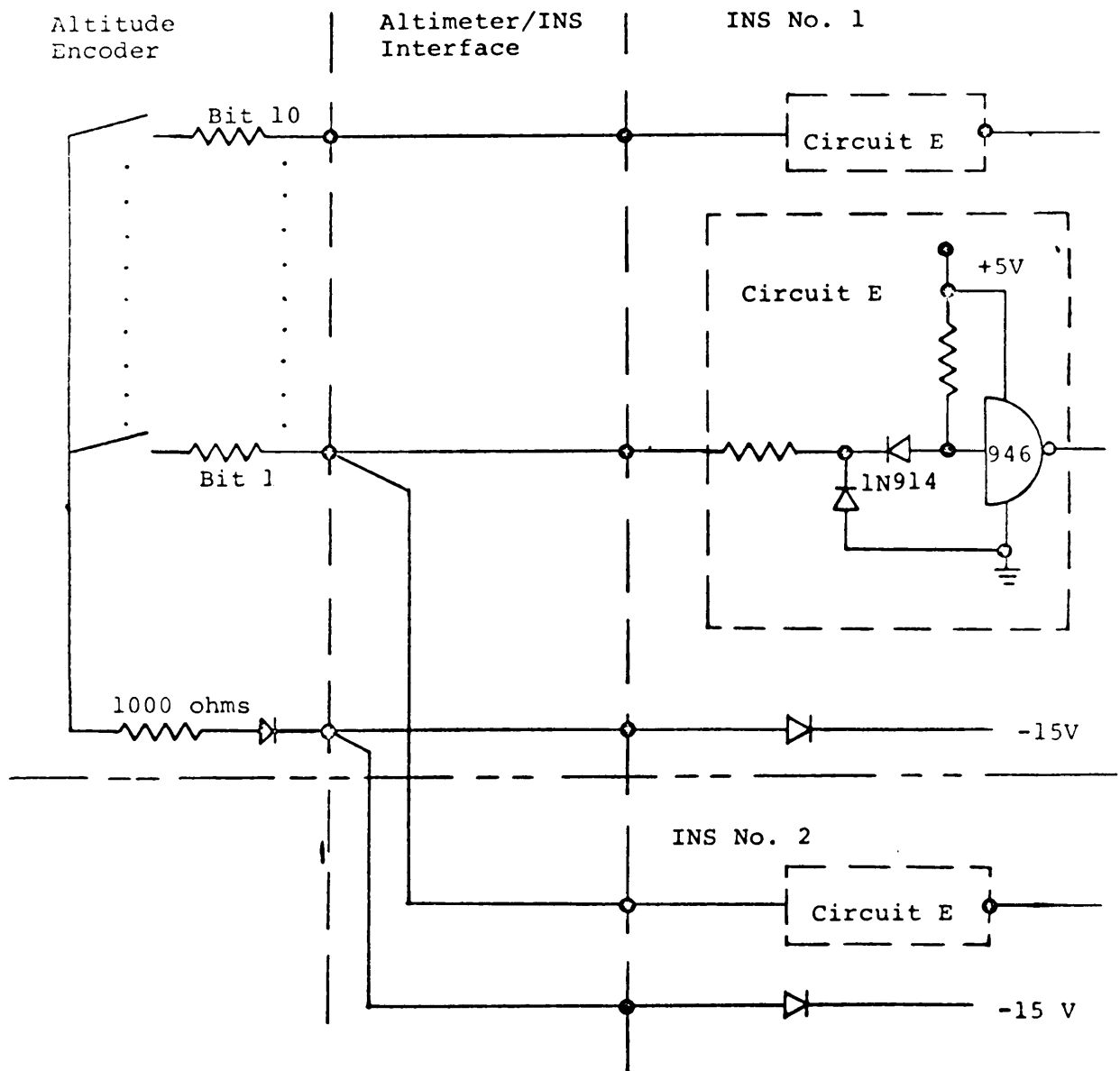


Figure 5

Input/Output Circuit Characteristics

SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004
INSTRUCTIONS		
<p>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 (as indicated on reverse hereof).</p>		
SPECIFICATION MIL-N-81497A(AS) NAVIGATION SET, INERTIAL AN/ASN-84		
ORGANIZATION (of submitter)		CITY AND STATE
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT \$
MATERIAL PROCURED UNDER A <input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> 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? <input type="checkbox"/> YES <input type="checkbox"/> 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

FOLD

DEPARTMENT OF THE NAVY

Naval Air Systems Command
Washington, D.C. 20360

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